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16. Abstract

Effective transportation planning for the 1,230-mile (1,980-km) long Texas-Mexico border must take into account not only the unique characteristics of a binational environment, but also the possible impacts of the North American Free Trade Agreement (NAFTA). Accordingly, this study developed two complementary concepts useful in such binational transportation planning: sector analysis and super-crossing. Sector analysis — a concept based on major traffic diversion areas — provides aggregated revenue and/or demand estimates that address regional (as against site-specific) transportation planning issues. The super-crossing concept, developed to address post-NAFTA commercial traffic, is based on Intermodal Surface Transportation Efficiency Act (ISTEA) guidelines intended to foster multi- and intermodal facilities. Both concepts are fully described in this report.

Additionally, border transportation planning and the implementation of sector analysis methodology require, in turn, assessments of traffic flow patterns and of post-NAFTA socioeconomic indicators. Thus, NAFTA socioeconomic impacts and origin and destination patterns are included as study objectives, both of which are fully documented in this report. The socioeconomic impact analysis was based on a maquiladora industry study prepared by the Institute for Manufacturing, Materials and Management (IM3) at The University of Texas at El Paso, and on a macroeconomic analysis of NAFTA impacts prepared by the LBJ School of Public Affairs at The University of Texas at Austin. Border-wide origin and destination patterns were based on a combination of available data and data collected specifically for this study.

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OVERVIEW OF THE TEXAS-MEXICO BORDER:

ASSESSMENT OF TRAFFIC FLOW PATTERNS

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Texas-Mexico Toll Bridge Study

conducted for the

Texas Department of Transportation
and the Texas Turnpike Authority

by the

CENTER FOR TRANSPORTATION RESEARCH
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February 1994

IMPLEMENTATION STATEMENT

This report describes the development of new concepts in binational entry systems analysis and provision, namely, sector analysis and the super-crossing concept. The former was implemented in this project to obtain the findings that will be documented in forthcoming reports (this implementation is only partly described in this report). Assessments of NAFTA impacts and of transborder traffic flow patterns are also provided. These assessments, similar to those required in most transportation planning studies, can be used specifically to predict future transportation needs along the border.

Prepared in cooperation with the Texas Department of Transportation and the Texas Turnpike Authority.

DISCLAIMERS

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SUMMARY

Effective transportation planning for the 1,230-mile (1,980-km) long Texas-Mexico border must take into account not only the unique characteristics of a binational environment, but also the possible impacts of the North American Free Trade Agreement (NAFTA). Accordingly, this study developed two complementary concepts useful in such binational transportation planning: sector analysis and super-crossing. Sector analysis — a concept based on major traffic diversion areas — provides aggregated revenue and/or demand estimates that address regional (as against site-specific) transportation planning issues. The super-crossing concept, developed to address post-NAFTA commercial traffic, is based on Intermodal Surface Transportation Efficiency Act (ISTEA) guidelines intended to foster multi- and intermodal facilities. Both concepts are fully described in this report.

Additionally, border transportation planning and the implementation of sector analysis methodology require, in turn, assessments of traffic flow patterns and of post-NAFTA socioeconomic indicators. Thus, NAFTA socioeconomic impacts and origin and destination patterns are included as study objectives, both of which are fully documented in this report. The socioeconomic impact analysis was based on a maquiladora industry study prepared by the Institute for Manufacturing, Materials and Management (IM3) at The University of Texas at El Paso, and on a macroeconomic analysis of NAFTA impacts prepared by the LBJ School of Public Affairs at The University of Texas at Austin. Border-wide origin and destination patterns were based on a combination of available data and data collected specifically for this study.

CHAPTER 1. INTRODUCTION

BACKGROUND

Investing in the infrastructure of the Texas-Mexico border could, proponents argue, enhance transportation efficiency and, at the same time, attract or retain the lucrative revenues associated with international border crossing mechanisms. However, such investment decisions require precise traffic pattern data, as well as a method for assessing the potential demand for (and financial viability of) additional toll bridges along the Texas-Mexico border.

In this project, undertaken in cooperation with the Texas Department of Transportation (TxDOT) and the Texas Turnpike Authority (TTA), we analyzed the border transportation infrastructure, developed a binational data base that includes traffic and socioeconomic data, and assessed the potential need for and financial viability of additional toll bridges along the Texas-Mexico border. A particular feature of this study is its use of an aggregated research approach, one in which individual sites are grouped into specific sectors. Such an approach — referred to here as the *sector analysis concept* — overcomes the obstacles inherent in predicting the potential demand at any new proposed binational entry system along the border, and allows planners to address the Texas-Mexico border area from a binational transportation planning perspective. The sector analysis concept is complemented by the super-crossing concept developed in this study to address long-haul transportation needs.

REPORT OBJECTIVES

This report assesses traffic flow patterns (based on the origin and destination study conducted under this project) and discusses the possible macroeconomic impacts of the North American Free Trade Agreement (NAFTA). Additionally, the report proposes ways in which to improve both traffic conditions and long-term binational transportation planning. Overall, this report lays the groundwork for identifying the potential need for new binational entry systems along the Texas-Mexico border.

REPORT ORGANIZATION

This report is divided into seven chapters and two appendices. Chapter 1, the introduction, describes the report objectives and scope. The development of the sector analysis concept is discussed in Chapter 2, along with approaches for its implementation at the Texas-Mexico border. (This sector analysis concept addresses primarily local traffic, which currently accounts for about 90 percent of all traffic.) The super-crossing concept is discussed in Chapter 3.

Chapter 4 analyzes the possible impacts of NAFTA on the border economy, first from a macroeconomics point of view, and then specifically from the point of view of the maquiladora industry. Chapter 5 reviews all recent origin and destination studies undertaken at the Texas-Mexico border. This chapter also describes the origin and destination surveys undertaken in this study to supplement the information obtained from the literature.

Economic indicators and traffic flow patterns form the basis for the first application of the sector concept described in Chapter 2. Accordingly, data from the previous chapters are utilized in Chapter 6 to identify the sector boundaries. (These sectors are used as the basis for the capacity and revenue analyses provided in subsequent project reports.) Finally, Chapter 7 presents the conclusions and makes recommendations for future studies.

ANALYSIS APPROACH

Overall Study Approach

The proper functioning of a toll bridge depends on its own traffic processing capability, as well as on the availability of infrastructure links and on the demand and capacity of neighboring binational entry systems. The overall capacity of the border on a macro level depends on how well these "micro" systems meet the local demand and interact with one another. However, the literature on traffic demand and revenue predictions on the Texas-Mexico border is almost entirely dedicated to the investigation of individual sites for local purposes. This site-specific approach cannot address the more general transportation planning problems associated with the border area. Moreover, the fact that a new vehicular bridge can pay for itself in a relatively short period does not necessarily mean that the provision of this bridge is the best solution for the transportation needs of that area. Thus, because one of the objectives of this study is to provide guidelines for assessing the potential need for and feasibility of new binational entry systems along the *entire* Texas-Mexico border, we developed a more holistic approach — one that does not tie demand forecasts to specific sites. The feasibility evaluation presented in this report can assist in determining whether a project ought to be pursued further (i.e., whether planners should perform more detailed and costly site-specific studies, including, for example, a toll bridge revenue forecast). This approach represents an aggregated analysis that can work in conjunction with traditional transportation planning techniques.

Approach for Assessing Traffic Patterns and Determining Sector Boundaries

The sector analysis concept was specifically developed in this study to meet the objectives discussed above. It was developed to work in tandem with traditional transportation planning techniques (such as trip assignment and direct-demand assessment), and its practical application requires availability of origin and destination patterns and other indicators of traffic demand (e.g., socioeconomic variables). This analysis approach reflects the report objectives described above, which include providing an origin and destination assessment, macroeconomic and industrial analyses, and a demand and revenue analysis.

CHAPTER 2. THE SECTOR ANALYSIS CONCEPT

INTRODUCTION

The sector analysis concept was developed as an analysis methodology capable of estimating both traffic demand and revenue for use in regional transportation planning. This concept was designed to work in conjunction with traditional trip assignment methods used in traffic demand estimates. This chapter explains the sector concept by describing the main phases of a comprehensive transportation planning process (including trip assignment models).

BACKGROUND

The transportation planning process consists of three basic phases: data collection, analysis and forecasting, and trip generation, distribution, and assignment. These phases are summarized in Figure 2.1, which depicts their interrelationships and their chronological order.

Because traffic demand depends on socioeconomic characteristics and on land use, it can be estimated as a function of such variables. Thus the data collection phase of transportation planning includes a review of (1) the performance history of relevant socioeconomic indicators, (2) land use, (3) traffic demand, and (4) the present and future inventory of transportation facilities (in addition to origin and destination data). The top row in Figure 2.1 represents the data collection phase.

Once sufficient data are collected, the socioeconomic and land use forecasts can be made. Next, origin and destination data and the inventory of transportation facilities are used in conjunction with the forecasts and other data to obtain trip generation and to define the network to be used in the trip assignment model. Trip generation predicts the number of trips generated in each zone of the study area as a function of socioeconomic variables and land use; such prediction requires extensive studies of real estate development in the areas of interest, as well as data disaggregated by zone whenever possible.

The next step assesses trip distribution, which predicts the percentage of trips originating in one zone and ending in another. A widely used trip distribution model is the gravity model, which basically assumes that trips generated in zone "i" are attracted to zone "j" in proportion to the sizes of population and in inverse proportion to some power of the travel impedance between zones (Ref 11). The model is shown in Equation 2.1.

Careful interpretation of the origin and destination data is paramount for accurate choice of the variables that represent "Aj," or the measurement of the trip attraction force of zone "j." For example, "Aj" can be the employment rates in zone "j" for work trips, but not for school or shopping trips. Variable "Dij" depends on Texas-Mexico border travel behavior characteristics that are very complex and not well understood at present. When the criteria for quantifying "Dij" are dubious, trips estimations should be made by expanding the origin and destination matrices based on hourly traffic data.

$$t_{ij} = P_i \frac{A_j / (D_{ij})^x}{\sum_{j=1}^{n} (\frac{A_j}{D_{ij}^x})} \quad (2.1)$$

where:

t_{ij} = trips from zone "i" to zone "j,"

P_i = total trips originating in zone "i,"

Aj = measurement of the trip attraction force of zone "j,"

Dij = measurement of the impedance between zones "i" and "j," and

x = travel impedance exponent.

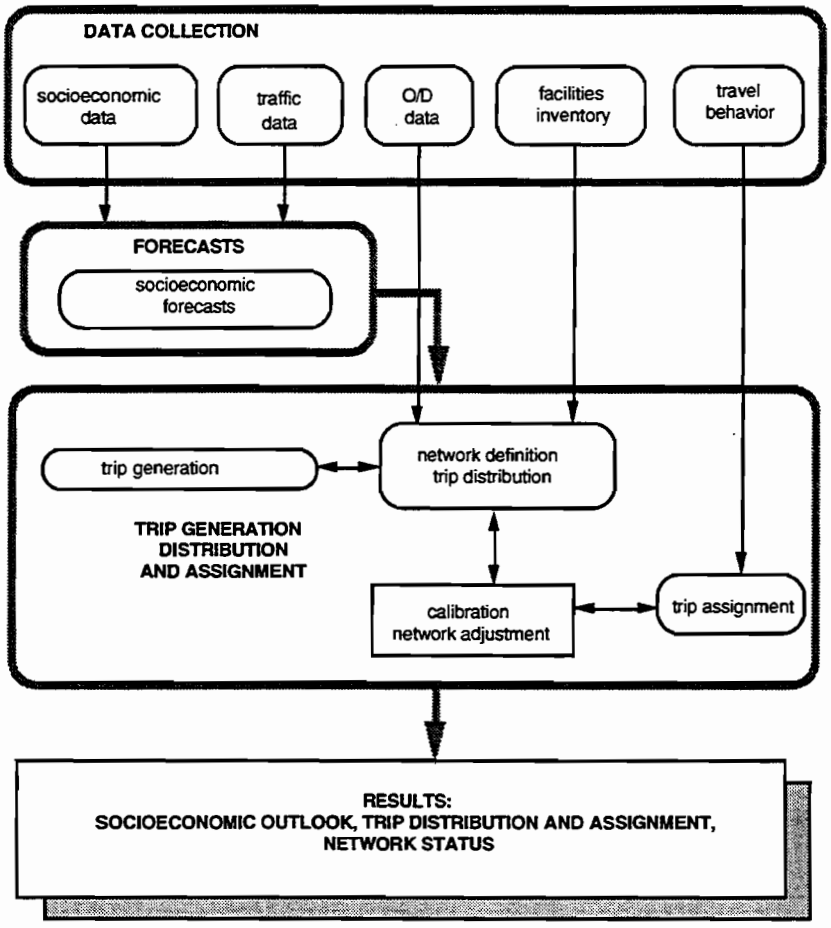

Figure 2.1. Major phases of a transportation planning process (Refs 11, 24)

Once the number of trips from each zone "i" to each zone "j" is estimated, trips can be allocated to each major network link using a trip assignment model. This model consists of an algorithm to assign trips between each pair of origins "i" and destinations "j" to the path of minimum impedance between the pair of zones. The impedances assigned to each link in each path must represent the choices made by the users of the network, and their quantification requires knowledge of travel behaviors in the study area. While for typical urban and metropolitan settings there are useful criteria for assigning link impedances (or penalties), comparatively less quantitative information is available on the travel behavior associated with the Texas-Mexico border.

The potential demand at any vehicular binational entry system can be estimated using a trip assignment model to provide the type of results depicted in Figure 2.2. In this figure, sister cities are traffic generating and attracting zones, and are identified by centroids US1 and M1. The other zones are identified by the other centroids in Mexico (M) and in the United States (US). Since a trip assignment model assigns trips based on path impedance and considers every path through every nearby binational entry system, traffic demand estimates at a particular bridge must take into account the effect of all facilities competing for the same demand, as shown in Figure 2.2. The sector analysis concept takes into account the technical foundation of trip assignment methods and redefines the results in terms of a demand range that is not associated with specific sites.

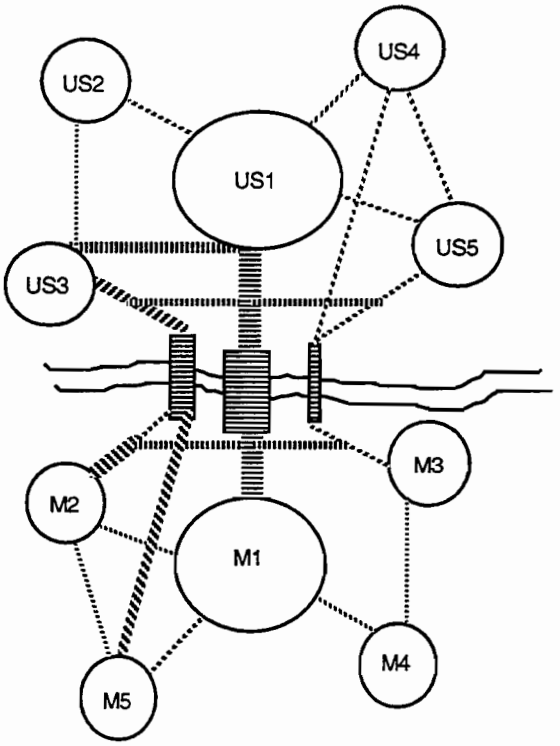

Figure 2.2. Generic results of trip assignment models

Sectors are defined based on major traffic diversion areas, which in turn depend on the socioeconomic indicators of the areas spanned by major origin and destination zones. The area of economic activity that can generate and/or attract traffic was termed "economic activity center." This concept is discussed in the next section.

CONCEPT OF ECONOMIC ACTIVITY CENTER

As previously discussed, traffic demand is a function of socioeconomic indicators, which are the same for certain areas of economic activity and demographic concentration. Areas having the same range of socioeconomic indicators (e.g., population, retail sales, employment by industry, and maquiladora activity) were termed *economic activity centers*; they can also be regarded as *traffic generating areas*.

An economic activity center may encompass both sides of the border, or one side only. Activity centers encompassing both sides of the border were termed *transborder activity centers*. They usually consist of the sphere of influence of sister cities (e.g., Brownsville and Matamoros), and they may or may not be part of major corridors. Transborder activity centers are conceptually depicted in Figure 2.3.

In some cases, economic activity centers can be identified on only one side of the border. These are termed *local activity centers*. A good example of a local economic activity center is Rio Bravo, a Mexican city located between Nuevo Progreso and Reynosa in the state of Tamaulipas. The nearest Texas cities are Progreso to the east and Hidalgo to the west. The nearest crossing is the Progreso-Nuevo Progreso Bridge. Although the Texas area immediately adjacent to Rio Bravo is scarcely populated, Rio Bravo itself has significant traffic-generating capability. A local activity center is conceptually shown in the right-hand side of Figure 2.3.

THE SECTOR CONCEPT

Definition

Because border bridges serve traffic demand, they are naturally located within economic activity centers (which is to say, a site far from any economic activity center would attract very little traffic). As this hypothetical site approaches the boundaries of an economic activity center, the traffic demand increases until it reaches either the peak traffic volume the binational entry system can process, or the maximum demand it can divert from nearby bridges. Within the economic activity center, each specific site has its own individual capability to attract traffic (within a certain range) and can be represented by an "average" potential demand anywhere within a certain subset of the economic activity center, which is termed *sector*. Sector is thus defined as the sphere of influence of an economic activity center where the potential demand of any transportation artery will fall within a certain range of traffic volumes (or within a certain interval whose extremes have no elasticity with respect to specific site location).

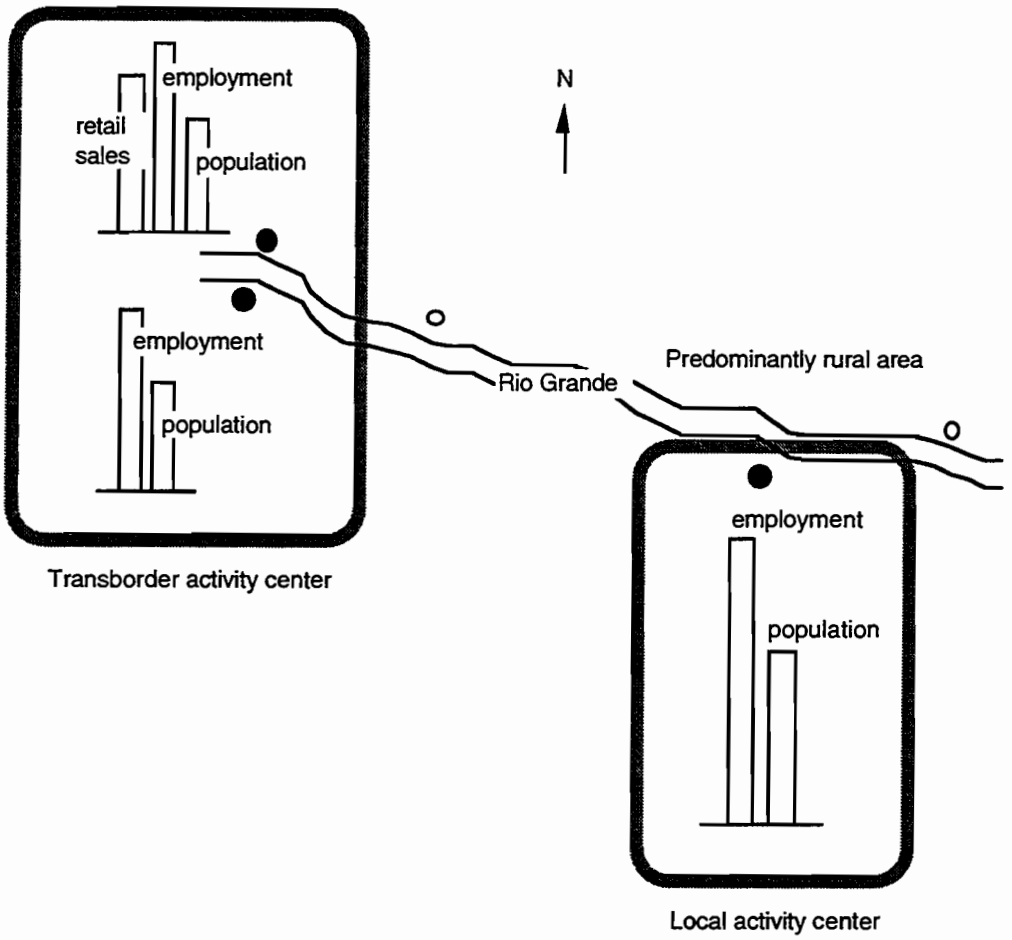

Figure 2.3. Conceptual identification of transborder and local activity centers

And since revenues are a direct function of traffic, sector can be defined in terms of revenue as the sphere of influence of an economic activity center where the potential *revenue* of any new toll transportation artery falls within a certain interval whose extremes have no elasticity with respect to specific site location.

A sector is conceptually depicted in Figure 2.4. In this figure, a hypothetical segment of the Rio Grande has three major economic activity centers with different levels of population, economic activity, and traffic demand schematically represented by bar charts. The areas in between are assumed to be rural areas having little traffic-generating capabilities. The traffic demand at each individual bridge is represented by horizontal lines.

The first primary sector is AB. In sector AB, the only existing bridge has the demand represented by dotted line AA_1, which is also the demand for the sector. If another bridge is proposed somewhere in this sector, say in A_1B, it will attract at least the traffic represented by the dotted line A_1B, and traffic at the first bridge will drop to the level represented by solid line $A'A_1$. The range of traffic demand for one out of two bridges in this sector goes from solid line

$A'A_1$ to dotted line A_1B, and the "average" demand is represented by heavy line AB. As one departs B heading toward C, less and less traffic is willing to divert, and the potential demand for a hypothetical site between B and C gradually decreases, until it reaches a minimum that may or may not be equal to zero. This type of area is termed "secondary sector." As one approaches point C, more and more traffic is willing to divert to the new site, and the potential revenue starts to increase until it reaches the plateau represented by heavy line CD. Sector CD has two existing and one proposed bridge. Demand for the two existing bridges is represented by dotted lines CC_1 and C_1D_1. If a new bridge is open in this sector, some of the traffic from CC_1 and C_1D_1 will divert to it, and the new demands are represented by solid lines $C'C'_1$ and $C'_1D'_1$. The "average" demand for each of the three bridges is represented by solid line CD. Sector EF represents a sector without any proposed bridge.

Average traffic demand at any sector depends on the number of binational entry systems in the particular sector. Average demand by sector indicates the overall potential demand, while the interval limits suggest the maximum and minimum potential demand at a generic new site within any specific sector.

SECTOR ANALYSIS BY MODE AND VEHICLE TYPE

Problem Definition

Total traffic demand is a summation of the individual demands for each vehicle type over all vehicle types. For example, let a particular binational entry system "i" be a vehicular bridge with pedestrian traffic, and let each mode or vehicle type be indicated by an index "v," varying from 1 to "m," where, for example, v=1 for pedestrians, v=2 for cars, and so on. The total demand in a particular period is indicated in Equation 2.2.

$$D_i(P) = \sum_{v=1}^{m} d_v \qquad (2.2)$$

where:

$D_i(P)$ = total demand at binational entry system i during period P,

v = 1,2.....m = modes and/or vehicle types at crossing i,

m = total number of modes and/or vehicle types, and

d_v = demand for vehicle/mode "v" during period P.

According to the definition of sector (Fig 2.4), there is an area with no elasticity of the extremes of the traffic demand interval with respect to site location. A traffic diversion assessment can determine how far from existing facilities the traffic is willing to divert to a new site and still be within the interval of interest. This varies with mode, with perhaps the most

obvious example being cars versus pedestrians. The sector with no elasticity for traffic demand range of a car trip is considerably larger than that for a pedestrian trip. Strictly speaking, in each economic activity center there are as many sector lengths as modes and vehicle types. Consequently, the sector length will strictly depend on the transportation mode and, within mode, on the vehicle type.

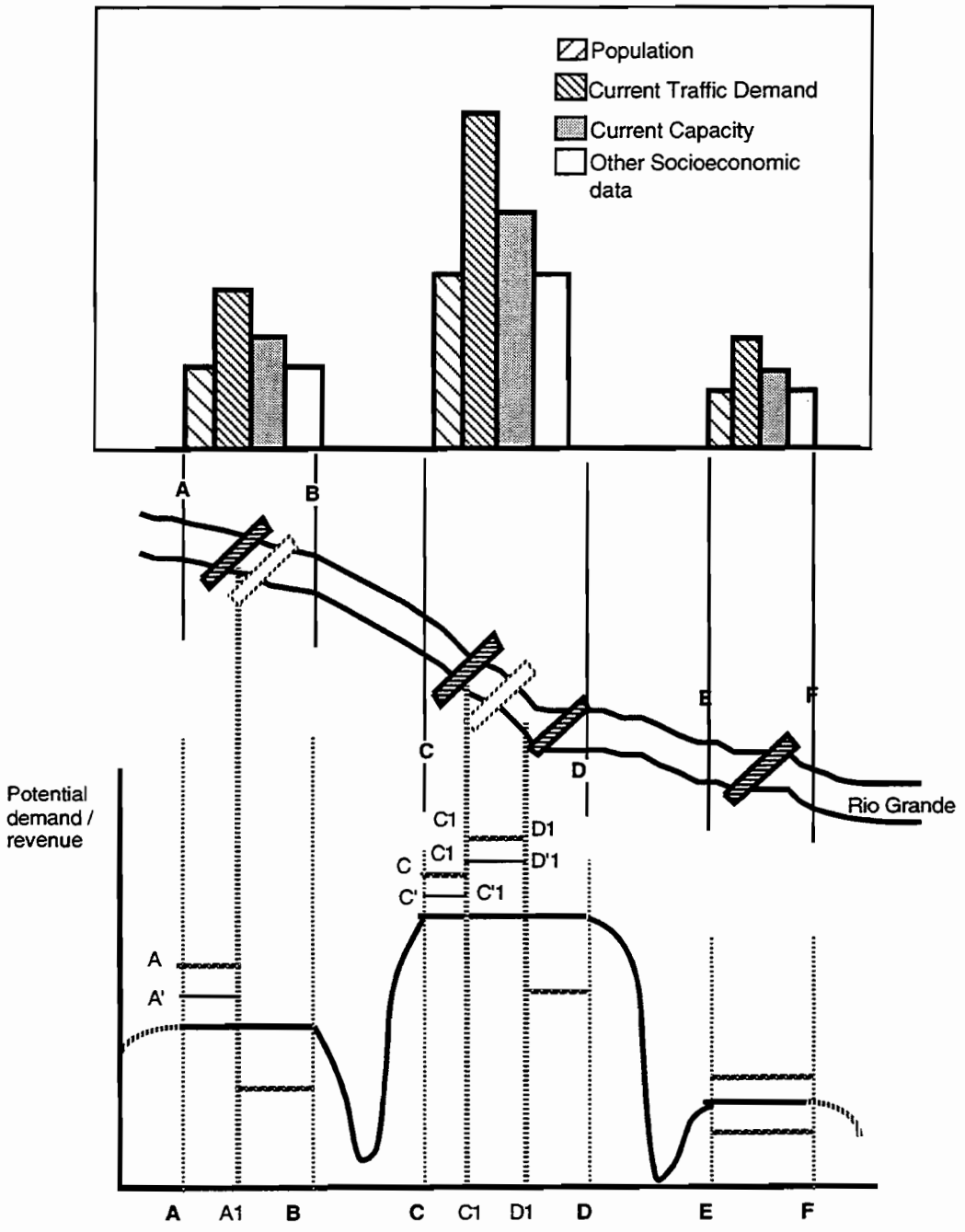

Figure 2.4. Sector concept

One possible approach to simplifying this problem is to consider the impacts of each mode/vehicle type on the revenues of existing sites within an economic activity center, and choose the sector boundaries based on the vehicles that have high impacts on the revenues, while taking into account the particular constraints within the economic activity center. The hypothetical case study described below will clarify this idea.

Case Study

Assume a hypothetical transborder activity center generated by neighboring sister cities on both sides of the border. There are three existing binational bridge entry systems, one of them linking the main downtown areas of these sister cities, and the other two on the outskirts of the economic activity center, one on the east and the other on the west. A new site in any downtown area is not feasible, owing to the unavailability of land on both sides of border. Figure 2.5 schematically shows the locations of the bridges within the economic activity center. Table 2.1 gives a hypothetical traffic distribution between bridges of an economic activity center.

Table 2.1. Traffic distribution at a hypothetical activity center

Bridge	**% of Each Mode/Vehicle at Each Bridge**				
Location	Pedestrians	Cars	Small trucks	Medium trucks	Large trucks
Downtown (1)	90	60	30	10	0
East outskirts (2)	2	10	50	60	70
West outskirts (3)	8	30	20	30	30
Total (all bridges)	100	100	100	100	100

Most pedestrians prefer the downtown area bridge. And since it is not feasible to build a new bridge in a downtown area, this hypothetical sector can be defined without taking pedestrian traffic into account. Table 2.1 also shows that while most cars prefer the downtown bridge, 75 percent of those who do not cross downtown do so at the west bridge, while the majority of trucks prefer the east bridge. Field trips to the area reveal that most customs brokers and warehouses are located on the east side. One can thus conclude that a new site on the east side will attract more truck traffic, while a new site on the west side will attract more auto traffic. Now assume that the overall distribution of vehicle types and the current toll schedule at the particular port of entry are according to Table 2.2.

If the total vehicular traffic during a particular period of interest is "T," then according to Equation 2.2 the revenue generated by each vehicle type at each bridge is given by Table 2.3.

According to Table 2.3, medium trucks have the greatest impact on the expected revenue, followed by large trucks. Thus the sector for this economic activity center should be defined in

terms of medium trucks. This sector encompasses the east side of the economic activity center. The sector is schematically depicted in Figure 2.5.

Table 2.2. Traffic distribution and toll schedules (all bridges)

Vehicle type/mode	% of Overall Traffic	Toll fares
Cars	50	$1.00
Small trucks	15	$4.00
Medium trucks	20	$6.00
Large trucks	5	$10.00

Table 2.3. Percent of revenue generated by each vehicle type

Bridge Location	Revenue from Each Vehicle Type at Economic Activity Center			
	Cars	Small trucks	Medium trucks	Large trucks
Downtown (1)	$0.30T	$0.18T	$0.60T	$0
East outskirts (2)	$0.05T	$0.30T	$0.72T	$0.35T
West outskirts (3)	$0.15T	$0.12T	$0.36T	$0.15T

This hypothetical example shows that the approach suggested above is likely to improve the accuracy of revenue estimates based on sector concept, while at the same time simplifying the procedure to determine such forecasts.

OTHER CRITERIA AND CONSTRAINTS FOR DETERMINING SECTORS

Iterative Determination of Sector Boundaries

Sectors are defined in terms of potential demand and/or revenue for an additional bridge. Accordingly, their specific boundaries depend on how far the traffic attracted by and generated at the economic activity center is willing to divert from existing bridges. Traffic demand at each existing and proposed bridge is estimated using trip assignment models, which in turn require preliminary sector boundaries to be defined before initial calibration of the model. This iterative procedure is depicted as a flowchart in Figure 2.6.

A preliminary analysis of traffic, origin and destination data, and qualitative information on traffic patterns is usually sufficient for determining initial sector boundaries. These boundaries are then used in the definition of the network and the zones for the trip assignment model. It is advisable to define these initial zones conservatively, because increases in sector size may require redefinition of the zones and the network for the model.

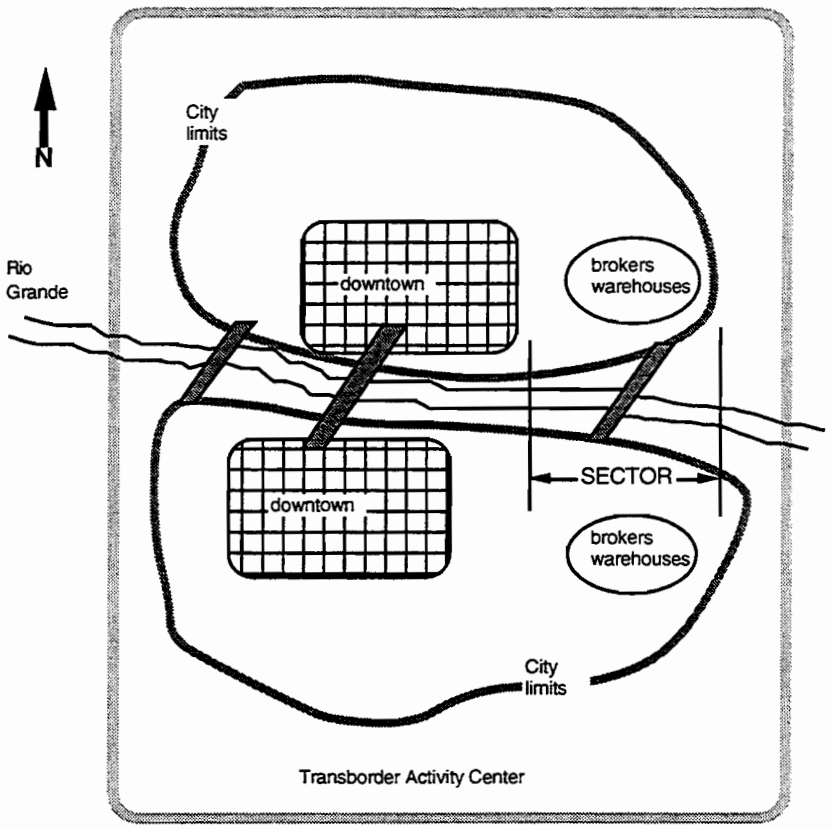

Figure 2.5. Sector analysis by vehicle type

Once the preliminary boundaries are determined, traffic diversion should be predicted within this area for various distances from the existing and proposed facilities. Final sector boundaries should ideally be located exactly where traffic diversion to the new location falls outside the lower boundary of interest. Owing to errors in random data sampling, it is advisable to stretch the boundaries a little further than the exact point where the model shows a decrease in demand. How far these boundaries stretch is determined case by case, based on the quality and amount of data available, and on the assumptions made to arrive at the traffic diversion forecasts. The final product, in any case, is a set of guidelines on the lower, upper, and average potential demand that can be expected at a new specific site anywhere within the sector.

The number of iterations required to arrive at final sector boundaries depends on the study objectives and on the sector characteristics. The boundaries of a sector located between two large rural areas are unlikely to change significantly with further iterations. On the other hand, the boundaries of a sector located within an area that comprises overlapping activity centers may change with further refinement, but only if very detailed origin and destination data are available. In the case of a border-wide transportation needs study, such level of detail is not technically required, and the definition of sector boundaries based on an assessment of socioeconomic, traffic and origin and destination data is enough for an accurate analysis.

Infrastructure Links to the Binational Entry Systems

Traffic diversion to a binational entry system is possible only if there are local links between the bridge and the main highway network. If links are scarce at any particular area of the economic activity center, that area has little potential to attract traffic and should lay outside the sector boundary. This requires careful study of area maps, as well as an awareness of any facilities under construction or to be constructed in the near future.

Sector within Overlapping Economic Activity Centers

There are several border sites distinguished by their dense populations and by adjacent economic centers (e.g., El Paso, Ciudad Juarez, and Fabens). Although two activity centers can be clearly defined, there is no significant rural area in between to separate them. Instead, there is an area in which the influence of both centers overlap. Existing binational entry systems are located either well within one sector, or well within the other. As shown in Figure 2.7, one possible preliminary definition of boundaries would be Sector 1, with traffic coming mostly from Economic Activity Center 1, and Sector 2, with traffic coming from Economic Activity Center 2. Owing to geographical proximity, however, some overlap of traffic from one sector into the other is inevitable. The situation shown in Figure 2.7 indicates that analyzing only Sector 1 and Sector 2 may not be sufficient, because of the possibility that the economic activity center overlap may in itself be another traffic demand area of significance. The best way to start the analysis in such cases is to define one sector with wider ranges of traffic demand, which encompasses the two main local corridors and their area of mutual diversion.

SUMMARY AND CONCLUSIONS

The sector analysis concept was developed to provide answers to questions pertaining to regional transportation planning, rather than to individual proposed sites. It works effectively in conjunction with trip assignment models because it is technically impossible to accurately predict traffic demand at a specific site without taking into account all other bridges within a certain area that generate traffic willing to use the new facility. Because of the uncertainties inherent to models using data from random samples, the sensitivity of the trip assignment model output with respect to specific site location is limited to a certain area. In this study, this area of sensitivity is termed *sector*. These sectors are always within economic activity centers — that is, areas that have approximately the same range of socioeconomic indicators and traffic generating capability. A sector can be practically defined as the sphere of influence of an economic activity center where any transportation artery will have approximately the same range of revenue capability.

The next chapter discusses a proposal for addressing deregulated commercial traffic, one that increases the overall efficiency of the border network while at the same time greatly reducing congestion in downtown areas of border cities.

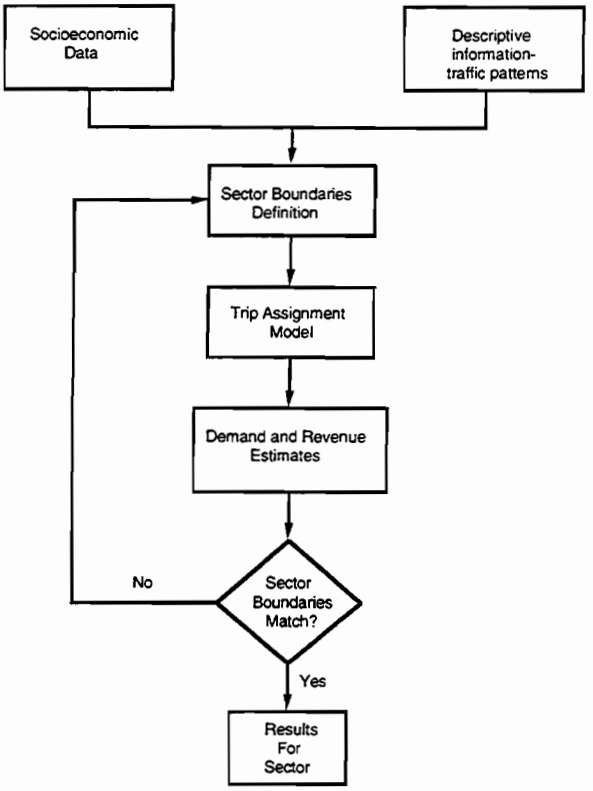

Figure 2.6. Iterative determination of sector boundaries

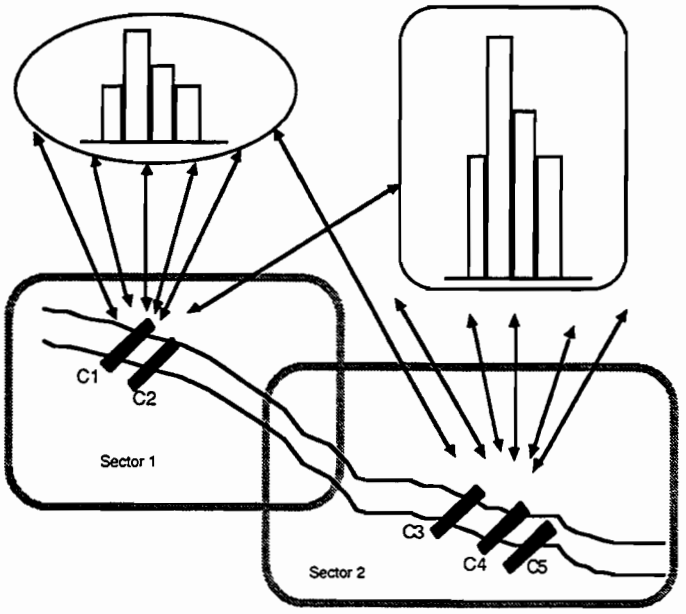

Figure 2.7. Sector overlap

CHAPTER 3. THE SUPER-CROSSING CONCEPT

INTRODUCTION

In a competitive world market, national living standards are directly related to production efficiency, with transportation being a key component. This being the case, we can observe that efforts to provide binational entry systems at the Texas-Mexico border have been constrained by operational modes that date back to the 19th century. This section discusses a proposal to increase border transportation efficiency by using an approach that addresses the complexities and the specific needs of transborder traffic, and takes into account the international market scenarios of the 21st century. A super-crossing would facilitate more rapid and efficient crossing, as compared with current practices, at a much reduced cost.

The sector analysis concept, discussed in the previous chapter, covers primarily local traffic, which accounts for about 90 percent of all transborder trips. However, the other 10 percent of the traffic is basically represented by the commercial flow between the two nations, and it is important that a modern solution also be developed to address this national interest. NAFTA's scheduled removal of current restrictions to foreign truck traffic will allow the implementation of more efficient facilities for commercial traffic. The super-crossing concept not only takes advantage of this new situation; it also reinforces the commitment to multi- and intermodal facilities fostered by the Intermodal Surface Transportation Efficiency Act (ISTEA).

BASIC CHARACTERISTICS OF A SUPER-CROSSING

A super-crossing addresses all present constraints to commercial traffic moving between the U.S. and Mexico; in addition, it takes advantage of the post-NAFTA liberalization of truck traffic to improve the overall efficiency of border-crossing operations and procedures. Finally, the concept addresses the needs of such agencies as U.S. and Mexican customs. These agencies have serious concerns about the possibility of increasing the number of binational entry systems beyond their staffing capabilities; they would prefer to concentrate their services at fewer locations, and to take greater advantage of state-of-the-art inspection equipment. A super-crossing optimizes all these needs, as discussed in the five characteristics listed below.

(1) *National and international service concepts.* A super-crossing would be planned, located, designed, and constructed to efficiently and effectively serve the transportation needs of international commerce between two nations. The super-crossings would incorporate state-of-the-art inspection equipment, and they would be located where they can directly serve the flow of trade between commercial/industrial regions of two nations.

(2) *Multimodal.* A super-crossing is not limited to vehicular mode, and the conceptual development of these new binational entry systems stresses inter-modality. A super-crossing has at least two complementary modes, such as rail and highway. A mix

such as highway, natural gas, fiber optics and oil may also work equally well. Specific transportation studies would determine the best mode combination for each site.

(3) *Super-crossings expedite existing traffic and encourage pre-cleared traffic.* As discussed in the previous sections, inspection procedures are one of the main causes for traffic delays at the Texas-Mexico border. One way to expedite these procedures is the implementation of inland ports, where items are inspected and sealed for rapid customs clearance at borders. Special lines would be available for pre-cleared traffic, which would cross considerably faster than traffic being normally inspected. This system would significantly improve the traffic circulation, but it cannot be efficiently implemented on the older bridges due to inadequate geometric layout. Super-crossings would have large customs areas with plenty of room for separate lanes for pre-cleared traffic.

(4) *Super-crossings offer economies of scale.* They will be large enterprises both in terms of physical infrastructure and the management of the crossing procedures. However, they would provide significant economies of scale in a variety of ways. Different modes would share the same right-of-way and the same costs of planning, location, financial feasibility study, environmental assessment, and other studies needed before construction. In addition, the same groups of customs, immigration and drug enforcement teams would handle different modes from the same facilities. For example, if a super-crossing has rail and vehicular elements, a single customs unit can handle both these modes from the same office, using the same personnel.

(5) *Super-crossings will be appropriate for implementing all the trucking technologies being currently developed under IVHS.* Such technologies include tagging, transponders, electronic number plates, weigh-in-motion, and other logging devices which will aid recognition of vehicles that cross the border. These will ultimately permit vehicles to be tracked, so that complex documentation covering the utilization in different states, different diesel tax and other such fees, are not required. Although this is somewhat on the "leading edge" of technology, there are lower technologies which may well have an important impact on cross-border transfers in the early part of the next century. Super-crossing capabilities developed through loops and other tracking devices set into the road can address these issues.

It has been shown that transportation facilities containing a variety of modes are extremely synergistic in financial terms, and a super-crossing combining different transport modes would be very effective and generate high economic rates of return and net present values. Experience suggests that a rail-only binational entry system is difficult to justify using conventional cost benefit methodologies. However, where rail is just one element in a multimodal binational entry system, rates of return can become attractive to the issuers of revenue bonds.

COMPONENTS OF A SUPER-CROSSING SYSTEM

A super-crossing system between Mexico and the United States is a binational entry system and, as such, it comprises the physical transportation facilities, and the facilities necessary for border crossing inspections. The specific design of a super-crossing would enable commodities to flow more efficiently between major trade corridors in the United States and Mexico, and would have three major components: the bridge across the border, the connecting transportation network, and the international inspection facilities and operations.

Bridge Component

The bridge crossing the Texas-Mexico border would ideally be designed, both structurally and geometrically, to accommodate heavy commercial loads, as well as several modes of travel such as truck, rail, and pipeline. Structural design criteria would ensure that the bridge deck and columns have sufficient strength to support heavy commercial loads. Geometric design criteria would ensure expedient processing of large commercial vehicles, and specific multimodal design criteria would allow for a more efficient border crossing procedures coupled with better traffic circulation.

Connecting Transportation Component

The connecting facilities would ideally be structurally and geometrically designed for the rapid movement of heavy commercial vehicles. Preferably, these facilities would have designated lanes for commercial traffic. Ideally, these exclusive commercial lanes should be physically separated from other traffic, so as to improve both safety and traffic circulation.

International Inspection Operations Component

The cargo inspection requirements for international trade between Mexico and the United States are a significant component of the process of transporting commercial goods between the two countries. NAFTA approval entails more complex cargo inspections to check origin of commodity components, and pre-clearance of such cargo would greatly improve overall efficiency. A super-crossing facility is attractive to a significant portion of the U.S.-Mexican trade flow, because of its efficiency for processing cargo. In order to create such a facility, attention has to be given to various design elements. The main elements listed and discussed below are based on a U.S. State Department report (Ref 3) and on field trips to the sites.

(1) *Superbooths.* This term refers to a free-standing kiosk at the primary inspection facilities for truck drivers hauling imported goods into the U.S. It houses the United States Custom Service inspector. Superbooths contain the computer equipment which allows the inspector to electronically enter the basics of the truck driver's paperwork and do some pre-clearance activity. Theoretically, super-booths should permit almost instantaneous approval of final clearance for line release participants. These booths should be safe and secure for the inspector who is stationed there. For example, the

booth will be planned so that it is elevated to the height of the truck and the inspector is positioned to look down into the cab. This would allow for a safer situation for the inspector and provide the ability to make a visual scan of the cab as well as the driver's paperwork.

(2) *Truck Docks.* The depth of truck docks should be adequate to allow the full length of a trailer to be unpacked and still allow some maneuvering space. Inspection time is decreased in this manner, thus increasing the capacity of the facility.

(3) *Dedicated Truck Lanes into the Cargo Compound.* Dedicated truck lanes with substantial queuing areas should be provided in order to remove trucks from the general traffic stream, so that their delays do not become delays for the passenger vehicles. In addition, these areas should allow a high degree of sorting of trucks into different queues so that, for instance, line-release shippers are not unnecessarily delayed behind truckers without pre-cleared paperwork.

(4) *Staging Areas for Cargo Trucks.* There should be adequate holding space for cargo trucks in the event of any delay in cargo clearance.

(5) *Customs Broker Facilities.* The design of the facilities should allow sufficient office space for on-site representation by each of the brokers with activity at the Port of Entry. The brokers provide the interface between the importers, exporters, trans-shippers, and the U.S. Customs and other federal and state agencies with interests/authority in the cargo compound. Brokers are very important to the clearance processes and to maximize the throughput. The broker is an element in the clearance queue, and as such, their operations should be made as efficient as possible.

(6) *Cargo Containment Facility.* A designated area should be established inside the truck compound to provide a safe and controlled area for the handling of hazardous materials. Accidental release or overflow of such materials can be contained or dealt with in such an area.

(7) *Dedicated Break Bulk Area.* Break bulk refers to those goods and commodities which are either not cartonized or do not lend themselves to containerization. Such items include liquids, barred or sheeted metals, cement, powdered chemicals, sawdust and wood chips. Currently unloading/reloading tasks are presently performed at other Border Stations by hand labor, and can take many hours. The break bulk area could include equipment to handle specific commodities common to the Border Station. This area should not be an impediment to the queue or the overall operation of the compound.

The high cost of providing exclusive commercial roadways and state-of-the-art inspection facilities and equipment mean that super-crossings need to be constructed at international trade corridors that generate enough commercial traffic to make a super-crossing financially viable.

Figure 3.1 displays two major transportation corridors that currently exist between the interior of Mexico and the United States. The link between these two interior transportation corridors should be served by what is termed in this report as a super-crossing. This super-crossing could evolve into an international high-speed corridor linking to the proposed Texas High-Speed Corridor between Houston, Dallas/Ft. Worth, and San Antonio.

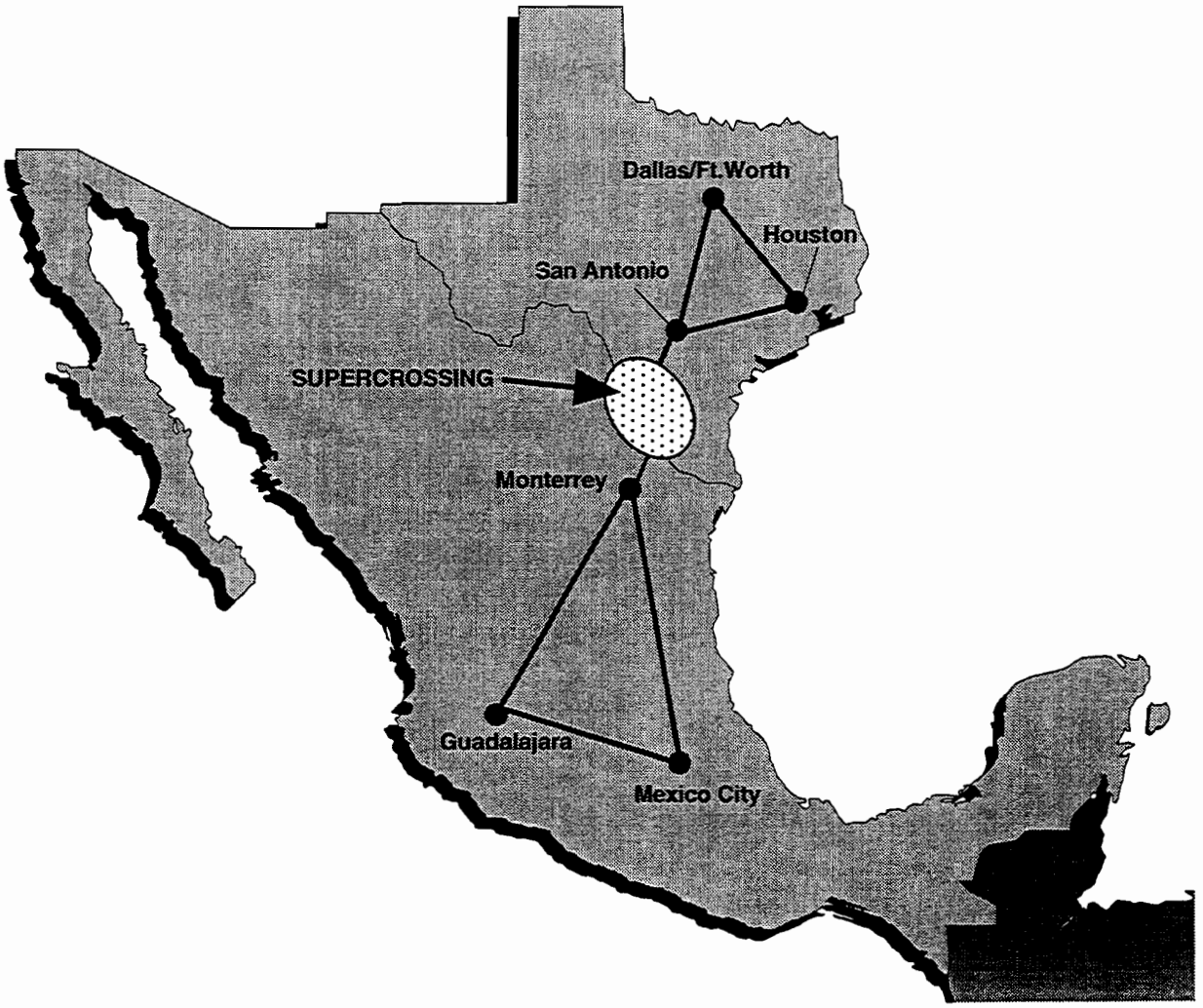

Figure 3.1. Existing major transportation corridors in U.S. and Mexico

MARKET FOR A SUPER-CROSSING

A super-crossing system would primarily serve international commerce flow between Mexico and the United States. Figure 3.2 shows the percentage of 1989 U.S. exports that originated in each of the ten U.S. states that correspond to the top ten in terms of Southbound exports (Ref 12). Although Texas exported six times more than the second highest, Figure 3.2

only partially illustrates the need for an exclusive commercial facility in Texas, because the data used in this figure do not address the fact that exports from other U.S. states to Mexico travel through the state of Texas.

Figure 3.3 shows the total 1990 trade movement between Texas and Mexico by border state. Texas handles almost three-quarters of the total trade between the U.S. and Mexico, and 94 percent of that trade is transported via surface transportation, as shown in Figure 3.4.

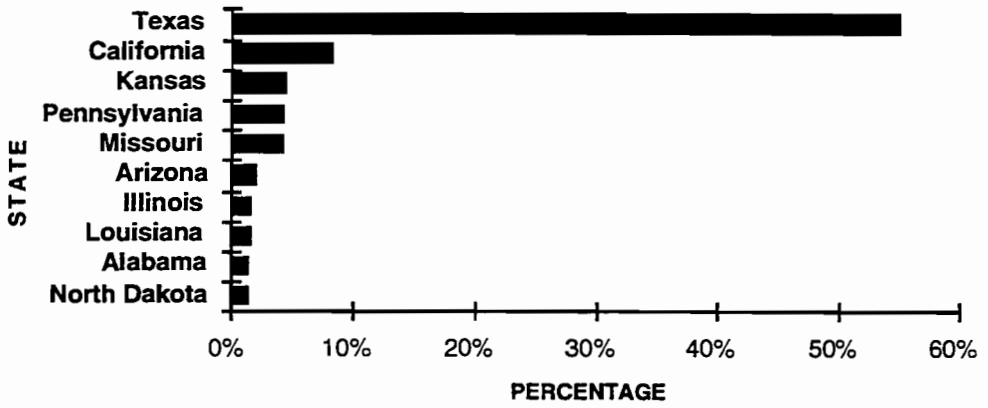

Figure 3.2. 1989 U.S. southbound export tonnage by state of origin

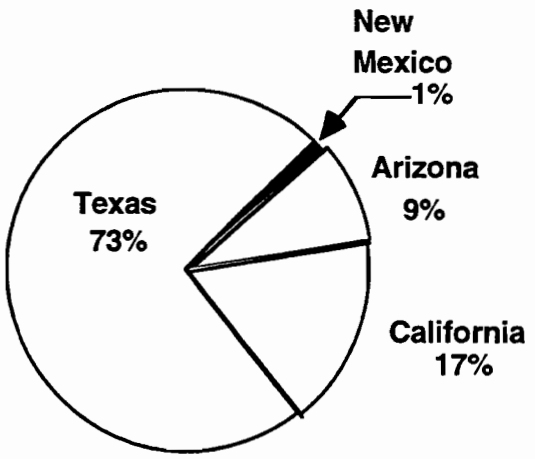

Figure 3.3. Total trade between the U.S. and Mexico through the border, 1990

Figure 3.5 displays a U.S./Mexico Port of Entry perspective on U.S. exports to Mexico. Laredo, Texas, is the largest port of entry in terms of dollar value of U.S. exports for the entire

U.S./Mexico border, indicating that the state of Texas serves as the major commercial port of entry for U.S. exports transported by ground to Mexico.

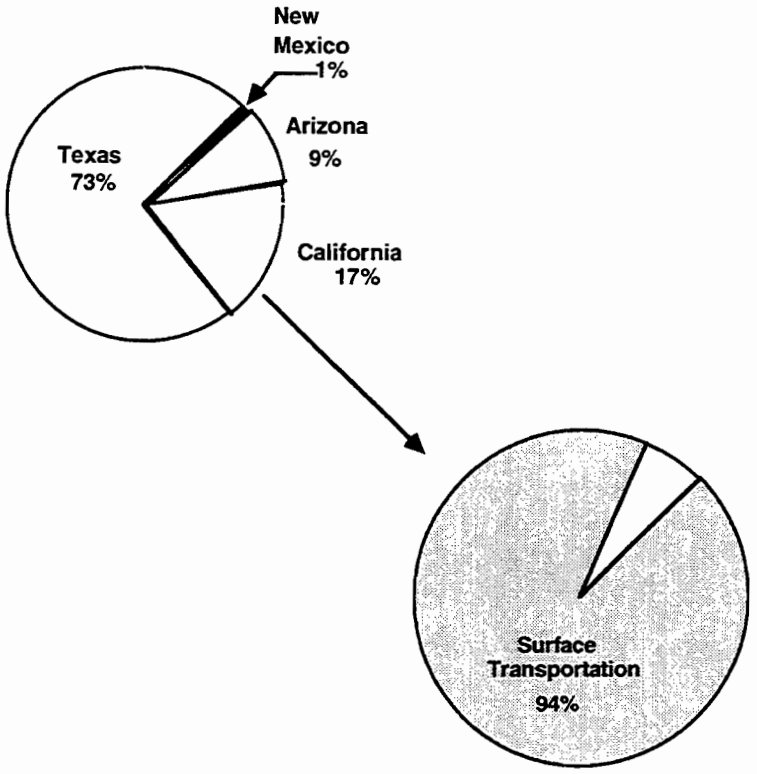

Figure 3.4. Surface transportation between the U.S. and Mexico

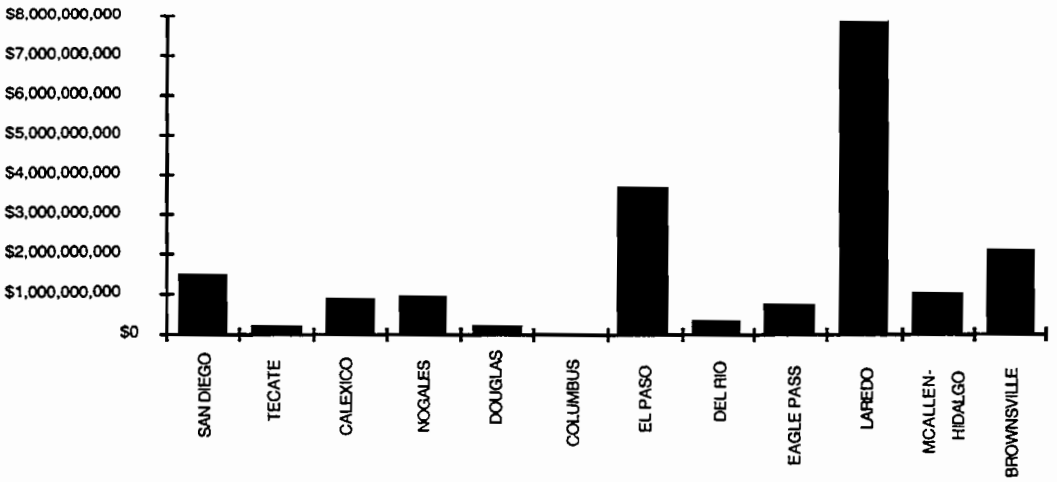

Figure 3.5. U.S. exports to Mexico shipped by ground through U.S. southern border ports

Figure 3.6 shows the March 1993 northbound commodity flow data by number of land shipments through five Texas ports of entry. The data were collected from the U.S. Customs regional office in Houston. These data show that El Paso is the largest port of entry in Texas in terms of number of northbound land shipments, while Laredo is the second largest. These rankings are best viewed in the map depicted in Figure 3.7, which shows the same data in percentages of the total shipments.

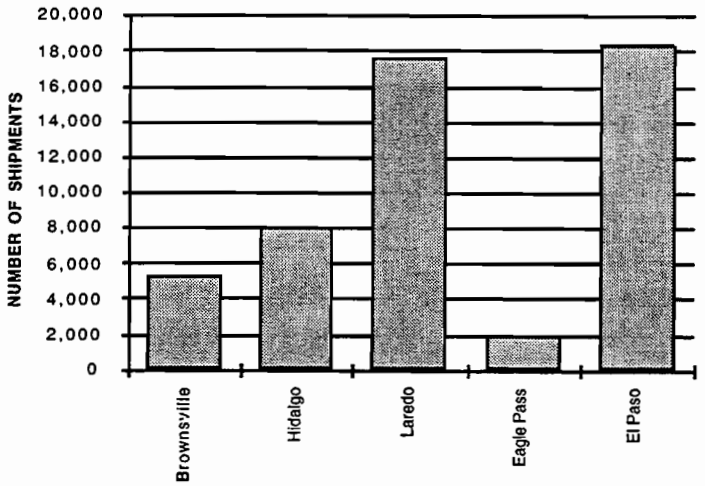

Figure 3.6. Northbound land shipments showing five Texas ports of entry, March 1993

In short, a significant portion of the trade between the United States and Mexico crosses the international border somewhere over the Rio Grande, and NAFTA is expected to increase both the traffic and the need for detailed cargo inspections. A super-crossing provides economies of scale for both the nations and for the private companies hauling cargo from one country to another. As such, they would be preferred border crossing sites for the latter, which would, in all likelihood, provide enough revenue to pay for a super-crossing.

IMPLEMENTATION

The super-crossing must offer a certain order-of-magnitude improvement in the benefit/cost ratio of the transborder shipping process before private business will utilize the facility. All three components of the super-crossing system (bridge structure, connecting facilities, and customs inspection facilities) need to be in place before such improvement in the benefit/cost ratio for shippers will occur.

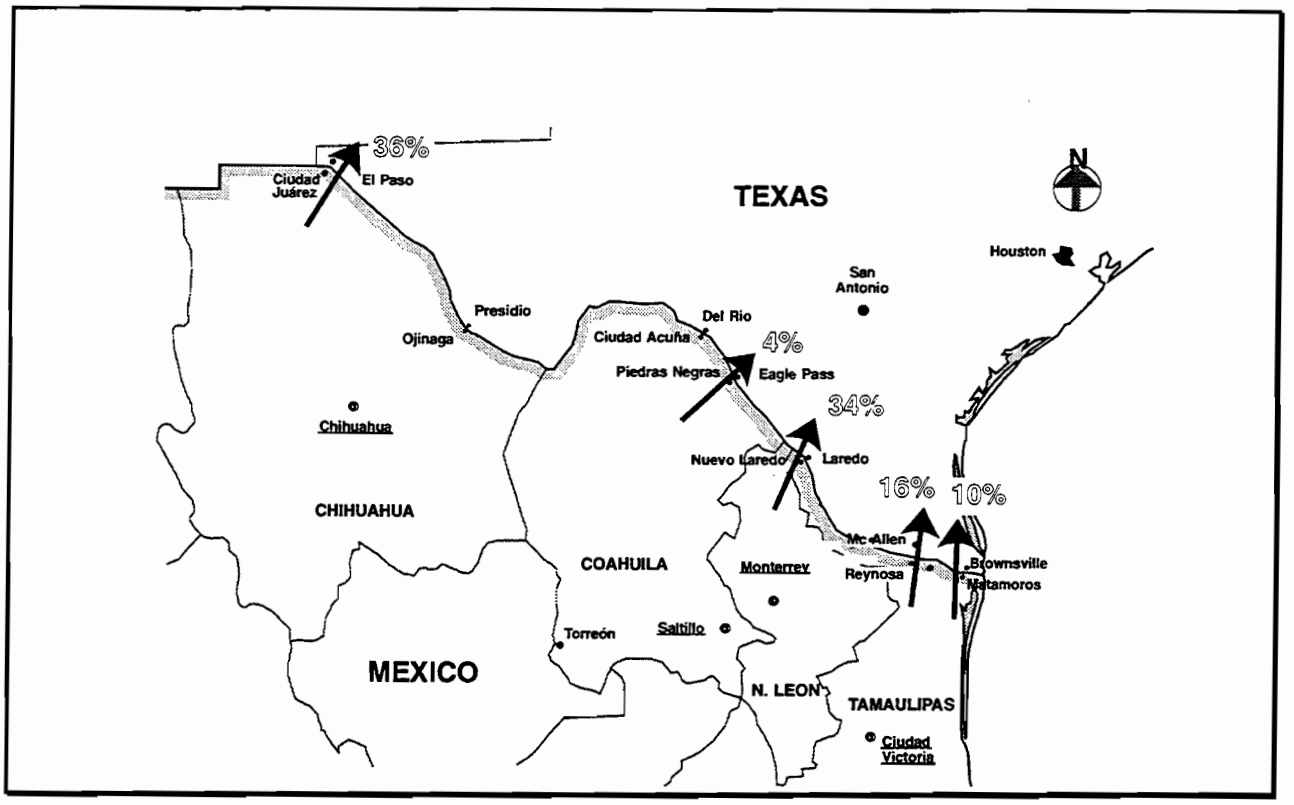

Figure 3.7. Percent of northbound land shipments for five Texas ports of entry, March 1993

There are three existing ports of entry which contain facilities specifically designed for significant amounts of U.S./Mexico commodity shipments by truck: the El Paso Port of Entry with the Ysleta/Zaragosa Bridge, the Laredo Port of Entry with the Colombia Bridge, and the Brownsville Port of Entry with the Los Indios Bridge.

The Ysleta Bridge has an exclusive four-lane commercial bridge span and excellent import inspection facilities, along with export inspection capabilities. The Colombia Bridge has an eight-lane bridge cross section (for commercial and private vehicles) along with its state-of-the-art import and export inspection facilities. The Los Indios Bridge has a four-lane bridge cross section (for commercial and private vehicles) and exceptional import and inspection facilities.

These three bridges are, in fact, potential super-crossings, as they have the vehicular bridge and some of the inspection facilities of a super-crossing system already in place. In addition, they are located in major commercial traffic corridors, thus having the market potential for a super-crossing. The remaining component of a super-crossing system, the connecting facilities, would require upgrading to meet the super-crossing criteria as outlined in this section.

CONCLUSIONS

Texas is by far the largest land port for U.S./Mexico imports and exports. The data show that two ports of entry stand out in terms of number of land shipments or shipment value in Texas, namely, the Laredo and El Paso ports of entry. These two ports of entry are the logical locations for a super-crossing, and bridges have recently been built at these two locations that meet some of the super-crossing criteria.

It is interesting to consider that both the Ysleta/Zaragosa and the Colombia Bridge are not being utilized by existing traffic to their fullest potential. Possible explanations vary by site. In El Paso, the presence of a toll-free bridge (Bridge of the Americas) which also has extensive import docking facilities and an exclusive lane in each direction for commercial trucks probably affects the route choice decision of trucks traveling through the El Paso Port of Entry. In Laredo, the infrastructure linking the main highways to the Colombia Bridge is poor on both sides of the border, discouraging potential bridge users. In addition, Mexican custom brokers are licensed by the state of Tamaulipas, while the Colombia Bridge is in the state of Nuevo Leon, forcing trucks to go to Tamaulipas.

In short, origin and destination characteristics, entrenched broker and union operations and political arrangements, competition with a free bridge, relatively remote bridge locations, and sub-par connecting infrastructure are all plausible explanations as to why one or more of the three potential super-crossing sites (El Paso, Laredo, Brownsville) are not being utilized to their fullest potential.

It appears that some localized commercial traffic may also be significant enough to warrant a super-crossing. U.S. Customs northbound shipment data show that approximately 74 percent of all northbound commodities utilizing the Brownsville Port of Entry originate in Matamoros (sister city of Brownsville), and a super-crossing at this location will meet the demands of local traffic. In contrast, the northbound commodities that utilize the Laredo Port of Entry are mainly originating from the interior of Mexico (approximately 80 percent), and a super-crossing at this location will be meeting the long range demand (Ref 7). In both instances, a case can be made for having a super-crossing. However, it is important to distinguish between long range and local demand since this will determine the nature of connecting infrastructure needs that will arise from a super-crossing.

According to the origin and destination data discussed in Chapter 5, about 90 percent of auto traffic crossing the border has the sister cities as origins and destinations. This means that local traffic is a significant component of the transborder traffic demand. While this demand can also be met by implementing super-crossings, these are conceptually developed to address the needs of long-haul auto trips and cargo. The sector analysis can provide indications of whether or not there is a need for additional infrastructure to serve local traffic. In some cases, this need can be addressed by implementing a super-crossing that would absorb the commercial and long-haul demand, thus improving traffic circulation at the binational entry systems that serve the local demand.

CHAPTER 4. IMPACTS OF THE NORTH AMERICAN FREE TRADE AGREEMENT

INTRODUCTION

The ability of the U.S.-Mexico infrastructure to handle the traffic increases imposed by NAFTA will depend on such macroeconomic factors as maquiladora activity and exports to and from Mexico. Accordingly, the first part of this chapter reviews the growth of maquilas in Mexico (a contribution provided by IM3 at The University of Texas at El Paso). Factors affecting this growth (e.g., labor availability, turnover, wages, costs of drayage, and tolls structure) are also discussed, with conclusions related to the growth of maquilas in the Mexican states.

The second part, provided by the LBJ School of Public Affairs at The University of Texas at Austin, is a macroeconomic analysis of possible NAFTA impacts. An overview of the macroeconomic picture in Mexico, the macroeconomic picture under NAFTA, and the impacts of NAFTA on the Texas economy are discussed. An LBJ model is used to project Texas exports to Mexico on a detailed economic sector[1] and regional basis, as tariff barriers are reduced and as Mexican GDP grows.

MAQUILADORAS GROWTH IN MEXICAN STATES BORDERING TEXAS

Throughout the 1980's, the maquiladora industry expanded rapidly in Mexico, with the most dramatic growth occurring in the four Mexican states bordering Texas — Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas. A maquiladora is a Mexican manifestation of the global trend toward co-production, or the so-called "twin plant." The co-production process attempts to lower the total cost of business for manufacturers, using various locations or options to derive the most favorable labor, materials, and technology cost structures. Under the maquila program, raw materials and partially finished components can be imported into Mexico under bond. In Mexico, imported materials and components can undergo virtually any operation in the manufacturing process, after which they must be exported to the United States or to other countries of origin. When re-entering the United States, the maquila products fall under Harmonized Tariff Schedule Subheadings (TSUS) 9802.00.60 and 9802.00.80. Any tariff due is paid only on the value added to the product in Mexico, and not on the U.S. content of its original composition. The tariffs, in other words, are imposed mostly on the cost of labor and utilities in Mexico. Although the proportion of value added in Mexico varies by product, the proportion of U.S. value for imports from the maquiladora plants as a whole is 50 percent. This means that the U.S. tariff is assessed, in general, on only 50 percent of the import value of a maquiladora product.

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[1]Economic sectors as traditionally defined and used in economics jargon—i.e., not the border sectors as defined in Chapter 3.

It is important to note that the maquiladora program is a Mexican program, and that the tariff provisions of the Harmonized Code are available to any manufacturer in the global marketplace. TSUS 9802.00.60 and 9802.00.80 provide an incentive to manufacturers whose products are sold within the United States to use U.S. materials and components (when such usage is cost effective). In actuality, products manufactured in Canada and Mexico contain significantly greater U.S. content than do those manufactured in the Far East or Europe, a fact which is not too surprising given those countries' proximity to the U.S. As the U.S.-Canada Free Trade Agreement phases in, and as many more Canadian-made components and products become duty free, Mexico's proportion of total imports under TSUS 9802.00.60 and 9802.00.80 has assumed greater prominence. TSUS 9802.00.80 is the primary tariff heading for goods assembled abroad, and is the tariff heading used most by the maquilas. In recent years, electronic goods and auto parts from Mexico have accounted for a significant percentage of the increase in imports under this heading (USITC Publication 2592, 2).

The maquiladora (or twin-plant program) has existed since 1965. Its greatest period of growth began in 1982, when the peso was drastically devalued. In 1982, 525 maquila operations were in existence. By the end of 1992, more than 2,000 maquilas were in operation. Over the same time period, employment grew from 127,000 to more than 490,000. Three primary factors account for the growth of the maquila program during this period: the devaluation of the peso relative to the dollar, the cost and relative scarcity of labor in some areas of the U.S., and the increasing international competition for market share.

Initially, the Mexican government restricted maquiladora operations to locations abutting the U.S.-Mexico border. As the program grew, however, and as population migration to border cities began to overburden the existing infrastructure, housing, and transportation systems, interior locations were approved (see Table 4.1 population growth figures for selected municipalities). Mexico removed the last location barriers to maquilas by permitting their entry into the large industrial cities of Monterrey, Guadalajara, and Mexico City.

During the explosive growth period of the 1980's, new maquila operations and existing maquilas looking to expand began to seek locations where the workforce was not saturated. In 1980, only 10 percent of maquila operations were conducted in interior cities; by 1990, 20 percent of the vastly greater number of maquilas were in interior locations (Vargas 1993, p. 35). The predominant locations, Ciudad Juarez, Tijuana, and Matamoros were experiencing inordinate turnover in the maquila workforce, with consequent higher training costs for new workers and lower productivity. A further incentive for seeking out new sites was the wage structure established for the maquila industry. The government of Mexico publishes a schedule of minimum wages for the various cities with maquila operations. Ciudad Juarez, Tijuana, and Matamoros have traditionally been the highest wage areas. Although the official minimum wage is usually a training wage for entry-level workers, real wages paid to direct workers and supervisors are usually predicated on ratios and multiples of the official minimum wage. In addition to adequate infrastructure, the availability of labor is the major requirement for maquila growth.

Table 4.1. Population growth for border municipalities, 1970 -1990 (thousands)

Location *	1970	1980	1990
Coahuila			
Cd. Acuña	32,500	41,948	56,336
Piedras Negras	46,698	80,290	98,185
Torreon (1)	250,524	363,886	464,825
Chihuahua			
Chihuahua (1)	277,099	406,830	530,783
Cd. Juarez	424,135	567,365	798,499
Nuevo Leon			
Guadalupe (1)	159,930	370,908	535,560
Monterrey (1)	858,107	1,090,009	1,069,238
Tamaulipas			
Matamoros	186,146	238,840	303,293
Nuevo Laredo	151,253	203,286	219,468
Reynosa	150,786	211,412	282,667
Rio Bravo	71,389	83,522	94,009

*All municipalities are located on the border except where noted.

(1) Interior municipality

Sources:
1990 census from Instituto Nacional de Estadistica, Geografia e Informatica (INEGI)
1970 & 1980 census from "Consejo Nacional de Población"

Labor Availability

Population statistics published by the Mexican National Institute of Statistics, Geography, and Information (Instituto Nacional de Estadística, Geografía e Informática [INEGI]), the Mexican counterpart to the U.S. Census Bureau, show that the pattern of explosive growth in border cities is continuing. In general, statistics for total population in the subject cities show extraordinary growth since 1970, the base year for the figures given (see Table 4.1). Mexico and other developing nations have had exceptionally high population growth rates since the Second World War. The population growth for Mexican border cities exceeds the national average, a result primarily of migration from the interior. Mexico is in fact experiencing the same migration of population — from rural to urban areas — that the United States experienced in the early 20th century. With the exception of Mexico City, border cities have shown the most

explosive rates of growth. The median age of the population in Mexico is approximately 19 years. Therefore, although the rate of population increase may slow as more women enter the labor market and delay childbearing, the total population will increase more rapidly than that of the United States, Western Europe, or Japan. Consequently, Mexico will be a labor-surplus area well into the next century. Even without the North American Free Trade Agreement, manufacturers will continue to seek locations in Mexico that take advantage of lower costs and abundant labor resources.

Until World War II, Mexico actively discouraged population migration and economic growth in its border cities because of the distance of those cities from the Republic's heartland, and because of the perceived deleterious influence of the United States on the populations of border regions. Since the war, an opposite policy has been in effect: Mexico has encouraged migration to the border to place a demographic barrier against what it still perceives to be the expansionist tendencies of the U.S. That policy has had the unintended effect of promoting economic activity in border areas more dependent on the U.S. than on the interior of Mexico, and to a large extent has increased, not decreased, the interdependence of Mexico with the U.S. Once again, the maquila program is an example of the interdependence.

Until approximately 1960, the cities on the U.S. side of the border were the larger of the twin cities; since 1960, the Mexican cities, with their massive population growth, have become the larger of the pairs. During this time Ciudad Juarez, Tijuana, Chihuahua, and others have doubled their populations. Cities on the U.S. side have experienced slower population growth, although their growth rates have far exceeded national and state growth rates.

In 1990, many cities (including El Paso) protested that the U.S. Census Bureau severely undercounted the populations of urban areas. The U.S. Census Bureau admitted that the undercount existed, but refused to adjust the official totals. A similar and more severe situation exists in Mexico. Local officials in Ciudad Juarez and El Paso familiar with trends in the area estimate the population of Ciudad Juarez at 1.2 million rather than the 800,000 official figure. Other Mexican border cities seem to exhibit a somewhat smaller (although still significant) undercount. This undercount in population has important implications in determining the adequacy of infrastructure, in calculating the size of the employment pool, and in determining the number and composition of unemployed persons available for work.

The availability of infrastructure to support future expansion is a major variable in growth projections. Mexico has announced ambitious plans to upgrade the infrastructure, housing, transportation and worker training programs in border cities. The government of Mexico has also initiated an ambitious program of environmental improvements, constructing sewage treatment facilities, additional electric generation capacity, and air quality programs. To date, those plans are being carried out with mixed success. Migration and natural increase in most border cities exceeds the capacity of Mexico to provide adequate urban facilities and infrastructure.

Ciudad Juarez and Chihuahua cannot maintain their current growth rates without a massive capital improvement program, which Mexico, with its unitary governmental and tax

structures, is ill-prepared to support. Municipal and state governments in Mexico do not have the tax base or taxing authority to locally provide infrastructure to meet demands. Ciudad Juarez is, in 1993, just beginning to construct its first sewage treatment facilities. Mass transportation is overburdened, and the streets are congested. Like their counterparts in the United States, Cd. Juarez and other border cities are experiencing growth on the periphery, exacerbating transportation problems and infrastructure deficiencies.

The housing stock in all the border cities is inadequate to shelter the existing population growth, fostering the establishment of colonias (unplatted subdivisions) and urban sprawl on both sides of the Rio Grande. Social activists in Cd. Juarez estimate the current housing shortage in that city alone at 40,000 units. Mexico has been pressuring the maquilas to "voluntarily" contribute funds to assist infrastructure development. In Ciudad Juarez, maquilas are contributing to the construction of sewage treatment facilities and for new bridge crossings. In addition, the maquila association in Ciudad Juarez assesses a "head tax" on its members based on numbers of employees for civic work in that city. The association contributes on the order of $1 million per year for infrastructure projects jointly selected by the association and the municipal government. Maquilas are resisting government pressures to assume an ever greater share of the burden in correcting past neglect in infrastructure development and modernizing the existing facilities to any extent greater than that now shouldered. All additional exactions add to the cost of doing business in Ciudad Juarez and in Mexico.

Nuevo Laredo, Ciudad Acuña, Piedras Negras, and Matamoros, however, began their growth spurt from a smaller base and could conceivably sustain their rates of expansion in population. In those cities, no formal programs of maquila contributions to significant infrastructure needs exist on a level akin to that of Ciudad Juarez. Assuming that the official unemployment statistics are relatively accurate for the formal sectors of the economy (Table 4.2), it is probable that migration to the border cities from the interior areas will continue. The supply of workers will continue to grow, albeit at a slower pace. Mexico's demographics assure that approximately one million new workers will enter the workforce each year for the foreseeable future; a significant percentage of those workers will be absorbed in the traditional sectors of the economy and the manufacturing centers of Monterrey, Guadalajara and Mexico City. However, the trend of movement from rural to urban centers can be expected to continue, and it will accelerate if President Salinas and his successors continue the program of land reform now underway. The supply of potential workers for maquila plants is available. The imbalance is between where the labor is located and where the plants wish to be based on infrastructure availability and transportation facilities.

Composition of the labor supply available to the maquila industry will continue to be predominantly young, female, relatively unskilled and mobile. Table 4.2 shows the disparity between the potential workforce (economically active) and the actual workforce. Productivity increases in the larger cities of Ciudad Juarez, Monterrey, and Chihuahua will be slowed unless training programs improve and labor retention rates improve. As has been the experience in the United States and other industrialized nations, labor productivity increases will be influenced

more by the introduction of higher technology innovations and processes than by increases in worker output per unit of measurement.

Table 4.2. Work force data for select border municipalities

Location	Economic Active	Work Force	Employed	Unemployed	% Unemployed	Maquila Employed	% Maquila Employed
Chihuahua							
Chihuahua	332,679	185,691	180,765	4,926	2.7%	29,723	16.0%
Juarez	465,050	289,554	283,182	6,372	2.2%	126,452	43.7%
Coahuila							
Acuña	33,655	20,824	20,465	359	1.7%	15,097	72.5%
Piedras Negras	59,064	32,906	32,095	811	2.5%	8,071	24.5%
Saltillo	263,972	141,236	136,857	4,379	3.1%	0	0%
Torreon	280,563	151,796	147,753	4,043	2.7%	3,596	2.4%
Nuevo Leon							
Guadalupe	329,184	181,602	176,762	4,840	2.7%	3,630	2.0%
Monterrey	684,249	371,416	361,520	9,896	2.7%	1,518	0.4%
Tamaulipas							
Matamoros	185,562	108,697	105,127	3,570	3.3%	38,410	35.3%
Nuevo Laredo	130,773	71,738	69,803	1,935	2.7%	16,165	22.5%
Reynosa	172,756	93,249	90,573	2,676	2.9%	23,578	25.3%
Rio Bravo	55,506	28,642	27,405	1,237	4.3%	1,301	4.5%

Source: Instituto Nacional de Estadistica, Geografia e Informatica (INEGI)

Table 4.3 tracks the value added per employee in the maquilas in selected municipalities. The figures, considered in light of the average hourly wage, correlate closely with the average wage paid in the various municipalities; those with higher wage rates exhibit a consistent pattern of greater value added per employee. However, the value added figures for Monterrey and other locations show a vastly greater amount. The smaller communities, like Piedras Negras and Ciudad Acuña, show much smaller value added figures, indicative of the movement of the more traditional labor intensive, low skilled industries to those municipalities. The mature municipalities, Cd. Juarez, Matamoros, and to some extent Chihuahua show rising productivity figures, demonstrating the incorporation of more technology and a greater level of reliance on more sophisticated manufacturing processes and products. Like their counterparts in other parts of the world, industries looking for locations in Mexico are greatly influenced in their location decisions by the composition and availability of workforce.

Table 4.3. Value-added

Location [1]	Year	Plants	Employees	Value-Added (Mill. $)	Value-Added Per Employee (Thou. $)
COAHUILA					
Cd. Acuña	1982	16	3286	11	3317
	1983	18	4551	13	2816
	1984	22	5388	21	3977
	1985	24	6266	25	4028
	1986	26	7641	28	3675
	1987	31	9608	36	3847
	1988	35	10655	42	3994
	1989	44	14151	60	4261
	1990	44	15097	73	4835
	1991	45	16504	91	5514
	1992	48	18599	119	6398
Piedras Negras	1982	17	2222	11	4750
	1983	17	2609	10	3699
	1984	17	3845	12	3241
	1985	18	4434	14	3277
	1986	21	5204	13	2644
	1987	24	5655	17	2995
	1988	32	6950	24	3414
	1989	42	8130	38	4637
	1990	46	8071	39	4832
	1991	42	7756	43	5544
	1992	42	8461	55	6500
Torreón (I)	1982	n/a	n/a	n/a	n/a
	1983	n/a	n/a	n/a	n/a
	1984	n/a	n/a	n/a	n/a
	1985	n/a	n/a	n/a	n/a
	1986	n/a	n/a	n/a	n/a
	1987	n/a	n/a	n/a	n/a
	1988	n/a	n/a	n/a	n/a
	1989	n/a	n/a	n/a	n/a
	1990	20	3596	17	4728
	1991	25	3169	18	5680
	1992	32	5783	34	5879

Continued

Location	Year	Plants	Employees	Value-Added (Mill. $)	Value-Added Per Employee (Thou. $)
Other	1982	n/a	n/a	n/a	n/a
	1983	n/a	n/a	n/a	n/a
	1984	n/a	n/a	n/a	n/a
	1985	n/a	n/a	n/a	n/a
	1986	n/a	n/a	n/a	n/a
	1987	n/a	n/a	n/a	n/a
	1988	n/a	n/a	n/a	n/a
	1989	41	8205	30	3705
	1990	36	6710	36	5365
	1991	42	8795	49	5571
	1992	48	10755	78	7252
CHIHUAHUA					
Cd. Juarez	1982	129	42695	290	6799
	1983	135	54073	313	5792
	1984	155	72495	437	6034
	1985	168	77592	468	6029
	1986	180	86526	434	5016
	1987	199	97800	530	5427
	1988	248	110999	695	6268
	1989	261	122452	896	7314
	1990	281	122452	939	7426
	1991	255	123514	1041	8428
	1992	267	128901	1230	9542
Cd. Chihuahua (I)	1982	n/a	n/a	n/a	n/a
	1983	n/a	n/a	n/a	n/a
	1984	26	9874	n/a	n/a
	1985	29	13307	n/a	n/a
	1986	40	20751	n/a	n/a
	1987	40	24235	n/a	n/a
	1988	46	27370	n/a	n/a
	1989	58	29229	199	6819
	1990	61	29723	205	6897
	1991	57	31915	257	8053
	1992	61	33024	325	9841

Continued

Location[1]	Year	Plants	Employees	Value-Added (Mill. $)	Value-Added Per Employee (Thou. $)
TAMAULIPAS					
Matamoros	1982	41	14643	86	5817
	1983	40	15639	106	6771
	1984	39	19454	133	6861
	1985	35	20686	145	6998
	1986	43	23442	129	5518
	1987	60	26994	149	5534
	1988	72	32450	228	7039
	1989	94	38268	299	7832
	1990	92	38410	361	9399
	1991	94	37195	410	11023
	1992	97	37510	445	11864
Nuevo Laredo	1982	12	2602	11	4276
	1983	12	2839	15	5194
	1984	14	3752	21	5527
	1985	15	3603	21	5776
	1986	23	4235	17	3932
	1987	33	6777	37	5421
	1988	44	11056	100	8773
	1989	63	16162	114	7054
	1990	63	16165	146	9032
	1991	62	16128	160	9921
	1992	68	16433	196	11927
Reynosa	1982	17	9259	51	5476
	1983	19	10660	42	3962
	1984	22	13867	60	4302
	1985	27	12761	59	4598
	1986	29	15887	64	4030
	1987	34	16948	74	4363
	1988	43	19785	121	6119
	•1989	71	24839	180	7243
	1990	57	23578	178	9032
	1991	66	26307	193	9921
	1992	76	29794	259	8693

Continued

Location	Year	Plants	Employees	Value-Added (Mill. $)	Value-Added Per Employee (Thou. $)
Rio Bravo	1982	n/a	n/a	n/a	n/a
	1983	n/a	n/a	n/a	n/a
	1984	n/a	n/a	n/a	n/a
	1985	n/a	n/a	n/a	n/a
	1986	n/a	n/a	n/a	n/a
	1987	n/a	n/a	n/a	n/a
	1988	n/a	n/a	n/a	n/a
	1989	n/a	n/a	n/a	n/a
	1990	11	1301	17	13067
	1991	12	1575	16	10159
	1992	14	1665	17	10210
Other	1982	n/a	n/a	n/a	n/a
	1983	n/a	n/a	n/a	n/a
	1984	n/a	n/a	n/a	n/a
	1985	n/a	n/a	n/a	n/a
	1986	n/a	n/a	n/a	n/a
	1987	n/a	n/a	n/a	n/a
	1988	n/a	n/a	n/a	n/a
	1989	24	12961	47	n/a
	1990	27	12942	60	3411
	1991	24	11154	65	4015
	1992	23	9984	54	5409
NUEVO LEON					
Guadalupe (I)	1982	n/a	n/a	n/a	n/a
	1983	n/a	n/a	n/a	n/a
	1984	n/a	n/a	n/a	n/a
	1985	n/a	n/a	n/a	n/a
	1986	n/a	n/a	n/a	n/a
	1987	n/a	n/a	n/a	n/a
	1988	n/a	n/a	n/a	n/a
	1989	n/a	n/a	n/a	n/a
	1990	17	3630	33	9091
	1991	19	5146	52	10105
	1992	21	6544	68	10391

Continued

Location[1]	Year	Plants	Employees	Value-Added (Mill. $)	Value-Added Per Employee (Thou. $)
Monterrey (I)	1982	n/a	n/a	n/a	n/a
	1983	n/a	n/a	n/a	n/a
	1984	n/a	n/a	n/a	n/a
	1985	n/a	n/a	n/a	n/a
	1986	n/a	n/a	n/a	n/a
	1987	n/a	n/a	n/a	n/a
	1988	n/a	n/a	n/a	n/a
	1989	n/a	n/a	n/a	16230
	1990	16	1518	18	11858
	1991	16	1858	32	17223
	1992	16	2005	44	21945
Other	1982	n/a	n/a	n/a	n/a
	1983	n/a	n/a	n/a	n/a
	1984	n/a	n/a	n/a	n/a
	1985	n/a	n/a	n/a	n/a
	1986	n/a	n/a	n/a	n/a
	1987	n/a	n/a	n/a	n/a
	1988	n/a	n/a	n/a	n/a
	1989	n/a	n/a	n/a	n/a
	1990	40	9119	95	10418
	1991	46	11164	123	11018
	1992	46	11116	148	13314

1 All cities are border or exterior cities except where noted. Other refers to other cities in the state.
(I) Interior cities
• Includes Rio Bravo data for only 1989
Source: American Chamber of Commerce of Mexico, A.C., except 1992 data from Desarrollo Economic del Estado de Chihuahua, A.C.

In general, the size of the labor pool is a function of the population of an area. However, in the case of Mexican border municipalities, the proximity of the work force to the work place must be a qualifying factor. In the larger municipalities, gross disparities exist between where the plants are located and where the workers live, in microcosm the same dichotomy as in Mexico as a whole. As stated before, the official unemployment rate in the subject municipalities ranges from a low of 2.08 percent to a high of 2.83 percent. Given the close percentage figures for the cities, no particular conclusion can be drawn regarding employment/unemployment and total population or number of maquila workers. What would appear to be a valid generalization is that the presence of maquila plants and workers acts as an economic stimulus for Mexican communities, and that despite the pattern of migration from the

interior to border areas, availability of employment opportunities in some of these municipalities exceeds the qualified labor pool. In their search for work force and infrastructure availability, maquilas are continuously saturating the limited supply of border locations.

Among the subject municipalities, some variation in labor force participation is evident, as shown in Table 4.4 by 1990 INEGI statistics.

Table 4.4. Variation in labor force participation

State	Municipality	Labor Force Participation Ages 16-65 (%)
CHIHUAHUA		
	Chihuahua	56
	Ciudad Juarez	62
COAHUILA		
	Ciudad Acuña	62
	Piedras Negras	56
	Saltillo	54
	Torreón	54
NUEVO LEON		
	Guadalupe	55
	Monterrey	54
TAMAULIPAS		
	Matamoros	59
	Nuevo Laredo	55
	Reynosa	54
	Rio Bravo	52

No significant correlation seems to exist between the degree of labor force participation and the unemployment rates of the subject municipalities (see Table 4.2). All other factors being equal, it would appear that the municipalities with the lower participation figures would have a greater potential to increase the existing labor pool by tapping into the differential. INEGI statistics indicate that the cohort between ages 12 and 16 has the lowest participation rates; this cohort is also the least educated and the least attractive to potential employers. In all the subject municipalities, the composition of the unemployed population shows a predominance of workers between the ages of 15 and 24 — no surprise to personnel managers in the maquilas.

Based upon the demographics of the 1990 census by INEGI, there does appear to be a probability that the available labor force for future maquila growth and expansion in border cities will have to be dependent upon continuing in-migration from interior cities. With the probability of a free trade agreement and its attendant stimulation of the domestic economy in Mexico becoming greater, continued competition for labor in the subject border cities is more likely, with the probability of turnover rates staying the same as they are at present, or even worsening unless wages and benefits in the maquila industry are so greatly increased that workers are drawn from their traditional posts in the domestic economy. Other than infrastructure availability, the variable which may have the greatest impact on the growth of the domestic economy under a free

trade scenario is the possibility of political and economic instability in Mexico after the 1994 elections.

Turnover Rates

Official calculations of unemployment rates in the subject Mexican municipalities all show virtual full employment, with an extremely low average unemployment rate of about 2.5 percent. The 5 percent unemployment figure in the United States is considered the benchmark for employment statistics: above that figure, the labor pool is considered to have surplus labor available; below that figure, the labor pool is considered to be depleted. The 5 percent figure in the United States is considered to be the full employment benchmark.

In Mexico, labor participation rates are lower than comparable rates in the United States, primarily owing to cultural factors involving the participation of women in the workforce and the large informal sector of the economy. To some extent, the lower participation rate for women is balanced by the presence of adolescents and bolstered by the presence of the so-called "informal" sector of vendors, small shopkeepers and day laborers. In some locations, notably Ciudad Juarez and Tijuana, the turnover rate experienced by many maquila operations supports the official reporting of low unemployment. A recent private survey (January 1992) of maquilas in Ciudad Juarez reported an average turnover rate of 7.3 percent per month, which equates to nearly 90 percent turnover per year. Many factors have been postulated to explain turnover rates in the maquilas. Dr. Lois Elias, a management consultant based in El Paso, has theorized a three-stage development process for the turnover phenomena in a 1990 series of articles in *Twin Plant News*, a maquila industry magazine. In the first stage of development, few maquilas exist in a region, there is a plentiful supply of workers, and the maquilas frequently hire young, unmarried females. Productivity is high and turnover is low in relatively unsophisticated assembly operations. During the second stage of development, more maquilas move in, the supply of workers dwindles and employment becomes more evenly split between males and females. Productivity declines somewhat and turnover increases to a level of between five and ten percent. At the third stage, the supply of new workers has almost disappeared and even more marginal workers are pursued. At this stage, turnover reaches an unacceptable level of between 10 and 25 percent. Dr. Elias believes, however, that the turnover rate is a social and cultural phenomenon rather than a business phenomenon. Her studies indicated that the climate of individual plants is the greatest variable in the turnover rate. Management attitudes influence the retention rate of workers.

While hard data on turnover rates for municipalities are not available, based on inquiries and inferences there would appear to be a strong correlation between the turnover rate in each municipality and the ratio of the maquila workforce to the total workforce. According to 1990 figures provided by INEGI for the economically active population, and to information on the size of the maquila workforce provided by the American Chamber of Commerce, the subject municipalities evidenced the percentages of maquila workers in the total workforce presented in Table 4.5.

Of the municipalities shown in Table 4.5, Ciudad Juarez would seem to have the greatest problems with turnover, with Tijuana and Nuevo Laredo following. Inferential data, based upon solicitations for employees at plants and in newspapers and interviews with maquila managers in Juarez, indicate a somewhat greater turnover problem than 7 percent. Juarez, Matamoros, and Nuevo Laredo are reputed to be the most afflicted with turnover problems among maquila managers. Acuña, although nearly three-fourths of its workforce is maquila related, does not have that reputation. The above municipalities can be categorized under Dr. Elias' system as Stage Three. From this small sample, it would appear that when the percentage of the maquila workforce in an area exceeds approximately 20 percent of the total work force, turnover problems become much greater. The interior municipalities, with maquila development being a much more recent phenomena, do not exhibit the same pattern.

Table 4.5. Percentages of maquila workers in total work force

State	Municipality	% Maquila Employment
Chihuahua		
	Chihuahua	16
	Ciudad Juarez	44
Coahuila		
	Ciudad Acuña	73
	Piedras Negras	25
	Saltillo	N/A
	Torreón	2
Nuevo Leon		
	Guadalupe	2
	Monterrey	0.4
Tamaulipas		
	Matamoros	35
	Nuevo Laredo	23
	Reynosa	25
	Rio Bravo	5

Population growth along the U.S.-Mexico border has outstripped the development of infrastructure on both sides. Today, that lack of adequate infrastructure constitutes the greatest bar to economic development for border cities. U.S. border cities are characterized by lower incomes, lower educational attainment, and less adequate infrastructure when compared with interior cities of similar size. In the United States, however, more state and federal aid is usually available, and the requirements are greater for the provision of safe drinking water, sewerage disposal, and the like. Border cities on the U.S. side of the international boundary have managed to cope with growth for the most part, while Mexican cities have been overwhelmed.

Population growth in Mexican cities along the international border has not been accompanied by a concomitant growth in housing, water and sewage capacity, public

transportation facilities, and other amenities that contribute to functional urban communities. The lack of infrastructure development in Mexican border communities is a function of the unitary political and tax structures of the Republic. Mexico has embarked upon an ambitious program of privatizing some elements of the necessary infrastructure, but states and cities (municipios) in Mexico have deficient abilities to raise funds for local needs.

Wages

Since maquilas are generally dependent on the labor cost differential between the United States and Mexico, the wage structure of labor is critical to considerations of the location and use of the maquila concept. Although the wage structure of the maquila program is usually determined by the minimum wage published by the National Salary Commission in Mexico City, that published minimum wage structure does not, in fact, bear much relationship to the actual wages paid to workers, especially once an initial training and acclimation period has passed. The perpetuation of the Solidarity Pact by the Salinas Administration has reduced the wage spiral despite Mexico's 20 percent inflation rate 2 years ago, and 11 percent last year. This year, the government is attempting to keep the inflation rate below 10 percent. The Solidarity Pact has targeted salary increases of less than 7.7 percent for assembly workers, and less than 10 percent for supervisors as a measure to hold the inflation level to the target figure.

The last significant change in the minimum wage rate was in January, 1993, when the rate was adjusted by some 7.6 percent. At present, the minimum rate for the border municipalities is $5.05 per day; Chihuahua and other interior municipalities are pegged at $4.21 per day. The published minimum wage bears scant relationship to the actual average wage paid. Actual wages paid, as might be expected, varies by location according to the prevailing wages in each area (see Table 4.6). For instance, Matamoros maquilas are heavily unionized while Cd. Juarez is not. Data on actual wages in Chihuahua could not be found, but inferential data from interviews in that city indicated that costs for direct labor were somewhat less than those for Ciudad Juarez, and that salaries for technicians and administrative personnel were comparable. In the Monterrey metropolitan area, including Saltillo and Guadalupe, salaries for direct labor (assembly workers), technicians and administrative are somewhat lower than is the norm for border municipalities in Tamaulipas and Chihuahua. Actual averages are significantly in excess of published minimum wages, although far below the norms in the United States. According to private wage surveys performed for maquilas in Cd. Juarez, wages paid by the maquilas are comparable to those paid in the service sector of that city, and somewhat below domestic industries. These data reinforce the perception of maquila managers and human resource personnel that the direct labor component in the maquila industry is an entry-level labor cohort.

Table 4.6. Maquiladora wages including benefits (dollar per hour)

Location	Year	Direct Labor	Technicians	Administrative
Coahuila				
Cd. Acuna	**1988**	0.86	2.06	2.47
	1989	1.06	2.27	3.08
	1990	1.21	2.7	3.75
	1991	1.37	3.09	4.4
	1992	1.61	4.03	5.03
	1993 (1)	1.8	4.73	5.64
Piedras Negras	**1988**	0.68	1.42	2.17
	1989	0.82	1.79	2.13
	1990	0.9	2.08	2.94
	1991	1.18	2.97	3.65
	1992	1.4	3.4	3.89
	1993	1.58	-	4.13
Chihuahua				
Cd. Juarez	**1988**	1.05	2.61	4.49
	1989	1.22	3.25	5.49
	1990	1.29	3.33	6.33
	1991	1.49	3.49	6.8
	1992	1.76	4.41	7.78
	1993	2	5.02	8.83
Tamaulipas				
Matamoros	**1988**	1.31	3.37	4.36
	1989	1.57	4.31	5.23
	1990	1.91	4.78	5.78
	1991	2.38	5.31	6.85
	1992	2.93	6.41	7.88
	1993	3.4	7.15	8.86
Nuevo Laredo	**1988**	0.98	2.85	3.84
	1989	1.04	3.49	7.63
	1990	1.12	3.71	8.21
	1991	1.43	4.2	8.52
	1992	1.65	4.41	10.84
	1993	1.84	4.88	12.03

(1) All 1993 data is projected.

Source: CIEMEX-WEFA.

As a component of this research effort, the relationship between the rise in the minimum wage rate and the historical average (since 1987) of actual wages according to CIEMEX-WEFA,

the most authoritative source for that data, was examined. Also examined was a privately published wage survey for Ciudad Juarez to conduct an in-depth study of that city. Based on these data sources, it is reasonable that the conclusions drawn from study of Ciudad Juarez can be generalized to the other cities in the study group, and that those conclusions will prove valid for the other cities.

In the United States, compensation to workers is primarily a function of labor availability at various skill levels. In Mexico, however, the Solidarity Pact of the Salinas government has instituted a set of wage and price controls similar to that attempted by the Nixon Administration in the United States in the 1970s. The Pact has been adhered to in Mexico, with the unions under Fidel Velasquez (CTM, the largest union organization affiliated with the PRI, the dominant political party), the business sector and the maquila industry moderating wage increases despite the inflation rate. Based upon data gathered for Ciudad Juarez, most maquilas in that city use the minimum wage rate as a benchmark for their Mexican employees. When the National Salary Commission mandates an increase in the minimum wage, almost all salaried workers receive an equivalent increase. After the November, 1991, increase in the minimum wage, 63 percent of companies surveyed in Ciudad Juarez granted salary increases of 10 to 15 percent, both direct and indirect, to workers who were above the minimum wage rate. Fifty-seven percent, both direct and indirect, granted equivalent increases to workers who were above the minimum wage rate. Fifty-seven percent of the survey respondents indicated that the rise in the rate influenced the timing and amount of increases. Private wage surveys for Cd. Juarez reflect this factor.

The extreme fluctuations in the value of the peso to the dollar make it difficult to derive a valid statistical picture of the relationship of the minimum wage to the actual average wage. The daily minimum salaries, as directed by the National Salary Commission, are listed in Table 4.7. The figures in the table are given in dollars, and represent the value of the peso to the dollar at the time of the increase. Since 1987, the differential in minimum wages in border cities has been generally eliminated. However, as an incentive to locate in interior cities, the wage rate in the interior is generally lower.

Table 4.7. Daily minimum salary, as directed by the National Salary Commission

Date	Location	Amount ($)
December, 1987	Baja California	4.60
	Nogales	4.55
	Juarez	4.55
December, 1988	All Locations	3.21
December, 1989	All Locations	3.52
December, 1990	All Locations	4.02
December, 1991	Border Cities	4.19
	Chihuahua	3.49
December, 1992	Border Cities	4.69
	All Others	3.91
January, 1993	Border Cities	5.05
	All Others	4.21

While the Solidarity Pact is in effect, the probability is that wage increases mandated by the National Salary Commission will be moderate and somewhat below the inflation rate. The wages for administrative and technical personnel can be expected to rise at somewhat above the rate of inflation, given the relative scarcity of trained personnel in those categories. The wage differential in these categories is much greater than that found in the direct labor category, reflecting the competition for these workers. Wages for highly trained, experienced Mexican nationals in management and engineering professions are approaching the wages for similar skills on the U.S. side of the border.

Generally, salaries for U.S. border cities are lower than in other areas of the country, but significantly higher than for Mexico. As companies attracted to the maquila program begin to migrate to the Mexican interior, wage rates in those areas can be expected to approximate those in border areas, as predicted by Dr. Elias's maquila development process.

The difference between the value of the peso and the dollar is a crucial variable in projecting whether wages will rise in real terms in the near future. Mexico has been using its scarce foreign exchange earnings to support the value of the peso. Many observers in the United States and Mexico believe that the support the peso has been receiving has again caused it to be overvalued. As of April 29, 1992, the peso was valued at 3.09 (New Pesos) to the dollar; the true value, according to some economists, should be closer to 3.5 (New Pesos) to the dollar. The Mexican Central Bank allows the peso to devalue at the rate of 20 centavos (0.2 pesos) per day. The support the peso has been receiving has induced confidence in investors, especially in the stock market, at the expense of Mexico's exporters. Political observers in Mexico expect the Salinas government to continue to support the peso, and to perpetuate the peso's slow devaluation rather than allowing another market-driven adjustment which might result in weakened confidence in the government before the 1994 elections.

Toll Facilities in Mexico

Mexico has embarked upon an ambitious program of infrastructure development. The cornerstone of that program is the privatization of infrastructure where feasible and cost effective. A number of toll roads are under construction or in operation. In Samalayuca, south of Ciudad Juarez, an electricity generating plant is under construction with private funds. Other electricity generating plants have been financed privately in the northern tier states. Despite protests from some elements of the political opposition, the Salinas government is committed to constructing infrastructure by granting franchises to private sector interests allowing those interests to construct facilities and to collect tolls or fees from individuals and companies using the facilities.

In the state of Chihuahua, a toll road is open between the two major metropolitan areas of that state, the state capitol of Chihuahua and Ciudad Juarez on the border at El Paso. The consortium which built that toll road charges the tolls mentioned in section 6.2.3 of Report 1976-1, Condition of Major Mexican Roads. On a per mile basis for automobiles, the tolls charged are

not excessive by American standards, but for Mexicans they are a significant cost. For freighters, the toll charges represent a significant cost which must be reflected in their rate structures. The median charge we found for carrying a full load of maquila goods in the El Paso area (in dollars) was as follows:

Torreón, Coah-El Paso, TX $1,300
Durango, Dgo- El Paso, TX $1,400
Chihuahua, Ch-El Paso, TX $550

The typical charge to cross a truck from El Paso to Juarez is between $75 and $90 one way. On average, then, the per-mile charge for tractor-trailer drayage in Mexico exceeds $2 per mile, far in excess of the intra-state rates in Texas, and greatly exceeding the more competitive inter-state rates in the United States. Transportation cost to and from the interior cities is a significant cost of doing business for maquila plants, and may obviate any labor savings attributable to the lower average wage structure in the interior cities for direct labor.

Much the same situation exists in the Monterrey-Nuevo Laredo corridor. Monterrey and Nuevo Laredo are approximately 200 kilometers apart (125 miles), with Saltillo some 80 km (50 miles) from Monterrey. The average freight charges for a fully loaded tractor-trailer that were quoted are as follows:

Monterrey, N.L.- Laredo, TX = $460
Saltillo, Coah-Laredo, TX = $510

The automobile charges for the tollway between Nuevo Laredo and Monterrey are listed in section 6.2.3 of Report 1976-1, "Condition of Major Mexican Roads."

The companies owning and operating the toll facilities are required to obtain permission from the Mexican government to raise the tolls. The tolls per kilometer planned for the Monterrey-Laredo corridor ($0.11 for cars and pickups, $0.37 for five-axle trucks) are somewhat lower than those in the Chihuahua-Ciudad Juarez region ($0.14 for cars and pickups, $0.65 for five-axle trucks), reflecting the shorter distance between the cities, and also the number of alternatives available in the more heavily populated, more compact Tamaulipas region. Costs of trans-border shipments between Laredo and Nuevo Laredo are higher than those in the Ciudad Juarez/El Paso region, ranging from $100 and up per crossing.

A significant cost of transportation for maquila plants and others is the toll charged to use bridges spanning the Rio Grande in the twin communities. To cross from Mexico to the United States, the standard at publicly owned bridges is $2.00 for cars and up to $20.00 for trucks. CAPUFE sets the toll and collects the funds. Local and state governments receive very little of the funds collected. On the U.S. side, a variety of owners exist, who set toll charges on their respective bridges.

Conclusions

The essential nature of the success of the maquila program from the production standpoint is the advantage which accrues to a manufacturer from the lower cost structure of labor in Mexico. The cost structure in Mexico for land, buildings, and equipment is higher, and

transportation costs are much higher. On the whole, the available workforce is productive but skill levels, training levels, and educational attainment are much lower than is the norm in the United States. Competition from the Far East drives the movement into Mexico for American and European manufacturers competing in the North American market. That competition for profits and market share, absent an extreme protectionist posture on the part of the Clinton or subsequent U.S. governments, will accelerate as more entries into the North American market occur. Therefore, production in Mexico will continue to be a viable strategy for Mexico into the future for many manufacturers, particularly those serving the price conscious consumer market.

Ciudad Juarez, the leading city for maquila production, is effectively saturated in its ability to sustain any significant additional growth in its maquila development. Border cities in the state of Tamaulipas can sustain additional growth, but their respective saturation levels (from the standpoint of infrastructure availability and work force availability) will be reached within the next 3 to 5 years. The opportunities for growth are in the interior of Mexico, and particularly in the northern tier of states. Baja California and Sonora in the west will continue to attract maquila production oriented to the huge consumer markets on the West Coast. The state of Chihuahua will continue to attract new maquila development, particularly in the region surrounding the city of Chihuahua. The greatest growth, however, will be in the communities surrounding Monterrey and on the east coast of Mexico. Despite the prevalence of unions and the threat of strikes in the state of Tamaulipas, and to a lesser extent in Coahuila, the access to markets in the United States and Mexico that the region affords will make it the most attractive growth area for new maquila development. Maquila development in the Lower Rio Grande region will have significant impacts on the already overburdened transportation facilities, particularly within the IH-35 corridor. Table 4.8 shows the U.S. imports from Mexico by Texas Customs Districts. The vast majority of goods flowing between the two nations goes through the Laredo Port of Entry, which encompasses the ports from Eagle Pass and Del Rio down to Brownsville.

Table 4.3 shows the pattern of value added by maquilas in the various subject cities. It shows that the states of Nuevo Leon and Tamaulipas add the most value per employee, an indication of the wage structure to some extent, but more importantly an indication of the higher technology used in the newer maquilas located in those states. The value added figures show that labor intensive, low skilled assembly maquilas are moving to smaller communities, and can exist where infrastructure is less developed. The more technology intensive industries require more developed infrastructure and a higher degree of support services, and are congregating in more developed areas, particularly in the Monterrey metropolitan area where a higher level of support services has developed to service the domestic industry there.

Projections of maquila growth have the numbers of plants and employees doubling by 1997 (CIEMEX-WEFA 1993, 51). To absorb an additional 2,000 plants and another half a million workers, Mexico will be required to develop its infrastructure more rapidly than it is presently capable of doing, and will therefore be required to accelerate its privatization program to keep pace with demand.

Table 4.8. U.S. imports from Mexico by Texas customs districts

Customs District	Year	Total Value	Percentage of Texas Custom District Total	Percentage of US Total
Port Arthur	1989	562,882,728	3.59%	2.12%
	1990	333,864,754	2.04%	1.13%
	1991	275,277,926	1.58%	0.90%
	1992	473,567,104	N/A	N/A
Laredo	1989	9,646,484,144	58.60%	34.61%
	1990	9,804,074,733	59.84%	33.23%
	1991	10,179,902,120	58.51%	33.44%
	1992	11,686,750,232	N/A	N/A
El Paso	1989	4,892,859,212	31.19%	18.42%
	1990	4,860,621,033	29.67%	16.47%
	1991	5,315,079,806	30.55%	17.46%
	1992	6,313,608,974	N/A	N/A
Houston	1989	872,431,408	5.56%	3.29%
	1990	1,242,118,727	7.58%	4.21%
	1991	1,487,127,333	8.55%	4.88%
	1992	N/A	N/A	N/A
Dallas	1989	164,843,989	1.05%	0.62%
	1990	142,581,199	0.87%	0.48%
	1991	141,366,889	0.81%	0.46%
	1992	N/A	N/A	N/A
Total Texas Customs Districts				
	1989	15,684,956,670	-	59.06%
	1990	16,383,260,446	-	55.53%
	1991	17,398,754,952	-	57.15%
	1992	18,473,926,310	-	N/A
US Total				
	1989	26,556,570,062	-	-
	1990	29,505,961,952	-	-
	1991	30,445,130,805	-	-
	1992	40,597,450,961	-	-

Source: US Customs

Much of the capital required for infrastructure development will have to come from foreign sources, primarily in the United States. If Mexico remains politically stable, the risk quotient will remain acceptable. Much of the risk potential revolves around passage of the North American Free Trade Agreement. With passage of NAFTA, it will be much more difficult for the successor to President Salinas to reverse the provisions of the treaty and return to a more protectionist posture.

With NAFTA, transportation costs in Mexico will be greatly reduced through increased competition and higher demand. Transportation costs in Texas and in its neighboring Mexican states will be one of the first to reach a comparable level, as NAFTA allows much greater freedom of access after the first 3 years. Consequently, both U.S. and Mexican freight companies will have to be more cognizant of the competitive rates charged. It is not necessarily true that Mexican companies will have the advantage. The interest rates for capital and tax structure in Mexico is not competitive vis-`a-vis Texas, and given an equal chance to compete, Texas haulers will gain a more significant market share for trans-border drayage. Passage of NAFTA will have a significant impact on intra-state transportation, as more international and interstate business is generated.

THE ECONOMICS OF NAFTA: THE TEXAS-MEXICO CONNECTION

Macroeconomic Picture in Mexico

The gross domestic product (GDP) of Mexico, which had been growing consistently at a real annual rate of about 6 percent for some 40 years, declined sharply starting in 1982 (see Figure 4.1). The triggering event was the foreign debt crisis, but the seeds of decline had been planted many years earlier during the years of the growth "miracle."

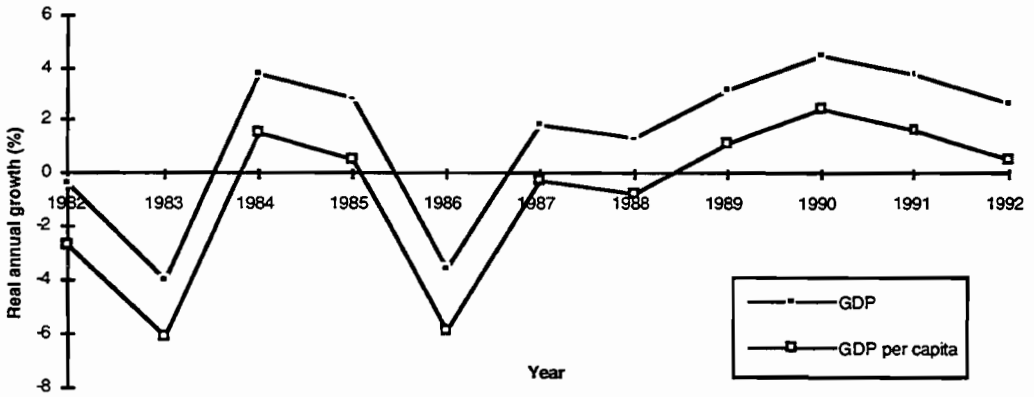


Figure 4.1. Annual change in Mexico's GDP

The earlier growth was based on a strategy of looking inward within Mexico for economic stimulus. The import substitution model that was begun in the 1930s and then reinforced in the period following World War II encouraged the establishment of industries behind protective walls of high tariffs and nontariff barriers. The main barrier was the use of import licensing. When a license was denied, a legal import was not possible. These border barriers were augmented by the use of domestic content provisions; that is, the requirement that specific proportions of the value of products produced must be composed of raw materials and intermediate products made in Mexico, and insistence that foreign investors export given proportions of their production. The domestic-content provisions meant that Mexican producers were unable to use the highest quality or the most economical inputs. Thus, when coupled with the import protection provided to producers, Mexican exporters of manufactured goods were generally not competitive in world markets, even though they were allowed to dominate the national market.

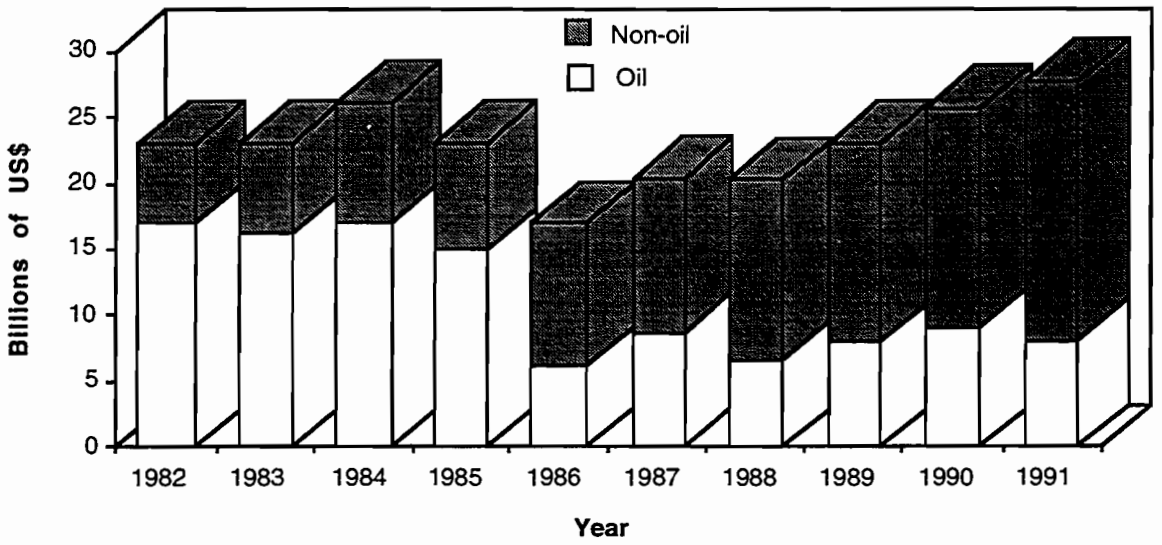
During the latter half of the 1970s, when production from recently discovered oil wells combined with high world prices, revenue from oil exports dominated Mexico's foreign trade. The country also went deeply into debt because lenders were quite prepared to provide funds based on the assurance of oil in the ground. The bubble burst when oil prices fell in the early 1980s. This came together with a rise in world interest rates, particularly as the United States tightened monetary policy as an anti-inflationary device.

Real GDP growth in Mexico, which was 9.1 percent in 1980 and 8.8 percent in 1981, fell in 1982 to minus 0.6 percent and then to minus 4.2 percent in 1983. Per capita income in Mexico declined by about 15 percent between 1982 and 1988. Changes in economic strategy were instituted modestly after 1983 and then accelerated after 1986, when Mexico joined the General Agreement on Tariffs and Trade, and even more after 1988, when Carlos Salinas de Gortari became president.

The main elements of the post-1988 policy were the following: Import protection was sharply reduced. Import tariffs, which were often in excess of 100 percent, were lowered to a trade-weighted average of 10 percent ad valorem, with a range of zero to 20 percent. Most import license requirements were abolished. Foreign investment, which earlier was tolerated and subjected to domestic content provisions and export performance requirements, was invited. Foreign equity, which legally was generally limited to 49 percent, was welcomed at 100 percent. The public sector deficit, which reached 16 percent of GDP in 1986, was gradually reduced. There was a surplus in financial accounts of the public sector (the public sector borrowing requirement) in 1992. This was a crucial element in the reduction of inflation from 150 percent on an annual basis in 1986 to less than 12 percent in 1992. Monetary policy was prudent, again in the interest of reducing inflation. Many government-owned enterprises were privatized, including the telephone company (Teléfonos de México) and the commercial banks.

The import opening was designed to instill competition in the domestic economy and encourage exports of manufactured goods by reducing the cost of necessary inputs. Manufactured products, which accounted for less than 20 percent of the value of export earnings

early in the 1980s, now account for the majority of export earnings. The culmination of this nonoil export-led drive was Mexico's initiative for a free-trade agreement with the United States. Under this, most remaining tariffs would move to zero percent over 10 to 15 years, import licensing would disappear, as would domestic-content and required export provisions.



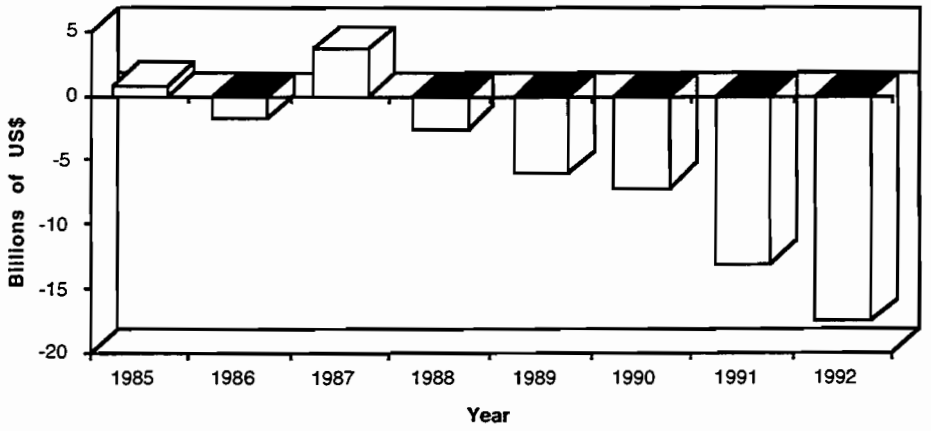
Source: Bank of Mexico

Figure 4.2. Mexico's oil and non-oil exports

Mexico's real GDP growth began to pick up in 1989, when it reached 3.3 percent. This increased to 4.4 percent in 1990, and then fell back in 1991 to about 3.6 percent. Forecasting growth in the years ahead must take into account a number of competing objectives of Mexican economic policy.

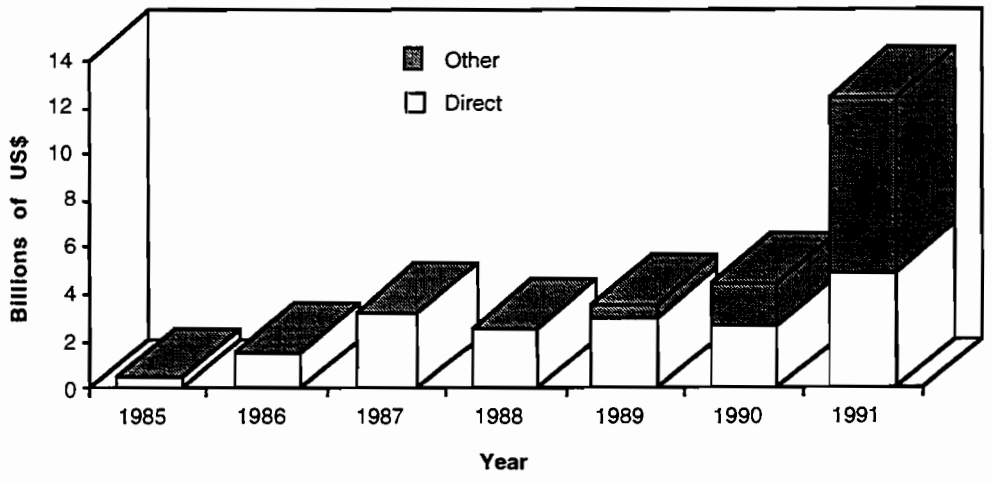
The anti-inflation program of Mexico has been based since 1987 on a series of *pactos* (pacts, or agreements) among the government, business, and labor. The government's contribution has been an austere fiscal policy and prudent monetary policy. Business has agreed to price limitations and labor to limited wage increases. In addition, the exchange rate has not been depreciated to the full extent of the difference in inflation between Mexico and the United States, which would be required if the real relationship between the peso and the dollar were to remain constant. Consequently, the peso has become overvalued in recent years, putting a burden on exporters and encouraging imports. The reason for this exchange-rate policy is to bring inflation to the one-digit level in 1993 and then to roughly the U.S. level in subsequent years. One consequence of an overvalued peso is the need for high real interest rates, which are close to 10 percent compared with 2 or 3 percent in the United States. The high real interest rate is designed to attract capital and dampen capital flight that might otherwise accompany an overvalued currency.

Real GDP growth was only 2.6 percent in 1992. The Mexican authorities deliberately constrained GDP growth last year for two reasons. The first reason was to reduce inflationary pressure. The second was to slow down the rate of imports. Mexico's current account deficit in the balance of payments was roughly $20 billion in 1992, about 7 percent of GDP. While this was financed by capital inflows, a deficit of this magnitude is precarious. Because the growth in imports can be explained largely by the increase in Mexico's GDP, dampening economic growth should act as a brake on imports.



Note: 1992 estimate based on first nine months
Source: Bank of Mexico

Figure 4.3. Mexico's current account balance of payment position



Source: Bank of Mexico

Figure 4.4. Private foreign investment flows into Mexico

The Mexican authorities had a number of options, but the choice for 1992 was clear. This was to put greatest emphasis on containing inflation and reducing the current account deficit and lesser emphasis on GDP growth. This priority is being followed so far in 1993 as well. The rationale is that sustainable growth is best achieved in a noninflationary environment. However, 1994 is a presidential election year and there is speculation that the anti-inflation priority may be downgraded modestly in favor of GDP growth. This could entail a large, one-time real depreciation of the peso and lower interest rates, accompanied by some sacrifice of fiscal austerity. The high probability, however, is that current priority will continue because too much sacrifice has gone into reducing inflation to discard this goal at the very moment it is reaching its climax.

Thus, short term growth in GDP is apt to be modest, perhaps 3 percent in 1993 and marginally higher in 1994. Over the longer term, if the anti-inflation drive accomplishes its objective of low, single-digit increases in consumer prices, GDP growth can accelerate to 4 and then 5 percent a year or more. This will require some adjustment in later years in the exchange rate or, alternatively, substantial increases in productivity which would accomplish much the same objective.

If the anti-inflation objective is discarded for 1994, GDP growth could accelerate immediately to between 4 and 5 percent, but then face an uncertain path in subsequent years. This is because the Mexican authorities would have to choose between continued high GDP growth accompanied by double-digit inflation, or once again making an effort to bring inflation down to a single-digit. The latter would then be an uphill battle because once the anti-inflation priority were discarded, expectations would have been built in that this objective was hostage to political convenience. This is another reason to expect continuation of current anti-inflation policy into 1994 and subsequently.

The Macroeconomic Impact of NAFTA

Mexico's ability to integrate its economy with that of the United States and Canada under the proposed North American Free Trade Agreement (NAFTA) is the result of the economic reforms undertaken pursuant to the change in development philosophy during the 1980s. NAFTA, therefore, should be seen as a complement to the domestic economic program, rather than as the essence of Mexico's economic strategy.

NAFTA, if approved, is scheduled to come into effect on January 1, 1994. Based on static general equilibrium economic modeling, this is expected to add up to 8 percentage points of increase to Mexican GDP by the end of the decade. This is another reason why it is reasonable to project real GDP growth in Mexico to accelerate to more than 4 percent a year by the mid-1990s and 5 percent a year by the end of the decade. Dynamic general equilibrium models forecast even more dramatic rates of GDP growth, perhaps as much as three-quarters of a percentage point a year over what would otherwise occur. Because U.S. exports to Mexico are determined primarily by Mexico's growth rate, these projections imply significant increases in U.S. exports.

There have been scores of studies on the effects of NAFTA on each of the three countries — Canada, Mexico, and the United States. These range from informed qualitative analysis to sophisticated computable general equilibrium models, or CGE studies. In addition, there have been many studies of the effects in specific sectors. The various studies come to different conclusions. The main conclusion of practically all the CGE studies is that the short-term effect of NAFTA on U.S. income and employment will be modest, but positive. The main reasons for this are that U.S. import barriers are already quite low — U.S. import tariffs on Mexican products average around 3.5 percent ad valorem — and because the Mexican economy is only about 1/25th the size of that of the United States.

Mexico purchases around 70 percent of its imports from the United States. Much of this takes the form of sales of intermediate products from a U.S. parent company to a subsidiary in Mexico. As the Mexican economy has grown in recent years, U.S. exports of capital goods to fuel Mexico's expanding manufacturing industries have also grown substantially. U.S. exports to Mexico were more than $40 billion in 1992, almost $25 billion more than in 1986, the year before the Mexican economy began its recovery from the collapse that began in 1982.

Most analyses of NAFTA by academic economists conclude that while Mexico will benefit most from NAFTA, largely because it starts from a much lower economic level, the United States will benefit as well, modestly in the short term, more substantially in the longer term. The comprehensive studies by U.S. government agencies, for example, those of the United States International Trade Commission (ITC), reach the same general conclusions as found in most academic studies.

In addition to projections about the effect of NAFTA on the U.S. economy as a whole, there are many studies of specific sectoral effects. Indeed, the CGE models are built up from sectoral analysis. The sectoral studies show winning and losing sectors. The conclusions of the ITC study can be summarized as follows: sectors in which the trade outcome of NAFTA should be favorable to the United States are grains and oilseeds, meat, chemicals, machinery and equipment, electronic equipment, textile mill products, alcoholic beverages, banking and insurance, and telecommunications; sectors in which Mexican export growth is likely to exceed that of the United States are horticultural products, household glassware, and finished apparel; and sectors in which trade changes as a result of the liberalization under NAFTA are either indeterminate or expected to be negligible are autos and auto parts, steel, cement, and energy. The sectoral studies also make clear that the effects will differ across regions of the United States.

Overall Effects of NAFTA on the Texas Economy

According to the U.S. Department of Commerce, Texas ranks first among the 50 states in exports to Mexico. (This statement and the other data in this paragraph come from the publication of the International Trade Administration, U.S. Department of Commerce, *U.S. Exports to Mexico: A State-by-State Overview, 1987-1990*, August 1991.) Table 4.9 presents Texas' leading exports to Mexico in 1991. Production originating in Texas, according to the

U.S. Department of Commerce, amounted to $13 billion in 1990, or 46 percent of all U.S. merchandise exports to Mexico that year. The Mexican market accounted in 1990 for 32 percent of all of Texas' exports. As the Mexican economy started to grow in 1987, following the drastic downturn of the previous five years, Texas captured 50 percent of the export growth from the U.S. to Mexico. Table 4.10 includes the fastest growing Texas exports to Mexico, 1989-1991.

Table 4.9. Texas' leading exports to Mexico: 1991

Goods-Producing Sector	SIC	Exports (in thousands of $)
Elec. Components, Accessories	367	$995,135
Aircraft & Parts	372	891,803
Communications Eqpt	366	663,318
Motor Vehicles & Eqpt	371	611,309
Agriculture—Crops	001	546,414
Non-Fer. Rolling/Drawing	335	514,528
Railroad Equipment	374	437,407
Misc. Elec. Mach. & Supplies	369	410,710
Audio-Video Equipment	365	409,391
Construction Equipment	353	405,654
Industrial Organic Chemicals	286	366,308
Lighting & Wiring Eqpt	364	338,044
Computer & Office Equipment	357	280,945

The data from the U.S. Department of Commerce are estimates because U.S. Customs does not keep track of the state of production of goods that are exported. Without deep tracing, the data would be inexact in any event because just as there is co-production between U.S. and Mexican firms, so is there co-production of goods within the United States. The Commerce data are pieced together from Census Bureau tapes from shippers' export declarations. Even if the Texas share of U.S. exports to Mexico is overstated — and we do not know that this is the case — it is clear that Texas is the big winner among the states as the Mexican economy grows.

Of the approximately $13 billion of Texas merchandise exported to Mexico in 1990, about $12.5 billion were manufactured goods and most of the remainder was agricultural crops. Of the manufactured goods, the five leading export categories according to the U.S. Department of Commerce were electric and electronic equipment, transportation equipment, computers and industrial machinery, chemicals, and primary metals. The leading Texas exports dovetail quite well with the sectors that the ITC projected would be the main U.S. export beneficiaries of NAFTA.

Table 4.10. Fastest growing Texas' exports to Mexico: 1989-1991

Goods-Producing Sector	SIC	1991 Exports (1,000s)	% Growth
Oil & Gas	013	$100,899	9050
Household Furniture	251	55,183	370
Misc. Furniture	259	249,532	370
Office Furniture	252	73,418	370
Asphalt Paving/Roofing	295	52,383	350
Misc. Petroleum Products	299	12,949	350
Petroleum Refining	291	273,133	350
Iron & Steel Foundry Products	332	196,905	300
Non-Fer. Rolling/Drawing	335	514,528	300
Rolled & Finished Steel	331	253,976	300
Non-Fer. Casting	336	133,836	300
Secondary Non-Fer. Refining	334	3,350	300
Primary Non-Ferrous Refining	333	280,226	300
Misc. Primary Metals	339	10,158	300
Misc. Transportation Eqpt	379	152,010	250
Aircraft & Parts	372	891,803	250
Railroad Equipment	374	437,407	250
Shipbuilding & Repairing	373	143,971	250
Motor Vehicles & Eqpt	371	611,309	250
Motorcycles, Bicycles, Parts	375	19,739	250

Researchers at the LBJ School of Public Affairs (University of Texas at Austin) have been engaged in a series of studies of NAFTA impacts on the Texas economy. (See for example: U.S.-*Mexico Free Trade Agreement: Economic Impact on Texas,* U.S.-Mexican Policy Studies Program, LBJ School of Public Affairs, University of Texas, 1992; and Jan Gilbreath Rich and David Hurlburt, *Free Trade with Mexico: What's In It for Texas?*, U.S.-Mexican Policy Studies Program, 1992.) One of the modeling exercises developed in these studies looks at how Texas exports to Mexico stand to increase on a detailed sector-by-sector and regional basis as tariff barriers are reduced and as Mexican GDP grows. Some limitations of the fairly conservative baseline exercise reported here include the following:

(1) The model only addresses the goods-producing sectors (agriculture, mining, and manufacturing),

(2) It focuses exclusively on direct spending and employment effects,

(3) It ignores the effects Texas investment in Mexico may have on the Texas economy,

(4) It does not factor Canada, Texas' second largest trading partner, into the analysis,

(5) Unlike CGE models, the LBJ School model does not explicitly account for price and other structural market adjustments that may take place under NAFTA,

(6) Finally, the model does not factor in the effects increased Texas imports of Mexican goods may have in competing with domestic production and thereby displacing local economic activity.

The first three of these caveats again imply that the LBJ School model understates the effects of NAFTA on Texas. The most critical is the first point. Distribution services, producer services, selected professional services, and retail and wholesale activities are all extremely important to the Texas economy, accounting for around 70 percent of Texas' Gross state Product. It is clear that those segments of these economic activities that are tightly linked to agriculture, mining, and manufacturing will also enjoy significant economic benefits from NAFTA above and beyond the modeled forecasts.

CGE models have the advantage over the LBJ School model of being able to incorporate investment effects, prices, certain structural adjustments, and, in a few cases, the impacts on all three signatory countries. They do so, however, at the cost of significantly greater aggregation of sectors and prices as well as at the cost of imposing controversially stylized market behavior (perfectly competitive markets, instantaneous adjustments, etc.).

The import side of the effect of NAFTA on Texas is difficult to incorporate explicitly into current models. However, initial analysis implies that the ratio of employment created by NAFTA to employment lost or displaced to be on the order of 6-to-1. The overall conclusion that NAFTA will have a positive effect on the Texas economy remains unaltered.

The LBJ School Model of NAFTA impacts on Texas shows that the leading sectors with the most to gain from liberalized trade with Mexico include aircraft and parts, electrical components and accessories, communications equipment, auto parts, and non-ferrous drawing and rolling. The model forecasts a 36.5 percent increase in overall Texas trade with Mexico over the 10-year period, most of which is driven by an average of 4.7 percent growth in Mexican GDP. Since many recent Texas exports to Mexico consist of capital goods for which Mexico has been starved for many years, some economists argue that we can expect to see export growth coming down as a certain level of saturation is felt in Mexico for basic production equipment. This is consistent with the modeled results.

As the results show, the 36.5 percent anticipated growth in exports translates into approximately $8.3 billion of direct increased spending (in 1991 dollars) over the period and into 182,000 new jobs between 1994 and 2003. To put this in perspective, this level of employment creation is equivalent to approximately 2.6 percent of Texas' current workforce. While this may seem small, it is difficult to identify other policy innovations that can compete with NAFTA in terms of creating employment in Texas in the 1990s.

The industries identified as gaining the most through NAFTA under the LBJ School baseline model closely match the predictions of most NAFTA studies. While comforting, this is

hardly surprising. In light of factor endowments in Texas and Mexico, the economic theory of comparative advantage would anticipate that Texas' advantages lie in the production of high value-added goods that tend to lie on the early side of the product cycle, depend on a relatively highly educated and skilled workforce, are closely linked to research and development efforts, and are influenced by modern production and inventory practices. This contrasts significantly with the kinds of economic activity over which Mexico can expect to enjoy distinct competitive advantages in the short- and medium-run: These are lower-value added goods that tend to lie on the tail end of the production cycle, are characterized by standardized production processes, and are goods in which labor costs are relatively large.

*Table 4.11. NAFTA impact on exports and employment in Texas: 1994-2003**

Sector	Total Export Growth (1,000s)	New Jobs
Aircraft & Parts	$581,700	12,800
Elec. Components, Accessories	$455,100	10,000
Communications Eqpt	$397,000	8,700
Motor Vehicles & Eqpt	$375,800	8,300
Non-Fer. Rolling/Drawing	$296,400	6,500
Audio-Video Equipment	$238,500	5,200
Misc. Elec. Mach. & Supplies	$230,000	5,100
Agriculture—Crops	$218,400	4,800
Misc. Furniture	$191,400	4,200
Construction Equipment	$189,800	4,200
Railroad Equipment	$188,400	4,100
Lighting & Wiring Eqpt	$178,000	3,900
Misc. Mfg., Tobacco, Scrap, etc.	$175,600	3,900
Refrig./Laundry/etc. Eqpt	$174,100	3,800
Electrical Indust. Eqpt	$128,300	2,800
Computer & Office Equipment	$122,900	2,700
Primary Non-Ferrous Refining	$120,700	2,700
TOTALS	**$8,264,900**	**182,000**

*Preliminary results of the LBJ School of Public Affairs Model of NAFTA Impacts, February 1993. Assumes Mexican GDP grows gradually by 3% to 6% over the period.

One area of export potential that the LBJ School baseline model may be shortchanging is Texas natural gas exports. U.S. natural gas exports to Mexico have grown dramatically in recent years. In large part, this increased demand is driven by growing sensitivity of Mexican policymakers to concerns about the environment. Clean-energy alternatives like natural gas have much to offer Mexico's efforts toward establishing sustainable development strategies. By some measures, natural gas is already California's largest export to Mexico. The U.S. Department of Energy is currently facing some two dozen petitions for permission to develop cross-border natural gas pipeline connections. To the extent that these patterns continue to develop in the future, the LBJ School model projections fall short in this important petroleum-related sector.

Significantly enough, the general kinds of economic activity that the LBJ School model and others identify as being especially favored under NAFTA tend to be those activities that have already taken—or are in a good position to take—advantage of the near-revolutionary changes that have been occurring in modern manufacturing over the past decade. These changes include the widespread diffusion of: Just-in-time production, delivery, and inventory systems; total quality management techniques; concurrent engineering; and other features of flexible production generally drawn from Japanese experience.

All these innovations rely heavily on dependable transportation, telecommunications, informatics, and educational infrastructure. The important point here is that Mexico lags far behind Texas and the United States in its ability to guarantee reliable infrastructure, and will continue to lag behind for many years to come. As a corollary to this, the benefits of NAFTA to Texas can be expected to unfold more slowly over time—and with greater frictional adjustments—than many people seem to be willing to acknowledge. The lesson for the private sector in the United States is that the greatest payoffs of doing business in Mexico will accrue in the long term. NAFTA should not be seen as a gold mine for short-term exploitation of low-wage labor and profit-taking.

A study conducted by the Texas Comptroller of Public Accounts ("The U.S.-Mexico Free-Trade Pact: Payoffs and Tradeoffs," November 1991) reached conclusions consistent with the LBJ School studies. The Comptroller's study projected job growth in Texas from free trade with Mexico of between 3.5 and 6.0 percent between 1990 and 2000. The exact numbers are subject to question because NAFTA will not go into effect before January 1, 1994, at the earliest, but the direction of expected employment change is positive. Employment in individual sectors, such as apparel, is projected to decline, while in others, particularly those sectors whose exports to Mexico are expected to increase under free trade, employment is expected to increase.

Several of the studies gave special attention to the border. The Comptroller's study anticipated a decline in border retail trade as a result of greater competition from Mexican retailers, but a probable increase in wholesale trade on the U.S. side of the border. The LBJ School study was more ambiguous about the effects of free trade on retail sales on the U.S. side of the border. Some clarity is necessary to assess these studies. Many Mexicans now shop on the U.S. side of the border because the selection is greater and the prices of comparable goods

are lower. There are also other reasons for coming to the United States, such as health care, visiting family, acting as a tourist, and these often lead to shopping as well. However, as Mexico eliminates its import duties on wearing apparel and other retail goods, the quality of products available to Mexican consumers should rise even as prices decline for better quality goods. Mexico has it in its power to eliminate its import duties with or without free trade. Indeed, Mexico has already done so to a large extent. In addition, as Mexican incomes increase, large U.S. retailers, such as Wal-Mart, have already found it attractive to enter the Mexican market.

NAFTA, therefore, is only one aspect of competition for retail sales on the two sides of the border. Competition for the retail dollar (or peso) should increase as the markets of the two countries become increasingly integrated. Sales, therefore, will depend on the usual conditions of competition, such as variety of selection, service, quality of goods, and prices, and less on policy barriers, such as the level of tariffs and other import restrictions. As incomes rise in Mexico, as they have in recent years, this should attract many more Mexican shoppers to the U.S. side of the border for the many types of services they require. The conclusion of the Comptroller's study that wholesale trade should increase on the U.S. side should be kept in mind.

Much of the border economy on the Mexican side is now sustained by production in maquiladora plants. NAFTA will change the nature of the maquiladora system. Under NAFTA, U.S. import tariffs on goods imported from Mexico (if they meet the rules of origin spelled out in the agreement) will disappear over the transition period. Thus, maquiladora production will be at a disadvantage in tariff terms in comparison with Mexican production in general.

There are now about 2,000 maquiladora plants employing some 500,000 Mexican workers. This production on the Mexican side of the border in turn spawns U.S. jobs, perhaps 20 to 30 percent as many as on the Mexican side, to complete a variety of tasks, such as customs clearance, storage, facilitation of transportation, and provide professional and banking services. The Mexicans who earn a living from work in the maquiladora plants shop on the U.S. side. The question thus arises whether the maquiladora plants, once the tariff advantage disappears, will move away from the border.

The border offers the convenience of proximity to the U.S. market and transportation system. Being at the border permits U.S. managers to live on the U.S. side and send their children to U.S. schools. However, the border location has disadvantages. Labor turnover is higher. The physical facilities at the border are already stretched to the limit. Housing is inadequate, sewage treatment is lacking, and water is scarce.

The 1992 LBJ School study included a survey of managers of maquiladora plants. They were asked if they contemplated staying at the border or moving inland in Mexico once free trade came into effect. There was a reluctance to answer the question. The survey response rate was too low (there were 39 responses) to draw conclusions with any confidence. However, it is noteworthy that not a single manager said that a plan existed to move away from the border, although many said this might happen.

Two other aspects of the Texas-Mexico relationship merit mention. The first is that Texas is a transportation corridor, not only for goods produced in the state, but for merchandise

produced elsewhere that traverses the state. As U.S.-Mexican trade increases, Texas should be the main beneficiary state in the United States for providing transportation services.

The second issue is related to this: Where in Texas will the increases in the goods destined for the Mexican market be produced? Where in Mexico will goods destined for the U.S. market be produced and therefore what transportation corridors are most likely to be used? As the two countries integrate economically, what measures will they take to assure that the separate transport links in the two countries comprise a coherent whole?

Spatial Impacts of NAFTA on Texas

By using Texas regional gross sales as a lever, it is possible to break the LBJ School statewide forecasts down to a regional level. The level of regional analysis chosen is based on the State of Texas Uniform State Services Region Plan and balances the desire for sectoral detail with the desire to maximize regional specificity. Purely as a matter of convenience, results of the model are denominated in terms of employment gains over the period 1994-2003. A crude approximation of the direct spending equivalents of these employment impacts can be calculated by multiplying jobs gained by $46,000.

Significant for transportation planning purposes is the distinct southwestern/northwestern pattern of demand for exports destined for Mexico (and, implicitly, for imports shipped from Mexico). The LBJ School model anticipates that almost eighty percent of the employment and direct spending effects of NAFTA exports over its first decade will be captured by the Metroplex, the Gulf Coast, South Texas, and Central Texas. Since these are also the regions with the greatest concentration of population and manufacturing activity, they can also be expected to be the regions with the greatest demand for growing Texas-Mexico commerce. Given that much of this commerce crosses the border at Laredo, is land-based, and is currently concentrated along the Interstate Highway 35 corridor, the model projections for Texas-Mexico trade just beyond the turn of the century suggest growing pressure on the current infrastructure.

The summary of forecasted regional impacts suggests that by far the greatest proportion of benefits will accrue to the Greater Dallas-Forth Worth Metroplex. With approximately 20 percent of the state's population, the Metroplex is projected to gain over 40 percent of the economic benefits. The economic base of the Metroplex possesses a scale, scope, and profile that squarely matches the kinds of economic activity widely expected to be stimulated by NAFTA. A casual glance at the current shares of gross sales in the detailed sectoral breakdowns shows that the Greater Dallas-Fort Worth Metroplex dominates those goods-producing sectors of the Texas economy that produce the kinds of high value-added and relatively capital-intensive commodities that Mexico has been demanding, and will most likely continue to demand well into the future. Table 4.13 presents the impact of NAFTA on exports and employment in the Greater Dallas-Fort Worth Metroplex over 1994-2003.

*Table 4.12. Impacts of NAFTA on regional employment: 1994-2003**

Region	Direct Jobs Created	% of Total TX Jobs Gained
High Plains	2,400	1.4
Northwest Texas	900	0.5
Greater DFW Metroplex	75,600	41.4
Upper East Texas	9,700	5.3
Southeast Texas	4,800	2.7
Gulf Coast	38,600	21.3
Central Texas	12,300	6.8
South Texas	14,000	7.7
West Texas	1,300	0.7
Upper Rio Grande	2,800	1.5
Unallocated	*19,500*	*10.8*
Totals	**182,000**	**100.00**

*Preliminary results of the LBJ School of Public Affairs Model of NAFTA Impacts, February 1993. Assumes Mexican GDP grows gradually by 3% to 6% over the period.

*Table 4.13. NAFTA impact on exports and employment in the greater DFW Metroplex: 1994-2003**

Goods-Producing Sector	Total Export Growth (1,000s)	New Jobs	Current Local Share of TX Gross Sales
Aircraft & Parts	$538,300	11,800	92.53%
Elec. Components, Accessories	$336,000	7,400	73.82%
Communications Eqpt	$254,000	5,600	63.95%
Motor Vehicles & Eqpt	$222,000	4,900	59.07%
Misc. Elec. Mach. & Supplies	$139,700	3,100	60.74%
Misc. Furniture	$137,600	3,000	71.89%
Lighting & Wiring Eqpt	$101,500	2,200	57.06%
Audio-Video Equipment	$95,500	2,100	40.05%
Men's & Boys Furnishings	$83,500	1,800	84.90%
Household Appliances	$60,700	1,300	57.57%
Computer & Office Equipment	$59,900	1,300	48.72%
Refrig./Laundry/etc. Eqpt	$54,500	1,200	31.31%
Electrical Indust. Eqpt	$48,800	1,100	38.03%
Totals For Region	$3,434,900	75,600	

*Preliminary results of the LBJ School of Public Affairs Model of NAFTA Impacts, February 1993. Assumes Mexican GDP grows gradually by 3% to 6% over the period.

The Gulf Coast region, centered around Houston and Harris County, is expected to account for over 20 percent of the direct economic benefits of NAFTA stimulus to exports, a proportion roughly in line with that area's share of the state's population. These figures ignore the significant recent boost in natural gas exports to Mexico. To the extent that these trends continue—and there are a number of reasons for expecting them to do so—the goods-producing

sectors of the Greater Houston area should reap greater benefits from NAFTA than the LBJ School model suggests. Table 9.14 depicts the impact of NAFTA on exports and employment in the Gulf Coast Area over 1994-2003.

*Table 4.14. NAFTA impact on exports and employment in the Gulf Coast area: 1994-2003**

Goods-Producing Sector	Direct Export Growth (000s)	New Jobs	Current Local Share of TX Gross Sales
Non-Fer. Rolling/Drawing	$101,500	2,200	34.25%
Industrial Organic Chemicals	$95,700	2,100	80.98%
Refrig./Laundry/etc. Eqpt	$95,200	2,100	54.65%
Construction Equipment	$84,700	1,900	44.61%
Petroleum Refining	$76,100	1,700	76.53%
Misc. Mfg., Scrap, etc.	$68,700	1,500	39.11%
Electrical Indust. Eqpt	$61,400	1,400	47.87%
Gaskets, Packing, Sealing, etc.	$56,000	1,200	74.85%
Misc. Fabricated Metals	$46,700	1,000	51.56%
Electric Trans./Distn. Eqpt	$41,400	910	39.29%
Genl Industrial Machinery	$41,400	900	42.45%
Computer & Office Equipment	$39,800	880	32.36%
Plastics, Synthetics, etc.	$36,200	800	73.06%
Iron & Steel Foundry Products	$35,700	790	41.83%
Laboratory Instruments & Eqpt	$34,400	760	41.94%
Metal Cans/Containers	$34,400	760	55.96%
Rolled & Finished Steel	$31,300	690	32.46%
Elec. Components, Accessories	$31,200	690	6.86%
Household Appliances	$31,000	680	29.41%
Totals For Region	**$1,754,300**	**38,600**	

*Preliminary results of the LBJ School of Public Affairs Model of NAFTA Impacts, February 1993. Assumes Mexican GDP grows gradually by 3% to 6% over the period.

The border area as a whole comes in third according to these projections despite the fact that it accounts for over 25 percent of the state's population. This ranking also obscures the fact that a good portion of these benefits accrue to San Antonio. While San Antonio's manufacturing base is not a strong one, it is congruent enough with the consensus of NAFTA winners to pull South Texas far ahead of the Upper Rio Grande border region surrounding El Paso. The fragile manufacturing base in this latter region of Texas is heavily concentrated in the kinds of labor-

intensive, late product-cycle, standard production technology industries that are most likely to become employment generators for Mexico under NAFTA. With only 1.5 percent of Texas employment gains accruing to this area and with a mere eight industries (at the 3-digit SIC level) accounting for 73 percent of the jobs projected to be created under NAFTA, the Upper Rio Grande will need to rely heavily on its service sector (especially distribution and professional services) and on its economic links with Ciudad Juárez on the other side of the border to maximize the benefits of NAFTA. Tables 4.15 and 4.16 present the impact of NAFTA on exports and employment in South Texas and the Upper Rio Grande areas, respectively.

*Table 4.15. NAFTA impact on exports and employment in South Texas: 1994-2003 **

Goods-Producing Sector	Direct Export Growth (000)	New Jobs	Current Local Share of TX Gross Sales
Communications Eqpt	$98,100	2,200	24.71%
Motor Vehicles & Eqpt	$78,800	1,700	20.98%
Misc. Elec. Mach. & Supplies	$36,500	800	15.86%
Agriculture—Crops	$36,000	790	16.50%
Aircraft & Parts	$30,100	670	5.17%
Misc Fabricated Products	$24,700	540	34.68%
Misc. Furniture	$16,300	360	8.53%
Canned, Frozen, Prsv'd Food	$14,200	310	42.10%
Misc. Mfg., Scrap, etc.	$14,100	300	8.00%
Construction Equipment	$12,700	280	6.70%
Shipbuilding & Repairing	$12,200	270	14.79%
Rolled & Finished Steel	$11,400	250	11.80%
Electric Trans./Distn. Eqpt	$10,000	220	9.37%
Meat Products	$9,200	200	14.59%
Misc Food Products	$9,200	200	18.18%
Metal Cans/Containers	$9,000	200	14.59%
Misc. Transportation Eqpt	$8,000	180	6.81%
Totals For Region	**$637,300**	**14,000**	

*Preliminary results of the LBJ School of Public Affairs Model of NAFTA Impacts, February 1993. Assumes Mexican GDP grows gradually by 3% to 6% over the period.

*Table 4.16. NAFTA impact on exports and employment in upper Rio Grande: 1994-2003**

Goods-Producing Sector	Direct Export Growth (000s)	New Jobs	Current Local Share of TX Gross Sales
Misc. Mfg., Scrap, etc.	$28,500	600	16.22%
Women's Outerwear	$24,700	540	40.35%
Misc Fabricated Products	$9,200	200	12.91%
Elec. Components, Accessories	$9,100	200	2.00%
Electric Trans./Distn. Eqpt	$7,000	160	6.67%
Lighting & Wiring Eqpt	$6,400	140	3.59%
Paperboard Containers/Boxes	$4,800	100	7.34%
Men's & Boys Furnishings	$4,500	100	4.59%
Motor Vehicles & Eqpt	$4,300	100	1.15%
Rolled & Finished Steel	$4,200	90	4.36%
Electrical Indust. Eqpt	$3,300	70	2.53%
Metalworking Machinery	$2,700	60	4.88%
Misc. Plastic Products	$2,500	50	2.06%
Boot & Shoe Cut Stock, etc.	$2,100	50	60.61%
Non-Rubber Footwear	$1,900	40	25.91%
Bakery Products	$1,800	40	9.74%
Metal Forging/Stamping	$1,700	40	2.15%
Totals For Region	**$128,400**	**2,800**	

*Preliminary results of the LBJ School of Public Affairs Model of NAFTA Impacts, February 1993. Assumes Mexican GDP grows gradually by 3% to 6% over the period.

The High Plains and Upper East Texas account for only a small proportion of expected NAFTA impacts on the state. The benefits they are projected to gain under NAFTA are dominated by a small number of industries, meat products (High Plains) and the rolling and drawing of non-ferrous metals, chiefly aluminum and copper (Upper East Texas). In both cases, these are probably sources of strength with much potential for future development. Tables 4.17 and 4.18 present the impact of NAFTA on exports and employment in the Texas High Plains and Upper East Texas areas, respectively.

*Table 4.17. NAFTA impact on exports and employment in Texas High Plains: 1994-2003**

Goods-Producing Sector	Direct Export Growth (000s)	New Jobs	Current Local Share of TX Gross Sales
Meat Products	$41,900	921	66.21%
Construction Equipment	$7,400	163	3.90%
Grain Mill Products	$5,900	130	15.56%
Genl Industrial Machinery	$4,700	104	4.85%
Special Industrial Machinery	$4,400	98	7.99%
Agriculture—Crops	$4,100	89	1.86%
Agricultural Chemicals	$3,600	80	9.00%
Misc. Elec. Mach. & Supplies	$3,600	79	1.57%
Elec. Components, Accessories	$3,100	68	0.68%
Motor Vehicles & Eqpt	$3,000	66	0.79%
Misc. Transportation Eqpt	$3,000	64	2.49%
Misc. Indus./Commercial Eqpt	$2,000	44	3.06%
Fabricated Structural Metal	$2,000	43	2.80%
Misc. Primary Metals	$1,800	39	39.99%
Grand Totals For Region	**$109,900**	**2,400**	

*Preliminary results of the LBJ School of Public Affairs Model of NAFTA Impacts, February 1993. Assumes Mexican GDP grows gradually by 3% to 6% over the period.

The high technology sectors of Central Texas are not significant enough to promise that region more than approximately 7 percent of Texas' employment gains under NAFTA. The fact, however, that Central Texas lies on some of the primary transportation arteries may lend it an additional boost that the LBJ model cannot capture. Table 9.19 presents the impact of NAFTA on exports and employment in Central Texas over 1994-2003. Other parts of Texas are expected to enjoy modest gains that are more or less in proportion with their contribution to Texas' population and current manufacturing base. It is important to note in closing that the largest portion of the 10.8 percent of unallocated employment projected to be generated probably ought to be attributed to the smaller regions. Among these, the El Paso area stands to gain the greatest share. Tables 9.20, 9.21 and 9.22 present the impact of NAFTA on exports and employment in Northwest Texas, Southeast Texas, and in West Texas, respectively.

*Table 4.18. NAFTA impact on exports and employment in upper east Texas: 1994-2003**

Goods-Producing Sector	Direct Export Growth (000s)	New Jobs	Current Local Share of TX Gross Sales
Non-Fer. Rolling/Drawing	$121,400	2,700	40.96%
Misc. Plastic Products	$39,900	870	33.57%
Agriculture—Crops	$28,200	620	12.90%
Misc. Transportation Eqpt	$28,100	620	24.05%
Pottery, etc.	$23,500	510	67.78%
Motor Vehicles & Eqpt	$19,700	430	5.24%
Communications Eqpt	$14,800	330	3.73%
Elec. Components, Accessories	$14,300	300	3.13%
Audio-Video Equipment	$13,600	300	5.71%
Rolled & Finished Steel	$11,500	250	11.88%
Refrig./Laundry/etc. Eqpt	$10,300	230	5.89%
Shipbuilding & Repairing	$8,600	190	10.47%
Construction Equipment	$7,700	170	4.05%
Heating Equipment	$6,900	150	17.73%
Totals For Region	**$439,000**	**9,700**	

*Preliminary results of the LBJ School of Public Affairs Model of NAFTA Impacts, February 1993. Assumes Mexican GDP grows gradually by 3% to 6% over the period.

*Table 4.19. NAFTA impact on exports and employment in central Texas: 1994-2003**

Goods-Producing Sector	Direct Export Growth (000s)	New Jobs	Current Local Share of TX Gross Sales
Audio-Video Equipment	$106,100	2,300	44.46%
Elec. Components, Accessories	$54,100	1,200	11.89%
Lighting & Wiring Eqpt	$45,500	1,000	25.59%
Agriculture—Crops	$36,200	800	16.57%
Medical Instruments & Supplies	$24,400	540	30.82%
Misc. Transportation Eqpt	$21,500	470	18.42%
Electric Trans./Distn. Eqpt	$16,000	350	15.21%
Motor Vehicles & Eqpt	$14,400	320	3.84%
Misc. Paper/Paperboard	$14,100	310	19.88%
Non-Fer. Casting	$13,800	300	16.49%
Misc. Furniture	$11,400	250	5.98%
Paperboard Containers/Boxes	$10,900	240	16.76%
Computer & Office Equipment	$10,500	230	8.55%
Office Furniture	$9,500	210	24.20%
Broad-Woven Cotton Fabric	$9,000	200	17.88%
Misc. Elec. Mach. & Supplies	$8,700	190	3.79%
Communications Eqpt	$8,400	190	2.13%
Totals For Region	**$558,700**	**12,300**	

*Preliminary results of the LBJ School of Public Affairs Model of NAFTA Impacts, February 1993. Assumes Mexican GDP grows gradually by 3% to 6% over the period.

*Table 4.20. NAFTA impact on exports and employment in northwest Texas: 1994-2003 **

Goods-Producing Sector	Direct Export Growth (000s)	New Jobs	Current Local Share of TX Gross Sales
Metal Forging/Stamping	$9,400	207	12.17%
Genl Industrial Machinery	$5,700	124	5.80%
Misc. Mfg., Tobacco, Scrap, etc.	$3,800	84	2.18%
Grain Mill Products	$2,174	48	5.71%
Construction Equipment	$2,100	47	1.12%
Misc. Indus./Commercial Eqpt	$1,900	41	2.84%
Beverages	$1,900	41	3.43%
Fabricated Rubber Products	$1,700	38	3.69%
Misc. Fabricated Metals	$1,500	33	1.67%
Fabricated Structural Metal	$1,300	29	1.89%
Oil & Gas	$1,000	21	2.22%
Dolls, Toys, Games, etc., Eqpt	$1,000	20	2.01%
Agriculture—Crops	$900	20	0.41%
Totals For Region	**$40,600**	**900**	

*Preliminary results of the LBJ School of Public Affairs Model of NAFTA Impacts, February 1993. Assumes Mexican GDP grows gradually by 3% to 6% over the period.

*Table 4.21. NAFTA impact on exports and employment in southeast Texas: 1994-2003**

Goods-Producing Sector	Direct Export Growth (000s)	New Jobs	Current Local Share of TX Gross Sales
Misc. Transportation Eqpt	$31,200	690	26.70%
Shipbuilding & Repairing	$21,700	480	26.46%
Construction Equipment	$18,800	410	9.88%
Paper Mills	$18,700	410	57.23%
Motor Vehicles & Eqpt	$16,600	370	4.43%
Iron & Steel Foundry Products	$12,300	270	14.44%
Petroleum Refining	$9,500	200	9.51%
Metal Forging/Stamping	$9,100	200	11.73%
Misc. Wood Products	$8,800	190	29.94%
Asphalt Paving/Roofing	$7,100	160	25.26%
Industrial Organic Chemicals	$6,800	150	5.71%
Communications Eqpt	$6,500	140	1.65%
Wooden Containers	$5,200	120	32.28%
Electrical Indust. Eqpt	$4,300	90	3.34%
Totals For Region	**$218,900**	**4,800**	

*Preliminary results of the LBJ School of Public Affairs Model of NAFTA Impacts, February 1993. Assumes Mexican GDP grows gradually by 3% to 6% over the period.

*Table 4.22. NAFTA impact on exports and employment in west Texas: 1994-2003**

Goods-Producing Sector	Direct Export Growth (000s)	New Jobs	Current Local Share of TX Gross Sales
Construction Equipment	$11,100	240	5.85%
Communications Eqpt	$6,000	130	1.51%
Misc. Indus./Commercial Eqpt	$3,900	90	5.87%
Iron & Steel Foundry Products	$3,000	70	3.56%
Misc. Chemical Products	$2,900	60	5.67%
Oil & Gas	$2,900	60	6.60%
Genl Industrial Machinery	$2,800	60	2.84%
Engines & Turbines	$2,600	60	6.88%
Dairy Products	$2,000	40	4.66%
Misc. Mfg., Scrap, etc.	$2,000	40	1.10%
Hydraulic Cement	$2,000	40	20.91%
Misc. Plastic Products	$1,800	40	1.51%
Fabricated Rubber Products	$1,700	40	3.56%
Totals For Regions	**$57,300**	**1,300**	

*Preliminary results of the LBJ School of Public Affairs Model of NAFTA Impacts, February 1993. Assumes Mexican GDP grows gradually by 3% to 6% over the period.

Conclusions

The location of maquiladora plants will determine the location of many transportation corridors. The maquiladora plants are now located on the Mexican side of twin cities, including Ciudad Juárez, Nuevo Laredo, and Matamoros. If they remain, the transportation facilities moving out of these locations will need to be upgraded.

If what are now the maquiladora plants become integrated with the productive structure of Mexico itself, which is a Mexican goal, but also largely remain where they are, this will require better transportation from inland Mexico to the border. At present, only about 2 percent of the physical inputs used by border maquiladora plants comes from Mexico and little of the output of the maquiladora facilities is sold in the interior of Mexico. If both sides of this equation — the

shipment of goods within Mexico to and from the plants — change, then this will set some requirements for the Mexican transport system. If the plants stay put, roads, rails, and other transport facility improvements will have to take these location considerations into account.

There is little doubt that the chief sources of Texas exports to Mexico and the chief attractors of Mexican imports are, and will continue to be, the greater Dallas-Forth Worth Metroplex and the Houston/Gulf Coast regions of the state. Studies conducted so far have not factored in the additional implications of trade passing through Texas and destined to elsewhere in the United States. Economic attractors like the Upper Midwest (especially the greater Chicago area which enjoys strong industrial and ethnic ties to Mexico), California, and the Northeastern United States will surely pull imports from Mexico and also serve as important sources of U.S. exports to Mexico.

It is noteworthy that additional commerce involving the Upper Midwest and Northeastern United States only reinforces the conclusion that increased commerce with Mexico will promote a more traffic moving to, from, and through the southwest (chiefly the Laredo area) and the northeastern quadrant of Texas. NAFTA's impact on California trade passing through Texas is more problematic to forecast. Among other things, anticipated patterns depend on the degree to which operations at Mexican Pacific Coast ports improve, the degree to which California-Mexico trade will be funneled through trucking and rail connections in Mexicali, and other questions related to potential modal diversion. In sum, NAFTA will contribute to existing pressures placed on the existing main transportation corridors of Texas-Mexico and U.S.-Mexico trade.

The projections of the various studies cited above as to the types of products that will benefit most from free trade also provide some guidance as to where transportation improvements will be most needed. We know that the bulk of the firms producing such products as electronics and computers, industrial machinery, and transportation equipment, that is, the Texas products whose exports are projected to grow most under free trade, are located in the Dallas-Fort Worth area and the Central Corridor. The increased exports of oil and gas field equipment projected in the LBJ School study points to the need for improved transportation facilities along the Gulf Coast. Transportation facilities in other regions will also need upgrading, but the examination of trade effects and pinpointing the production locations of the goods most likely to benefit from free trade with Mexico can help the state set priorities for expenditures for transportation improvements.

CHAPTER 5. ASSESSMENT OF TRANSBORDER ORIGIN AND DESTINATION PATTERNS

INTRODUCTION AND OBJECTIVE

To identify the border region's traffic flow patterns, this study inventoried recent origin and destination surveys and, where appropriate, conducted new ones. The first part of this chapter reviews recently published surveys; the second part discusses the surveys CTR conducted specifically for this study, along with border traffic flow patterns identified through origin and destination data from CTR surveys and from the literature. Finally, the chapter outlines survey methodologies useful in obtaining origin and destination information at the Texas-Mexico border.

OVERVIEW OF RECENT ORIGIN AND DESTINATION STUDIES

During the early stages of the origin and destination investigation, CTR reviewed recent surveys conducted along the Texas-Mexico border. Careful review of these surveys provided valuable data on traffic patterns at the border, as well as useful guidelines for conducting new field surveys. The surveys compiled by CTR included:

(1) Traffic and Revenue Feasibility Study for the Proposed International Bridge Between Pharr and Reynosa by Charles Rivers Associates, 1992 (Lower Valley area).

(2) Texas A&M Maquiladora Study by Texas Transportation Institute, 1992.

(3) Sunland Park — Santa Teresa Initial Analysis Report by Wilson & Company, 1991 (El Paso area).

(4) Brownsville Urban Area Travel Survey, by Parsons, Brinkerhoff, Quade & Douglas, Inc., 1991.

(5) Traffic and Revenue Study for the Proposed Zaragoza Bridge Replacement by Wilbur-Smith Associates, 1989 (El Paso area).

(6) Monterrey-Nuevo Laredo Highway Origin and Destination Survey, by Tecnodesar Rollo, S.C., 1992.

(7) Laredo Cross-Border Truck Shipments Origin and Destination Study by Laredo Development Foundation, 1989.

The following sections discuss the surveys, the associated results, and the methodology.

Charles Rivers Associates' Study

In 1992, Charles Rivers Associates (CRA) published a report on their southbound revenue analysis for the proposed Pharr/Reynosa Bridge. The study area, along with the identified sectors, are shown in Figure 5.1. This study considered both short-haul and long-haul trips, with the traffic diversion area identified as the geographic area from Brownsville to Laredo.

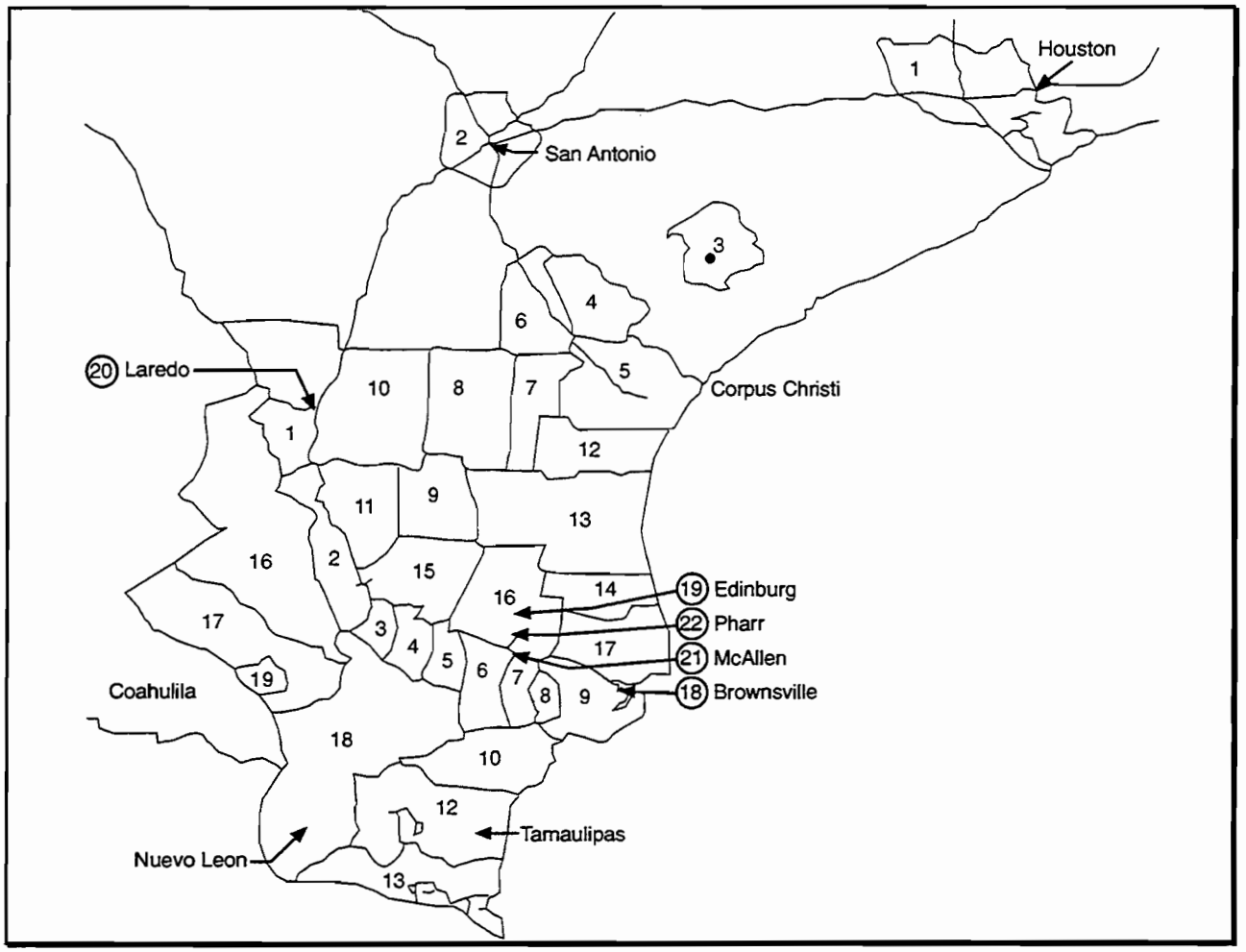


Figure 5.1. Study area covered by CRA's origin and destination surveys

CRA's survey covered southbound traffic at six bridges (see Table 5.1), from Brownsville through Colombia, west of Laredo. Conducted at the southbound toll booths, the survey captured 6,011 vehicles at six surveyed bridges (3,846 autos, 2,165 trucks, and no pedestrians). CRA's report does not specify the duration of the surveys, nor does it indicate on which days of the week the surveys took place. Nonetheless, it can be inferred from the report that the surveys' duration exceeded one day at some bridges, and that priority was given to truck traffic. Table 5.1 shows the number of interviews at each bridge, along with an ADT estimate based on CAPUFE annual counts. Assuming that this estimate approximates daily southbound volumes, the CRA survey sampled (roughly) 3 to 21 percent of the average daily auto traffic, and 14 to over 100 percent of the average daily truck traffic, as shown in Table 5.1. Table 5.2 shows an analogous sample size estimate based on CRA's ADT estimates. According to CRA's ADT estimates, the truck samples captured from 19 to 58 percent of the average daily truck traffic,

while the auto samples captured 4 to 14 percent of the average daily auto traffic. Table 5.1 presents a sample size analysis disaggregated by bridge, while Table 5.2 presents a sample size analysis aggregated by city or port. In both analyses, truck samples are more numerous than auto samples, reflecting the study's concern with truck traffic.

Table 5 .1. Sample sizes from CRA study compared with CAPUFE ADT estimates

BRIDGE	Surveyed Yes / No	ADT estimate		Number of surveys (approximate percentage of ADT captured)	
		Trucks	Autos	Trucks	Autos
Brownsville B&M	Yes	130	4800	21 (16%)	515 (11%)
Brownsville Gateway	Yes	650	10700	120 (18%)	1109 (10%)
Progreso-Nuevo Progreso	No	-	-	0	0
Hidalgo-Mission/Reynosa	Yes	570	13500	91 (16%)	1399 (10%)
Los Ebanos-Diaz Ordaz Ferry	No	-	-	0	0
Rio Grande City-Camargo	No	-	-	0	0
Roma-Miguel Aleman	Yes	35	2100	6 (17%)	169 (8%)
Falcon Dam	No	-	-	0	0
Laredo-Nuevo Laredo I	Yes	1200	7300	548 (46%)	337 (5%)
Laredo-Nuevo Laredo II	Yes	1400	9200	1349 (96%)	317 (0.3%)
Colombia-Dolores	No	-	-	0	0

* The survey duration exceeded one day.

Table 5.2. Sample sizes from CRA study compared with CRA ADT estimates

BRIDGE	Surveyed Yes / No	ADT estimate[1]		Number of surveys (approximate percentage of ADT captured)	
		Trucks	Autos	Trucks	Autos
Brownsville B&M	Yes	725	11,695	141 (19%)	1,624 (14%)
Brownsville Gateway	Yes				
Progreso-Nuevo Progreso	No	-	-	0	0
Hidalgo-Mission/Reynosa	Yes	354	12,451	91 (26%)	1,399 (11%)
Los Ebanos-Diaz Ordaz Ferry	No	-	-	0	0
Rio Grande City-Camargo	No	-	-	0	0
Roma-Miguel Aleman	Yes	29	2,071	6 (20%)	169 (8%)
Falcon Dam	No	-	-	0	0
Laredo-Nuevo Laredo I	Yes	3,261	16,946	1897 (58%)	654 (4%)
Laredo-Nuevo Laredo II	Yes				
Colombia-Dolores	No	-	-	0	0

[1] Based on CRA 1991 annual estimates of trips by crossing location

The CRA study utilized the following four travel markets (or trip purposes):

(1) auto users traveling for business purposes,

(2) auto users traveling for non-business purposes,

(3) loaded trucks, and

(4) empty trucks.

While this survey provides important border bridge traffic flow information, its main disadvantage is the somewhat low percentage of captured auto surveys to the ADTs, which may cause odd trips that occur only occasionally to appear as a high percentage of the total trips in the expanded trip table. The fact that weekly and monthly traffic variabilities were taken into account when expanding the trip tables does not preclude the inclusion of biases in expanding rare trip occurrences.

Texas A&M Maquiladora Study

This 1992 study describes a truck survey Texas A&M conducted at eight binational bridge entry systems along the Texas/Mexico border. The survey consisted of handing out mail-back questionnaires to truck drivers traveling in both directions. The response rate varied from 2 to 35 percent on individual bridges, with an average of 12 percent. The surveyed bridges included:

(1) Brownsville/Matamoros (Gateway),

(2) Progreso/Nuevo Progreso,

(3) Hidalgo-Mission/Reynosa,

(4) Eagle Pass/Piedras Negras,

(5) Del Rio/Cd. Acuña,

(6) Zaragoza, and

(7) Bridge of the Americas (BOTA).

According to the report, the primary purpose of this study was to investigate specific truck origin and destination characteristics, such as whether the origin or destination was a maquiladora, a rail yard, or a warehouse. The study also sought to identify cargo type by destination. The overall objective was to investigate the commodity flow patterns at the Texas-Mexico border.

Neither the origin and destination tables nor the trip frequency data was fully documented in the report. Although the survey asked for specific origin and destination addresses, researchers at Texas A&M indicated that the information collected was unreliable.

Because of current truck traffic regulations that limit truck movements to the commercial zone, most cargo is transferred from one border warehouse to another through drayage companies, with the drivers for these companies unaware of the origin of the cargo and where it is going (a circumstance that made difficult the determination of the actual origin and destination of truck cargo). This problem — one faced by A&M researchers — is difficult to overcome and will affect any truck survey conducted at the Texas-Mexico border under present traffic

regulations. Finally, the low response to Texas A&M's mail-back questionnaires indicates that such a survey technique is not effective at the Texas-Mexico border.

Wilson & Company Sunland Park/Santa Teresa Initial Analysis Study

The Sunland Park/Santa Teresa survey was conducted in the northbound direction over the 4-day period from May 15 to May 18, 1991, in El Paso, Texas. The survey, which started each day at 7:00 a.m. and ended at 8:00 p.m., covered the Bridge of the Americas, Paso Del Norte, and Ysleta. This very detailed survey divided the sister cities into several zones. For example, Juárez was divided into ten zones (with one external zone), while El Paso was divided into twelve zones.

A total of 19,043 automobile drivers, 1,901 truck drivers, and 6,691 pedestrians were surveyed. Within the survey period, these numbers represent 16.3 percent of the total automobile, 36.5 percent of the total truck, and 10.7 percent of the total pedestrian counts.

This survey, the most detailed of all recently published surveys, was submitted to Wilbur-Smith Associates (WSA) for use in a more-detailed analysis of the El Paso sector. It will also supplement and update the origin and destination data already gathered by WSA for their revenue analysis of the Zaragoza Bridge in El Paso.

Brownsville Urban Area Travel Survey

The Brownsville Urban Area Travel Survey, conducted in Brownsville between February and May of 1991, consists of four travel surveys: a home travel survey, a workplace travel survey, a truck travel survey, and an external travel survey. These four travel surveys are part of a very detailed urban transportation planning model being developed by TxDOT for the Brownsville MPO. The surveys included a telephone survey of 1,411 households, an employee and visitor survey of 78 work sites, a survey of 404 commercial vehicle drivers, and a survey of nine external highway stations along major travel routes from Brownsville.

The external travel survey provides valuable information that is being utilized in CTR's study for the modeling of southbound transborder traffic crossing Gateway and B&M Bridges in Brownsville and Matamoros. In this survey, Brownsville was divided into nineteen traffic origin zones, with traffic surveyed at nine external stations around the outskirts of the city. Gateway and B&M Bridges were among the nine stations. Transborder commercial truck traffic refused to participate in the survey (including the truck travel survey).

According to this survey, the one origin zone for the entire city of Brownsville for southbound auto transborder traffic crossing Gateway and B&M Bridges can be further disaggregated into nineteen zones. However, no data were collected on the destination of southbound transborder traffic.

WSA's Traffic and Revenue Study for the Proposed Zaragoza Bridge Replacement

As part of the revenue analysis undertaken for the Zaragoza Bridge in El Paso, WSA conducted an origin and destination survey in the El Paso area using the direct interview method.

The interviews took place in August 1989 at the old Zaragoza Bridge and at the Bridge of the Americas for 12-hour periods on a weekday and on a weekend. The survey involved pedestrian and vehicular traffic, with a sample size of about 14 percent of the total traffic using these bridges during the survey period. Because the actual origin and destination matrices and raw data are not documented in the report, it is difficult to comment on their results. On the other hand, WSA revenue predictions for this bridge replacement are very accurate; the difference between the predicted and observed revenues for 1990 and 1991 is less than 10 percent. Since this level of accuracy cannot be achieved with inaccurate data, it is concluded that WSA's origin and destination data accurately captured the traffic flow patterns for the El Paso area, and are thus adequate for the purposes of this study (especially when supplemented with the Sunland Park origin and destination study discussed previously).

Monterrey-Nuevo Laredo Highway Origin and Destination Survey

The Monterrey-Nuevo Laredo Highway Origin and Destination Survey is a component of the feasibility study for the Colombia Bridge access road in Mexico that was undertaken for the State of Nuevo León by a Mexican consultant, TECNODESARROLLO, S.C. The survey was conducted on the major access routes to the northern border between the two Laredos and to Colombia, using the direct interview method. The selected O/D stations were the following:

1. Anahuac Station: Located on State Highway No. 1, from Monterrey to Colombia, (total road length of 118 miles [190 km]).
2. Vallecillos Station: Located on Federal Highway MEX 85, from Monterrey to Nuevo Laredo (total length of 77.6 miles [125 km]).
3. Toll Booth Station: located on the Toll Road from Monterrey to Nuevo Laredo (total road length of 62 miles [100 km]).

The information collected on the survey included:

- origin, destination, and purpose of the trip,
- vehicle type and occupancy,
- commodity (for commercial traffic),
- willingness to use a toll road to Colombia Bridge, and
- use of safety belts.

The survey was conducted from November 12 to November 16, 1992, 24 hours a day, for northbound and southbound traffic. The reported ADT for the three highways was 8,139 in both directions, and the total number of vehicles surveyed during the 5 days was 34,240. Thus, the survey captured about 84 percent of the ADT during that 5-day period. Vehicle classification is reported at each of the O/D stations for each direction of traffic. The survey did not concentrate exclusively on border crossing trips: a significant number of trips made within Nuevo Leon, as

well as within the rest of Mexico, were captured.

During the 5-day survey, the interviewers collected data on 16,000 trips with U.S. origin or destination points close to the Laredo bridges. Given that the total number of crossings in the Laredo area for the month of the survey was about 1,200,000, the survey captured approximately 8 percent of the transborder traffic using the Laredo bridges. Thus, it can be concluded from this survey that over 90 percent of the trips using the Laredo bridges travel neither to nor from the interior of Mexico. The 5-day survey captured 5,617 trips into Laredo, Texas, while the average daily traffic at all Laredo bridges in that month was about 40,000. Consequently, this survey captured only about 3 percent of the transborder trips using the Laredo bridges, which is consistent with the finding that over 90 percent of the vehicles using the Laredo bridges remain fairly close to the border. The survey data are not sufficient for estimating the relative percentages of trips having destinations in Nuevo Laredo by U.S. origin; nor can they estimate the percentages of trips having their origin in Nuevo Laredo by destinations in the U.S.

Interestingly, this survey asked Laredo-bound drivers if they would use Colombia Bridge if a direct link were provided. The responses are shown in Table 5.3. The high percentage of "yes" answers was a key factor in the study's conclusion regarding the feasibility of a toll road to Colombia Bridge.

Table 5.3. Decision to use a toll road direct to Colombia

Station	Percentages of Each Answer		
	Yes	No	Undecided
Anahuac	94%	3%	3%
Vallecillo	65%	33%	2%
Caseta de Cobro	60%	27%	13%

Laredo Development Foundation Cross-Border Truck Shipments Study

The Laredo Development Foundation (LDF) conducted a survey of the origin and destination of truck shipments crossing Laredo bridges in 1989. The study team sent questionnaires to 30 of the largest trucking companies located in Laredo, and to 65 maquiladora plants located in Nuevo Laredo. Origin and destination of shipments were reported for the U.S. in terms of major regions (southeast, northeast, central, southwest, and west) and in terms of percentages of traffic by the main highway links to Laredo in the U.S. (IH-35, US 59, and US 83). On the Mexican side, origin and destinations were reported by major metropolitan area (Monterrey, Mexico City, Nuevo Laredo, and Guadalajara). Origin and destination of shipments were reported independently.

Because the LDF study provides useful information regarding the nature of transborder truck shipments at Laredo, it has been extensively used for the analysis of transportation infrastructure studies in the Laredo area. The study does not, however, provide information that can be input into a trip assignment model that assigns traffic to individual bridges within a sector of traffic diversion (the study objective was to look at the Laredo bridge system as a whole).

Since the questionnaires were sent to trucking companies and to maquiladora plants (rather than to truck drivers), the data gathered by this survey capture the actual origins and destinations of the cargo. Therefore, the collected data do not have the limitations associated with the Texas A&M study described earlier.

Summary of Previous Origin and Destination Studies

An overview of the most recent origin and destination studies conducted at the Texas-Mexico border reveals interesting points about traffic patterns and about the adequacy of different methodologies for conducting an origin and destination survey in that area. The main points of interest are the survey methodologies, the need for and expected accuracy of additional surveys, identification of problems affecting origin and destination surveys at the border, and the identification of transborder traffic flow patterns. This last item helped in ranking the bridges in terms of priority to obtain additional origin and destination data.

To be sure, the nature of transborder truck traffic is unique. For example, because of current regulations regarding accessibility of U.S. and Mexican truck traffic into the adjacent country, drayage companies transport the load from a warehouse on one side of the border to another warehouse on the other side of the border. As a result, a truck survey conducted on the bridges mostly captures the drayage company drivers, who are unaware of the true origin and destination of the commercial load. The Laredo Development Foundation survey, discussed earlier, is the only origin and destination survey identified by CTR that captured the actual origin and destination of the shipments.

In all studies reviewed by CTR, the direct interview method was shown to yield remarkably good response rates, while the best response rate of mail-back surveys was around 20 percent, a rate lower than that generally obtained in urban environments. This low response rate is probably a result of the binational nature of the trips (one which does not permit such conveniences as pre-stamped cards). Another advantage of the direct interview is that surveyors can clarify misunderstandings of questions posed during the interview, thus receiving answers more useful than those obtained from a poorly completed mail-back form. Consequently, the direct interview method is considered the most effective technique for conducting origin and destination surveys in the border area. The obvious need for additional origin and destination data is discussed in the next sections for Segment 1 and Segment 2 binational entry systems.

NEED FOR ADDITIONAL SURVEYS — SEGMENT 1

CRA's study of the Valley area appears comprehensive and accurate, representing a wide traffic diversion area from the Valley up to Laredo. However, the relatively small auto traffic sample size might cause concerns about the probability of obtaining a biased expanded origin and destination table. Since truck traffic is about 5 percent of the total traffic volume, at current fares, autos have more impact on revenues than trucks, and the previously mentioned biases might even have a large impact on the predicted revenues. Therefore, there is a need to supplement CRA's origin and destination data with additional surveys at the Brownsville area

bridges, Hidalgo Bridge, and at Progreso Bridge.

The Laredo area is a very important corridor that carries a significant portion of the long-haul trips across the Texas-Mexico border. In addition, it carries a percentage of truck traffic that is roughly twice that of the rest of Segment 1. This suggests that this area should receive priority for new origin and destination surveys. However, precisely because of its significance, this area has received comparatively more attention, both in the U.S. and in Mexico. Consequently, more information is available for this area. In addition, the analysis of traffic flow patterns from existing origin and destination studies indicates that, although additional information is needed to better identify the Laredo traffic flow patterns, origin and destination surveys are not recommended specifically for this transportation needs study for the following reasons:

(1) At current toll fares, truck traffic has more impact on revenues than auto traffic, and the accuracy of truck origin and destination is more important for Laredo than it is for other areas. The existing studies analyzed by CTR focused more on truck traffic than on auto traffic, except for the Nuevo León study. The LDF study gathered long-haul trip information that is impossible to obtain using origin and destination surveys at the bridges, because of the current truck traffic restrictions between the U.S. and Mexico mentioned earlier. A new origin and destination survey of a magnitude compatible with a transportation needs study would not be sufficient to obtain additional information needed to satisfactorily separate the long-haul truck trips from the local truck trips across the Laredo bridges; moreover, the truck traffic would be better analyzed using the existing studies compiled by CTR staff.

(2) The geographical location of Laredo makes it the preferred corridor for long-distance transborder trips. In an area where most of the traffic is local, the reliability of origin and destination data is not highly dependent on the date of the survey, since the traffic flow patterns are not expected to vary much during the year. On the other hand, long-haul trips are more susceptible to seasonal fluctuations than are local trips that involve daily activities (e.g., shopping or work commutes). Consequently, in an area marked by large numbers of long-haul trips (e.g., Laredo), if the traffic flow patterns obtained with an additional origin and destination survey differ from those identified using existing surveys, there is no practical way to diagnose these differences, because they may be due to actual seasonal fluctuations in the origin and destination pairs. Ideally, origin and destination surveys in the Laredo area should be repeated seasonally, and the trip purposes and frequencies should be used in conjunction with socioeconomic data to analyze and explain seasonal differences found in the origin and destination patterns.

(3) Finally, there is no need to develop a revenue estimate for a new bridge in the Laredo area, since a recently published report is available that presents revenue estimates for such a facility in this area. These results already provide the type of answers sought by this study in terms of revenue forecasts (WSA Laredo Study).

NEED FOR ADDITIONAL SURVEYS — SEGMENT 2

The Santa Teresa study of the El Paso area is the most recent and detailed origin and

destination survey conducted, one whose trip tables provide the traffic patterns required by trip assignment models. As discussed previously, WSA used these results to supplement and update the trip tables they had previously developed for their El Paso area study. It was thus concluded that there was no need to survey the El Paso area.

CTR did, however, conduct surveys at sites in Segment 2 not covered by any origin and destination study; these sites included the Fabens, Eagle Pass, Del Rio, and Presidio Bridges.

ORIGIN AND DESTINATION SURVEYS

Description of the Field Work

As reported above, we concluded that additional surveys were needed and could satisfactorily be conducted at the following bridges: Gateway, B&M, Progreso, Hidalgo, Eagle Pass, Del Rio, Presidio, and Fabens. The method chosen was direct interview, with 1-day surveys considered the most appropriate.

Thus, origin and destination data were collected at four bridge sites in Segment 1 (Gateway, B&M, Progreso, and Hidalgo) and at four bridge sites in Segment 2 (Fabens, Eagle Pass, Del Rio, and Presidio). Since the study uses toll revenue estimates as feasibility indicators, southbound automobile and truck traffic were surveyed. The sites, dates, and number of interviews are described in Table 5.4. Estimates of average daily truck and auto traffic are also included in Table 5.4 to indicate the sample size of those surveys. The survey methodology, results, and conclusions are discussed below.

Survey Questionnaires and Methodology

Because our overview of recent origin and destination surveys conducted at the border revealed that a remarkably high response rate can be obtained by direct interview (as opposed to mail-back forms), we decided to use the direct-interview method in all surveys. The survey questionnaire we used was designed to:

(1) determine traffic patterns in terms of origin and destination pairs;

(2) identify auto trip purposes and quantify them with respect to the total number of auto trips — the main focus being the identification of number of business trips (as opposed to non-business trips);

(3) quantify the number and frequency of trips made between each origin and destination pair;

(4) quantify the auto occupancy rate; and

(5) quantify the number of truck axles.

Table 5.4. Summary of origin and destination surveys

BRIDGE	U.S. City / Mexican City	Survey Dates	ADT		Number of Surveys	
			Autos	Trucks	Autos	Trucks
Gateway	Brownsville / Matamoros	6-28-93 / 6-29-93	9,955 (1)	718 (1)	4258	185
B&M	Brownsville / Matamoros	6-30-93 / 7-1-93	4,611 (1)	11 (1)	2407	3
Progreso	Progreso / Nuevo Progreso	6-30-93 / 7-1-93	2,138 (1)	46 (1)	1548	29
Hidalgo	Hidalgo / Reynosa	6-1-93	14,467 (2)	572 (2)	4003	137
Eagle Pass	Eagle Pass / Piedras Negras	4-22-93	6,244 (2)	207 (2)	483	15
Del Rio	Del Rio / Ciudad Acuña	4-29-93	3,205 (3)	65 (3)	824	33
Presidio	Presidio / Ojinaga	4-29-93	1,560 (4)	20 (4)	594	5
Fabens	Fabens / La Caseta	4-27-93	840 (5)	N.A.	563	1

(1) Average 24-hour counts on dates of survey
(2) 24-hour count on date of survey
(3) Monday-Friday average, March 1993
(4) Estimate based on monthly counts
(5) Monday-Friday average, June 1993
NOTE: The lower number of trucks at B&M Bridge during the dates of the survey was due to construction work on the highway infrastructure on the Mexican side.

Our original survey form, shown in Appendix B as Exhibit B.1, was based on a form developed by Charles Rivers Associates (Ref 1). Requiring less than 30 seconds to complete, this form was used in all Segment 2 origin and destination surveys. Exhibit B.2 in Appendix B shows the survey modified to include license plate (and other) information. Additional categories were added to "trip purposes," since during the Segment 2 origin and destination surveys it was observed that many respondents spontaneously answered this question with their actual trip purpose. Questions regarding the origin and destination of truck shipments (whether loaded or empty) were also added as optional items in the Brownsville and Progreso survey forms in order to obtain some information on commodity flows. This modified form is shown in Exhibit B.3 of Appendix B. The results obtained with the questionnaires are discussed in the upcoming sections of this chapter. Each binational entry system is listed in chronological order according to the survey date.

EAGLE PASS / PIEDRAS NEGRAS BRIDGE

Description of Field Work

The Eagle Pass survey — the pilot survey of this study — had two objectives: gather as much reliable data as possible and, at the same time, record logistics, organization, and other useful information that could be helpful in future surveys.

Eagle Pass Bridge is a two-lane toll binational entry system. There are three toll booth lanes for southbound traffic: one is open 24 hours a day, 7 days a week, while the others are opened according to traffic demand.

The survey started at 6:30 a.m. on April 22, 1993. Although traffic at this time was extremely light, there was a noticeable increase beginning around 7:00 a.m. The schedule had

minor interruptions, owing to an insufficient number of crew members. Table 5.5 shows the hours the survey was actually conducted, the traffic counts for these hours, and the number of responses. The survey hours did not include evening and weekend peak periods.

Table. 5.5. Manual counts for Eagle Pass Bridge

	COUNTS			SURVEYS	% CAPTURED
Time	AUTOS	TRUCKS	TOTAL	TOTAL	
6:00-7:00	21	0	21	15	71%
7:00-8:00	67	1	68	68	100%
8:00-9:00	202	5	207	129	62%
9:00-10:00	230	11	241	*25	10%
10:00-11:00	309	10	319	101	31%
11:00-11:40	229	0	229	42	18%
2:00-3:00	403	19	422	128	30%
Total	1461	46	**1507**	**498**	**34%**

*A break in the survey was taken from 9:10 to 9:50, while the counts continued

Table 5.6 depicts the frequency of auto trips for each 1-hour time slot. The data show a morning peak from 8:00 a.m. to 9:00 a.m. and from 10:00 a.m. to 11:00 a.m., and an afternoon peak from 2:00 p.m. to 3:00 p.m. While overall truck samples were small, we observed a morning peak period for trucks from 8:00 a.m. to 10:00 a.m., and an afternoon peak period after 2:00 p.m.

Table 5.6. Auto trip distribution by time — Eagle Pass Bridge

Time	Recorded Trips	Percentage	Cumulative Trips	Cumulative Percentage
6:00 a.m.-7:00 a.m.	15	3.1	15	3.1
7:00 a.m. - 8:00 a.m.	74	15.3	89	18.4
8:00 a.m. - 9:00 a.m.	118	24.4	207	42.9
9:00 a.m. - 10 a.m.	25	5.2	232	48.0
10:00 a.m. - 11 a.m.	99	20.5	331	68.5
11:00 a.m. - 12:00 p.m.	41	8.5	372	77.0
1:00 p.m. - 2:00 p.m.	6	1.2	378	78.3
2:00 p.m. - 3:00 p.m.	105	21.7	483	100.0

Origin and Destination Matrices

The survey results indicate that over 80 percent of the auto trips and 60 percent of the truck trips had their origin in Eagle Pass and their destination in Piedras Negras. On the other hand, about 90 percent of the auto and truck trips had either an Eagle Pass origin or a Piedras Negras destination. The results are fully presented in Tables 5.7 and 5.8. All origins and destinations other than Eagle Pass and Piedras Negras are presented as "other," with those origins and destinations summarized in Table 5.9. The "other" category includes any origin or destination having less than a 5 percent occurrence.

Table 5.7. Auto origin/destination matrix — Eagle Pass Bridge

Origin	Destination		
	Piedras Negras	Other	Total (Origin)
Eagle Pass	390	40	430
	81%	8%	89%
Other	44	9	53
	9%	2%	11%
Total (destination)	434	49	483
	90%	10%	100%

Table 5.8. Truck origin/destination matrix — Eagle Pass Bridge

Origin	Destination		
	Piedras Negras	Other	Total (Origin)
Eagle Pass	9	2	11
	60%	13%	73%
Other	4	0	4
	27%	0%	27%
Total (destination)	13	2	15
	87%	13%	100%

Table 5.9. "Other" origins and destinations — Eagle Pass Bridge

Other Origins	Other Destinations	
El Indio (2)	Acuña (3)	Muzquiz (3)
Houston (1)	Allende (7)	Nava (7)
La Pryor (3)	Celya (1)	Nueva Rosita (2)
Laredo (1)	DF, Mex (1)	Rio Escondido (7)
Los Angeles (1)	Juarez (1)	Rosita (1)
McAllen (1)	Monclova (3)	Sabinas (6)
Mississippi (1)	Monterrey (1)	Saltillo (2)
Quemado (1)	Morales (1)	San Isidro (1)
San Antonio (18)	Morelos (1)	Zaragoza (1)
Uvalde (4)		

Trip Frequencies

Weekly frequencies for auto trips are depicted in Table 5.10 and 5.11 for non-business and business trips. There are seven instances where trip purposes are unknown (i.e., instances where travelers refused to answer this question). Over 80 percent of non-business trips are undertaken either fewer than three times a week or seven or more times a week, while over 40 percent of all business trips are undertaken seven or more times a week and less than 30 percent are taken fewer than three times a week. The non-business trip frequencies probably reflect the

numerous school-related trips and other personal purposes, while the daily or more-business-trip frequency usually indicates people commuting to work.

Table 5.10. Non-business auto weekly frequencies — Eagle Pass Bridge

Frequency Category	Recorded Trips	Percentage	Cumulative Trips	Cumulative Percentage
<1	76	26%	76	26%
1≤FQ<2	57	20%	133	46%
2≤FQ<3	63	22%	196	67%
3≤FQ<4	25	9%	221	76%
4≤FQ<5	11	4%	232	80%
5≤FQ<6	12	4%	244	84%
6≤FQ<7	3	1%	247	85%
≥7	38	13%	285	98%
N/A	7	2%	292	100%
Total	292	100%		

Table 5.11. Business auto weekly frequencies — Eagle Pass Bridge

Frequency Category	Recorded Trips	Percentage	Cumulative Trips	Cumulative Percentage
<1	18	10%	18	10%
1≤FQ<2	14	8%	32	17%
2≤FQ<3	19	10%	51	28%
3≤FQ<4	18	10%	69	38%
4≤FQ<5	7	4%	76	41%
5≤FQ<6	16	9%	92	50%
6≤FQ<7	10	5%	102	55%
≥7	78	42%	180	98%
N/A	4	2%	184	100%
Total	184	100%		

Table 5.12 shows the weekly frequency counts for truck trips. Over 50 percent of these trucks make seven or more trips per week. This reflects the drayage companies' practice of conveying cargo from one side of the border to the other.

Table 5.12. Truck weekly frequencies — Eagle Pass Bridge

Frequency Category	Recorded Trips	Percentage	Cumulative Trips	Cumulative Percentage
<1	1	7%	1	7%
1≤FQ<2	2	13%	3	20%
2≤FQ<3	3	20%	6	40%
3≤FQ<4	1	7%	7	47%
≥7	8	53%	15	100%
Total	15	100%		

Trip Purpose and Auto Occupancy

Table 5.13 depicts the auto occupancy rates for business and non-business auto trips. It also summarizes the trip purpose responses (second column). As shown in column 2 of Table 5.13, over 60 percent of auto respondents indicated non-business trip purposes, while 38 percent indicated business-related trips (seven respondents refused to answer). Some respondents answered with just a "yes" or "no" to the question, "Is this a business trip?," while others stated the actual purpose. Business trips for this survey included trips from and to work and trips related to business operations (such as purchase of materials or equipment). Trips to deliver children to or from school and personal shopping trips were considered non-business trips. The reliability of some of the responses could be considered questionable, given that many cross-border travelers are extremely cautious about revealing the actual purpose of a trip. Average auto occupancy is higher for non-business than it is for business-related trips, indicating less carpooling activity for business trips than for personal trips.

Table 5.13. Average auto occupancy by trip purpose — Eagle Pass Bridge

Trip Purpose	Recorded Trips (Percentage)	Auto Occupancy			
		Average	Std. Dev.	Minimum	Maximum
N/A	7 (1%)	1.71	0.95	1	3
Personal	292 (61%)	1.93	0.95	1	6
Business	180 (38%)	1.42	0.78	1	6
Total	479 (100%)				

License Plates

Table 5.14, which records the occurrence of auto license plate origins by U.S. and Mexican states, shows that 93 percent of all auto plates are either from Texas or from Coahuila, the two states linked by the Eagle Pass Bridge. The truck sample size was too small to permit meaningful conclusions. There were twelve (80 percent) Texas plates, two (13 percent) Mexico City plates, and one (7 percent) Coahuila plate. The size of the truck sample renders the truck percentages statistically insignificant.

Conclusions and Recommendations

While the sample size obtained at this bridge was the smallest of all origin and destination surveys, a critical examination of the data did not indicate a need to supplement the data with additional surveys. With such a large percentage of all trips identified as local, additional data would merely confirm this finding (i.e., more precise numbers would have little effect on the accuracy of the non-local origins and destination pairs). Because of the geographical location of this bridge, a traffic demand analysis for a needs study can be performed with only two origins (Eagle Pass and external) and two destinations (Piedras Negras and external). This is another reason for not recommending additional surveys at this bridge.

Table 5.14. Auto license plates — Eagle Pass Bridge

Plate	Frequency	Percent
ARIZONA	4	0.8%
CALIFORNIA	2	0.4%
CHIH MEX	1	0.2%
COLORADO	4	0.8%
COAH MEX	174	37%
DGO MEX	1	0.2%
IDAHO	1	0.2%
ILLINOIS	1	0.2%
MEX MEX	1	0.2%
MINNESOTA	4	0.8%
NL MEX	2	0.4%
QRO MEX	1	0.2%
TAMP MEX	1	0.2%
TEXAS	266	56%
US G	2	0.4%
WISCONSIN	8	2%
WYOMING	1	0.2%
TOTAL	474	100%

Over 60 percent of all respondents answered "no" when asked if their trip was business-related. However, surveyors question the reliability of these answers, based on the reluctance of many respondents to answer the question. Therefore, it is likely that the responses underestimate the number of business-related trips. Average auto occupancy is approximately two for non-business and less than 1.5 for business-related trips, indicating little carpooling activities at this bridge (especially for business trips).

The majority of trip frequencies for autos is either less than once a week or more than once a day, both for business and non-business trips. Over half of all trucks surveyed were crossing the bridge more than once daily, which reflects the drayage companies transferring cargo across the border and within the commercial zones of both countries. Although the truck sample is small, these numbers are compatible with the fact that an origin and destination survey at a border bridge captures mostly drayage companies that cross the border with cargo transfers.

According to the responses, non-business trips for this bridge included parents from Piedras Negras taking their children to school in Eagle Pass, people from Eagle Pass visiting the doctor in Piedras Negras, people from Piedras Negras doing their daily shopping in Eagle Pass, and people visiting relatives. The willingness to participate was fairly high, but there was an impression that travelers making business trips might be less willing to participate.

FABENS / CASETA BRIDGE

Description of Field Work

The Fabens/Caseta Bridge survey was conducted Tuesday, April 27, 1993, from 7:00

a.m. to 6:00 p.m. This facility is a two lane, toll-free bridge accommodating both directions of traffic. Load limit prevents truck traffic from using this bridge. For southbound traffic there is a stop sign at the entrance of the bridge (though not all vehicles come to a complete stop). In order to conduct the survey, a "stop ahead" sign was placed on the approach road, with cones used to pull autos slightly to one side (so as not to interfere with northbound traffic and to improve the overall safety).

Traffic counts and the number of interviews at Fabens bridge are shown in Table 5.15. The survey took place over three intervals, during which most vehicles were captured. With the average daily traffic for this bridge set at 930, the survey captured 60 percent of the ADT.

Table 5.15. Response rates — Fabens Bridge

From - To	TRAFFIC COUNTS	SURVEYS	% CAPTURED
6:50 a.m. - 10:30 a.m.	205	195	95%
11:55 a.m. - 2:00 p.m.	114	114	100%
3:00 p.m. - 6:00 p.m.	300	255	85%
Total	**619**	**564**	**91%**

Table 5.16 shows the auto trip distribution by one-hour time slots. There is a morning peak from 9:00 a.m. to 10:00 a.m. and a mid-afternoon peak from 12:00 a.m. to 1:00 p.m.; the largest increase in demand occurs after 4:00 p.m.

Origin and Destination Matrices

The results of the survey indicate that, while many trips had origin in Fabens and destination in Porfirio Parra, some origins and destinations extended as far away as El Paso. The O/D matrix depicted in Table 5.17 summarizes these results. The "other" category represents those origins and destinations with less than 4.5 percent. These origins and destinations are summarized in Table 5.18.

Table 5.17 indicates that 57 percent of all trips originated in Fabens, and about 11 percent originated in El Paso — a considerable spread, given the distance between the two cities and the availability of bridges in El Paso. This attraction may be due to the fact that Fabens is a free bridge, and is less congested than the free bridge in El Paso (BOTA). Fabens is the closest bridge to Tornillo, which accounts for almost 17 percent of all origins.

Table 5.16. Auto trip distribution by time — Fabens Bridge

Time	Recorded Trips	Percentage	Cumulative Trips	Cumulative Percentage
7 a.m.-8 a.m.	33	5.9	33	6%
8 a.m.- 9 a.m.	41	7.3	74	13%
9 a.m. - 10 a.m.	68	11.9	142	25%
10 a.m. - 11 a.m.	53	9.4	195	34%
11 a.m. - 12 p.m.	2	0.4	197	35%
12 p.m. - 1 p.m.	57	10.1	254	45%
1 p.m. - 2 p.m.	55	9.8	309	55%
2 p.m. - 3 p.m.	64	11.4	373	66%
3 p.m. - 4 p.m.	94	16.7	467	85%
4 p.m. - 5 p.m.	97	17.2	564	100%
Total	564	100%		

All major traffic destinations on this bridge can be considered local. Guadalupe and Porfirio Parra are the closest Mexican cities; together they account for over 75 percent of all destinations. Praxedis, approximately halfway between Fabens and Fort Hancock, accounts for about 9 percent of all destinations.

Table 5.17. Origin/destination matrix — Fabens Bridge

	Destination				
Origin	Guadalupe	Porfirio Parra	Praxedis	Other	Total (Origin)
El Paso	15	29	10	4	58
	2.5%	54%	2%	1%	10.5%
Fabens	92	151	27	49	319
	16%	27%	5%	9%	57%
Tornillo	32	42	3	17	94
	5.5%	7.5%	0.5%	3%	16.5%
Other	14	49	5	25	93
	2.5%	8.5%	1%	4%	16%
Total(Destination)	153	271	45	95	564
	27%	48%	8.5%	17%	100%

Frequency Missing = 1

Table 5.18. Other origins and destinations — Fabens Bridge

Other Origins		Other Destinations	
Acala (1)	La Isla (2)	Ascension (1)	Porvenir (7)
Anthony (1)	Las Cruces (1)	Bravo (1)	Reforma (21)
Az (2)	New Mexico (2)	El Suazal (1)	S.A. Valdiva (1)
Canutillo (1)	San Antonio (1)	Jesus Carranza (2)	San Agustin (4)
Clint (27)	San Euzario (12)	Juarez (5)	San Ignacio (1)
Farwell (1)	Socorro (22)	Mimbre (1)	San Isidro (5)
Fort Hancock (2)	Spar (1)	Million (15)	Tres Jacales (5)
Horizon City (3)	Van Horn (4)	Placitas (1)	Zaragoza (5)

Auto Occupancy and Trip Purpose

The average auto occupancy at this bridge is over two for non-business trips and under two for business-related trips, indicating a low carpooling activity for business and non-business trips. This is shown in Table 5.19. The second column of this table shows the number of vehicles surveyed broken down by trip purpose response. Three drivers (approximately 1 percent) refused to state their trip purpose. Non-business trips were 395, or slightly over 70 percent of all responses. Business trips were 29 percent of all trips, which could be an underestimate owing to some travelers' reluctance in revealing their trip purposes.

Many non-business trips were visits to relatives. Business trips included people from Mexico coming to the U.S. side to work on farms, ranches, and in a manufacturing plant (Wrangler) located in Fabens.

Table 5.19. Average auto occupancy — Fabens Bridge

Trip Purpose	Recorded Trips (Percentage)	Auto Occupancy			
		Mean	Std Dev	Minimum	Maximum
N/A	3 (1%)	3.00	1.41	2	4
Personal	395 (70%)	2.29	1.27	1	8
Business	164 (29%)	1.80	1.03	1	5
Total	562 (100%)				

Trip Frequency

Weekly trip frequencies are shown in Table 5.20, which indicates that over 54 percent of all trips occur fewer than three times a week, while about 15 percent occur daily or more. Intermediate frequencies (four or five times a week) are less commonplace.

Table 5.20. Weekly frequencies — Fabens Bridge

Frequency Categories	Recorded Trips	Percentage	Cumulative Trips	Cumulative Percentage
<1	105	19%	105	19%
1≤FQ<2	121	21.5%	226	40.5%
2≤FQ<3	81	14%	307	54.5%
3≤FQ<4	58	10%	365	64.5%
4≤FQ<5	13	2%	378	66.5%
5≤FQ<6	88	16%	466	82.5%
6≤FQ<7	5	1%	471	83.5%
≥7	82	14.5%	553	98%
N/A	11	2%	564	100%
Total	564	100%		

License Plates

Recorded license plates are shown in Table 5.21. Texas plates were recorded on 70 percent of all vehicles, while 24 percent of the vehicles showed Chihuahua plates. Other recorded license plates were U.S. state plates. No other Mexican state plates were recorded.

Table 5.21. License plates — Fabens Bridge

Plate	Frequency	Percent
ARIZONA	9	1.5%
CALIFORNIA	2	0.5%
CHIHUAHUA	135	24%
COLORADO	4	0.5%
NEW MEXICO	15	3%
OKLAHOMA	2	0.5%
TEXAS	395	70%
TOTAL	562	100%

Summary

Fabens is a small toll-free facility that attracts little traffic from origins other than Fabens. Destinations included nearby cities not served by other bridges. But because it is a free bridge, it attracts traffic from an area wide enough to include El Paso.

According to CTR's survey, there were 70 percent non-business trips, 29 percent business-related trips, and 1 percent (three respondents) who refused to answer the question. The results could be biased owing to the reluctance some may have had in identifying their travel as work-related, given the binational environment. Average auto occupancy is around two for business and non-business related trips, indicating little carpooling activity. Regarding trip frequency, over 50 percent of all trips occur fewer than three times a week, while 15 percent occur once or more daily.

In short, the survey conducted at Fabens Bridge sought to complement both the WSA survey (Ref 22) and the Santa Teresa study (Ref 23) of El Paso. This survey captured about 60

percent of the ADT, which indicates that the data are reliable and could be fully incorporated in an analysis of the El Paso sector.

PRESIDIO/OJINAGA BRIDGE

Description of Field Work

An origin and destination survey was conducted at the Presidio/Ojinaga Bridge on Thursday, April 29, 1993. Presidio Bridge is a two-lane facility that carries two-way traffic. Since it is toll-free in the southbound direction, the traffic rarely stops at the entrance of the bridge. In order to conduct the survey, the project surveyors employed a series of "Be Prepared to Stop" and "Survey Crew Ahead" signs on the access road (cones and flags were also employed at the bridge approach). These measures were sufficient for stopping traffic for the survey, and almost all vehicles were captured, as shown in Table 5.22. At approximately 2:30 p.m., heavy rain started to fall. After about half an hour, the survey crew decided to continue the survey on the Mexican side (where customs inspection facilities for southbound traffic are roofed). After receiving permission from Mr. Roberto Albo Pantoja, the Delegado de Servicios Migratorios of Ojinaga, the survey continued in front of the Mexican Custom's inspection lane. In order to avoid any traffic backups or queues (traffic volumes were increasing at the time), the survey crew interviewed fewer vehicles. While conducting the survey on the Mexican side, the survey crew observed that the toll booths for northbound traffic were taken over by a group of Mexican farmers who avoided CAPUFE by not charging tolls. There is no reason to believe, however, that this demonstration had any impact on the origins and destinations of trips.

Table 5.22 depicts the traffic counts and response rates at Presidio. Despite the rain, the survey crew captured at least 85 percent of all vehicles crossing the bridge during each time interval, thus obtaining a sample whose size was considered satisfactory.

Table 5.22. Traffic counts and response rates — Presidio Bridge

	HOURLY COUNTS			SURVEYS	% CAPTURED
From - To	AUTOS & PICKUPS	TRUCKS	TOTAL		
7 a.m. - 8 a.m.	21	0	21	19	91%
8 a.m. -9 a.m.	40	1	41	39	95%
9 am. - 10 a.m.	68	0	68	68	100%
10 a.m. - 10:30 a.m.	43	0	43	41	95%
11:55 a.m. - 12:00 p.m.	8	0	8	7	88%
12 p.m. - 1 p.m.	98	1	99	89	90%
1 p.m. - 2 p.m.	109	2	111	109	98%
3 p.m.- 4 p.m.	8*	0*	8*	8*	*
4 p.m. - 5 p.m.	123	0	123	123	100%
5 p.m. - 6 p.m.	114	0	114	96	84%
Total	632	4	**636**	**599**	**94%**

* Raining

Table 5.23 shows the auto trip distribution by time of day. The morning peak for autos occurred between 9:00 a.m. and 10:00 a.m. The mid-day peak occurred between 12:00 a.m. and 2:00 p.m.; the afternoon peak started at 4:00 p.m. The truck sample is too small to warrant conclusions (there was one truck between 8:00 a.m. and 9:00 a.m., two trucks between 12:00 a.m. and 1:00 p.m., and another two between 1:00 p.m. and 2:00 p.m.).

Table 5.23. Auto trip distribution by time — Presidio Bridge

Time	Recorded Trips	Percentage	Cumulative Trips	Cumulative Percentage
7 a.m. - 8 a.m.	19	3.2	19	3.2
8 a.m. - 9 a.m.	38	6.4	57	9.6
9 a.m. - 10 a.m.	69	11.6	126	21.2
10 a.m. - 11 a.m.	40	6.7	166	27.9
11 a.m. - 12 p.m.	7	1.2	173	29.1
12 p.m. - 1 p.m.	87	14.6	260	43.8
1 p.m. - 2 p.m.	107	18.0	367	61.8
3 p.m. - 4 p.m.	16	2.7	383	64.5
4 p.m. - 5 p.m.	115	19.4	498	83.8
5 p.m. - 6 p.m.	96	16.2	594	100.0
Total	594	100%		

Origin and Destination Matrices

Table 5.24 shows the summary origin and destination matrix for Presidio Bridge. About 89 percent of the total trips had their origin in Presidio and their destination in Ojinaga; approximately 92 percent of all trips had their origin in Presidio; and nearly 96 percent had Ojinaga as their destination. These findings indicate that this bridge serves almost exclusively local traffic between Presidio and Ojinaga. The other origins and destinations, which account for only 1 percent of all trips, are shown in Table 5.25.

Table 5.24. Origin and destination matrix — Presidio Bridge

	Destination		
Origin	Ojinaga	Other	Total (origin)
Presidio	535	14	549
	89%	3%	927%
Other	43	7	50
	7%	1%	8%
Total (destination)	577	22	599
	96%	4%	100%

Table 5.25. Other origins and destinations — Presidio Bridge

Other Origins		Other Destinations
Alpine (2)	Midland (2)	Casas (1)
Andes (2)	Monahans (1)	Chihuahua (8)
Arkansas (1)	Mule Shoe (1)	Coyame (2)
Big Bend (2)	NM (1)	Cuauhtemoc (1)
Big Spring (1)	Odessa (10)	Delicias (3)
Candelaria (1)	Oklahoma City (1)	Durango (1)
Del Rio (1)	Pampas (1)	Miguel Allende (1)
Dumas (1)	Pecos (3)	Parral (3)
El Paso (3)	Redford (3)	Sonora (1).
Fort Davis (1)	Ruidosa (1)	
Ft. Stockton (1)	Terlengua (1)	
Kermit (1)	Tyler (1)	
Lajitas (2)	Valentine (1)	
Marfa (3)	Van Horn (1)	

Trip Frequency

Auto weekly frequencies are shown in Table 5.26, with truck weekly frequencies shown in Table 5.27. Over 54 percent of all auto trips are made fewer than three times a week, while 25 percent are made once or more daily. All truck trips in the small sample size captured are made fewer than three times a week, out of which 40 percent are made fewer than once a week.

Table 5.26. Auto weekly frequencies — Presidio Bridge

Frequency Category	Recorded Trips	Percentage	Cumulative Trips	Cumulative Percentage
<1	99	17%	99	17%
1≤FQ<2	126	21%	225	38%
2≤FQ<3	92	15.5%	317	53.5%
3≤FQ<4	47	8%	364	61.5%
4≤FQ<5	9	1.5%	373	63%
5≤FQ<6	40	7%	413	70%
6≤FQ<7	19	3%	432	73%
≥7	150	25%	582	98%
N/A	12	2%	594	100%

Table 5.27. Truck weekly frequencies — Presidio Bridge

Frequency Category	Recorded Trips	Percentage	Cumulative Trips	Cumulative Percentage
<1	2	40%	2	40%
1≤FQ<2	1	20%	3	60%0
2≤FQ<3	2	40%	5	100%

Auto Occupancy and Trip Purpose

As shown in Table 5.28, the average auto occupancy was about two for non-business trips, and under two for business-related trips, indicating a predominance of individual trips for business-related crossings. The second column of Table 5.28 shows the number of business and non-business related trips for this bridge. Non-business trips accounted for 69 percent of all trips, while business-related trips accounted for 31 percent of all trips. Again, these numbers may be biased owing to the travelers' reluctance in declaring a work-related trip in a binational environment. There were eight non-declared trip purposes. Trip purposes included visits to relatives, work commutes to Mexico, and trips related to ranch activities (e.g., to purchase cattle).

Table 5.28. Average auto occupancy — Presidio Bridge

Trip Purpose	Recorded Trips (Percentage)	Mean	Std Dev	Minimum	Maximum
Personal	409 (69%)	2.14	1.13	1	7
Business	182 (31%)	1.75	1.05	1	6
Total	591 (100%)				

License Plates

License plate counts are shown in Table 5.29, with Mexican state plates indicated in bold. Of all plates, approximately 53 percent indicated Texas vehicles, over 42 percent indicated Chihuahua vehicles, while the rest were plates from other U.S. or Mexican states.

Summary

This survey captured at least 85 percent of all traffic for each given time interval, making it a very large and reliable sample size. This bridge serves almost exclusively local traffic, with almost 90 percent of all trips made between Presidio and Ojinaga. It must be observed that, although Presidio (population approximately 3,100) is a much smaller town than Ojinaga (approximately 18,200 population), still over half of all license plates indicated Texas travelers.

Nearly 70 percent of the respondents stated they were making non-business trips, but, as was observed in other surveys, this number may be overestimated owing to a reluctance in declaring a work-related trip between the two countries. Average auto occupancy is around two for non-business and under two for business trips, indicating little carpooling. License plates are

almost exclusively from Texas and Chihuahua. The usual urban pattern of a morning peak, a mid-day peak, and an afternoon peak in traffic volume was observed during this survey.

Table 5.29. License plates — Presidio bridge

Plate	Frequency	Percent
ALABAMA	1	0.2%
ARIZONA	1	0.2%
CHIHUILA	253	42.5%
COLORADO	1	0.2%
COAHUILA	1	0.2%
MEX-DF	1	0.2%
ILLINOIS	1	0.2%
KANSAS	1	0.2 %
NORTH CAROLINA	1	0.2%
NEW MEXICO	12	2.0%
OHIO	1	0.2%
OKLAHOMA	2	0.5%
TEXAS	317	53%
ZAC	1	0.2%
Total	594	

DEL RIO/CIUDAD ACUÑA

Description of Field Work

The bridge linking Del Rio, Texas, and Ciudad Acuña, Coahuila, is a four-lane toll facility, with an average daily traffic between 2,500 and 3,000 vehicles. The 13-hour origin and destination survey was conducted on April 29, 1993, from 6:00 a.m. to 7:00 p.m.

Initially, the bridge was not busy, as Mexico was not observing daylight savings time. Nevertheless, there were a few autos crossing to the other side that could be interviewed. Between 6:30 a.m. and 7:00 a.m., traffic increased considerably, with such traffic consisting mostly of people who live in Del Rio and who work in the Ciudad Acuña maquiladoras. The crew surveyed continually until about 11:00 a.m., when heavy rain began to fall. The rain lasted for about 3 hours; around 2:10 p.m. the crew continued the survey.

A total of 859 vehicles were surveyed. According to the traffic counts provided by Mr. Aguirre of the City of Del Rio, the survey captured approximately 30 percent of the April average daily traffic. Moreover, the response rate was very close to 100 percent, with very few drivers refusing to answer the survey.

Origin and Destination Matrices

Table 5.30 summarizes the origin and destination matrix, which shows that 94 percent of all trips originate in Del Rio and have their destination in Ciudad Acuña. All other origins and

destinations (Table 5.31) account for very few trips, indicating that the bridge serves mostly local traffic.

Table 5.30. Origin and destination matrix — Del Rio Bridge

Origin	Destination		
	Ciudad Acuña	Other	Total (origin)
Del Rio	807	16	823
	94%	2%	96%
Other	30	6	36
	3.1%	1.1%	4.2%
Total (destination)	837	22	859
	97%	3%	100%

Table 5.31. Other origins and destinations — Del Rio Bridge

Other Origins:		**Other Destinations:**	
Abilene (2)	El Paso (1)	Allende (2)	Monterrey (1)
Austin (1)	Ft Worth (1)	DF, Mex (2)	Nueva Rosita (1)
Bakersfield (1)	Harper (1)	Honduras (1)	Piedras Negras (3)
Brownsville (1)	Houston (2)	Jimenez (2)	Presa Amistad (1)
Brownwood (1)	Laredo (1)	Mendoza (1)	San Carlos (1)
California (1)	Laughlin (1)	Mex (1)	San Miguel (1)
Carta Valley (2)	Meoste (1)	Monclova (1)	Zaragoza (3)
Cleveland (1)	New Orleans (1)		
Comstock (1)	Robert Lee (1)		
Dallas (1)	Rock Springs (1)		
Des Moines (1)	San Antonio (5)		
Eagle Pass (3)	Uvalde (2).		

Trip Frequency

The auto weekly frequencies are depicted in Tables 5.32 and 5.33. About 34 percent of auto frequencies are fewer than three times a week, while about the same percentage use the bridge six times a week or more. As for trucks, over half of all trips are made once or more daily, reflecting the drayage companies activities within the commercial zone only.

Table 5.32. Auto weekly frequencies — Del Rio Bridge

Frequency Category	Recorded Trips	Percentage	Cumulative Trips	Cumulative Percentage
<1	95	11.5%	95	11.5%
1≤FQ<2	96	12%	191	23.5%
2≤FQ<3	84	10%	275	33.5%
3≤FQ<4	42	5%	317	38.5%
4≤FQ<5	18	2%	335	40.5%
5≤FQ<6	232	28%	567	68.5%
6≤FQ<7	21	2.5%	588	71%
≥7	219	27%	807	98%
N/A	17	2%	824	100%

Table 5.33. Truck weekly frequencies — Del Rio Bridge

Frequency Category	Recorded Trips	Percentage	Cumulative Trips	Cumulative Percentage
1≤FQ<2	1	3%	1	3%
2≤FQ<3	3	9%	4	12%
3≤FQ<4	3	9%	7	21%
5≤FQ<6	6	18%	13	39%
≥7	18	55%	31	94%
N/A	2	6%	33	100%

Auto Occupancy and Trip Purpose

Table 5.34 shows the average auto occupancy, which is slightly over two for non-business trips, and under 1.5 for business-related trips. This trend has been consistent throughout Segment 2. The second column reflects the number of respondents by trip purpose, which is equally split between business and non-business trips; the remainder (4 percent) represents those respondents refusing to answer.

Table 5.34. Average auto occupancy — Del Rio Bridge

		Auto Occupancy			
Trip Purpose	Sample Size (Percent)	Mean	Std Dev	Minimum	Maximum
N/A	33 (4%)	1.27	0.63	1	3
Non-business	388 (48%)	2.19	1.32	1	9
Business	392 (48%)	1.40	0.84	1	8
Total	813 (100%)				

Summary

The results indicate that the vast majority of trips made between Del Rio and Ciudad Acuña are local. The majority of business trips seemed to be related to Del Rio residents working at Ciudad Acuña's maquiladoras. In addition, a significant number of non-business trips were related to personal activities, such as school, visits to relatives, medical visits, and

shopping. While at all other Segment 2 bridges the trip purpose response was split at approximately 70–30 percent between non-business and business, in Del Rio these percentages were equally split between the two purposes. This may be owing to the high number of Del Rio citizens working in Ciudad Acuña maquiladoras. Moreover, these workers are legally documented workers who have no reason to avoid declaring their true trip purpose.

HIDALGO/REYNOSA BRIDGE

Description of Field Work

The Hidalgo Bridge, a toll facility in both directions, was surveyed on June 1, 1993, from 7:00 a.m. to 7:00 p.m., by a crew consisting of three TxDOT surveyors, eight CTR surveyors, and one coordinator who acted as a support person for the field crew. The bridge comprises two separate four-lane bridges, one for each traffic direction. It is a very busy facility, one that required a significant number of surveyors. It was found during the field work that an eleven-member crew was not sufficient for obtaining the 50 percent ADT goal (the crew members, working for 12 hours in the hot sun, had to take frequent breaks to prevent heat-related illnesses). The truck survey, however, went smoothly (the survey was abetted by the Hidalgo Police, who were holding the trucks in a line one block in front of the toll booth entrance, where they could thus be interviewed; police said that traffic delays on the U.S. side are due to Mexican customs, and that traffic control measures are necessary to ease the traffic flow across the bridge).

According to the traffic data released by bridge management, the survey captured approximately 28 percent of all autos and 24 percent of all trucks. Assuming that the hourly distribution observed for other days is similar to what was observed on the day of the survey, approximately 37 percent of all vehicles using the bridge between 7:00 a.m. and 7:00 p.m. were captured.

Table 5.35 shows a sample trip distribution by time of day over the survey period. The peaks were not sharp for autos, probably because the bridge was already operating at full capacity most of the time, and because the number of vehicles the crew could capture was already at its maximum most of the time. The morning peak occurred between 10:00 a.m. and 12:00 a.m.; the afternoon peak started at 5:00 p.m. For trucks, there was a peak from 7:00 a.m. to 9:00 a.m., and another peak in the afternoon after 5:00 p.m. Some of these trucks may not have crossed the bridge exactly during the time interval stated in Table 5.35, because they were interviewed while waiting to cross.

Origin and Destination Matrices

Tables 5.36 and 5.37 show the auto origin and destination matrices, respectively, for the Hidalgo Bridge. The data in these matrices indicate that most of the traffic demand for this bridge comes from the Hidalgo-McAllen-Mission-Pharr area, which accounts for 82.9 percent of the auto origins and 74.5 percent of the truck origins. McAllen leads the demand, accounting for 60.5 percent of the auto origins, and 43.8 percent of the truck origins; Reynosa is the

predominant destination for both autos and trucks.

Table 5.35. Trip distribution by time of the day — Hidalgo Bridge

TIME	Autos		Trucks	
	Recorded Trips	Percent	Recorded Trips	Percent
7	185	4.6	17	12.4
8	326	8.1	27	19.7
9	380	9.5	5	3.6
10	486	12.1	7	5.1
11	465	11.6	3	2.2
12	311	7.8	10	7.3
13	203	5.1	7	5.1
14	198	4.9	12	8.8
15	291	7.3	4	2.9
16	395	9.9	11	8.0
17	507	12.7	29	21.2
18	256	6.4	5	3.6

The "other" origins and destinations and their occurrence are shown in Table 5.39. The "other" category consists of all origins or destinations whose frequency was less than 5 percent of the total (with the exception of Mission and Pharr, whose truck frequency, while less than 5 percent, was shown to be consistent with the auto tables).

Table 5.36. Auto origin and destination matrix — Hidalgo Bridge

Origin	**Destination**		
	REYNOSA	OTHER	Total (origin)
HIDALGO	310	20	330
	8%	0.5%	8.5%
MCALLEN	2134	288	2422
	53%	7%	60%
MISSION	315	27	342
	8%	1%	9%
PHARR	211	13	224
	5%	0.5%	5.5%
OTHER	560	125	685
	14%	3%	17%
Total (destination)	3530	473	4003
	88%	12%	100%

Table 5.37. Truck origin and destination matrix — Hidalgo Bridge

Origin	Destination		
	REYNOSA	OTHER	Total (origin)
HIDALGO	18	18	36
	13%	13%	26%
MCALLEN	47	13	60
	34%	10%	44%
PHARR	21	1	22
	15%	1%	16.03%
OTHER	0	14	35
	0%	10%	25.55%
Total (destination)	90	47	137
	62%	34%	100.00%

Trip Purpose

This survey expanded the non-business trip purposes into four more categories: "school," "recreation," "shopping," and "other." Table 5.39 shows these trip purpose frequencies. The responses at this bridge follow the usual pattern — about 30 percent for business and 70 percent for non-business — that was found in all Segment 2 bridges (except Del Rio's). Data also indicate that the non-business purposes were split almost evenly among shopping, recreation, and all others, with a higher number for shopping. School-related trips may be underestimated, since the survey was undertaken in June (i.e., during summer vacation).

Trip Frequency

Auto weekly frequencies by trip purpose are shown in Table 5.40. Over 61 percent of all auto trips occur fewer than three times a week, and 11 percent occur once or more a day. Over 62 percent of all school-related trips are undertaken either five to six times a week or more, and some more than once a day. This latter finding may have been the result of respondents misunderstanding the question; that is, declaring that they cross the bridge twice a day (once to go to school and once to come back). Almost 88 percent of all recreational trips are less frequent than four times a week (this included tourism and visits to relatives and friends). Over half of all shopping trips are less frequent than twice a week, with most of them reflecting periodic grocery shopping and other domestic shopping. Almost 10 percent of all shopping trips are made daily or more, probably reflecting some "chivero" activity (i.e., Mexican nationals who buy small quantities for resale or by order). Almost 37 percent of all business trips reflect the weekday pattern, that is, five and six times a week. The apparently unusual occurrence of 18 percent responding that they make business-related trips once or more daily may again indicate respondent confusion to the question (although many respondents reiterated the high frequency when asked "You mean five times a week, don't you?," or something to that effect).

Table 5.38. Other origins and destinations — Hidalgo Bridge

Other Origins		Other Destinations	
Alamo (58)	Michigan (2)	Acamar (1)	Monte Morelos (6)
Alice (1)	Midland (2)	Acapulco (1)	Monterrey (116)
Alto Bonito (1)	Mississippi (1)	Aguas Calientes (4)	Moute Tam (1)
Arizona (1)	Missouri (1)	Allende (1)	Nicaragua (1)
Arkansas (1)	Monte Alto (3)	Aquismon (2)	Nuevo Leon (11)
Atlanta (1)	New Mexico (1)	Belize(1) Camargo (3)	Pachula (1)
Austin (5)	New York (1)	Ciudad Mante (1)	Puerto Vallarta (2)
Blanco (1)	North Carolina (2)	Ciudad Mexico (1)	Queretaro (1)
Boston (1)	Nuevo Laredo (2)	Ciudad Victoria (1)	Rio Bravo (146)
Brownsville (25)	Nuevo Leon (1)	Celia (1) Chino (2)	Rio Verde (1)
California (1)	Nuevo Progreso (1)	Cina nl (1)	Saltillo (4)
Canada (2)	Ohio (1)	Coahuila (1)	San Luis Potosi (5)
Chicago (3)	Oklahoma (1)	Del Norte (1)	San Bernardo (1)
Corpus Christi (23)	Panview (1)	Diaz Ordaz (47)	San Fernando (1)
Crosby (2)	Penitas (3)	Durango (3)	San Pedro (1)
Dallas (9)	Pennsylvania (1)	El Salvador (8)	Santiago (1)
Denton (1)	Precio (1)	General Bravo (8)	Santillo (2)
Denver (1)	Progreso (3)	Guadalajara (3)	Sinaloa (1)
Donna (34)	Progresso (1)	Guanajuanto (1)	Tamaulipas (1)
Edinburg (188)	Pt. Isabel (1)	Guatemala (11)	Tamazula (1)
Falfurrias (3)	Pt. Lavaca (3)	Hidalgo (1)	Tampico (12)
Florida (7)	Quebec Canada (1)	Honduras (7)	Tapachula (1)
Freeport (1)	Rancho Viejo (1)	Hualahuises (1)	Tecas (1)
Ft. Worth (1)	Raymonaune (1)	Jimenez (1)	Teran (1)
Garciaville (1)	Rio Grande (8)	Lake Guerrero (1)	Tomatlan (1)
Harlingen (21)	Roma (2)	La Planta(2)	Torreon Coah (3)
Houston (42)	San Antonio (17)	Las Herraras (1)	Valadeces (2)
Humble (1)	San Benito (4)	Linars (1)	Valle Hermoso (6)
Illinois (2)	San Diego (1)	Matamoros (13)	Veracruz (8)
Indiana (1)	San Isidro (1)	Mendez (2)	Victoria (10)
Jasper (1)	San Jose (1)	Mexico City (28)	Villa Hermosa (1)
Kansas City (1)	San Juan (87)	Michoacan (1)	Zacatecas (1)
Kentucky (1)	Sebastian (1)	Miguel Aleman (1)	Frequency Missing = 7
Kingsville (1)	South Padre (2)		
La Villa (1)	Sullivan City (3)		
La Ciso (1)	Tennessee (1)		
La Feria (3)	Texas City (1)		
La Joya (6)	Utah (1)		
Laredo (4)	Virginia (1)		
Las Milpas (3)	Washington (2)		
Los Angeles (4)	Weslaco (54)		
Louisiana (1)	Wisconsin (1)		
Lubbock (2)	Xicotencotl (1)		
Maleman (1)	Frequency Missing=8		
Maryland (1)			
Mercedes (16)			
Miami (1)			

Table 5.39. Auto trip purpose distribution — Hidalgo Bridge

Purpose	Number of trips	Percent
Recreation	941	23.7
School	37	0.9
Shopping	1061	26.7
Other	908	22.8
Non-Business	**2972**	**74.2**
Business	1031	25.9
Total	4003	

Non-declared purpose = 25

Table 5. 40. Auto weekly frequencies by trip purpose — Hidalgo Bridge

	School		Shopping		Recreation		Business		Other		Total	
Freq.	Trips	%	Trips	%	Trips	%	Trips	%	Trips	%	Trips	%
<1	3	8%	239	22%	321	34%	113	11%	326	36%	1007	25%
1-2	2	5.5%	328	31%	256	27%	83	8%	203	22%	872	22%
2-3	2	5.5%	180	17%	148	16%	94	9%	160	17%	587	15%
3-4	3	8%	135	12.7%	98	10%	89	9%	96	11%	425	10.5%
4-5	3	8%	38	4%	17	2%	35	3%	22	2%	117	3%
5-6	13	35%	26	2%	15	2%	380	37%	22	2%	456	11%
6-7	1	3%	9	1%	7	1%	43	4%	4	1%	64	1.5%
>=7	10	27%	103	10%	69	7%	186	18%	68	8%	441	11%
N/A	0	0	3	0.3%	10	1%	8	1%	7	1%	34	1%
Total	37	100%	1061	100%	941	100%	1031	100%	908	100%	4003	100%

Non-declared purpose = 25

Truck weekly frequencies, shown in Table 5.41, occur mostly within the once-or-twice-a week category, and at the five-to-six-times-a-week and daily-or-more categories. The latter two probably reflect the drayage companies transferring cargo from one warehouse to another.

Table 5.41. Truck weekly frequencies — Hidalgo Bridge

Frequency	Number of trips	Percent
<1	7	5%
1≤FQ<2	33	24%
2≤FQ<3	12	9%
3≤FQ<4	8	6%
4≤FQ<5	2	1%
5≤FQ<6	31	23%
6≤FQ<7	3	2%
≥7	38	28%
N/A	3	2%
Total	137	100%

Auto Occupancy

Average auto occupancy is shown in Table 5.42, broken down by trip purpose. The overall occupancy average was approximately two people per auto, with a maximum of eight. Recreation and other purposes account for the highest auto occupancy, while business accounts for the lowest, a fact consistent with the already observed tendency for business travelers to disregard carpooling for business trips across the border. There were 24 instances of refusal to answer this particular question; the average occupancy for these unknown purposes was 2.03.

License Plates

The license plate frequencies are shown in Table 5.43 for autos and in Table 5.44 for trucks. Local auto plates are 91.5 percent of the total, with 55.8 percent from Texas and 35.7 percent from Tamaulipas. The only other auto plates having more than 1 percent occurrence were from Nuevo León and Mexico City. Over half of all truck plates are from Mexico, while 25 percent are from Texas.

Table 5.42. Average auto occupancy — Hidalgo Bridge

Trip Purpose	Auto Occupancy				
	Number of Trips	Average	Std. Dev.	Minimum	Maximum
Recreation	932	2.22	1.27	1	8
School	37	1.87	1.23	1	6
Shopping	1053	2.19	1.08	1	8
Other	901	2.26	1.33	1	8
Business	1014	1.52	0.86	1	8
Total Trips	3961	2.04	1.18	1	8

Frequency missing (no trip purpose declared) = 24.

The truck axle average for this bridge was 4.32, at a standard deviation of 1.36. The minimum number of axles was 2, while the maximum was 8. These axle numbers include the tractor.

Summary

The Hidalgo Bridge mainly serves the McAllen-Hidalgo-Mission-Pharr area. Most of the demand comes from McAllen, with Pharr having the least demand. Reynosa accounts for most auto and truck destinations, with no other destination having more than 5 percent. Having a very high demand, the bridge appeared to be operating over capacity most of the time. However, the Hidalgo police said that traffic delays are usually due to Mexican Customs inspections, rather than to excessive traffic using the bridge. The pattern of 70 percent non-business and 30 percent business trips found in all Segment 2 bridges (except Del Rio's) appears again in Hidalgo, and so does the predominance of local license plates and local origins and destinations. The average auto occupancy also conforms to the pattern found with the other bridges.

Table 5.43. Auto license plates — Hidalgo Bridge

PLATE	Frequency	Percent	PLATE	Frequency	Percent
ALABAMA	1	0.0	NORTH CAROLINA	4	0.1
ARKANSAS	1	0.0	NORTH DAKOTA	1	0.0
ARIZONA	1	0.0	NEW JERSEY	1	0.0
CALIFORNIA	11	0.3	NL MEX	73	2.0
COLORADO	3	0.1	NEW MEXICO	4	0.1
COAH MEX	9	0.2	NEW YORK	1	0.0
WASHINGTON DC	1	0.0	OHIO	8	0.2
DELAWARE	2	0.1	OKLAHOMA	6	0.2
DF MEX	7	0.2	ONTARIO	1	0.0
DGO MEX	1	0.0	PENNSYLVANIA	2	0.1
FLORIDA	27	0.7	QRO MEX	1	0.0
GEORGIA	7	0.2	QUEBEC	2	0.1
HGO MEX	1	0.0	RHODE ISLAND	1	0.0
IOWA	2	0.1	SOUTH CAROLINA	3	0.1
IDAHO	4	0.1	SIN MEX	1	0.0
ILLINOIS	11	0.3	SLP MEX	2	0.1
INDIANA	2	0.1	SON MEX	1	0.0
KANSAS	2	0.1	TAMPS ME	1409	35.5
LOUISIANA	2	0.1	TENNESSEE	5	0.1
MARYLAND	2	0.1	TEXAS	2207	55.5
MAINE	1	0.0	US	11	0.3
MEX MEX	60	1.5	UTAH	3	0.1
MICHIGAN	10	0.3	VIRGINIA	2	0.1
MINNESOTA	5	0.1	VER MEX	2	0.1
MISSOURI	4	0.1	WASHINGTON	6	0.2
MOR MEX	1	0.0	WISCONSIN	9	0.2
MISSISSIPPI	2	0.1	WYOMING	2	0.1
MONTANA	1	0.0	Total	3949	100%

Frequency missing = 54

Table 5.44. Truck license plates — Hidalgo Bridge

PLATE	Frequency	Percent
CALIFORNIA	2	1.5
ILLINOIS	5	3.8
MAINE	1	0.8
MEX DF	5	3.8
MICHIGAN	1	0.8
MINNESOTA	1	0.8
NEW JERSEY	1	0.8
NL MEX	5	3.8
OKLAHOMA	1	0.8
SLP MEX	6	4.5
SPF MEX	26	19.6
TAMPS MEX	41	31
TENNESSEE	2	1.5
TEXAS	33	25
VER MEX	2	1.5
Total	132	100%

Frequency missing = 5

The survey form used on this bridge successfully retrieved more detailed information without adding to the survey time. This was the first bridge surveyed that had high truck traffic: it was observed that the trucks had to wait in queues for long periods (not a result of the survey). The traffic delays here would have made a slightly longer questionnaire feasible for trucks. These findings were implemented in the form used in the other Segment 1 origin and destination surveys; the results are discussed in the next section.

BROWNSVILLE/MATAMOROS GATEWAY BRIDGE

Description of Field Work

Gateway Bridge consists of two separate two-lane structures, one for each traffic direction. As a toll facility in both directions, it carries a very high volume of traffic — auto ADT climbs to around 10,000, while truck ADT reaches to around 650. The traffic counts on the survey dates (provided by the bridge manager) are shown in Table 5.45. Hourly counts were not provided.

The 12-hour survey was conducted over two consecutive 6-hour shifts, the first on June 28, 1993, from 1:00 p.m. to 7:00 p.m., and the second on June 29, 1993, from 7:00 a.m. to 1:00 p.m. The survey crew consisted of eight surveyors and two coordinators who acted as support persons. This survey benefited by the availability of a crew coordinator who served to alert the first surveyor in the queue as to which vehicle should be stopped, and which had already been surveyed. As a consequence, the survey captured approximately 43 percent of the average auto traffic and 26 percent of the average truck traffic on the two survey dates.

Table 5.45. Daily traffic counts — Gateway Bridge

Date	Autos		Trucks	
	Number of vehicles	Average hourly counts	Number of vehicles	Average hourly counts
6/28/93	9,730	405/hour	717	30/hour
6/29/93	10,181	424/hour	720	30/hour

Auto and truck trip sample distributions by time of day are shown in Table 5.46, where we see that auto sample sizes in each 1-hour interval are comparable, with the exception of the early afternoon hours. Truck traffic is higher in the afternoon than in the morning, as reflected by the samples shown in Table 5.46. A mid-day peak in truck traffic volumes occurred between 11:00 a.m. and 12:00 p.m.; after 2:00 p.m. truck traffic increased and remained at the same level, causing street congestion in Brownsville. Absence of sharp peaks in auto and truck traffic is consistent with the fact that Gateway Bridge appeared to be over capacity.

Table 5.46. Trip distribution by time of day — Gateway Bridge

TIME	Autos		Trucks	
	Surveyed Trips	Percent	Recorded Trips	Percent
7 a.m. - 8 a.m.	308	7%	0	0%
8 a.m. - 9 a.m.	343	8%	2	1%
9 a.m. - 10 a.m.	498	12%	5	3%
10 a.m. - 11 a.m.	422	10%	8	4%
11 a.m. - 12 p.m.	430	10%	31	17%
12 p.m. - 1 p.m.	230	6%	12	7%
1 p.m. - 2 p.m.	160	4%	8	4%
2 p.m. - 3 p.m.	339	8%	22	12%
3 p.m. - 4 p.m.	435	10%	26	14%
4 p.m. - 5 p.m.	389	9%	28	15%
5 p.m. - 6 p.m.	392	9%	22	12%
6 p.m. - 7 p.m.	312	7%	21	11%
Total	4258			

Origin and Destination Matrices

Tables 5.47 and 5.48 reflect the origin and destination matrices for autos and trucks, respectively. The auto matrix shows that Gateway Bridge serves almost exclusively local traffic between Brownsville and Matamoros. Over 96 percent of all trips have Matamoros as final destinations, and about 87 percent started in Brownsville. For trucks, Brownsville is the origin of over 94 percent of all trips, while Matamoros is the predominant destination for over 72 percent of all trips. Mexico City and Monterrey are the only other noteworthy destinations in the data summary, with 9 percent of all trips destined for Mexico City and 7 percent for Monterrey.

The "Other" category of origins and destinations are those contributing less than 5 percent of all trips. These origins and destinations are listed in Table 5.49.

Table 5.47. Auto origin and destination matrix — Gateway Bridge

	Destination		
Origin	MATAMOROS	OTHER	Total (Origin)
BROWNSVILLE	3617	90	3707
	85%	2.%	87%
OTHER	489	62	551
	11.5%	1.5%	13%
Total (Destination)	4106	152	4258
	96.5%	3.5%	100%

Table 5.48. Truck origin and destination matrix — Gateway Bridge

	Destination				
Origin	Matamoros	Mexico DF	Monterrey	Other	Total (Origin)
Brownsville	126	14	11	23	174
	68%	8%	6%	12%	94%
Other	8	2	1	0	11
	4%	1%	1%	0%	6%
Total (Destination)	134	16	12	23	185
	72%	9%	7%	12%	100.00%

Trip Purpose

This survey used the following trip purposes: Doctor, Recreation, School, Shopping, Business, Taxi, and Other. We attempted to determine if the trip was made from or to the main purpose, or if it was made from one purpose to another (e.g., if a trip was made from Brownsville to Matamoros to visit a doctor, or was made for shopping from Brownsville to home in Matamoros). However, the traffic congestion on Gateway frequently made surveying difficult; consequently, only about 30 percent of all surveys captured this information.

Table 5.50 shows a summary of the auto trip purposes, with the "from purpose" and "to purpose" identification, wherever available. Of all 4,258 auto trips surveyed, 450 were coming back from the trip purpose, 801 were going to the trip purpose, 2,986 indicated the purpose but did not answer whether it was from or to, and 21 travelers did not declare a purpose. There were 15 taxicabs surveyed, a newly added category. The common pattern found in the border of a 30–70 percent split between business and non-business trips is also found on this bridge. Recreational purposes are more frequent than shopping purposes. The 2 percent school-related trips may be underestimated, owing to the fact that the survey was made during summer vacation.

Table 5.49. Other origins and destinations — Gateway Bridge

Other Origins		Other Destinations	
Alamo (3)	Massachusetts (1)	Anahuac (1)	
Alice (1)	McAllen (38)	Cadereyta (5)	Monterrey (6)
Austin (1)	Mercedes (6)	Cd Mante (1)	Nuevo Leon (3)
Burnett (1)	Michigan (2)	Cd Victoria (6)	Oaxaca (2)
California (1)	Minnesota (1)	Coahuila (1)	Pueblo (1)
Calwell (1)	Mission (3)	Coblado (1)	Queretaro (1)
Cameron Park (1)	New Orleans (1)	Empalme (3)	Reynosa (4)
Cd Victoria (2)	Nuevo Laredo (1)	Guadalajara (1)	Riobravo (1)
Chicago (4)	Ohio (1)	Guanajuato (1)	San Luis Potosi (9)
Colorado (1)	Olmito (7)	Guatemala (2)	San Fernando (15)
Corpus Christi (9)	Phoenix (1)	Hidalgo (2)	San Juan (1)
Dallas (15)	Portsville (1)	Honduras (1)	Soto la Marina (1)
Denver (1)	Progreso (1)	Jalisco (2)	Tamaulipas (2)
Donna (2)	Pt Isabel (48)	Jimenez (1)	Tampico (14)
Ed Couch (1)	Rancho Viejo (4)	Las Flores (1)	Valle Hermoso (48)
Edinburg (9)	Rangerville (1)	Los Timones (1)	Vasolo (1)
Engleton (1)	Reynosa (3)	Mexico DF (12)	Veracruz (6)
Florida (21)	Rio Bravo (1)	Mezquital (1)	Zacatecas (1)
Ft Worth (2)	Rio Grande (5)	Monclova (5)	Frequency Missing=11
Gainsville (1)	Rio Hondo (5)		
Galveston (1)	San Angelo (1)		
Garcia (1)	San Antonio (9)		
Gregory (1)	San Benito (66)		
Groesbeck (1)	San Jose (1)		
Harlingen (101)	San Juan (1)		
Houston (45)	San Patricio (1)		
Indiana (2)	San Pedro (1)		
Kingsville (2)	Santa Rosa (1)		
La Feria (4)	Sebastian (1)		
Laredo (1)	Sioux City (1)		
Las Vegas (1)	South Padre (46)		
Ligthweter (1)	Spain (1)		
Lopez (4)	St Francis (1)		
Los Angeles (1)	Tampico (1)		
Los Fresnos (40)	Uvalde (1)		
Los Indios (1)	Weslaco (2)		
Louisiana (1)	Frequency missing=6		
Lozano (1)			
Lyford (1)			

Trip Frequency

Auto weekly frequencies are shown in Table 5.51 by trip purpose and total autos. There were 21 undeclared trip purposes and 15 taxis. Taxi passengers were not asked their actual trip purpose, since that would lengthen the interview. Over 72 percent of auto trips are made either less than three times a week or more than seven times a week. Medical trips are made less than three times a week (86 percent), and almost half of them are undertaken less than once a week. It was observed that people who needed to see a doctor often preferred to do so in Mexico, owing to the lower rates. Recreational trips are usually undertaken less than four times a week (79

percent), and 13 percent are daily or more. Over half of all business trips are made more than five times a week, with 34 percent of total business trips made daily or more. This reflects the typical weekday schedule, and the typical border activity of people crossing several times a day for buy-and-sell activities. Over 75 percent of all school trips were made over five times a week. Part of the non-daily school trips (24 percent) reflect parents that carpool. Many Mexican respondents mentioned taking their children to extracurricular classes (such as swimming in the U.S., which is a summer-only activity). The total number of weekday school-related trips is probably higher during the school year. Finally, taxi frequencies (not shown in the table) were divided into 60 percent daily or more, 33 percent between three and five times a day, and 7 percent occasionally (fewer than one a week).

Table 5.50. Auto trip purposes — Gateway Bridge

Purpose	From	To	Undeclared To/From	Total	Percent of total
Doctor	3	30	94	127	3%
Other	17	60	113	190	4.5%
Recreation	47	351	999	1,397	33%
School	30	8	58	96	2%
Shopping	273	104	874	1,251	29.5%
Business	80	248	833	1,161	27%
Taxi	.	.	15	15	1%
Total	450	801	2,986	4,237	100%

Frequency missing (purpose not declared) = 21

Taxi = 15

Table 5.51. Auto weekly frequencies — Gateway Bridge

Weekly Frequency	Recorded Trips (Percentage of Category)						
	Shopping	Recreation	Doctor	School	Business	Other	Total
<1	180 (14%)	330 (23.5%)	60 (47%)	3 (3%)	82 (7%)	47 (24.5%)	707 (16.5%)
1-2	328 (26%)	356 (25.5%)	30 (24%)	6 (6.5%)	94 (8%)	33 (17%)	849 (20%)
2-3	285 (23%)	265 (19%)	19 (15%)	8 (8.5%)	73 (6%)	36 (19%)	686 (16%)
3-4	197 (16%)	151 (11%)	8 (6%)	2 (2%)	88 (8%)	17 (9%)	467 (11%)
4-5	47 (4%)	52 (4%)	1 (1%)	4 (4%)	47 (4%)	7 (4%)	162 (4%)
5-6	29 (2%)	35 (2.5%)	3 (2%)	28 (29%)	305 (26%)	7 (4%)	409 (9.5%)
6-7	15 (1%)	7 (0.5%)	0 (0%)	2 (2%)	76 (6.5%)	2 (1%)	102 (2%)
>=7	164 (13%)	186 (13%)	5 (4%)	43 (45%)	393 (34%)	40 (21%)	846 (20%)
n/a	6 (1%)	15 (1%)	1 (1%)	0 (0%)	3 (0.5%)	1 (0.5%)	30 (1%)
Total	1,251 (100%)	1397 (100%)	127 (100%)	96 (100%)	1,161 (100%)	190 (100%)	4,258 (100%)

Missing purpose = 21
Taxi = 15

Truck frequencies are shown in Table 5.52 by load status and total trucks. Over half of all truck trips are made once (or more) a day for all types of load status, reflecting the activities of drayage companies specializing in hauling cargo from one commercial zone to another.

Table 5.52. Truck weekly frequencies — Gateway Bridge

Weekly Frequency	Recorded Trips (percent)			
	Loaded	Empty	Tractor	Total
<1	9 (10%)	3 (7.75%)	1 (8.25%)	14 (8%)
1≤FQ<2	8 (8.%)	1 (2.5%)	1 (8.25%)	19 (10%)
2≤FQ<3	10 (11%)	4 (10%)	0 (0%)	17 (9%)
3≤FQ<4	7 (7%)	3 (7.75%)	0 (0%)	10 (5%)
4≤FQ<5	1 (1.%)	2 (5%)	0 (0%)	3 (2%)
5≤FQ<6	3 (3%)	5 (13%)	1 (8.25%)	13 (7%)
6≤FQ<7	4 (4%)	1 (2.5%)	1 (8.25%)	6 (3%)
≥7	51 (54%)	19 (49%)	8 (67%)	99(54%)
N/A	2 (2%)	1 (2.5%)	0 (0%)	4 (2%)
Total	95 (100%)	39 (100%)	12 (100%)	185 (100%)

Missing load status = 39

The average auto occupancy by trip purpose is shown in Table 5.53. Overall average auto occupancy was 1.99, with a standard deviation of 1.24, and a range between a minimum of one to a maximum of eight people per auto. This average was calculated for 4,222 trips, as there were 36 instances of unavailable occupancy data. Doctor trips had the highest average occupancy, of 2.29, followed by shopping (2.24), which is in turn followed by recreation (2.21). Business and school related trips had the lowest occupancies, with 1.59 and 1.44, respectively. The school-related sample may be unusually small owing to summer vacation. The pattern of little carpooling activity and the magnitude of average occupancy found in other border bridges are also found at Gateway.

Table 5.53. Average auto occupancy by purpose — Gateway Bridge

Trip Purpose	Auto Occupancy				
	Recorded Trips	Average	Std. Dev.	Minimum	Maximum
Doctor	126	2.29	1.20	1	6
Other	185	2.06	1.23	1	7
Recreation	1,388	2.21	2.21	1	8
School	96	1.59	0.87	1	4
Shopping	1,242	2.24	1.25	1	8
Business	1,150	1.44	0.86	1	8
Taxi	15	1.40	0.83	1	4
All trips	4,222	1.99	1.24	1	8

Unavailable Auto Occupancy Data for 36 trips

Auto license plates are shown in Table 5.54. As usual, we found a majority of local plates, with a predominance of Texas plates over Mexican plates.

Table 5.54. Auto license plates — Gateway Bridge

PLATE	Frequency	Percent	PLATE	Frequency	Percent
AGS MEX	1	0.0%	MAINE	1	0.0%
ALABAMA	1	0.0%	MICHIGAN	6	0.1%
ARKANSAS	1	0.0%	MINNESOTA	8	0.2%
CALIFORNIA	4	0.1%	MONTANA	1	0.0%
COLORADO	2	0.0%	NORTH CAROLINA	4	0.1%
COAH MEX	4	0.1%	NORTH DAKOTA	1	0.0%
CONNECTICUT	1	0.0%	NEW JERSEY	2	0.0%
DISTRICT OF COLOMBIA	1	0.0%	NL MEX	34	1%
DELAWARE	2	0.0%	NEW YORK	1	0.0%
DF MEX	5	0.1%	OAX MEX	1	0.0%
FLORIDA	64	1.5%	OHIO	9	0.2%
GTO MEX	3	0.1%	OKLAHOMA	9	0.2%
GUATEMALA	1	0.0%	SAF MEX	1	0.0%
IOWA	4	0.1%	SLP MEX	7	0.2%
ILLINOIS	6	0.1%	SPF MEX	3	0.1%
INDIANA	6	0.1%	SRE TEC	1	0.0%
JAL MEX	2	0.0%	TAMPS MEX	1,275	31%
KANSAS	1	0.0%	TENNESSEE	3	0.1%
LOUISIANA	8	0.2%	TEXAS	2,681	64%
MASSACHUSETTS	1	0.0%	VER MEX	3	0.1%
MARYLAND	4	0.1%	WISCONSIN	3	0.1%
			Total	4,176	100%

(Frequency Missing = 82)

Truck license plates are shown in Table 5.55. In the case of Gateway, there was a predominance of Mexican plates, either from Tamaulipas or from federal origins in Mexico (total of 66 percent).

Table 5.55. Truck license plates — Gateway Bridge

PLATE	Frequency	Percent
DF MEX	2	1.1
ILLINOIS	2	1.1
MICHIGAN	1	0.6
NL MEX	1	0.6
OKLAHOMA	2	1.1
SAF MEX	13	7.5
SPF MEX	53	30.5
TAMPS MEX	47	27.0
TENNESSEE	4	2.3
TEXAS	49	28.2
Total	174	100%

Frequency Missing=11

In surveying truck traffic load status, we received a 78.9 percent overall response rate. This high response rate to the longer truck questionnaire was possible owing to the extra time the trucks had to stay in the congestion queues. The responses are summarized in Table 5.56.

Table 5.56. Truck load status — Gateway Bridge

Load status	Recorded trips	Percent
Empty	39	27%
Loaded	95	65%
Tractor	12	8%
Total	146	100%

Frequency missing (no load status available) = 39

Of all trucks using this bridge southbound, 65 percent were loaded, while 35 percent crossed unloaded, indicating that more efficient use of the bridge would be possible if the drayage and trucking companies optimized their cargo.

The commercial origin and destination of truck cargo was asked whenever possible, yielding a response rate of approximately 43 percent. This question requires the longest time of all survey questions, and it can be asked only while the trucks are waiting in long queues. Nevertheless, a response rate of over 42 percent warrants some conclusions from the data, which are depicted in Table 5.57.

Table 5.57. Commercial origin and destination of cargo — Gateway Bridge

Cargo Origin	Cargo Destination			
	Manufacturing Plant	Port	Warehouse	Total (Origin)
Airport	4	0	0	4
	5%	0%	0%	5%
Manufacturing Plant	15	0	1	16
	19%	0%	1%	20%
Port	10	3	7	20
	13%	4%	9%	26%
Warehouse	18	0	21	39
	22.5%	0%	26.5%	49%
Total (Destination)	47	3	29	79
	59.5%	4%	36.5%	100.%

Approximately 72 percent of respondents were going from one warehouse to another, reflecting the transborder activities of specialized drayage companies transferring cargo within the commercial zones of the two countries. The second highest percentage, from a U.S. warehouse to a manufacturing plant in Mexico (22.5 percent), reflects maquiladora activity. The nearby Port of Brownsville represents about 21 percent of all origins, and Mexican manufacturing plants represent almost 60 percent of all destinations. An average of 4.7 axles per truck was observed at this bridge. The standard deviation was 1.16, and the maximum number of axles was six (with a minimum of two).

Summary

The data indicate that Gateway Bridge is used almost exclusively by local traffic between Brownsville and Matamoros. For trucks, Monterrey and Mexico City together make up 16 percent of all destinations, while Matamoros accounts for 72 percent.

Auto trip purposes fit the usual pattern of a 30 –70 percent split between business and non-business trips. Response rates for the "to or from purpose" question — a disappointing 30 percent — reflected the impatience some respondents felt as a result of the questioning. It was found that more respondents were going to the purpose than were coming back from the purpose, which indicates that Matamoros attracts traffic from Brownsville. However, the sample is too small to warrant general conclusions.

Auto weekly frequencies indicate a predominance of trips undertaken less than three times a week. Data also show that nearly 20 percent of all trips are made once or more daily, which indicates the possibility of further congestion as the traffic demand of that particular category grows.

Average auto occupancy data also conform to the pattern found throughout the border, with an average around two. The highest auto occupancy was for medical trips, and the lowest for business and school-related trips.

Auto license plates are either from Tamaulipas or Texas, and the usual border pattern of a 30–70 percent split between the two states was also found at Gateway Bridge. Florida plates were the only ones accounting for more than 1 percent, but this was probably due to summer vacation. Truck license plates were split 70–30 percent between Mexico and Texas, respectively, with the Mexican plates mostly from Tamaulipas and from federal offices.

A truck-load-status response rate of nearly 79 percent revealed that only 65 percent of all trucks were crossing the border loaded. This indicates that some of the congestion at this bridge would be alleviated if drayage companies optimized their cargo and avoided empty trucks, especially considering that most truck trips are undertaken once or more daily.

Commercial origin and destination of truck cargo yielded a response rate of 42.7 percent. The data basically reflect the activities of drayage companies hauling cargo between the two commercial zones, as about 27 percent of respondents were going from one warehouse to another.

BROWNSVILLE/MATAMOROS B&M BRIDGE

Description of Field Work

The Brownsville and Matamoros Bridge (B&M Bridge) is a two-lane toll facility used by vehicles and rail traffic. When the train uses the bridge, vehicular traffic stops and forms a queue until the train passes. While this bridge was closed for trucks during the survey, three small trucks crossed and were interviewed.

The survey was undertaken over two 6-hour shifts, one on June 30, 1993, from 1:00 p.m to 7:00 p.m., and the second on July 1, 1993, from 7:00 a.m. to 1:00 p.m. One train used the

bridge during the survey, arriving around 12:45 p.m. on the second day. Vehicles were interviewed while waiting in the queue.

Auto traffic was 4,331 on June 30, 1993, and 4,785 on July 1, 1993, at an average of 4,558. The survey captured 2,407 autos, or 52.8 percent of the average total ADT during the survey dates. Because hourly counts were not provided by the bridge manager, it is not possible to estimate the sample size with respect to actual counts during the survey hours.

Auto sample trip distribution by time of day is shown in Table 5.58. Over half of the sample was taken after 3:00 p.m. No morning or afternoon peaks were observed on this bridge, only a change of demand level in the afternoon (see increase in surveyed trips after 3:00 p.m. in Table 5.58).

Table 5.58. Trip distribution by time of the day — B&M Bridge

TIME	Recorded Trips	Percent
7 a.m.-8 a.m.	57	2.5%
8 a.m.-9 a.m.	114	5%
9 a.m.-10 a.m.	126	5%
10 a.m.-11 a.m.	158	6.5%
11 a.m.-12 p.m.	170	7%
12 p.m.-1 p.m.	160	6.5%
1 p.m.-2 p.m.	192	8%
2 p.m.-3 p.m.	186	8%
3 p.m.-4 p.m.	254	10.5%
4 p.m.-5 p.m.	300	12.5%
5 p.m.-6 p.m.	361	15%
6 p.m.-7 p.m.	329	13.5%
Total	2407	100%

Origin and Destination Matrices

The auto origin and destination matrix is depicted in Table 5.59, with the "other" category consisting of all origins and destinations having less than 5 percent occurrence. The data indicate the almost exclusive use of this bridge by local traffic between Brownsville and Matamoros, with 90.36 percent trips originating in Brownsville and ending in Matamoros, at totals of 95.7 percent Brownsville origins, and 94 percent Matamoros destinations.

Table 5.59. Auto origin and destination matrix — B&M Bridge

Origin	Destination		
	Matamoros	Other	Total (Origin)
Brownsville	2175	93	2268
	90%	4%	94%
Other	129	10	139
	5%	1%	6%
Total (Destination)	2304	103	2407
	95%	5%	100%

Other origins and destinations are shown in Table 5.60. Over 50 percent of all origins other than Brownsville are other Lower Valley locations, including Harlingen, McAllen, and San Benito. South Padre Island accounts for 7.3 percent of all other origins, though it is possible that this figure is a summer peak.

Table 5.60. Other origins and destinations — B&M Bridge

Other Origins		Other Destinations
Alabama (1)	Mercedes (1)	Cd Victoria (3)
Alamo (1)	New York (1)	Celeya Guanajuato (1)
Arlington (1)	Olmito (3) Pharr (1)	Durango (1)
California (1)	Pt Isabel (5)	General Bravo (1)
Cd Victoria (1)	Ranchito (1)	Mexico Df (5)
Colorado (2)	Rancho Viejo (1)	Monterrey (4)
Corpus Christi (3)	Raymondville (2)	Oaxaca (1)
Dallas (2)	Reynosa (4)	Rio Bravo (5)
Del Rio (1)	Rio Bravo (1)	San Fernando (11)
Demargo (1)	Rio Grande (1)	South America (1)
Florida (1)	Rio Hondo (1)	Tampico (2)
Harlingen (36)	San Antonio (1)	Valle Hermoso (63)
Houston (11)	San Benito (17)	Frequency Missing=5
Kingsville (2)	San Pedro (4)	
La Paloma (1)	Santa Rosa (1)	
Laredo (1)	South Padre (10)	
Los Fresnos (6)	Weslaco (2)	
Maryland (1)	Frequency Missing=2	
McAllen (7)		

Trip Purpose

Auto trip purposes are shown in Table 5.61. The common border pattern of a 30–70 percent split between business and non-business is approximately found here, with a 22 percent-78 percent split. The overall response rate for the "from or to purpose" question was 29.5 percent, with the only sample large enough for drawing conclusions being shopping trips. The latter confirms the predominance of northbound shopping trips along the Texas-Mexico border.

Trip Frequency

Auto weekly frequencies are summarized in Table 5.62, broken down by trip purpose. Over 54 percent of all auto trips are undertaken fewer than three times a week, a figure consistent with the fact that many respondents of the "shopping" trip purpose mentioned household shopping trips. Over 21.1 percent of trips are daily or more, reflecting perhaps a considerable amount of "chivero" activity undertaken several times a day. Half of all medical trips are

occasional, while the rest reflect patients who require longer-term medical care. Recreational trips are typically undertaken either fewer than three times a week, or more than daily, with relatively fewer instances of four to six times a week. These trips include visits to relatives and friends, a very frequent trip purpose along the Texas-Mexico border. Over one-fourth of all business trips are during the weekday schedule, while over 38.3 percent are daily or more, a pattern found in many other bridges along the border. Some school-related trips reflect the typical regular class weekday schedule, while others reflect the every-other-day schedule of extracurricular activities. The school figures are likely to change during the academic year.

Table 5.61. Auto trip purpose frequencies — B&M Bridge

PURPOSE	From purpose	To purpose	Undeclared	Total	Percent
Doctor	2	8	26	36	1.5
Other	19	34	33	86	3.6
Recreation	25	151	477	653	27.2
School	11	1	27	39	1.6
Shopping	302	23	732	1,057	44.0
Taxi			3	3	0.1
Business	47	88	393	528	22.0
Total	406	305	1691	2402	100

Missing purpose = 5
Missing "from or to" specification = 1,696

Table 5.62. Auto weekly frequencies by trip purpose — B&M Bridge

	Recorded Trips (Percentage of Category)						
Weekly Frequency	Shopping	Recreation	Doctor	School	Business	Other	Total
<1	113 (10.5%)	89 (13.5%)	18 (50%)	1 (3%)	26 (5%)	18 (21%)	266 (11%)
1-2	302 (28.5%)	185 (28%)	9 (25%)	2 (5%)	35 (6.5%)	19 (22%)	553 (23%)
2-3	276 (26.%)	144 (22%)	4 (11%)	6 (5%)	43 (8%)	9 (10.5%)	483 (20%)
3-4	124 (12%)	64 (10%)	3 (8%)	2 (5%)	26 (5%)	5 (6%)	224 (9%)
4-5	45 (4%)	26 (4%)	0 (0%)	0 (0%)	9 (2%)	1 (1%)	81 (3%)
5-6	29 (3%)	24 (4%)	0 (0%)	15 (39%)	135 (25.5%)	4 (4.5%)	207 (9%)
6-7	7 (1%)	12 (2%)	0 (0%)	4 (10%)	47 (9%)	3 (3.5%)	74 (3%)
>=7	161 (15%)	105 (16%)	2 (6%)	9 (23%)	202 (38%)	24 (28%)	507 (21%)
n/a	0	4 (0.5%)	0 (0%)	0 (0%)	5 (1%)	3 (3.5%)	12 (1%)
Total	1057 (100%)	653 (100%)	36 (100%)	39 (100%)	528 (100%)	86 (100%)	2,407 (100%)

Missing purpose = 5
Taxi = 3

Overall average auto occupancy was 2.04 persons per auto, with a standard deviation of 1.23, within the trend observed along the border. Average auto occupancies by trip purpose are shown in Table 5.63. The lowest occupancy is for business trips, while the highest is for shopping, followed by recreation and doctor (trends observed throughout the border area); there

was little carpooling for business trips, and average auto occupancy was less than 2.5.

Table 5.63. Average auto occupancy by trip purpose — B&M Bridge

Trip Purpose	Number of Trips	Auto Occupancy			
		Average	Std. Dev.	Minimum	Maximum
Doctor	36	2.11	0.98	1	5
Recreation	651	2.15	1.33	1	8
School	39	1.79	1.22	1	6
Shopping	1,053	2.27	1.23	1	8
Other	86	2.01	1.44	1	8
Business	525	1.44	0.88	1	8
All trips	2,397	2.04	1.23	1	8

Frequency missing (no trip purpose declared) = 16.
Taxi = 3

Auto license plate counts are shown in Table 5.64. Over 96 percent of all plates are either from Texas or Tamaulipas, which is consistent with the origins and destinations observed, as well as with the pattern found throughout the border area. For most other bridges, the plates are split about 70–30 percent between Texas and the neighboring Mexican state, while on B&M there is a 52–44 percent split.

Table 5.64. Auto license plates — B&M Bridge

PLATE	Frequency	Percent	PLATE	Frequency	Percent
ALABAMA	1	0.0%	LOUISIANA	3	0.1%
ARKANSAS	1	0.0%	MINNESOTA	3	0.1%
BC MEX	1	0.0%	MISSOURI	1	0.0%
CANADA	1	0.0%	MOR MEX	1	0.0%
CHIH MEX	1	0.0%	NORTH CAROLINA	2	0.1%
COLORADO	1	0.0%	NL MEX	10	0.4%
COAH MEX	3	0.1%	OHIO	4	0.2%
CONNECTICUT	1	0.0%	OKLAHOMA	2	0.1%
DF MEX	2	0.1%	QRO MEX	3	0.1%
DGO MEX	1	0.0%	SLP MEX	3	0.1%
FLORIDA	27	1.1%	SRE CONS	1	0.0%
GEORGIA	2	0.1%	SRE TEC	1	0.0%
GTO MEX	1	0.0%	TAMPS MEX	1,047	44.0%
IOWA	2	0.1%	TENNESSEE	1	0.0%
ILLINOIS	1	0.0%	TEXAS	1,246	52.3%
INDIANA	1	0.0%	VIRGINIA	1	0.0%
JAL MEX	2	0.1%	WASHINGTON	1	0.0%
			TOTAL	2,379	100%

Frequency Missing=27

The three trucks captured by the survey were from Brownsville, with two going to Matamoros and one going to San Fernando. One had a Texas plate, while the other two had

Tamaulipas plates. Two were two-axle trucks, while the other was a tractor. One truck came during the 11:00-12:00 time slot, while two others came between 4:00 p.m. and 6:00 p.m. As for the frequencies, two declared daily or more, while the other declared a weekday schedule. Only one truck could provide the commercial origin and destination of the cargo, which in that case was from one warehouse to another.

Conclusions and Recommendations

Although the B&M Bridge was ostensibly closed to trucks during the survey, three small trucks did cross and were interviewed. According to the data provided by the bridge manager, trucks make up only about 1 percent of the June traffic; thus the trucks surveyed on this bridge would represent a very small percentage of all trucking activity within the Brownsville sector.

This bridge was also surveyed in two 6-hour shifts, and, like Gateway, there was a crew coordinator ensuring that the first surveyor would not stop vehicles already surveyed further down the survey line. These measures greatly improved survey efficiency.

The results indicate an almost exclusive use of this bridge by local traffic between Brownsville and Matamoros, which accounts for over 90 percent of all origin and destination pairs. Auto trip purposes were split 22–78 percent between business and non-business, with a predominance of shopping trips in the latter. The "to or from purpose" question did not give a satisfactory response rate in this bridge, because the traffic flows continuously and there is no time to ask longer questions. Average auto occupancy is around two persons per auto, with the lowest occupancies for business and school-related trips, a trend observed along the rest of the border. Auto weekly frequencies are concentrated in the fewer than three times a week categories, with 21.1 percent in the daily or more category. The same trend was observed at nearby Gateway Bridge. Auto license plates are either from Texas or Tamaulipas, respectively, representing a 52–44 percent split.

PROGRESO/NUEVO PROGRESO BRIDGE

Description of Field Work

Progreso-Nuevo Progreso Bridge is a two-lane toll facility located in a rural area on the U.S. side; in Mexico, the bridge terminates in the central business district of Nuevo Progreso. The average daily traffic at this bridge consists of about 2,150 autos and 40 trucks.

The survey was conducted over 6-hour shifts to reduce the surveyors' exposure to heat and fumes. The survey started on June 30, 1993, at 1:00 p.m., and was completed the next morning; the crew consisted of two bilingual surveyors and one coordinator (who also acted as a support person for the field crew). The hourly traffic counts and sample sizes for this day are shown in Table 4.65. Hourly counts for the survey dates were provided by the bridge management. A two-person crew working two 6-hour shifts sampled from 62.2 to 100 percent of all vehicles using the bridge at any given 1-hour interval. In terms of ADT, the survey sampled approximately 72 percent of the auto ADT and 67.5 percent of the truck ADT—more than were

sampled during a 12-hour shift.

Table 5.65. Traffic counts and sample sizes — Progreso Bridge

Time	Day	Vehicles Counted	Vehicles Surveyed	Percent captured
7 a.m.-8 a.m.	7/1/93	35	28	80.0
8 a.m.-9 a.m.	7/1/93	74	73	98.6
9 a.m.-10 a.m.	7/1/93	126	120	95.2
10 a.m.-11 a.m.	7/1/93	190	179	94.2
11 a.m.-12 p.m.	7/1/93	187	184	98.4
12 p.m.-1 p.m.	7/1/93	172	107	62.2
1 p.m.-2 p.m.	6/30/93	152	127	83.6
2 p.m.-3 p.m.	6/30/93	136	135	99.3
3 p.m.-4 p.m.	6/30/93	139	127	91.4
4 p.m.-5 p.m.	6/30/93	140	137	97.9
5 p.m.-6 p.m.	6/30/93	164	163	99.4
6 p.m.-7 p.m.	6/30/93	197	197	100
	Total	1,712	1,577	92%

The survey form used on the Hidalgo Bridge was expanded for use on the Progreso Bridge to include more non-business trips categories and more questions for truck drivers. The latter included load status (loaded, empty, or tractor) and commercial origin and destination of the cargo (warehouse, port, airport, manufacturing plant). An attempt was also made to identify if the auto trip was going to or coming back from whatever purpose was declared. However, the response rate for this particular question was very low, and surveyors noticed a significant number of drivers misunderstanding the question or impatient to answer it (it required a longer explanation). The longer truck questionnaire was effective only when truckers were waiting in a line; it is too long to be administered in free-flowing traffic.

The truck sample, though small, consisted of 60 percent of the truck ADT, a percentage we determined to be representative. The predominance of loaded over unloaded trucks indicated that the bridge was being effectively used (though the ideal situation would be no unloaded trucks — especially considering the current regulations requiring load changes within the commercial zone).

Time distribution for truck trips is shown in Table 5.66. There were no trucks before 10:00 a.m., and after that time truck activity began to increase only after 4:00 p.m. The assumption that the cargo was being loaded early in the day is consistent with the finding that most trucks are loaded and origins are local.

Origin and Destination Matrices

The origin and destination matrices are depicted in Table 5.67 for autos and in Table 5.68 for trucks. The "other" category consists of origins and destinations that occur less than 5 percent of the time; they are shown in Table 5.69.

Table 5.66. Truck trip distribution by time of the day — Progreso Bridge

TIME	Recorded Trips	Percent	Cumulative Trips	Cumulative Percent
10 a.m. - 11 a.m.	2	6.9	2	6.9
11 a.m. - 12 p.m.	1	3.4	3	10.3
1 p.m. - 2 p.m.	2	6.9	5	17.2
2 p.m. - 3 p.m.	3	10.3	8	27.6
3 p.m. - 4 p.m.	1	3.4	9	31.0
4 p.m. - 5 p.m.	4	13.8	13	44.8
5 p.m. - 6 p.m.	7	24.1	20	69.0
6 p.m. - 7 p.m.	9	31.0	29	100.0

This bridge, located in a rural area on the U.S. side, serves demand from nearby cities and towns, with Weslaco leading the demand. On the Mexican side, over 80 percent of auto travelers head either to Nuevo Progreso or to Rio Bravo, with about 60 percent of all auto travelers heading for Nuevo Progreso. The Progreso facility is the nearest bridge to Rio Bravo, and, for that reason, Rio Bravo is the second preferred destination for users of the Progreso Bridge. In the case of trucks, Rio Bravo is the most frequent destination, accounting for over 41 percent of all destinations, while Nuevo Progreso is second, with 20.69 percent of all destinations. Together with Guadalajara, these two cities account for over 72 percent of all truck destinations. Major auto origins and destinations are all located within the Lower Valley area. And while truck origins are also within the Lower Valley area, major truck destinations are spread over several states in Mexico.

Table 5.67. Auto origin and destination matrix — Progreso Bridge

Origin	Destination				
	Las Flores	Nuevo Progreso	Rio Bravo	Other	Total (origin)
Donna	17	62	32	11	122
	1%	4%	2%	1%	8%
Harlingen	30	87	9	6	132
	2%	5.5%	0.5%	0.5%	8.5%
McAllen	11	53	9	5	78
	1%	3%	0.5%	0.5%	5%
Mercedes	15	76	27	4	122
	1%	5%	2%	0.3%	8.3%
Progreso	10	89	22	3	124
	1%	6%	1%	0.2%	8.2%
Weslaco	51	273	153	30	507
	3%	17.5%	10%	2%	32.5%
Other	70	298	63	32	463
	4.5%	19%	4%	2%	29.5%
Total (Destination)	204	938	315	91	1548
	13.15%	60%	20%	6.5%	100%

Frequency missing=1

Table 5.68. Truck origin and destination matrix — Progreso Bridge

Origin	Destination						
	Coahuila	Guadalajara	Monterrey	Nuevo Progreso	Rio Bravo	Other	Total (origin)
Alamo	0	0	0	1	0	1	2
	0%	0%	0%	3.5%	0%	3.5%	7%
Brownsville	0	0	0	0	3	0	3
	0%	0%	0%	0%	10%	0%	10%
Progreso	2	3	1	0	6	3	15
	7%	10%	3.5%	0%	21%	10%	51.5%
Weslaco	0	0	0	1	1	0	2
	0%	0%	0%	3.5%	3.5%	0%	7%
Other	0	0	1	4	2	0	7
	0%	0%	3.5%	14%	7%	0%	24.5%
Total (Destination)	2	3	2	6	12	4	29
	7%	10%	7%	21%	41.5%	13.5%	100.00%

Trip Purpose

The non-business trip purposes were expanded to include a few new categories; Table 5.70 depicts the frequencies of auto trip purposes. Recreation and shopping account for 76.5 percent of responses, while business trips account for a relatively small proportion (11.7 percent). School-related trips may be underestimated, because of the summer vacation. The usual pattern of 70 percent non-business and 30 percent business was not found at the Progreso Bridge, where over 88 percent of all trips are non-business trips.

An attempt in this survey to match the auto trip purpose with a "to" or "from" was only partly successful, owing to the amount of extra time needed to ask this question. On the Progreso Bridge, the response rate for this question was 77 percent, the best for the Valley area. The responses to this question are also shown in Table 5.70. The first column of this table indicates the trip purpose. The second column indicates the number of trips coming from the purpose, and the third indicates the number of trips going to the purpose. Total trips (to, from, and to or from not available) and the percent of each purpose are shown in the last two columns. For example, there were two trips coming back from a U.S. doctor, and 105 instances of travelers going to a doctor in Mexico, while 26 drivers on medical trips did not answer this question.

Table 5.69. Other origins and destinations — Progreso Bridge

Other Origins		Other Destinations
Alamo (37)	Lubbock (1)	Anahuac (2)
Arkansas (1)	Matamoros (1)	Canales (1)
Austin (3)	McAllen (1)	Cd Victoria (3)
Baytown (1)	Michigan (1)	Ejido Ver (1)
Bishop Tx (1)	Mission (22)	Empalme (9)
Bluetown (2)	Monte Alto (1)	Galispa Coah (1)
Brownsville (33)	Palm Beach (1)	Gonzalez (1)
Cd Victoria (1)	Pasadena (1)	Jalisco (1)
Chicago (1)	Pharr (27)	La Sierrita (1)
Combes (1)	Progreso Lakes (2)	Matamoros (8)
Conroe Tx (1)	Pt Aransas (1)	Mexico Df (1)
Corpus Christi (5)	Pt Isabel (3)	Monterrey (3)
Dallas (3)	Pt Mansfield (2)	Morelia (1)
Ed Couch (14)	Rancho Viejo (1)	Ocampo (1)
Edinburg (48)	Rangerville (2)	Ramirez (1)
Elsa (32)	Raymondville (8)	Ramos Arispe (1)
Florida (6)	Refugio (1)	Reynosa (12)
Georgia (1)	Relampago Tx (1)	Rio Rico (1)
Grand Prairie (2)	Reynosa (3)	Saltillo (1)
Harlingen (1)	Rio Hondo (5)	San Luis Potosi (1)
Hidalgo (3)	Rivera (1)	San Miguel Aleman (3)
Houston (10)	San Antonio (1)	Valle Hermoso (38)
Illinois (1)	San Benito (50)	Vasolo (1)
Indiana (1)	San Carlos (1)	
Kansas City (1)	San Juan (25)	
Kingsville (3)	Santa Maria (15)	
La Sara (2)	Santa Monica (1)	
La Via (1)	Santa Rosa (12)	
La Villa (3)	Sebastian (2)	
La Blanca (4)	South Padre (5)	
La Feria (36)	Starr Co. Area (1)	
Little Field (1)	Waco (1)	
Los Fresnos (4)	Yoakum (1)	
Los Indios (4)		
Louisiana (1)		

Frequency Missing=3

The results for the shopping purpose may indicate some misunderstanding on the part of the surveyed driver. The vast majority of shopping trips along the Texas-Mexico border consist of Mexican people buying U.S. goods; in this case, the results show that the opposite is true, and the origins of most trips are U.S. urban areas, where shopping is not a problem. On the other hand, the results for doctor trips and for recreation trips are consistent with the fact that a

significant number of U.S. border city residents see Mexican physicians for their cheaper rates, and that they also travel frequently into Mexico for recreational purposes (e.g., visits to relatives and friends). Responses to the "to and from purpose" question needs clarification for this bridge.

Table 5.70. Auto trip purpose frequencies — Progreso Bridge

Trip Purpose	Trips from purpose	Trips to purpose	Total trips	Percent
Doctor	2	105	133	8.7
Other	5	26	42	2.7
Recreation	27	419	556	36.3
School	2	1	5	0.3
Shopping	69	389	617	40.2
Work	44	86	179	11.7

Frequency missing from total= 15

Auto Occupancy

Average auto occupancy is shown in Table 5.71 by trip purpose. The highest auto occupancy is for medical-related trips, followed by shopping; business trips reflect the usual pattern of infrequent carpooling observed throughout the border. The sample for school-related trips is too small to warrant conclusions. Overall average auto occupancy is over 2.5, within the range observed for other border bridges.

Table 5.71. Average auto occupancy by trip purpose — Progreso Bridge

Trip Purpose	Number of Trips	Auto Occupancy			
		Average	Std. Dev.	Minimum	Maximum
Doctor	131	2.82	1.40	1	8
Recreation	545	2.69	1.53	1	8
School	5	1.40	0.55	1	2
Shopping	610	2.72	1.33	1	8
Other	41	2.46	1.83	1	8
Business	176	1.71	1.28	1	8
All trips	1524	2.59	1.46	1	8

Frequency missing (no trip purpose declared) = 16.

The vehicles' sample distribution by time of day was previously shown in Table 5.65; owing to the small percentage of trucks, the conclusions from the total data are the same for autos. The morning peak occurred between 10:00 a.m. and 12:00 p.m., and the afternoon peak started at 5:00 p.m. The late-morning peaks are consistent with the high incidence of shopping and recreational trip purposes, which typically start later in the day. The survey captured a consistent number of the hourly counts (except during the lunch hour).

Trip Frequency

Observed auto weekly frequencies by trip purpose are shown in Table 5.72. Over half of all auto users cross fewer than once a week, and this pattern is repeated for all trip purposes except business and recreation. This may be explained by the need for a longer trip to arrive at a U.S. urban area where trip purposes can be asked during a survey. Business trips, however, are undertaken mostly daily or more, indicating little influence of the U.S. rural area in such frequencies.

Table 5.72. Auto weekly frequencies — Progreso Bridge

	Recorded Trips (Percentage of Category)						
Frequency	Shopping	Recreation	Doctor	School	Business	Other	Total
<1	402 (65.2%)	266 (47.8%)	108 (81.2%)		24 (13.4%)	24 (57.1%)	833 (53.8%)
1-2	95 (15.4%)	95 (17.1%)	14 (10.5%)	1 (20%)	8 (4.5%)	7 (16.7%)	222 (14.3%)
2-3	58 (9.4%)	83 (14.9%)	5 (3.8%)	1 (20%)	15 (8.4%)	2 (4.8%)	165 (10.7%)
3-4	24 (3.9%)	43 (7.7%)	6 (4.5%)	1 (20%)	19 (10.6%)	2 (4.8%)	96 (6.2%)
4-5	8 (1.3%)	19 (3.4%)			9 (5%)		36 (2.3%)
5-6	3 (0.5%)	6 (1.1%)			19 (10.6%)	2 (4.8%)	30 (1.9%)
6-7	2 (0.3%)	2 (0.4%)			9 (5%)		13 (0.8%)
>=7	25 (4.1%)	35 (6.3%)		2 (40%)	75 (41.9%)	5 (11.9%)	145 (9.4%)
n/a		7 (1.3%)			1 (0.6%)		8 (0.5%)

Missing purpose = 15

Truck weekly frequencies are shown in Table 5.73, broken down by load status category. The truck sample is too small to warrant any conclusion by load status. The overall frequencies show a predominance of daily or more trips, again probably reflecting the drayage companies' cargo movements within the commercial zones of both countries.

Table 5.73. Truck weekly frequencies — Progreso Bridge

	Recorded Trips (Percentage Of Category)			
Frequency	Loaded	Empty	Tractor	Total
<1				1 (3.4%)
1-2	1 (7.1%)			1 (3.4%)
2-3	3 (21.4%)			4 (13.8%)
3-4	1 (7.1%)	3 (37.5%)	1 (100%)	7 (24.1%)
4-5	1 (7.1%)			2 (6.9%)
5-6	2 (14.3%)			2 (6.9%)
6-7				
>=7	6 (42.9%)	5 (62.5%)		12 (41.4%)

Missing load status = 4

License Plates

Table 5.74 shows auto license plate distribution. As found throughout the border, over 90

percent of all plates indicate either Texas or Tamaulipas, with a 76.9–13.2 percent split between the two states. All other license plates (with the exception of Florida, whose plates reflect summer vacation travelers) make up less than 1 percent.

Table 5.74. Auto license plates distribution — Progreso Bridge

PLATE	Frequency	Percent	PLATE	Frequency	Percent
ALABAMA	2	0.1	NORTH CAROLINA	3	0.2
ARKANSAS	1	0.1	NEBRASKA	3	0.2
ARIZONA	1	0.1	NL MEX	4	0.3
CALIFORNIA	3	0.2	NEW MEXICO	1	0.1
CANADA	1	0.1	OHIO	6	0.4
FLORIDA	42	2.8	OKLAHOMA	5	0.3
GEORGIA	4	0.3	OREGON	3	0.2
GTO MEX	2	0.1	PENNSYVANIA	1	0.1
IOWA	9	0.6	SOUTH CAROLINA	1	0.1
IDAHO	4	0.3	SPF MEX	1	0.1
ILLINOIS	7	0.5	TAMPS MEX	198	13.2
INDIANA	8	0.5	TENNESSEE	1	0.1
KANSAS	4	0.3	TEXAS	1152	76.9
LOUISIANA	4	0.3	VIRGINIA	1	0.1
MICHIGAN	9	0.6	WASHINGTON	1	0.1
MINNESOTA	4	0.3	WISCONSIN	7	0.5
MISSOURI	1	0.1	WYOMING	1	0.1
MISSISSIPPI	3	0.2			

Frequency Missing = 50

The average number of truck axles was 4.6, at a standard deviation of 1.65. The minimum number of axles was 2 and the maximum was 6. The number of axles includes the tractor axles. Table 5.75 shows truck license plates; there is a predominance of Mexican plates, which account for 79.3 percent of the total. Federal origins in Mexico account for the majority of truck plates.

Table 5.75. Truck license plates distribution — Progreso Bridge

PLATE	Frequency	Percent
SAF MEX	5	17.2
SPF MEX	12	41.4
TAMPS MEX	6	20.7
TX	6	20.7

Truck Data

The response rate to a new question concerning the load status of trucks (added to the truck questionnaire) was relatively successful, with 79.3 percent of interviewed truckers

responding. A missing response to this questions usually means that there was no time to ask. The observed frequencies of each load status are depicted in Table 5.76.

Table 5.76. Truck load status frequencies — Progreso Bridge

Load status	Frequency	Percent
Empty	8	34.8
Loaded	14	60.9
Tractor	1	4.3

Frequency missing=6, or 20.7 percent of all truck trips.

A new question concerning commercial origin and destination of the cargo was added to the questionnaire; the results are shown in Table 5.77, in origin and destination matrix format. Because the longer questionnaire could be administered only when there were queues, the response rate for this particular question was somewhat low, with only four trucks responding. The sample is too small to warrant any conclusions, but it is interesting to observe that economic activity within the current commercial zone is enough to generate destinations and origins other than warehouses.

Table 5.77. Commercial origins and destinations of truck cargo — Progreso Bridge

	Cargo Destination			
Cargo Origin	Manufacturing Plant	Ranch	Warehouse	Total (origin)
Manufacturing Plant	0	0	1	1
	0.00%	0.00%	25.00%	25.00%
Warehouse	1	1	1	3
	25.00%	25.00%	25.00%	75.00%
Total (destination)	1	1	2	4
	25.00%	25.00%	50.00%	100.00%

Frequency Missing = 25

Summary

This survey captured a sample of approximately 52 percent of all autos and 67.5 percent of all trucks using the bridge on that day. A slightly longer truck questionnaire resulted in a drop in the response rate (less than 75 percent) to questions on commercial origin and destination of cargo and on load status.

The Progreso Bridge is located in a rural area on the U.S. side, while in Mexico it terminates in downtown Nuevo Progreso. This fact creates some traffic patterns that differ from those of other border bridges. The origins are split among the nearby U.S. cities, with Weslaco leading the origins. Most destinations are Nuevo Progresso, though Rio Bravo accounts for a significant number of destinations. Rio Bravo is another instance of a Mexican urban concentration having no U.S. counterpart (the Progresso Bridge is the nearest such facility to this town). Rio Bravo is the most frequent destination for truck traffic, while Progreso itself is the

main origin of truck traffic.

The usual pattern of a 30–70 percent split between business and non-business trips was not found at the Progreso Bridge, probably owing to its rural U.S. location (fewer business trips). Auto weekly frequencies are concentrated in the fewer-than once-a-week category for most trip purposes, probably owing to the extra amount of time required to reach the nearest U.S. urban area where the listed trip purposes can be accomplished.

Truck frequencies are concentrated in the daily-or-more category, probably reflecting cargo hauling within commercial zones. Auto license plates are mainly from Texas and Tamaulipas, with 76.9 percent plates for the former and 13.2 percent for the latter. Truck plates indicate mainly Mexican federal origins.

It was found in this survey that the trip purposes added to the questionnaire add no extra time to the auto survey, while the identification of "to and from purpose" requires extra time and thus yields a low response rate. Insistence in this "to or from" question is not recommended, since the answers are likely to be unreliable, owing to respondent eagerness to end the interview and move on. The expanded truck questionnaire is applicable only on busy bridges where trucks are required to wait in a queue for long periods.

CONCLUSIONS

The existing origin and destination data, coupled with the additional data collected for the eight bridges in both segments, allow for the determination of traffic flow characteristics across the Texas-Mexico border and the development of procedures specific for origin and destination surveys at the border region. This section summarizes the major findings of the origin and destination data, sets guidelines for origin and destination surveys at the Texas-Mexico border, and makes recommendations for further studies.

Origins and Destination Patterns Across the Texas-Mexico Border

Table 5.78 summarizes the major auto origins and destinations for the Texas-Mexico border (as identified by either CTR surveys or one of the studies reviewed by CTR). Similarly, Table 5.79 summarizes border truck traffic. The Laredo area trip tables, developed from a combination of existing studies, are discussed later in this chapter.

CTR surveys indicate a predominance of auto origins and destinations within the vicinity of the bridge. Progreso Bridge is the exception: Because it is located in a chiefly rural area on the U.S. side, the bridge attracts traffic from neighboring cities and towns. The other two Lower Valley bridges are Rio Grande and Roma Bridges, which were surveyed by Charles Rivers Associates (Ref 1). While they reported their results by overall traffic diversion area, they do not specify origins and destinations of traffic at each bridge. According to sources interviewed on field trips, these bridges serve almost exclusively local traffic moving between the two sister cities. Specific origin and destination surveys are necessary if accurate percentages of local versus external traffic are needed, which is not the case at this point because these bridges account for less than 3 percent of Segment 1 traffic.

Table 5.78. Major origins and destinations of auto traffic

US-Mexican City or Town	US Bridge Name	Major Origins	Major destinations	Source
Brownsville-Matamoros, TAMP	Gateway	Brownsville	Matamoros	CTR surveys
Brownsville-Matamoros, TAMP	B&M	Brownsville	Matamoros	CTR surveys
Progreso-Nuevo Progreso, TAMP	Progreso	Donna, Harlingen, McAllen, Mercedes, Progreso, Weslaco	Las Flores, Nuevo Progreso, Rio Bravo	CTR surveys
Hidalgo-Reynosa, TAMP	Hidalgo	Hidalgo, McAllen, Mission, Pharr	Reynosa	CTR surveys
Rio Grande City-Ciudad Camargo, TAMP	Rio Grande	Rio Grande City	Cd. Camargo	Ref. 1
Roma-Miguel Alemán, TAMP	Roma	Roma	Cd. Miguel Alemán	Ref. 1
Eagle Pass-Piedras Negras, COAH	Eagle Pass	Eagle Pass	Piedras Negras	CTR surveys
Del Rio-Cd. Acuña, COAH	Del Rio	Del Rio	Cd. Acuña	CTR surveys
Presidio-Ojinaga, CHIH	Presidio	Presidio	Ojinaga	CTR surveys
Fabens-Caseta, CHIH	Fabens	Fabens, Tornillo, El Paso	Porfirio Parra, Praxedis, Guadalupe	CTR surveys
El Paso-Cd Juarez, CHIH	Zaragoza	El Paso	Cd Juárez	Ref. 23
El Paso-Cd Juarez, CHIH	BOTA	El Paso	Cd Juárez	Ref. 23
El Paso-Cd Juarez, CHIH	Good Neighbor	El Paso	Cd Juárez	Ref. 23
El Paso-Cd Juarez, CHIH	Paso del Norte	El Paso	Cd Juárez	Ref. 23

Wilson and Company (Ref 23) confirmed the predominance of local trips for the El Paso area, where trips between El Paso and Ciudad Juarez were found to be the majority for all four bridges. Fabens itself is the predominant origin of most trips crossing the Fabens Bridge, though nearby El Paso and Tornillo contribute over 10 percent each. The traffic Fabens diverts from El Paso is a negligible percentage of all El Paso area traffic.

With the exception of the Progreso Bridge, major truck origins in the Lower Valley are within the vicinity of the bridge. The Progreso Bridge serves a slightly wider truck traffic diversion area from Brownsville to Alamo. The most frequent truck destinations are also local, but destinations as far south as Mexico City and Guadalajara, Jalisco, were found at Gateway and Progreso Bridges, with frequencies between 5 percent and 15 percent of all destinations.

Table 5.79. Major origins and destinations of truck traffic

US-Mexican City or Town	US Bridge Name	Major Origins	Major destinations	Source
Brownsville-Matamoros, TAMP	Gateway	Brownsville	Matamoros, Mexico City, Monterrey	CTR surveys
Progreso-Nuevo Progreso, TAMP	Progreso	Alamo, Brownsville, Progreso, Weslaco	COAH, Guadalajara, Monterrey, Nuevo Progreso, Rio Bravo	CTR surveys
Hidalgo-Reynosa, TAMP	Hidalgo	Hidalgo, McAllen, Mission, Pharr	Reynosa	CTR surveys
Rio Grande City-Ciudad Camargo, TAMP	Rio Grande	Rio Grande	Cd. Camargo	Ref. 1
Roma-Miguel Alemán, TAMP	Roma	Roma	Cd Miguel Alemán	Ref. 1
Eagle Pass-Piedras Negras, COAH	Eagle Pass	Eagle Pass	Piedras Negras	CTR surveys
Del Rio-Cd. Acuña, COAH	Del Rio	Del Rio	Cd Acuña	CTR surveys
El Paso-Cd Juarez, CHIH	Zaragoza	El Paso	Cd Juarez	Ref. 23
El Paso-Cd Juarez, CHIH	BOTA	El Paso	Cd Juarez	Ref. 23
El Paso-Cd Juarez, CHIH	Good Neighbor	El Paso	Cd Juarez	Ref. 23
El Paso-Cd Juarez, CHIH	Paso del Norte	El Paso	Cd Juarez	Ref. 23

For the El Paso area, Wilson and Company (Ref 23) also found a predominance of local trips between the sister cities of El Paso and Ciudad Juarez. The predominance of truck trips remaining within the two countries' commercial zones is to be expected under current transborder traffic regulations.

Traffic Characteristics Across the Texas-Mexico Border

The origin and destination surveys revealed origin and destination pairs, auto trip frequencies and purposes, truck axles, load status, load origin and destination, and license plate origin. The findings are discussed below.

The trend for auto trip purposes along most of the Texas-Mexico border is a split between 20-30 percent business and 80-70 percent non-business purposes. Two bridges were found to be exceptions: Del Rio has a near 50-50 split (a result of an influx of Del Rio residents into the maquiladoras of Ciudad Acuña), while Progreso has approximately a 10–90 percent split between business and non-business. The low occurrence of business trips on the Progreso Bridge may be owing to its predominantly rural location in the U.S. In the El Paso area, Wilson and Company found a 4–96 percent split between business and non-business auto trips. The survey questionnaire, however, differed from that used by CTR, as it asked for the trip purposes as origins and destinations and, importantly, listed "home" as a possible choice. Home trips are 90 percent of all trip purposes, and it is possible that a different questionnaire might yield different percentages, since most trips ultimately begin or end at home. On the other hand, there

is no reason to expect that the El Paso area trip purposes should conform to the 30–70 percent split between the business and non-business pattern found throughout the rest of the border, notwithstanding the fact that the El Paso-Ciudad Juarez area is an important center of economic activity.

For the Lower Valley bridges, the non-business trip purpose was split into additional categories. The predominant non-business categories were shopping, with 27 percent to 44 percent of all trips, and recreation, with 24 percent to 36 percent of all trips. Medical trips were always less than 10 percent of the total. School-related trips were under 2.5 percent (these were collected during summer vacation). Segment 2 surveys did not record the specific non-business trip purposes, but a considerable number of respondents stated a dual-purpose trip (shopping and school); it is likely that during the academic year the number of dual purpose trips would be significant enough to warrant splitting the trip purpose variable into two or more. Visits to relatives and friends were frequently mentioned by respondents at all bridges, and it may therefore be worth a separate category (i.e., aside from "recreation") in a more detailed study. For the El Paso area, a predominance of shopping and "social" purposes was found by Wilson and Company, consistent with the pattern found by CTR surveys.

The magnitudes of the average auto occupancies were consistent throughout the border, with most bridges having an average of around two persons per auto. The figures are also always higher for non-business and non-school purposes, ranging from 2.04 to 2.82, depending on the specific non-business purpose. Average auto occupancy was always fewer than 3 for every trip purpose at every bridge surveyed, and always fewer than 1.75 for business trips, at every bridge surveyed. These magnitudes were found both by CTR and by Wilson and Company for the El Paso area.

Texas is the origin of at least 70 percent of license plates on all bridges but B&M, for which Tamaulipas plates account for 44 percent. Considering that the U.S. auto ownership rate is far higher than that of any other country, the B&M license plate distribution is a peculiarity that cannot be satisfactorily explained by the available data.

The license plate distribution is inverse for trucks, with a predominance of Mexican plates on most bridges. This fact reflects the predominance of Mexican trucking companies in the border region.

Auto trip frequencies are consistent with the observed pattern of predominantly local origins and destinations, and predominantly "everyday" trip purposes such as shopping and work. The predominant frequencies were either under three or under four times a week, depending on the bridge, with a significant occurrence of daily or more trips.

The sample of load status of trucks (loaded, unloaded, or tractor) was not sufficient to provide overall conclusions, because this question takes time and can be asked only when there were queues. Still, a 40 percent-60 percent split between unloaded and loaded trucks was identified at the Lower Valley region. Owing to the same problem of interview time, the sample of commercial origin and destination of the load (warehouse, manufacturing plant, etc.) is also small. However, when coupled with the origin and destination of the trip, it confirms that most

truck trips remain within the commercial zones of both countries, and thus probably consist of cargo transfers from one commercial zone to another, and cargo transfers from warehouses to nearby maquiladoras. The Laredo Development Foundation (Ref 7) also confirms the 40 percent-60 percent split between loaded and unloaded trucks for the Laredo area.

Truck trip frequencies are consistent with the local origins and destinations of most truck trips, as over half of all truck trips are daily or more, while about another 20 percent reflect the weekday pattern. The only exception was the Hidalgo Bridge, with only 28 percent daily or more truck trips. Even the Progreso Bridge, where we recorded instances of destinations far from the border, had over 40 percent daily or more truck trips. These truck frequencies are consistent with the other truck findings in that they lead to the conclusion that most trucks are hauling cargo from one commercial zone to another (in accordance with regulations prevailing in both countries). By 1997 trucks will be allowed to travel outside the commercial zones, and the truck data discussed herein will be obsolete.

Analysis of the Laredo Sector

Several of the sources of origin and destination data previously mentioned provide information for the port of Laredo. Among these sources are the CRA study (Ref 1) and the Monterrey-Nuevo Laredo origin and destination study (Ref 13). Another study, the Laredo Development Foundation truck shipments study (Ref 7), provides valuable information on commodity flows, though it does not reveal how such cargo flows translate into truck traffic across the border. While all three sources were to some degree limited (they were not, after all, designed to determine origins and destinations of the traffic using each bridge), we were still able to extract quantitative origin and destination information for the Laredo sector as a whole, as discussed below.

The CRA study surveyed traffic origins and destinations at each Laredo bridge, though it did not report the results for those individual bridges. Moreover, the study subordinated auto samples to truck traffic, since it was, ostensibly, a new bridge revenue analysis (in Laredo trucks are responsible for over half of the revenue from the Laredo bridges). The results, reported by origins and destinations in the area from Brownsville to Laredo, do not specify which bridges were being used.

All trips captured by the CRA study that can be assumed to use the Laredo bridges are shown in Figure 5.2. In this figure, "A" trips are those with destinations in Nuevo Laredo, and origins anywhere but Laredo; "B" trips are those with origins in Laredo and destinations in Nuevo Laredo; "C" trips are those with origins in Laredo and destinations other than Nuevo Laredo; and "D" trips are those with origins and destinations other than Laredo and Nuevo Laredo, and within routes where the Laredo bridges are the most convenient ones to use. Tables 5.80 through 5.82 show the data from the CRA study that fit these four trip categories. Auto and truck trips from external U.S. zones to external Mexican zones would require making additional assumptions based on the information available in the CRA study, and percentages of total trips could not be accurately determined for autos and trucks separately. The number of total vehicles

(Table 5.82) approximately matches the traffic counts for the survey year, provided by the Laredo Bridge Authorities, which was 6,715,600. The difference is approximately 257,000 vehicles, or 4 percent of the actual counts, with this difference an indication of the reliability of the CRA study survey data. On the other hand, since the magnitude of the difference approximately matches the magnitudes of the external origins and destinations cells, this difference may be due to the assumptions made about the number of types "A," "C," and "D" trips actually using the Laredo bridges. The basic assumption was the shortest route, which does not always correspond to the actual choice.

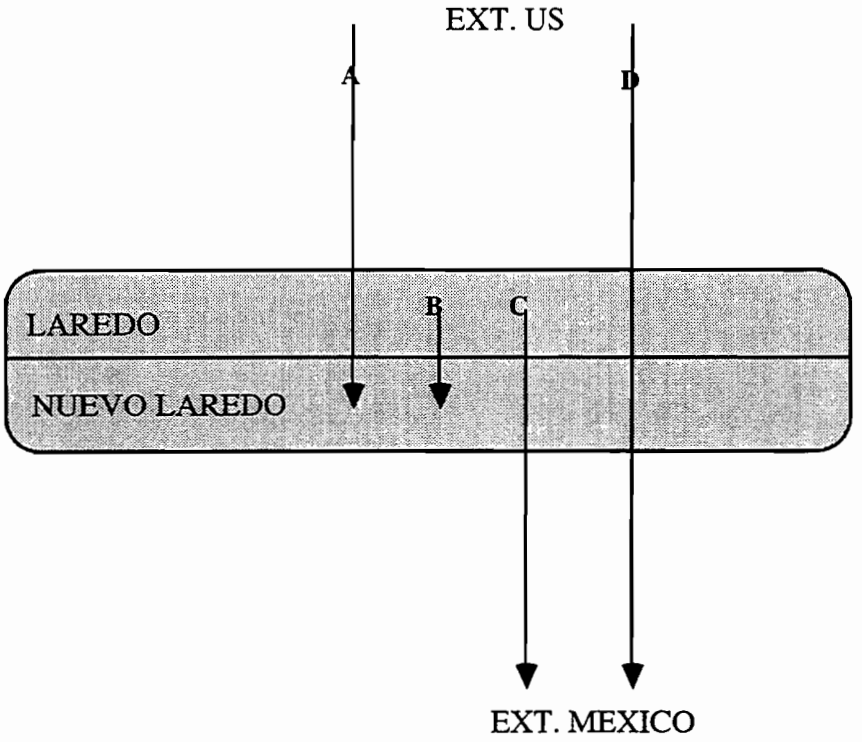


Figure 5.2. Origins and destinations of trips using the Laredo bridges

Table 5.80. Auto origin and destination — Laredo bridges

Origin	Destination		
	Nuevo Laredo	External Mexico	Total (origin)
Laredo	2420287 (90%)[1] (71.3%)[2]	257713 (10%)[1]	2678000
External US	972417 (28.7%)[2]	n/a	n/a

Table 5.81. Truck origin and destination — Laredo bridges

Origin	Destination	
	Nuevo Laredo	External Mexico
Laredo	245634 (58%)[1] (98.9%)[2]	178509 (42%)[1]
External. US	2832 (1.1%)[2]	n/a

[1]Percentages are with respect to Laredo origins
[2]Percentages are with respect to Nuevo Laredo destinations

Table 5.82. Total vehicle origin and destination — Laredo bridges

Origin	Destination		
	Nuevo Laredo	External Mexico	Total (origin)
Laredo	2665921 (38.2%)	436222 (14%)	3102143
External. US	975249 (14%)	2895921 (41.5%)	3971170
		Total trips	6973313

The percent of total trips with an origin in Laredo and a destination in Nuevo Laredo appears to indicate an unusually low figure (if compared with other twin cities across the border). However, this figure is consistent with the total estimates for the external to external cell, and it can be partially explained by the fact that Laredo-Nuevo Laredo lies on a major U.S.-Mexico route. On the other hand, the auto trips sample captured by the survey was small, resulting in perhaps a biased auto trip table that affects the total vehicle trip table.

The stations where the 5-day Nuevo León survey was conducted were located on the main highway corridors between Monterrey and Nuevo Laredo, not at the bridge crossings.

Consequently, the sample of vehicles actually coming from U.S. origins was relatively small, thus increasing the possibility of biases in this particular subset of the sample. A summary of all the trips captured by the survey that have U.S. origins is shown in Table 5.83. The integer numbers in Table 5.83 are the sampled total vehicles surveyed over the 5 days in all three survey stations. The percentages refer to total traffic.

The Laredo-Nuevo Laredo cell was not captured by this survey; the estimates in this cell were obtained by applying the percentages estimated in Table 5.82 to an estimate of total traffic using the Laredo bridges over the survey period.

Table 5.83. Summary of Nuevo León survey data — total vehicles

Origin	**Destination**		
	Nuevo Laredo	External Mexico	Total (origin)
Laredo	382876 (67.8%)	36090 (6.4%)	418966 (74.2%)
External US	141612 (25.1%)	4050 (0.7%)	145662 (25.8%)
Total (destination)	524488 (92.9%)	40140 (7.1%)	564628

If it is assumed that the percentages shown in Table 5.83 accurately represent the percentages observed in a year, the trip tables obtained with the CRA study and the Monterrey-Nuevo Laredo origin and destination study show discrepancies that may or may not be totally owing to a lack of data or to problems with the assumptions.

These results are not accurate enough to use in a trip assignment model, but since a recent revenue analysis for a new bridge in the Laredo sector was already found in the literature, additional origin and destination data in the Laredo area are not necessary for this study.

Additional data obtained from on-site surveys at the three Laredo bridges would be helpful to obtain better estimates of these tables, particularly for auto traffic. It must be observed, however, that the port of Laredo presents particular characteristics that must be taken into consideration in order to evaluate the need and feasibility of an on-site interview survey. The three bridges in Laredo, as compared with all other border crossings between Texas and Mexico, present the highest truck/auto ratio, while for other border crossings, truck traffic represents at most values on the order of 5 percent of total traffic. For Laredo, this value has increased from about 5 percent in 1986 to a current level of about 10 percent. This percentage increase has two implications. First, the estimation of truck traffic origins and destinations is more relevant in Laredo, since bridge revenues obtained from trucks represent a higher share of total revenues (more so than with any other border bridge). Second, the higher volume of trucks makes surveying difficult, expensive, and unsafe.

Another possible explanation for the discrepancies between the results of the two surveys is seasonal variation in the origins and destinations. Because most long-haul trips across the Texas-Mexico border pass through Laredo, that city has a greater share of non-local trips, which are usually more subject to seasonal fluctuation. The Monterrey-Nuevo Laredo origin and destination study survey was conducted in early November; it is not clear when the CRA study

surveys were conducted.

While a one-time-only survey would provide valuable information regarding the Laredo area, a year-long program of seasonally repeated origin and destination surveys is recommended for obtaining accurate Laredo area data. This survey program should be undertaken only after careful review of recent literature about traffic in the area, and after determining (with the help of bridge authorities and trucking companies) those survey schedules capable of verifying seasonal data fluctuations.

GUIDELINES FOR BORDER ORIGIN AND DESTINATION SURVEYS

The special character of the Texas-Mexico border requires that surveys be crafted carefully. The first set of recommendations presented below pertains to the survey methodology, field work, and data entry. The second set of recommendations addresses the specific attributes of border data.

Survey Methodology

The literature review indicated that results obtained by direct interview were superior to those obtained from mail-back forms. A fluently bilingual crew can obtain a remarkable response rate in such surveys.

The preparations for the survey should start in the office, at least two weeks before the survey date. Whenever possible, the survey timing should be based on an examination of hourly traffic counts at the bridge; if the latter are not available, a 12-hour survey from 7:00 a.m. to 7:00 p.m. can capture most of the non-recreational traffic crossing the border. The bridge authorities should be contacted for permission and for hourly counts during the survey. Once the survey is approved, it is advisable that surveyors contact the local police, who can help with traffic control. Field forms should be prepared for at least 80 percent of the ADT, with the crew consisting of at least two surveyors per open lane. Whenever the bridge ADT is greater than approximately 100 trucks and/or 8,000 autos, a crew of at least six is required. About ten surveyors are required if the truck ADT is greater than 200, and/or if the auto ADT is greater than 10,000. Crews of four or more surveyors require a crew coordinator to act as a support person, and to cue the first surveyor in the line as to which vehicle should be stopped. Ideally, there should be one coordinator at each lane for busier bridges.

The field form shown in Exhibit 3 of Appendix B, which we recommend, takes an average of 30 seconds to complete. Accurate estimates of the number of surveyors required to achieve a certain percentage of the ADT in a certain time can be made using the 30-second figure, and taking into account each surveyor's need for periodic short breaks .

No additional interview time is required to obtain more detailed trip purposes. However, care should be taken with purposes such as "recreation," "social," and "family" in the same form, because the exact same type of trip can be perceived differently by different people, and there is not sufficient time to explain what is meant by each category.

The wearing of safety vests, besides providing a measure of safety, also alert vehicles to stop. Signs on the approach road indicating that a survey is being conducted are useful and

should be employed whenever possible. Summer shifts longer than 6 hours are not recommended, primarily because the heat can begin to erode surveyor efficiency. The same results can be achieved with smaller crews and 6-hour shifts, thereby avoiding the long breaks necessary to prevent heat strokes.

Results — Reliability and Interpretation

One problem worth noting when conducting a truck survey at the Texas-Mexico border concerns the nature of transborder commercial truck traffic. Currently, drayage companies are hired to transport the load from a warehouse on one side of the border to another warehouse on the other side of the border. A truck survey mainly captures the drayage company drivers who are unaware of the true origin or ultimate destination of the commercial load. This survey can capture the traffic patterns, but will reveal nothing about commodity flows across the border.

Trip purpose and trip frequency may also be subject to systematic biases. For example, because the general public knows little about the purpose of origin and destination surveys, surveyed drivers may feel apprehensive about answering certain questions, resulting in a lower response rate. This apprehension is greater at a binational crossing: Although such border travelers are presumably used to being stopped by a number of inspectors from a variety of agencies, very few take the time to understand the different inspection procedures. And when stopped at a border crossing by a person having a name tag, a safety vest, a clipboard, and a pen, many will think they are being subject to some inspection procedure. Precisely for this reason, they may feel apprehensive about revealing trip purpose and/or frequency for fear of customs inspections on their goods, or of immigration inspections on their work authorization. Trip purpose and trip frequency tables at the Texas-Mexico border are likely to be affected by systematic errors that effectively downplay trip frequency and the number of work-related trips, while at the same time overestimating the number of "inspection-immune" trip purposes (such as recreation and other non-business purposes).

Other Recommendations

The low average auto occupancy, together with the high percentage of unloaded trucks crossing the border (more than once a day in most cases), suggest that any measures to foster carpooling and to discourage unloaded trucks would improve the overall efficiency of the transborder vehicular transportation system.

With its high percentage of truck traffic and its peculiar geographical location, the Laredo area is by far the most difficult area for conducting successful origin and destination surveys. The trip tables obtained through reduction and comparison of available data show inconsistencies that could partially be explained by high seasonal fluctuations of destinations and origins of traffic crossing the Laredo bridges. Ideally, Laredo should be subject to a year-long survey with seasonal repetitions to identify seasonal variations.

Currently, foreign truck traffic is not allowed to travel outside a narrow commercial zone on both sides of the border. For example, if some cargo is going from South Mexico into the northern U.S., either the Mexican truck delivers the cargo in the U.S. commercial zone or a

drayage company specializing in moving cargo from one commercial zone into another receives the cargo in the Mexican commercial zone and transports it to the U.S. commercial zone, where it will be taken north by a U.S. company. Because NAFTA requires that trucking restrictions be lifted by 1997, truck traffic crossing the border may drastically change, making all the available data obsolete. Auto surveys indicate that a majority of non-commercial, everyday trip purposes (such as school or shopping) will not be greatly affected by NAFTA. Still, business trips account for about 30 percent of all trips through most bridges, and these may be affected by NAFTA, thus indicating the need to re-evaluate the area.

The next chapter discusses the application of the origin and destination information in the determination of the sector boundaries for sector analysis of the Texas-Mexico border.

CHAPTER 6. SECTOR IDENTIFICATION

INTRODUCTION

Assessing the need for, and financial viability of, additional toll bridges along the Texas-Mexico border required that we divide the area into sectors encompassing a certain range of traffic demand. This sector analysis approach provided aggregated findings that did not limit the scope of the study to specific proposed sites. This chapter discusses the first step in applying the sector analysis concept to the Texas-Mexico border, namely, the identification of the sector boundaries.

METHODOLOGY

The sector analysis concept was designed to work in conjunction with traditional methods for traffic demand and revenue predictions (since border sectors are associated with traffic diversion areas). Sector analysis is thus an iterative process: while sector boundaries are defined by the locations where the demand for a new facility falls outside the interval of interest, the demand analysis requires previous definition of sector boundaries. As discussed in Chapter 5, about 90 percent of transborder trips are locally generated. This means that local socioeconomic variables, together with traffic volumes and origin and destination data, are good indicators of sector boundaries. Within every economic activity center, which is usually comprised by sister cities on both sides of the border, there is an area of traffic diversion indicated by the origin and destination information, which provides the boundaries of the border sectors.

The methodology for determining sector boundaries is outlined in Figure 6.1. Socioeconomic data are compiled to identify centers of economic activity along the border. The southbound transborder traffic is then examined to determine the locations of each economic activity center.

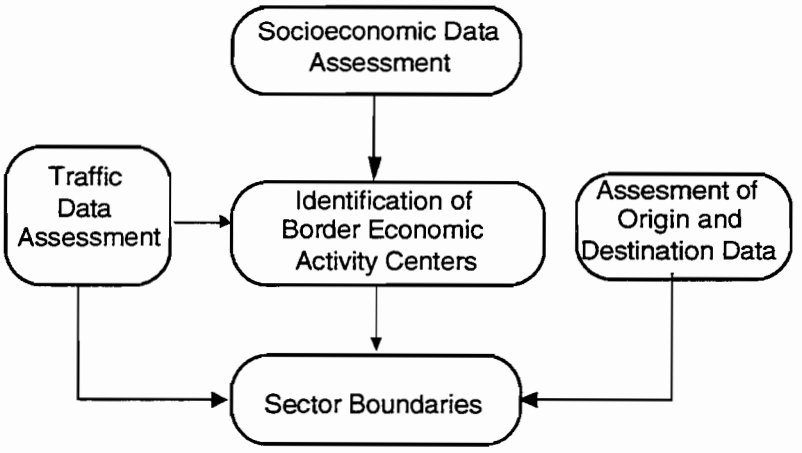


Figure 6.1. Methodology for sector identification

It is important to note that, while the various levels of transborder traffic are due in large part to the economic activity along the border, the traffic volumes themselves are helpful both in verifying economic activity center locations and in determining sector boundaries. Transborder origin and destination data provide additional information on the transborder traffic patterns and the area of traffic diversion spanned by the current demand, which constrain the sector boundaries. In short, after identifying the economic activity centers along the border, we assessed the southbound traffic at existing binational entry systems to further assist in verifying the economic activity center definition, as well as to start the process of determining sector boundaries. Transborder origin and destination patterns provide information on traffic diversion areas, which are used to further refine the sector boundaries.

IDENTIFICATION OF ECONOMIC ACTIVITY CENTERS

The methodology described above required that we analyze the following data to identify economic activity centers along the border: (1) population, (2) total sales, (3) retail sales, (4) total employment by industry, (5) number of maquiladora plants, and (6) maquiladora employment.

An economic activity center is defined in terms of its potential as a traffic generation area, and as such the analytical focus of this assessment is the identification of areas with potential to generate and attract a significant amount of international traffic. These areas are defined based on socioeconomic variables, and further refined by an assessment of the current levels of transborder traffic.

Assessment of Population Data

Because it is a key indicator of traffic activity, population is the first variable analyzed in the socioeconomic data assessment. Figure 6.2 shows 1990 census data for border cities in Texas and in Mexico. The population data shown for the interior of Mexico are by municipality, rather than for city. Figure 6.3 depicts the average annual percent growth of border city populations between 1980 and 1990.

As these figures show, the single largest binational metropolitan area on the border is El Paso-Ciudad Juarez, with a combined 1990 population of over 1.3 million. Brownsville-Matamoros is second at 365,000, and Laredo/Nuevo Laredo is third at 341,312.

Throughout this chapter the Texas-Mexico valley area outside of Brownsville/Matamoros is divided into subareas in order to show differences in population throughout the valley. The subarea labeled "Eastern Valley" in the U.S. consists of the cities of Weslaco, Donna, Mercedes, La Feria, Progreso, Elsa, Edcouch, and Santa Rosa. The Mexican city adjacent to the Eastern Valley subarea where population data are available is Rio Bravo. Although there are additional cities on the Mexican side within this valley subarea (e.g., Nuevo Progreso), no population data were available for those cities. The combined binational city population in this valley subarea is 130,969.

The valley subarea termed "Central Valley" is comprised of the U.S. cities of McAllen, Edinburg, Mission, Pharr, Hidalgo, San Juan, Alamo, and the Mexican city of Reynosa. The

combined binational population in this valley subarea is 463,460. This valley subarea population is second in border city binational population (the first being the El Paso-Ciudad Juarez area).

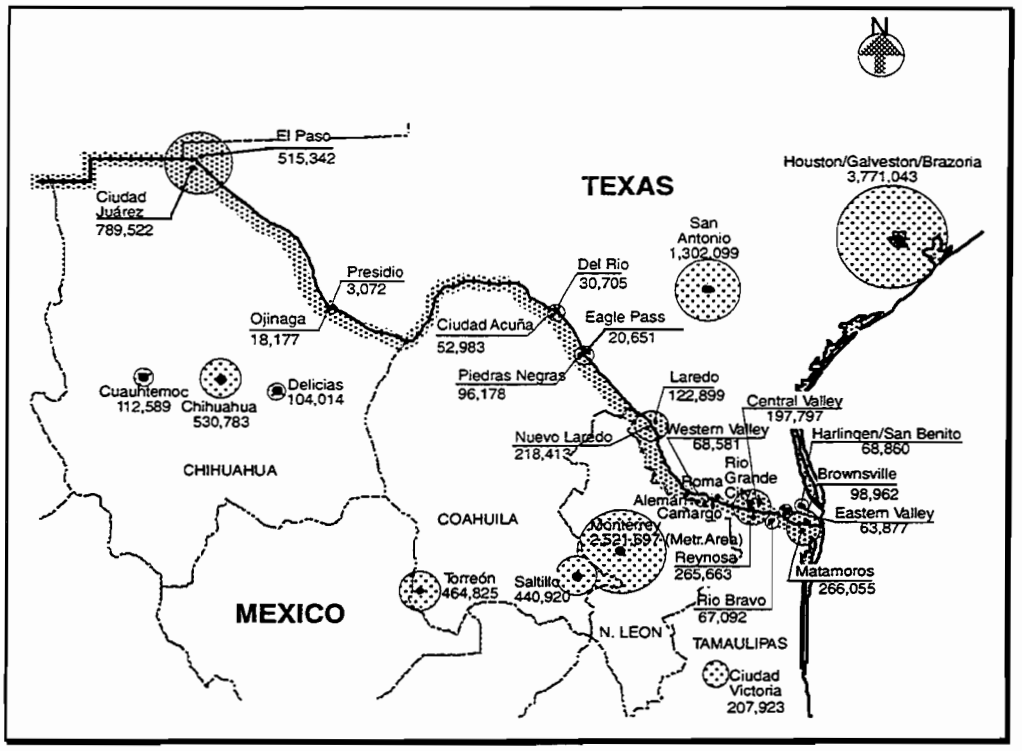


Figure 6.2. Border cities population (1990 Census)

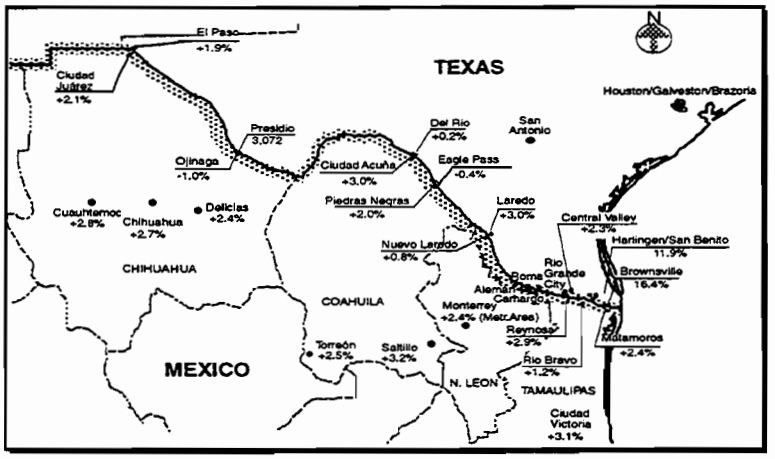


Figure 6.3. Average annual percent population growth: 1980–1990

The valley subarea termed "Western Valley" consists of the cities of Rio Grande City, Roma, Rosita, Sullivan City, and La Grulla on the U.S. side (where population data are

available), and the sister Mexican cities of Nueva Cd. Guerrero, Mier, Cd. Miguel Aleman, Cd. Camargo, and Gustavo Diaz Ordaz. The combined binational sister-city population of this valley subarea is 68,581. The population data alone suggest the possibility of nine major economic activity centers along the border; these are listed below in geographical order from the Gulf of Mexico to the Texas-New Mexico border:

(1) Brownsville-Harlingen/Matamoros
(2) Eastern Valley Area
(3) Central Valley Area
(4) Western Valley Area
(5) Laredo/Nuevo Laredo
(6) Eagle Pass/Piedras Negras
(7) Del Rio/Ciudad Acuña
(8) Presidio/Ojinaga
(9) El Paso/Ciudad Juarez

Total and Retail Sales

Shopping accounts for a significant number of transborder auto trips in the U.S. Figures 6.4, 6.5, and 6.6 show Texas border city sales data obtained from the State Comptroller's Office. The data show that El Paso is the single largest Texas border city in terms of total sales or retail sales; Laredo ranks second, McAllen third, and Brownsville fourth. The combined area between Brownsville through Laredo, which includes Eastern, Central, and Western Valley areas, is still second to El Paso in total sales activity.

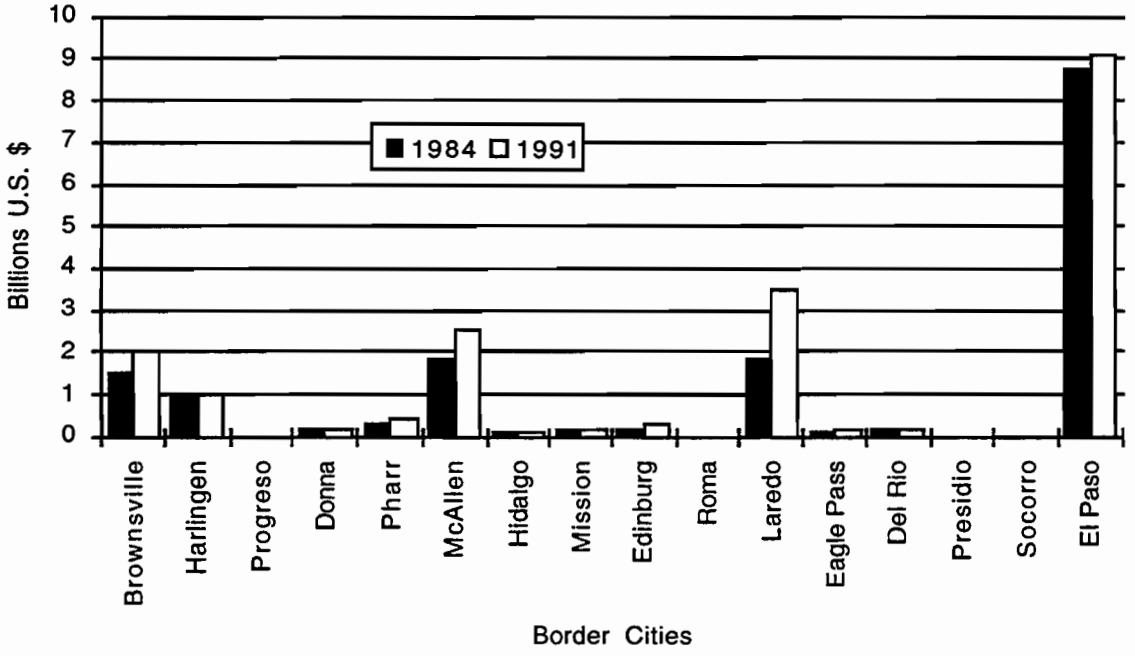


Figure 6.4. U.S. border cities' total sales (1992, in billion dollars)

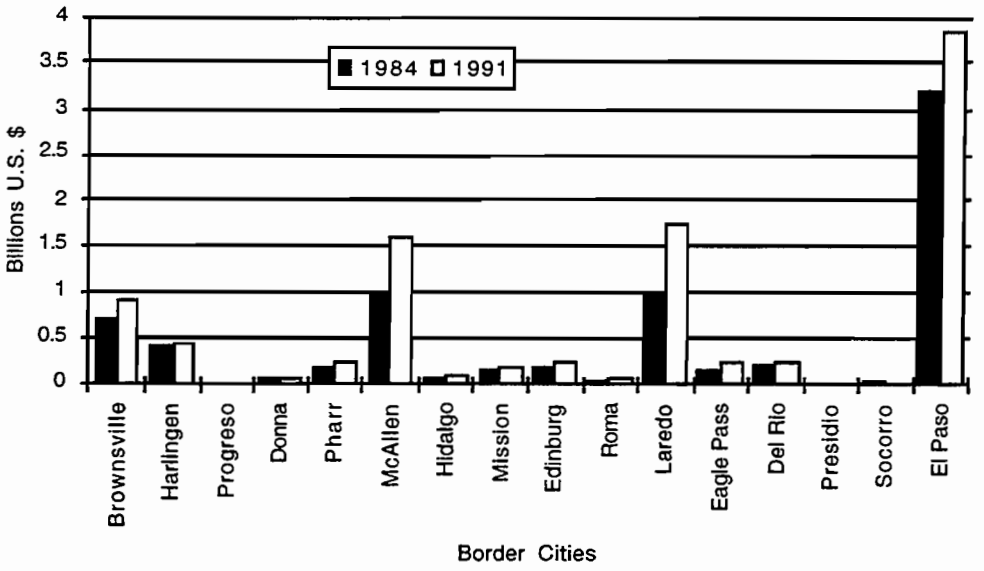


Figure 6.5. U.S. border cities' retail sales (1992, in billion dollars)

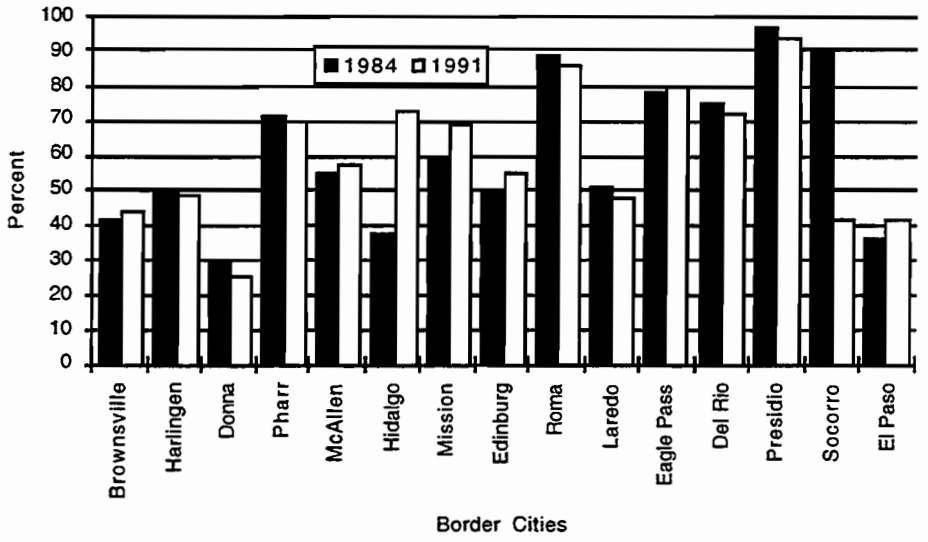


Figure 6.6. Comparison of total and retail sales

Texas sales data suggest the following hierarchy of the nine binational population centers listed in the previous section in terms of total sales on the U.S. side of the border:

(1) El Paso/Ciudad Juarez $9,162,000
(2) Central Valley Area $3,965,000
(3) Laredo/Nuevo Laredo $3,567,000
(4) Brownsville-Harlingen/Matamoros $3,033,000

(5) Eagle Pass/Piedras Negras $295,000
(6) Del Rio/Ciudad Acuña $294,000
(7) Eastern Valley Area $134,000
(8) Western Valley Area $52,000
(9) Presidio/Ojinaga $20,000

Total Employment

Border employment should also be considered when assessing the various regions along the border. Figure 6.7 shows the total number of employees in the border area. In the U.S., employment data were collected by Metropolitan Statistical Area (MSA), not by city. The Brownsville-Harlingen MSA includes all of Cameron County, the McAllen MSA includes Hidalgo County, the Laredo MSA includes Webb County, and the El Paso MSA includes El Paso County. Data for Eagle Pass and Del Rio are for the entire counties of Maverick and Val Verde, respectively. While total employment data were not collected for Presidio or Presidio County, we did determine that 1990 employment for the total upper Rio Grande border region (consisting of border counties extending from the Big Bend National Park to El Paso) — was 7,400.

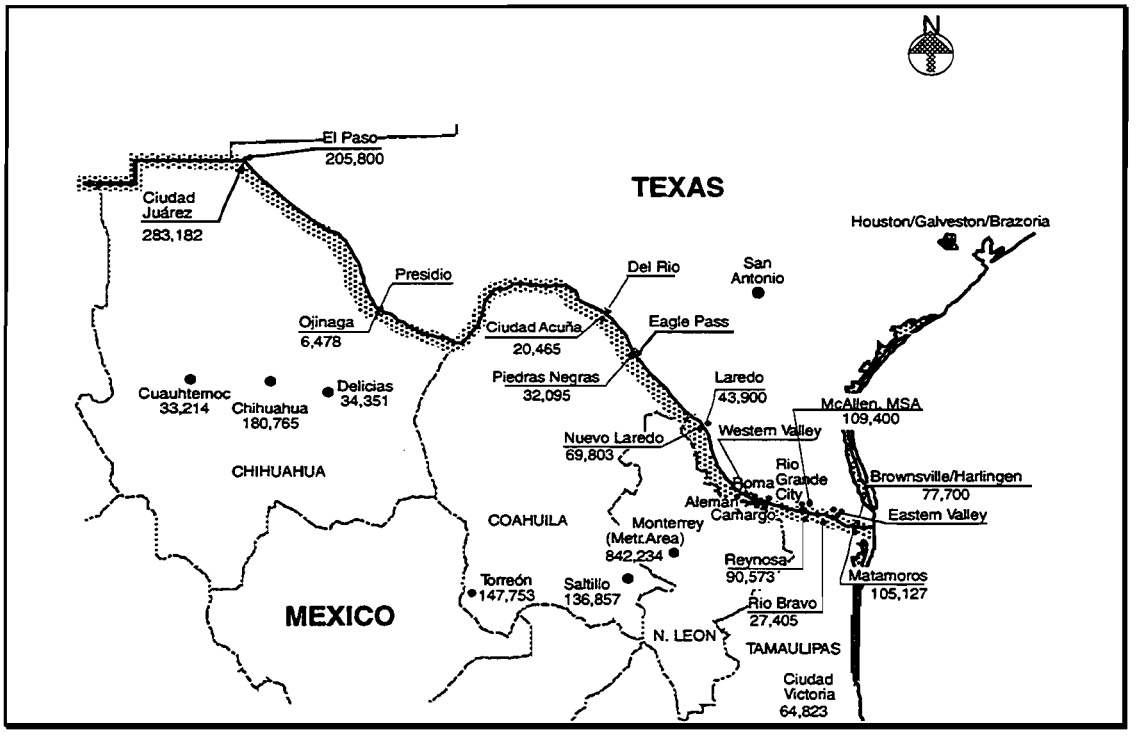


Figure 6.7. Border cities total 1990 employment

As the single largest binational metropolitan area, El Paso/Ciudad Juarez has a combined 1990 total employment of about 489,000. The combined binational valley area (McAllen MSA/Reynosa-Rio Bravo) ranks second, with a combined total employment of about 237,000.

Brownsville/Matamoros is third at 183,000, while Laredo/Nuevo Laredo ranks fourth at 114,000 total employment. For the four Texas MSAs along the border (El Paso, Laredo, McAllen, and Brownsville), the average annual growth rates in total employment between 1982 and 1990 were +2.9 percent for El Paso, +1.4 percent for Laredo, +2.9 percent for McAllen, and +2.2 percent for Brownsville.

Figure 6.8 shows the 1990 employment data broken down by economic activity area and aggregated by binational urban area. The rank of the binational areas in terms of employment is the same as discussed previously for every economic activity area.

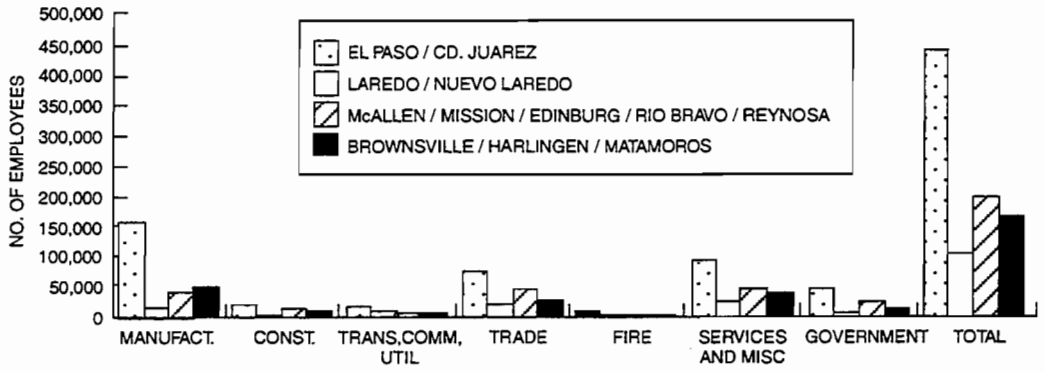


Figure 6.8. Border cities' 1990 employment by industry

The employment data discussed above indicate seven economic activity centers along the Texas-Mexico border. These are listed in Table 6.1 by total employment, in descending order.

Table 6.1. Binational activity centers ranking by total employment

CITY	EMPLOYMENT
El Paso/Ciudad Juarez	488,982
Valley Area/Reynosa-Rio Bravo	236,576
Brownsville-Harlingen/Matamoros	182,827
Laredo/Nuevo Laredo	113,703
Eagle Pass/Piedras Negras	42,260
Del Rio/Ciudad Acuña	32,194
Presidio/Ojinaga	6,478

Maquiladora Employment

Maquiladora employment is a main indicator of transborder traffic, as it generates work-related trips as well as other trips indirectly created by the industrial activity. Figures 6.9 and

6.10 provide the most recent (1992) data on number of maquiladora employees, and a map of maquiladora plants, respectively. Ciudad Juarez is first in maquiladora employment and number of plants at 128,901 and 267, respectively. Matamoros is second with 37,510 employees and 97 plants, Reynosa is third at 29,794 employees and 76 plants, and Nuevo Laredo is fourth at 16,433 employees and 68 plants.

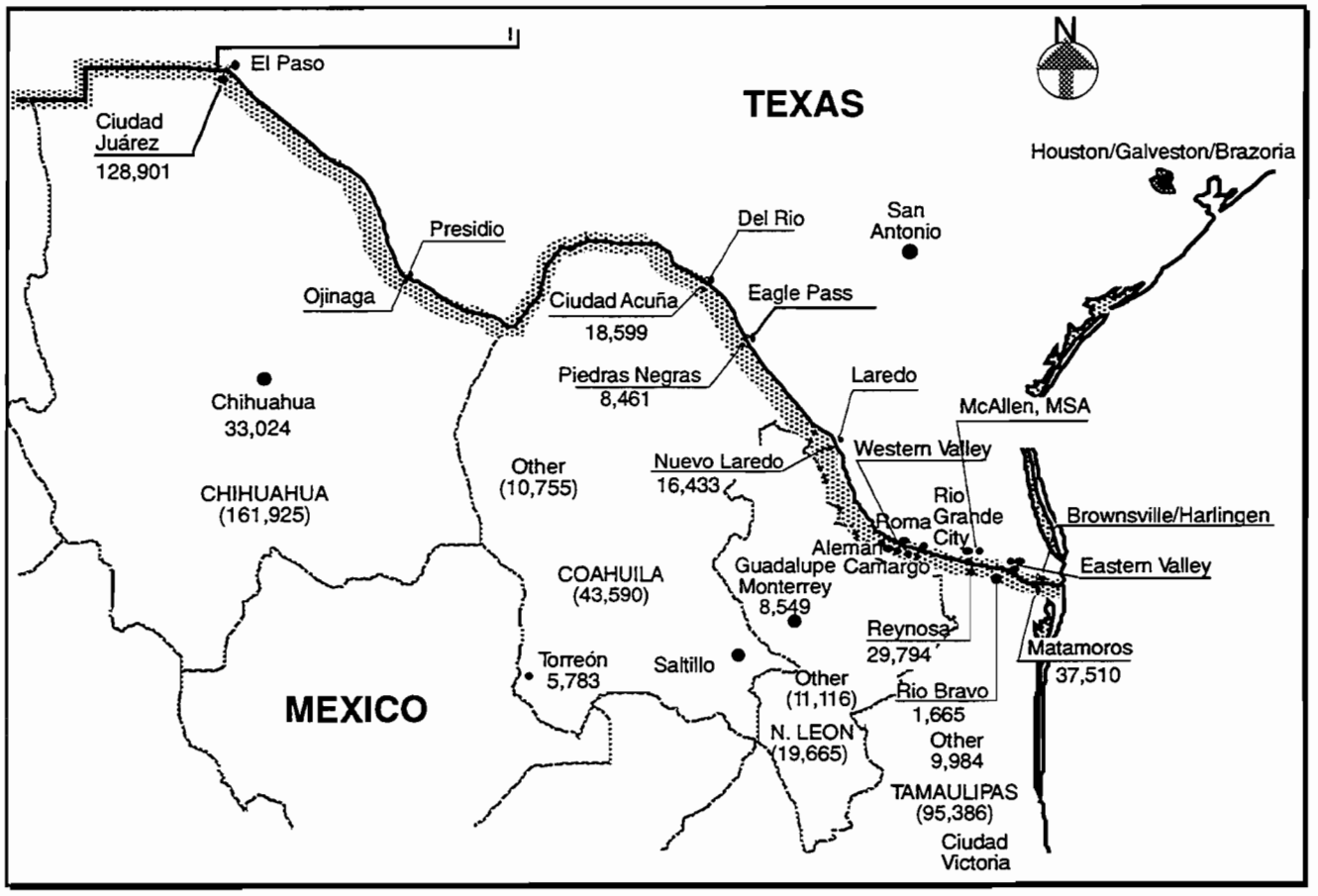


Figure 6.9. Maquiladora employment (1992)

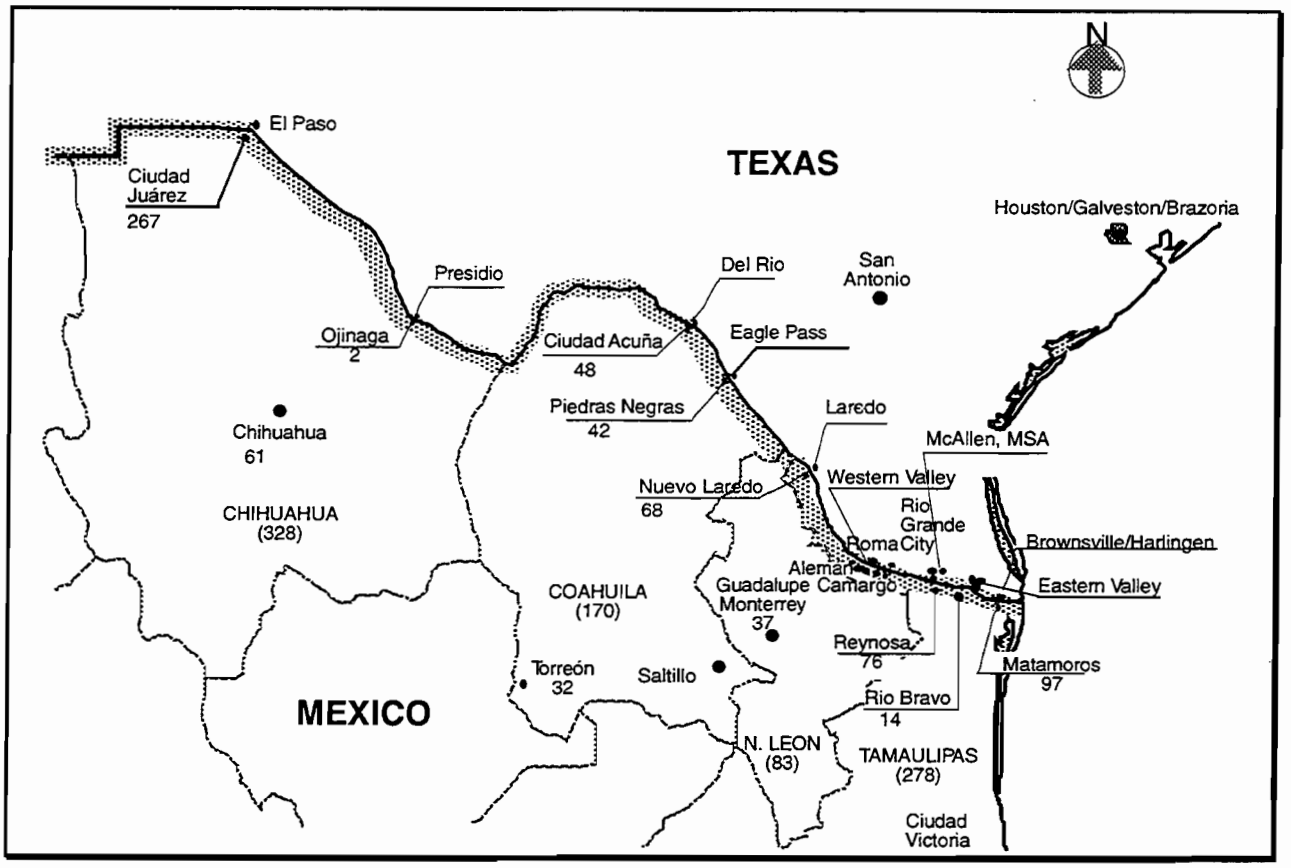


Figure 6.10. Maquiladora plants (1992)

Figures 6.11 through 6.14 show the historical growth of maquiladora employment in the four border states of Tamaulipas, Nuevo Leon, Coahuila, and Chihuahua. Chihuahua leads the total number of employees, while Coahuila leads in terms of average annual percent growth rate. Tamaulipas' growth between the early 1980s and 1989 was impressive, though it became somewhat stagnant thereafter. Nuevo Leon owes a significant part of its development to the maquiladora industry, which has lately shown accelerated growth (especially in the city of Guadalupe). The state of Coahuila shows steady maquiladora growth for the past 10 years, while Chihuahua has three separate growth periods: before 1983, between 1983 and 1989, and after 1989. These growth periods, however, become somewhat stagnant between 1990 and 1991. Some of the early growth rates reflect the beginning of the maquiladora industry in the region.

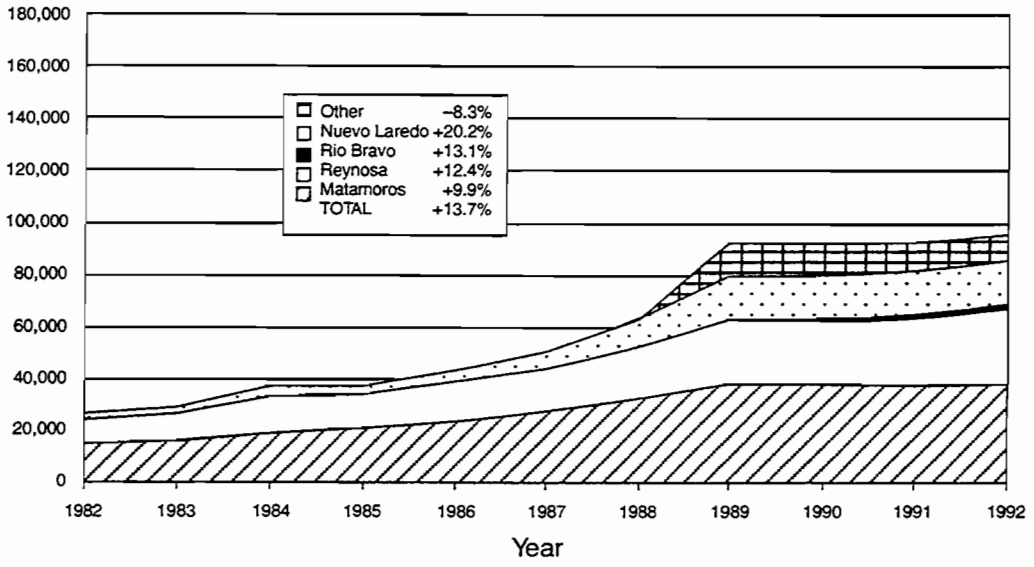


Figure 6.11. Growth of maquiladora employment — Tamaulipas

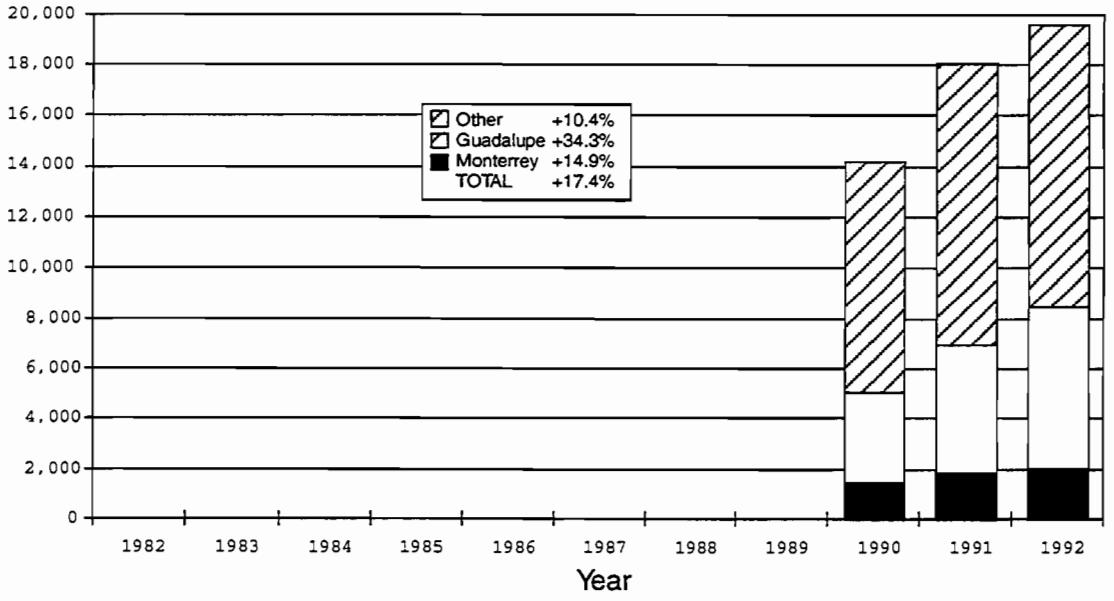


Figure 6.12. Growth of maquiladora employment — Nuevo Leon

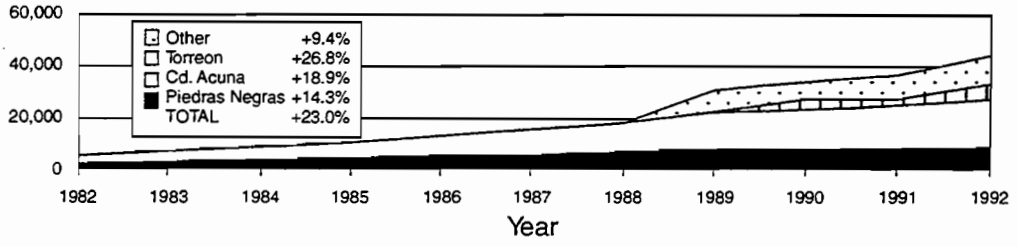


Figure 6.13. Growth of maquiladora employment — Coahuila

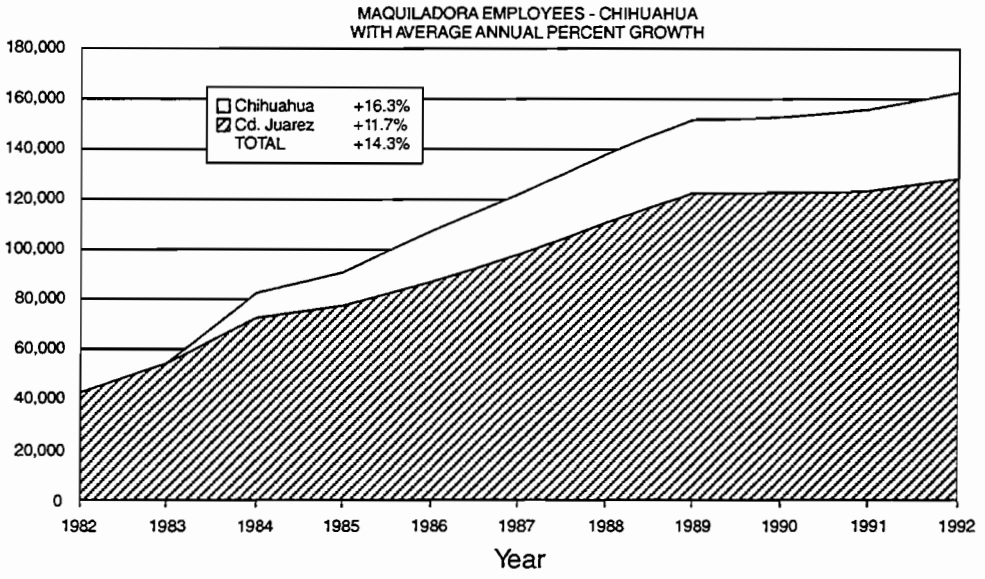


Figure 6.14. Growth of maquiladora employment — Chihuahua

Analogous trends can be seen in the number of maquiladora plants, which are shown in Figures 6.15 through 6.18, for Tamaulipas, Nuevo Leon, Coahuila, and Chihuahua. Tamaulipas shows the steepest growth rate during the 1985-1989 period, with a localized growth spurt between 1988 and 1989. Nuevo Leon shows a smaller growth rate, and, on average, Monterrey has been stagnant in the early 1990s. Coahuila shows small but steady growth between 1982 and 1988, at which time it suddenly increases. However, Cd. Acuña and Piedras Negras, the main border cities in this state, have been stagnant since 1989. Figure 6.18 shows Chihuahua's steady maquiladora growth (the state in fact has the largest number of maquiladora plants). There has been a slight decrease in maquiladora activity between 1990 and 1991, with recovery thereafter.

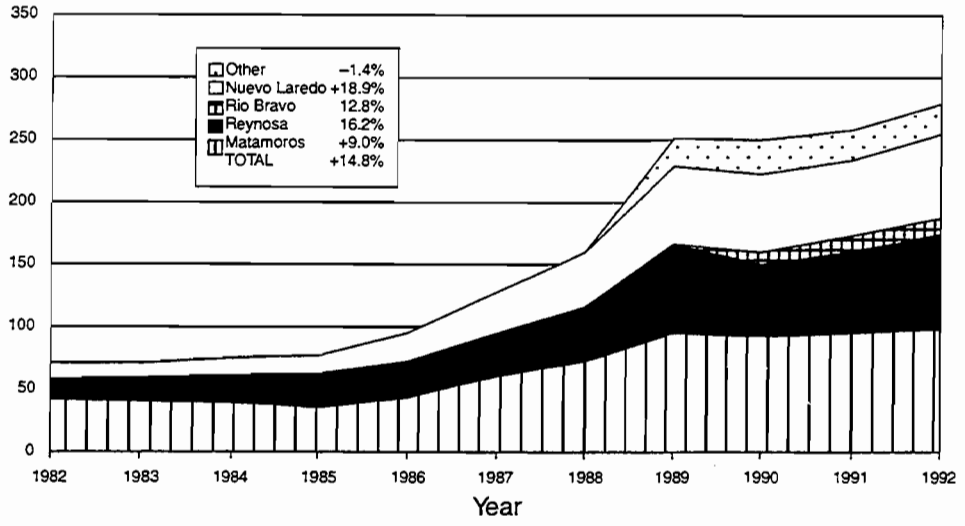


Figure 6.15. Growth of maquiladora plants — Tamaulipas

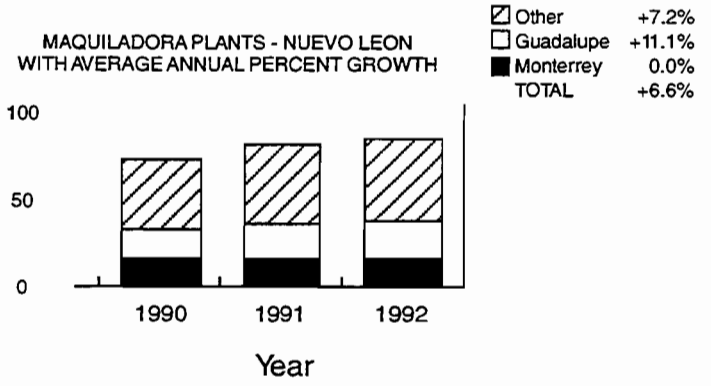


Figure 6.16. Growth of maquiladora plants — Nuevo Leon

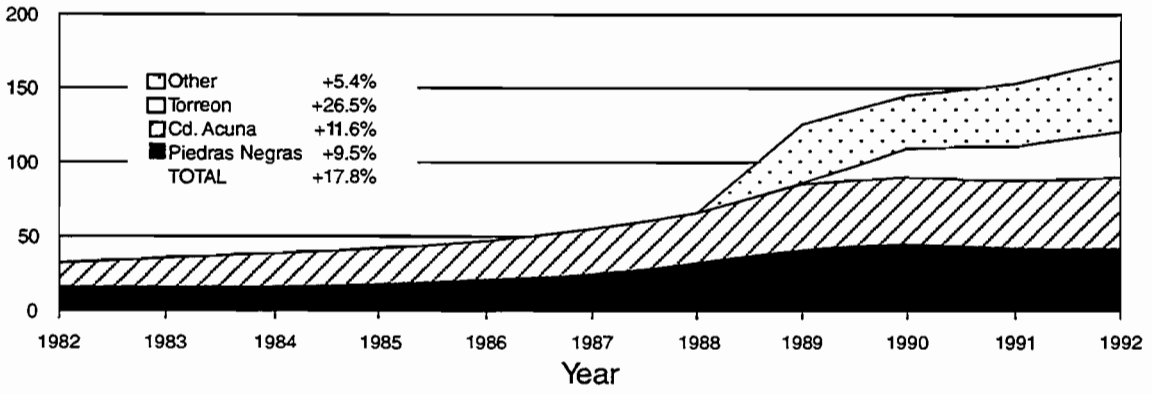


Figure 6.17. Growth of maquiladora plants — Coahuila

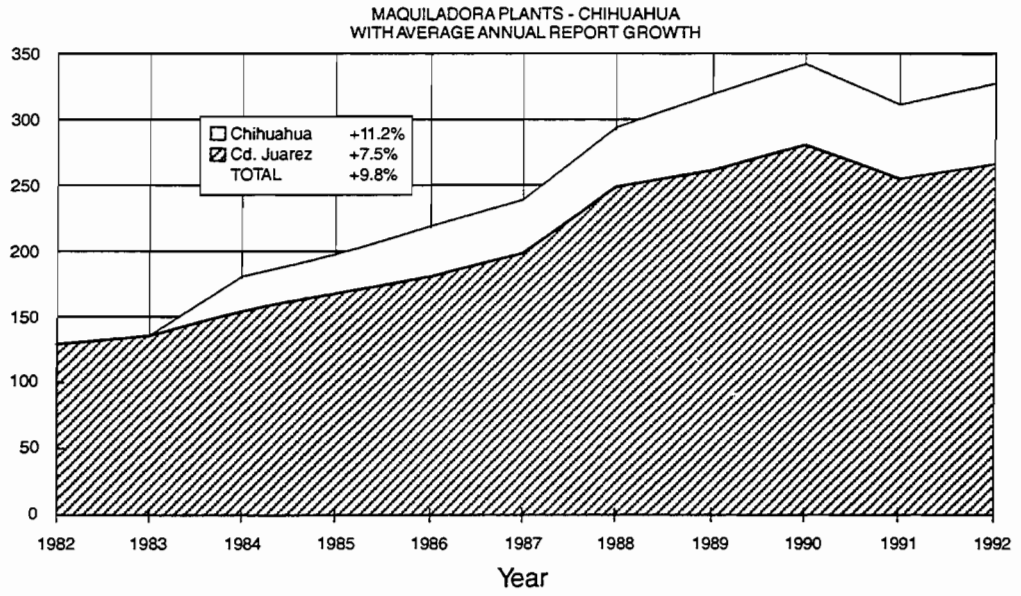


Figure 6.18. Growth of maquiladora plants — Chihuahua

The ranking of the Texas-Mexico border activity centers by maquiladora employment and maquiladora plants indicates the hierarchy depicted in Table 6.2.

Table 6.2. Binational activity centers ranking by maquiladora activity

ACTIVITY CENTER	MAQUILADORAS
El Paso/Ciudad Juarez	128,901
Brownsville-Harlingen/Matamoros	37,510
Valley Area/Reynosa-Rio Bravo	31,459
Laredo/Nuevo Laredo	16,433
Eagle Pass/Piedras Negras	8,461
Del Rio/Ciudad Acuña	18,599
Presidio/Ojinaga	(two plants)

Tables 6.1 (total employment) and 6.2 (maquiladora employment) display almost exactly the same ranking, except for 2 and 3, which are switched: Valley Area/Reynosa-Rio Bravo, and Brownsville-Harlingen/Matamoros rank second and third in total employment, while they rank third and second in maquiladora employment. Their difference in terms of maquiladora employment is about 16 percent, while in total employment the difference is greater, amounting to over 22 percent. The combined ranking for maquiladora and total employment is shown in Table 6.1.

Conclusions

The population and economic data presented in the previous sections suggest that the McAllen area can be distinguished from the rest of the valley area. An estimate of population density can assist in verifying this point. The average density for a particular area indicates the amount of population encompassed by the area comprised by that city and its neighboring cities, as shown in Eq. 6.1. In this equation, APD is given in number of inhabitants per unit area, implicitly assuming that the urban area of interest is a rectangle of unit width and length "d."

$$APD = \frac{\sum_{i=1}^{n} Pi}{d} \tag{6.1}$$

where:

APD = Average population density in the urban area of interest,

Pi = population in city ""i,"

d = distance between the first and the last cities of the urban area of interest, and

n = number of cities in the urban area of interest.

Figure 6.19 shows the average population densities in all urban conglomerates in the Valley area. The areas between Brownsville and Edinburg, and between Mission and Roma, are less developed than the McAllen area; and while definitive boundaries in the valley area do not exist, these data indicate that the valley can be divided into three subareas, namely, Eastern, Central, and Western Valley.

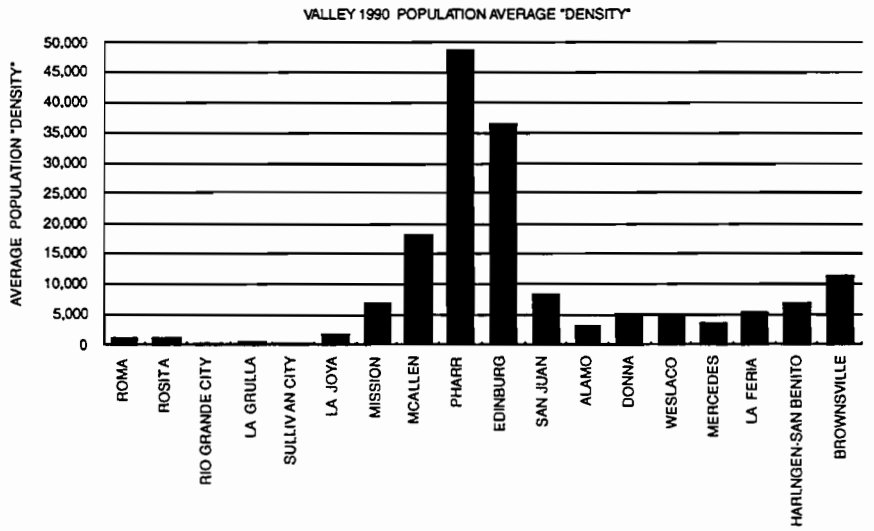


Figure 6.19. Average population density in the Valley cities

The aforementioned evaluation of the socioeconomic data results in nine economic activity centers along the Texas-Mexico border. These are presented in geographical order in Table 6.3, beginning at the easternmost side of the Texas-Mexico border and extending to the western end of the Texas-Mexico border. Table 6.3 shows these activity centers and the cities they encompass on both sides of the border.

Table 6.3. Economic activity centers along the Texas-Mexico border

Center	US Cities	Mexican Cities
1	Brownsville-Harlingen	Matamoros
2	Eastern Valley (Weslaco, Donna, Mercedes, La Feria, Progreso, Elsa, Edcouch, Santa Rosa)	Rio Bravo
3	Central Valley (McAllen, Edinburg, Mission, Pharr, Hidalgo, San Juan, Alamo)	Reynosa
4	Western Valley (Rio Grande City, Roma, Rosita, Sullivan City, La Grulla)	Cd. Guerrero, Cd. Mier, Cd. Camargo, Cd. Miguel Alemán, Dias Ordaz
5	Laredo	Nuevo Laredo
6	Eagle Pass	Piedras Negras
7	Del Rio	Cd. Acuña
8	Presidio	Ojinaga
9	El Paso	Cd. Juarez

TRAFFIC VOLUMES ASSESSMENT

The economic activity centers defined in Table 6.3 were identified based on their potential as areas that generate and attract most of the traffic that uses binational entry systems within each center. Definition of these centers is the first step towards determining the sector boundaries, and an analysis of the current traffic volumes using each binational entry system assists both in the identification of the sectors and in the verification of the economic activity centers depicted in Table 6.3.

Analysis of Transborder Traffic Volumes

Figures 6.20 and 6.21 show the privately owned vehicular (POV) and truck traffic entering the U.S. through its various ports of entry. The El Paso Port of Entry is the largest port in terms of northbound vehicular traffic for both autos and trucks. The Laredo Port of Entry is the second largest port in terms of autos and trucks, while the Hidalgo and Brownsville ports of entry are tied for third in terms of auto traffic. The Brownsville Port of Entry is third in terms of truck traffic, while Hidalgo is the fourth largest port of entry for northbound truck traffic.

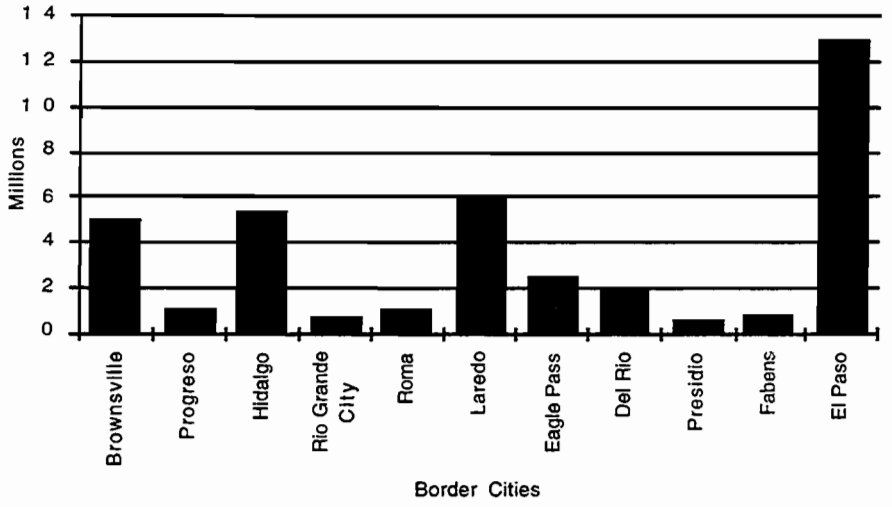


Figure 6.20. Northbound POV traffic by port of entry

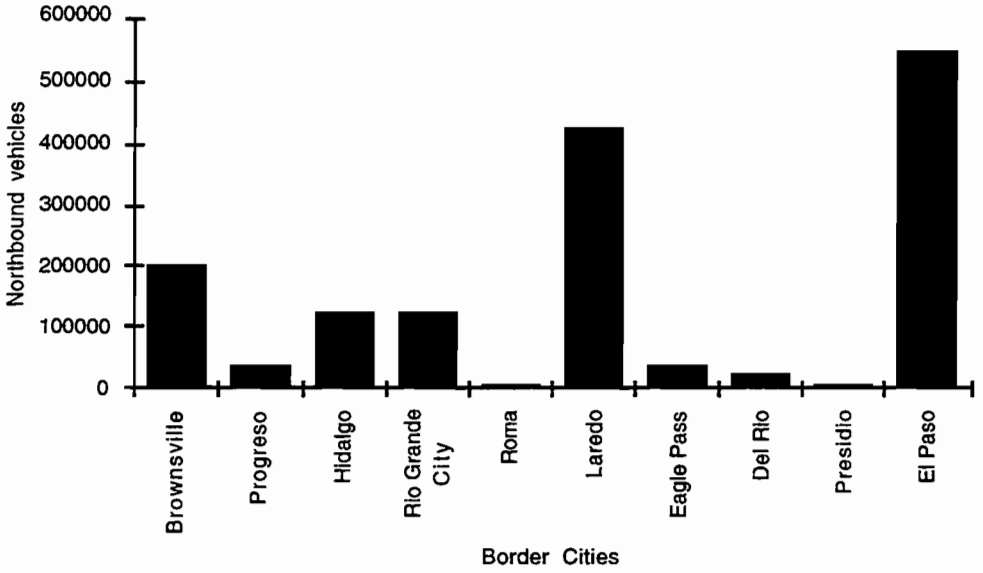


Figure 6.21. Northbound truck traffic by port of entry

It is worthwhile discussing the type of truck traffic among the various ports of entry. The data in Figure 6.22 indicate that the Laredo Port of Entry is significantly different in that around 60 percent of its truck traffic is not related to the maquiladora industry. The implication is that non-maquiladora truck traffic is supposedly long-haul or corridor traffic and, conversely, northbound maquiladora traffic is mostly local. Another implication is that long-haul commercial traffic prefers the Laredo area, which is justified by its convenient geographical location.

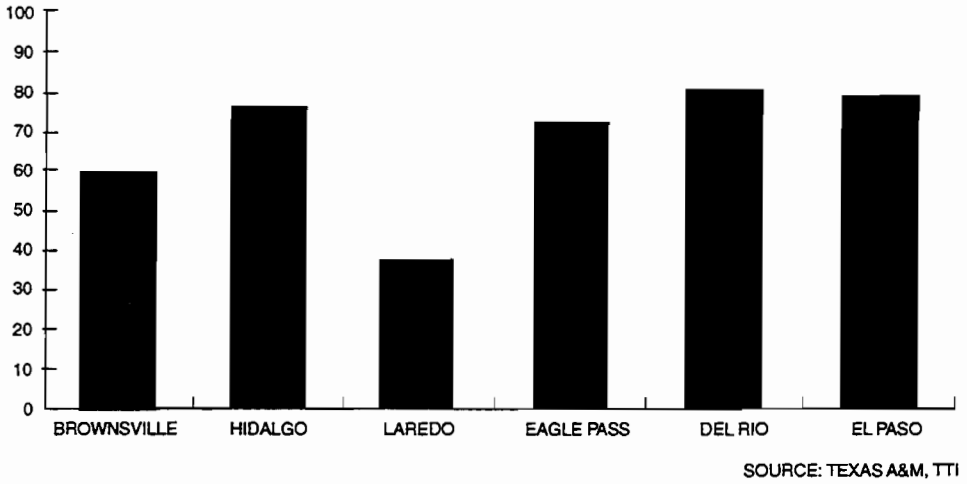


Figure 6.22. Proportion of maquiladora-related northbound truck traffic by port of entry

Figure 6.23 compares northbound pedestrian traffic among the various U.S. ports of entry. The Laredo Port of Entry is ranked first in terms of northbound pedestrian traffic, the El Paso Port of Entry is second, and the Brownsville Port of Entry is third.

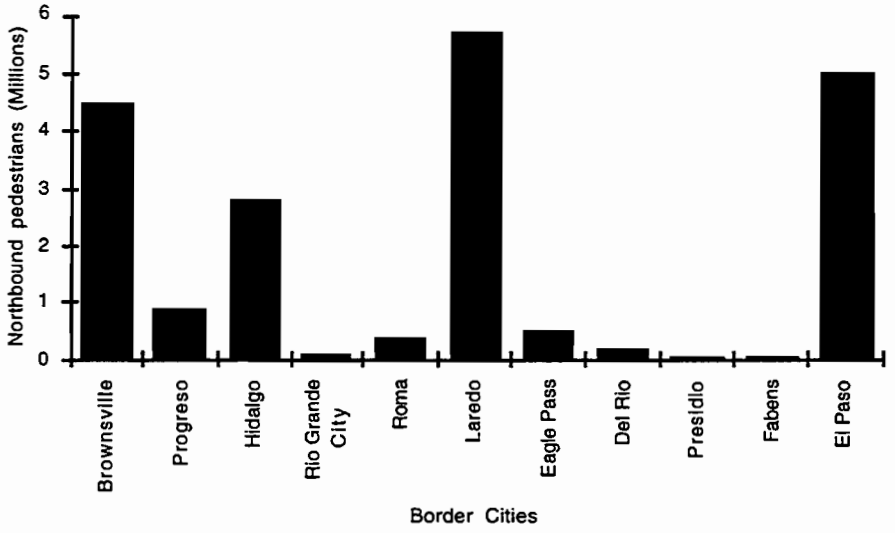


Figure 6.23. Northbound pedestrian traffic by port of entry

Conclusions

Truck traffic alone defines the Laredo region as a sector. Moreover, geographical distance and economic activity center locations suggest that, in Segment 2, each binational entry system is a separate sector, with the possible exception of Fabens, owing to its proximity to El

Paso. As for Segment 1, the analysis of the traffic volumes, coupled with the economic activity center identification, roughly suggests some sector boundaries that encompass the binational entry systems with the same magnitude of traffic volumes and/or within the same economic activity center. Analysis of the origin and destination patterns within each economic activity center is necessary to further clarify some sector boundaries.

TRANSBORDER AUTO ORIGIN AND DESTINATION PATTERNS

Chapter 5 discussed the results of the origin and destination surveys conducted in the southbound direction at eight bridges along the Texas-Mexico border, as well as results from previous surveys conducted at other bridges. While only southbound vehicles (i.e., U.S. to Mexico) were surveyed, in this section the terms "trip production" and "trip attraction" are used interchangeably when discussing either side of the border, an assumption that suggests northbound origin and destination patterns are symmetrical with southbound patterns.

El Paso/Ciudad Juarez Surveys

The data suggest that most transborder auto trips are local. In the El Paso/Ciudad Juarez border area, the Santa Teresa Study (Ref 23) suggests that 90 percent or more of auto traffic using the bridges in El Paso/Ciudad Juarez begin or end their trip in Cd. Juarez and El Paso. The survey conducted by CTR for this study at the Fabens/Caseta binational entry system indicates that about 85 percent of the auto trips using this bridge are generated between Tornillo/Fabens/Caseta, and El Paso/Ciudad Juarez. These data indicate that the sector for local traffic in the El Paso/Ciudad Juarez area extends from Tornillo through El Paso.

Presidio-Del Rio-Eagle Pass Surveys

The survey conducted at the Presidio/Ojinaga Bridge location suggests that about 90 percent of transborder auto traffic in this area is generated by the border twin cities of Presidio and Ojinaga. Similar results were obtained from the surveys conducted at Del Rio/Ciudad Acuña and Eagle Pass/Piedras Negras Bridges. These data indicate the existence of three sectors, one for each of these binational entry systems.

Valley Area Surveys

The surveys conducted at four bridges in the valley from Brownsville/Matamoros to Hidalgo/ Reynosa suggest similar local generation of auto transborder traffic, except that the U.S. area that generates trips is larger than that at other locations surveyed along the border.

Figures 6.24 and 6.25 show the areas that generate about 90 percent of the southbound auto traffic crossing one of the four bridges surveyed. Figure 6.24 shows that about 90 percent of the auto traffic using the Hidalgo/Reynosa Bridge is generated on the Mexican side by the city of Reynosa, and on the U.S. side by cities lying within a 400-square-mile (1,034 km^2) area stretching from Mission to Donna and from Hidalgo to Edinburg. The trip generation is not uniformly distributed across this area; the city of McAllen is the largest U.S. traffic generator at

this bridge (60 percent).

The Hidalgo/Reynosa Bridge survey indicates that sector boundaries may exist at some distance on either side of the city limits of Reynosa. The survey data show that the characteristics of U.S. traffic origins/destinations differ from those found in Mexico. As stated above, about 90 percent of the U.S. southbound transborder traffic originates within an area of about 400 square miles (1,034 km^2). However, this traffic terminates in a much smaller area in Mexico, namely, the city of Reynosa. As a hypothetical new bridge located on either side of Reynosa moves further away from Reynosa, it would lose more and more of its potential market, depending on the overall travel time and value of time for traffic demand between the various origins and destinations. Thus, the Mexican traffic attraction area constrains the sector boundaries around the city of Reynosa.

For the B&M and Gateway Bridges in Brownsville/Matamoros, about 90 percent of the transborder auto traffic is generated by the border twin cities. This would suggest preliminary sector boundaries that encompass the Brownsville/Matamoros area. For the Progreso/Nuevo Progreso Bridge, Figure 6.25 shows that about 90 percent of the auto traffic is produced/attracted by three cities in Mexico: Nuevo Progreso, Las Flores, and Rio Bravo, covering an area of about 100 square miles (259 km^2), with the largest generator being Nuevo Progreso at 60 percent, and nearby Las Flores accounting for another 14 percent. On the U.S. side, the area required to encompass 90 percent of the traffic producers/attractors of the Progreso Bridge is about 900 square miles (2,333 km^2). This area stretches from Mission to Harlingen and from Progreso Lakes to Edcouch, with the largest generator being Weslaco at 30 percent.

The Progreso/Nuevo Progreso Bridge survey data suggest a sector boundary width wider in this area of the Valley than elsewhere. The smaller of the two trip producing/attracting areas on either side of the border will be taken as the constraint for estimating sector boundaries — in this case, the cities of Nuevo Progreso, Las Flores, and Rio Bravo.

The transborder traffic moving between cities in this area of the valley, as indicated by traffic on this bridge, amounts to only about 17 percent of the transborder traffic at the Reynosa Bridge, but requires twice the area in the U.S. to be produced and/or attracted. The trip purposes for the Progreso Bridge may indicate reasons for this phenomenon. While about 25 percent of the trips surveyed elsewhere in the valley had a work-related trip purpose, only about 12 percent of the traffic surveyed using the Progreso Bridge reported a work-related purpose. Also, as shown earlier, the population density of the Eastern Valley area in the U.S. is less than that in the Central Valley (McAllen) area. The population on the Mexican side of the border between Reynosa and Matamoros is less dense as well. These factors indicate a smaller, less work-related transborder traffic market for this area of the border.

Conclusions and Observations

Present border trucking operations effectively limit the usefulness of border origin and destination surveys of commercial vehicles. Existing trucking rules between the two countries has established a transborder drayage system in which southbound trailers with cargo are picked

up at a U.S. freight forwarding yard or warehouse by a Mexican tractor. The loaded trailer is then taken to a Mexican yard or warehouse and dropped off by the drayage company to be taken to its final destination. Similar procedures are observed for trucks heading north.

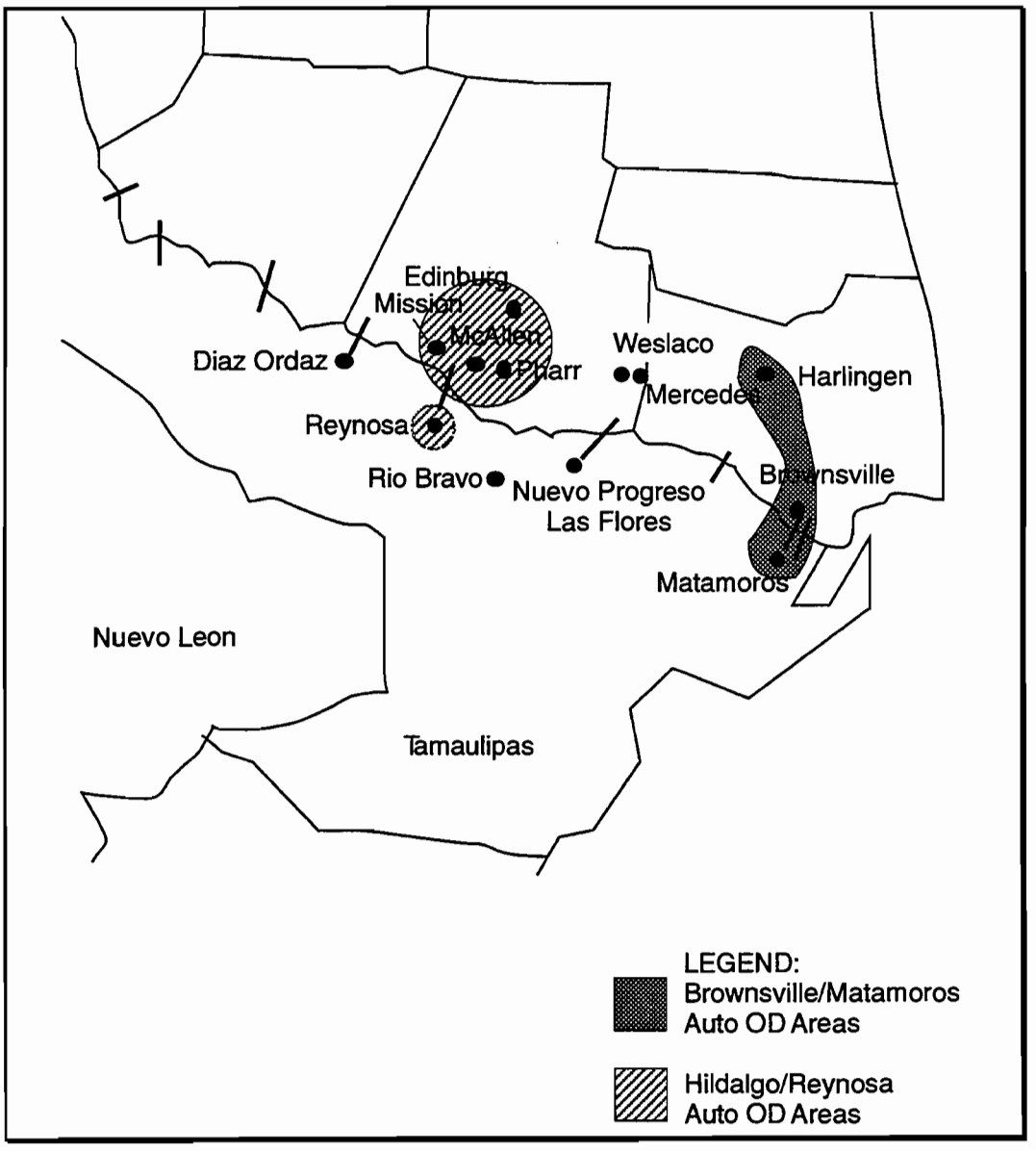


Figure 6.24. Southbound traffic patterns in the Valley area

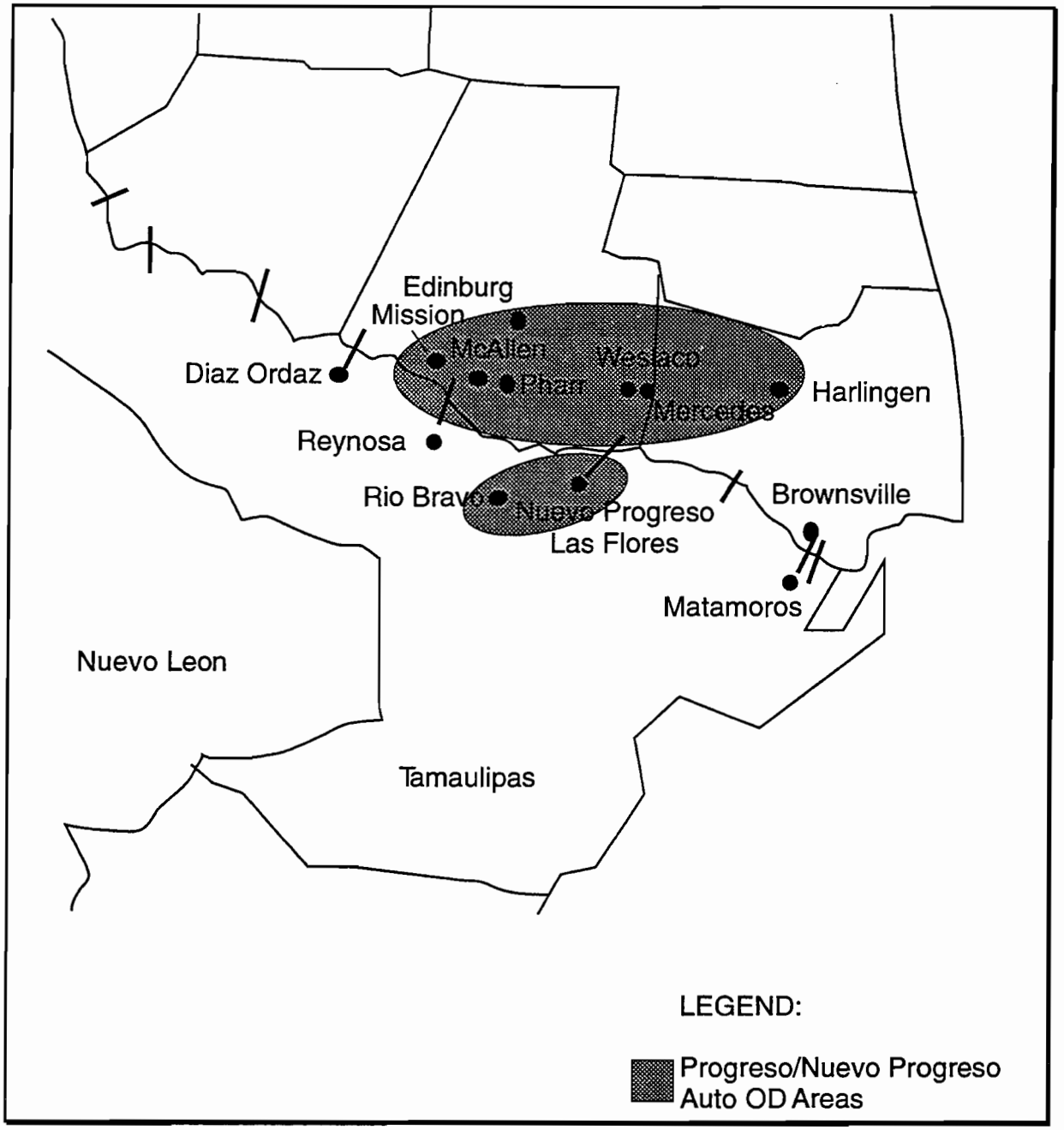


Figure 6.25. Southbound traffic patterns in Progreso area

Thus, regardless of the true origin or destination of the cargo, a driver of a drayage company will respond to an origin and destination survey on the bridge by saying that the origin and destination of the cargo are both within the commercial zones of the two countries. This suggests that long-haul trips cannot be adequately addressed with origin and destination data from a survey conducted on a binational bridge. Commodity flow data are needed to adequately

separate long-haul from local commercial traffic (long-haul being defined as originating from and/or destined to locations outside the commercial zones of the two countries). Under NAFTA, the ban on foreign commercial traffic moving beyond the commercial zones will be lifted, and the current traffic patterns will probably change. For these reasons, a sector analysis of pre-NAFTA commercial traffic patterns has no practical use; thus, the sector boundaries will concentrate primarily on auto trips and on the few conclusions about post-NAFTA commercial trips that can be made at this point.

Another point: The available auto data reflect origin and destination patterns under no-NAFTA conditions, as well as under current socioeconomic conditions. Now that it has been passed, NAFTA will foster changes in land use and in ways of living and conducting business on the Texas-Mexico border, which in turn will alter traffic patterns.

SECTOR BOUNDARIES

The origin and destination analysis discussed above, along with the economic activity centers and the traffic analyses discussed in the previous sections of this chapter, indicate that the Texas-Mexico border can be divided into the sectors shown in Table 6.4. Figure 6.26 graphically displays the sector boundaries. The limits of sector 5 were chosen to extend eastward to encompass the Los Ebanos Ferry, some 25 miles east of Reynosa, in order to not discount at this preliminary stage the possibility of a market for a bridge at Los Ebanos to serve the Central Valley transborder traffic. Table 6.5 shows the existing and proposed binational entry systems by sector.

Table 6.4 shows several sectors which, though located outside any economic activity center, were defined to provide a continuous division of the entire border into sectors. The predicted demand and/or revenue for any new binational entry system in sectors 1, 3, 7, 9, 11, 13, 14, 15, and 17 is very small for current conditions. Long-term predictions for these regions, very difficult to make at this point, must be based on a specific study that predicts land use, business and other socioeconomic developments in these areas, as well as on updated origin and destination patterns encompassing these areas under a post-NAFTA scenario.

CONCLUSIONS AND RECOMMENDATIONS

A sector is, by definition, the sphere of influence of an economic activity center where the potential demand for a new transportation artery falls within a certain interval whose extremes have no elasticity with respect to specific site location. Accordingly, the only way to strictly define the boundaries of a sector is by successively predicting the number of trips willing to divert to new facilities located further and further away from the sector's mid-point, until the predicted traffic falls outside the desired range of interest. In a transportation needs study, this range of interest does not require a detailed traffic diversion analysis that detects revenue changes of interest to a bond investor. While a more detailed traffic diversion analysis would refine the sector boundaries, such refinement is not needed at this point.

Table 6.4. Boundaries of Texas-Mexico border sectors

Sector	Eastern Boundary	Western Boundary	Economic Activity Center
1.	Gulf of Mexico	Palmito Hill Road	none
2.	Palmito Hill Road	Flor de Mayo Road	Brownsville- Harlingen - Matamoros
3.	Flor de Mayo Road	Extension of FM 491	none
4.	Extension of FM 491	Extension of FM 1423	Eastern Valley/Rio Bravo
5.	Extension of FM 1423	Extension of FM 886	Central Valley/Reynosa
6.	Extension of FM 886	Western city limits of Roma	Western Valley/Ordaz-Camargo-Aleman-Mier
7.	Western city limits of Roma	Eastern city limits of Laredo	none
8.	Eastern city limits of Laredo	Colombia Bridge	Laredo / Nuevo Laredo
9.	Colombia Bridge	Eastern city limits of Eagle Pass/Piedras Negras	none
10.	Eastern city limits of Eagle Pass	Western city limits of Eagle Pass	Eagle Pass / Piedras Negras
11.	Western city limits of Eagle Pass	Eastern city limits of Del Rio	none
12.	Eastern city limits of Del Rio	Western city limits of Del Rio	Del Rio /Ciudad Acuña
13.	Western city limits of Del Rio	East Boundary of Big Bend National Park	none
14.	Big Bend National Park East Boundary	Big Bend National Park West Boundary	none
15.	Big Bend National Park West Boundary	Eastern Boundary of Presidio	none
16.	Eastern city limits of Presidio	Western city limits of Presidio	Presidio/Ojinaga
17.	Western city limits of Presidio	Fabens Bridge	none
18.	Fabens Bridge	Texas/Chihuahua/New Mexico tri-state border	El Paso / Ciudad Juárez

Table 6.5. Existing and proposed binational entry systems by sector

Sector	Sector Name	Existing Binational Entry Systems	Proposed Binational Entry Systems
1.	Gulf of Mexico	None	None
2.	Brownsville/Matamoros	1.Gateway 2. B&M	1. Port of Brownsville 2. Los Tomates 3. Flor de Mayo
3.	Los Indios	1. Los Indios	None
4.	Eastern Valley/Rio Bravo	1. Progreso	1. Donna/Rio Bravo
5.	Central Valley/Reynosa	1. Hidalgo/Reynosa 2. Los Ebanos Ferry	1. Pharr/Reynosa 2. Anzalduas 3. Mission 4. Los Ebanos
6.	Western Valley	1. Rio Grande City/Camargo 2. Roma/Miguel Aleman	None
7.	Lake Falcon	1. Lake Falcon Dam	None
8.	Laredo/Nuevo Laredo	1. Laredo Bridge #1 2. Laredo Bridge #2 3. Colombia	1. Laredo Bridge #3
9.	Guerrero	None	None
10.	Eagle Pass /Piedras Negras	Eagle Pass /Piedras Negras #1	Eagle Pass/Piedras Negras #2a & #2b
11.	Quemado	None	None
12.	Del Rio/Ciudad Acuña	Del Rio /Ciudad Acuña	None
13.	La Linda	La Linda Bridge	None
14.	Big Bend National Park	1. Boquillas Ferry 2. Santa Elena Ferry	None
15.	Terlingua	None	None
16.	Presidio/Ojinaga	Presidio/Ojinaga	None
17.	Ft. Hancock/El Porvenir	Ft. Hancock/El Porvenir	None
18.	El Paso/Ciudad Juárez	1. Fabens 2. Ysleta 3. BOTA 4. GNB 5. PDN	1. Fabens Replacement 2. Socorro 3. BOTA Replacement

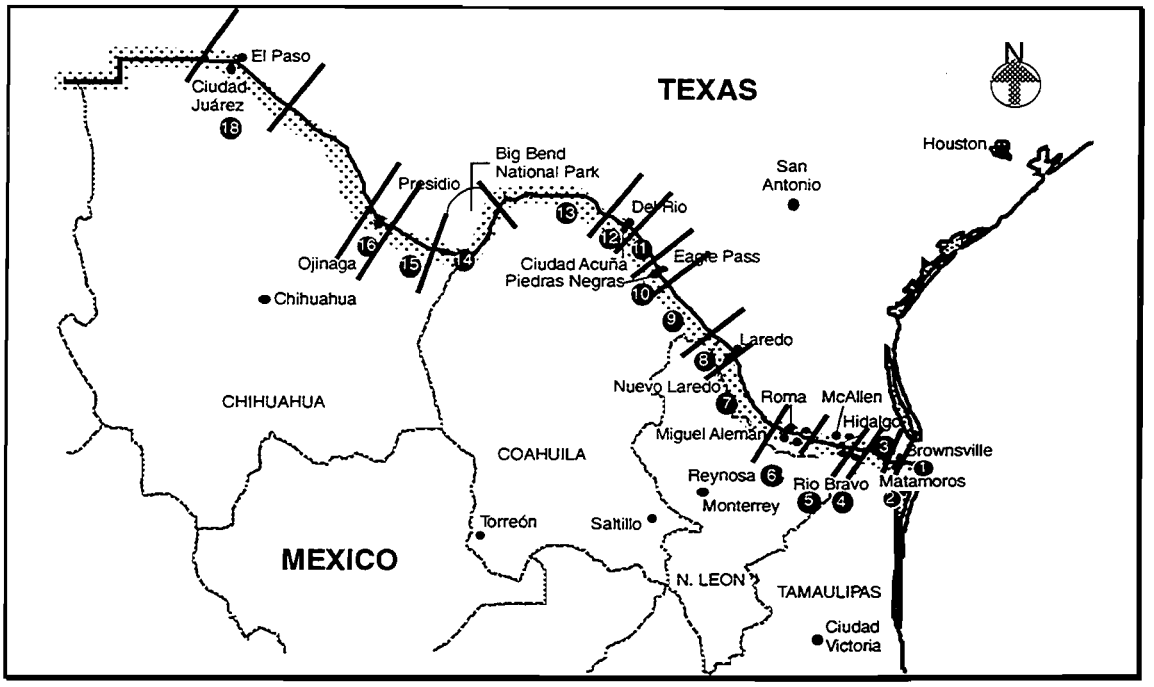


Figure 6.26. Sector boundaries

NAFTA is expected to generate changes in transborder commercial and auto traffic. In addition, the Intermodal Surface Transportation Act (ISTEA) may foster changes in border transportation modes, especially for commercial traffic. All these facts point toward the need for a dynamic approach, one based on the constant monitoring of economic activity and traffic over the entire border area.

CHAPTER 7. CONCLUSIONS AND RECOMMENDATIONS

This final chapter presents the conclusions and recommendations relating to the two report objectives: (1) a border-wide identification of major traffic patterns, and (2) an assessment of the impacts of the North American Free Trade Agreement on the Texas-Mexico border economy and maquiladora industry.

TRAFFIC FLOW PATTERNS

Transborder traffic origin and destination patterns are used to determine the prefeasibility of new toll bridges in border sectors. These transborder traffic flow patterns were identified using a combination of results obtained from previous surveys and from surveys conducted specifically for this study.

Methodology for Binational Origin and Destination Surveys

The border's binational environment precludes the use of pre-stamped mail-back survey forms. Because these forms must be bilingual, they are necessarily lengthy, a fact that discourages their completion and, consequently, provides poor response rates. On the other hand, direct interviews give a remarkably high response rate. Other findings: The binational environment requires bilingual surveyors, and bridges with ADT greater than about 7,000 require at least three surveyors per open lane. A crew coordinator acting as a support person (standing in a convenient position to cue surveyors as to which vehicles had already been interviewed further down the line) was found to greatly improve the efficiency of the survey and the sample size.

Shift length can also affect survey results. Exposed to inclement weather, exhaust fumes, and dangerous traffic conditions, canvassers cannot work effectively for long periods. The best survey results were obtained by CTR when a 6-hour shift was used; this is thus our recommended maximum shift length.

Traffic Patterns Identification

Auto data indicate that most bridges serve primarily local traffic between the sister cities on both sides of the border. When there are no sister cities, as in the case of the Progreso Bridge (located in a U.S. rural area), the traffic nonetheless comes primarily from nearby cities and towns. The trip purposes are 30 percent business and 70 percent non-business in almost all bridges, with the non-business trip purposes mostly shopping and recreational. Auto traffic is usually about 95 percent of total traffic. Truck traffic is never above 10 or 11 percent, even in areas that carry a significant percentage of the transborder truck traffic (e.g., Laredo). We thus conclude that the vehicular bridges at the Texas-Mexico border serve primarily social purposes, which must be considered in addition to the commodity flow between the two countries.

Truck traffic reflects primarily the activities of drayage companies specializing in hauling cargo from one commercial zone into another. This is required by current traffic regulations, which

will be lifted in 1997. It is thus recommended that the survey data be considered obsolete according to this time frame.

Two important survey findings were the low average auto occupancy (about two travelers per vehicle) and the high percentage of unloaded trucks (around 40 percent) using border bridges with frequencies of at least three or four times a week (often more than daily). This fact suggests that facilities are inefficiently used and that any measures that foster high auto occupancy and discourage unloaded trucks would greatly improve current traffic flows.

Recommendations

We recommend additional origin and destination surveys be undertaken to identify seasonal fluctuations in origin and destination pairs. Ideally, this study should be 1-year long, with the surveys repeated each season. The Laredo area should be included and given priority, as it currently has conflicting data that must be verified (in addition to its being very likely to be influenced by seasonal fluctuations).

ECONOMIC IMPACTS OF NAFTA

The report objective regarding NAFTA consisted of two parts: an assessment of NAFTA impacts on the maquiladora industry, and a macroeconomic analysis of NAFTA effects. The former was prepared by The University of Texas at El Paso's IM3 staff led by Gordon Cook, while the latter was prepared by The University of Texas at Austin's LBJ School of Public Affairs. The following summarizes the findings of these two assessments.

Maquiladora Industry

Maquiladora growth in Mexico is highly impacted by labor availability, turnover, wages, costs of drayage, and toll structure. Certain border cities are saturated in their ability to sustain additional growth of maquiladoras, while other cities can sustain additional growth for the next three to five years, or longer. More opportunities for maquiladora growth can be found in the interior of Mexico, particularly in such areas as Monterrey, the east coast of Mexico, Baja California, Sonora, and Cd. Chihuahua.

Projections show that the number of plants and employees are to double by 1997. This requires developing the infrastructure rapidly — that is, accelerating the privatization program in Mexico. Funding could be provided from foreign sources, such as the U.S. Moreover, as a consequence of NAFTA, transportation costs in Mexico are expected to decrease through competition and demand.

Macroeconomic Impacts

The economic benefits of NAFTA to both Mexico and Texas will strain capacity of the transportation corridors of Texas and Mexico. However, these gains will not be uniform across all regions of Texas and Mexico, nor across different sectors of the economy. The LBJ School of Public Affairs at The University of Texas at Austin has developed a model to estimate the increase

of Texas exports to Mexico as tariff barriers are reduced and as Mexican GDP grows. The predictions are disaggregated by economic activity sector. Exports such as electronics, computers, industrial machinery and transportation equipment are expected to grow under NAFTA, which means that transportation links from Dallas-Fort Worth and the Central Corridor should be improved in Texas. Also, oil and gas field equipment exports are expected to grow, thus prompting the need to improve transportation networks along the Gulf Coast. In addition, other regions across Texas need transportation improvements owing to the growth of different exports under NAFTA.

NEW CONCEPTS IN BINATIONAL ENTRY SYSTEMS

Current efforts to provide new binational entry systems are designed to meet needs that are strictly local; that is, their planning does not take into account the concerns of all agencies involved in border crossing procedures. In addition, the literature on demand and revenue forecasts of new binational bridge entry systems is restricted to methods for analyzing individual sites, and this cannot provide the type of information required for regional transportation planning. To meet the needs of regional planning, this project developed two concepts: the sector analysis and the super-crossing concepts. These complementary concepts address both local and long-haul traffic.

Sector Analysis Concept

The sector analysis was developed to provide answers to questions pertaining to regional transportation planning, as opposed to individual sites. It works in conjunction with trip assignment models, since it is technically unsound to predict traffic demand at a specific site without taking into account all other sites within a certain area that generates demand for the new site. The concept is also adequate to plan for local traffic, i.e., traffic generated and attracted by sister cities and their neighboring areas, because sectors are defined based on local demand, which accounts for 80 to 90 percent of the transborder traffic, and on traffic diversion areas, which are defined by the majority of the traffic.

Models that use data from random samples limit the sensitivity of a trip assignment model with respect to a certain area. We defined this area as "Sector," meaning the sphere of influence of an activity center where any transportation artery will have approximately the same range of traffic demand or revenue capability. The sector analysis is then intrinsically iterative, because the actual sector boundaries can be strictly determined only by successive runs of some trip assignment methodology that determines the demand for a new site within a certain area. However, in most transportation planning applications it is sufficient to define sector boundaries based on socioeconomic indicators, traffic history, and origin and destination patterns. The sector analysis concept is a convenient and technically efficient tool for analyzing most of the traffic across the Texas-Mexico border, which, as shown by the origin and destination data, is primarily of a local nature; as such it depends on the level of economic activity of nearby cities and towns, captured by the activity center concept.

The Texas-Mexico binational entry systems also serves an important flow of commodity and long-haul trips that can come from as far as away as northern Canada. Currently, these trips are a small percentage of the total, and as such they do not greatly affect the accuracy of demand estimates based on the sector analysis concept. On the other hand, because the long-haul bridge users represent a significant percentage of international trade, they are extremely important to national interests. The long-haul user needs and priorities are totally different from those of a local user going, for example, from the grocery store in El Paso, Texas, to his home in Cd. Juarez, Mexico. The former are concentrated in main corridors, while the latter are typically localized. The former measures his trip time in days, while the latter may worry about a 5-minute delay in the trip. Looking at the border from a regional perspective, it is clear that, while the needs of the local bridge user were being addressed by the traditional way of providing border bridges and can be better planned using the sector concept developed in this project, the needs of the long-haul trips have not yet been sufficiently addressed. NAFTA and ISTEA should remove foreign traffic restrictions and encourage intermodal facilities — developments that may create significant changes in commercial trips. From a technical transportation planning perspective, these innovations are highly desirable, as they will allow more efficient and faster transborder traffic flow. Super-crossings take advantage of these innovations.

Super-Crossings

Super-crossings represent a new binational entry system concept, one devised to take advantage of the aforementioned changes in the transborder commercial traffic patterns and modes, while at the same time taking into consideration the needs and concerns of the agencies that perform border crossing inspections on both sides of the border. In addition, a super-crossing would divert most commercial traffic outside the already congested urban and downtown areas of border cities, allowing for more efficient urban planning and creating conditions that foster more auto traffic between the sister cities. Multimodal facilities would provide economies of scale, and a super-crossing is essentially multi- and intermodal (i.e., it can accommodate rail and vehicular traffic as well as pipelines and pedestrian traffic). The basic characteristics of a super-crossing are:

(1) state-of-the-art inspection equipment,

(2) convenient location to serve heavy traffic,

(3) multimodality,

(4) availability of special lines for pre-cleared traffic, and

(5) possibility of further implementation of trucking technologies being developed under IHVS.

Currently, three ports of entry have potential market for a super-crossing, namely, El Paso with the Ysleta Bridge, Laredo with the Colombia Bridge, and Brownsville with the Los Indios Bridge. Because these bridges have several of the super-crossing characteristics already in place, additional investment could convert them into super-crossings.

According to the origin and destination data discussed in Chapter 5, local traffic accounts for about 90 percent of the transborder traffic demand. The sector analysis can provide indications of whether there is a need for additional infrastructure to serve local traffic. In some cases, this need can be addressed by implementing a super-crossing that would absorb the commercial and long-haul demand, thus improving traffic circulation at the other binational entry systems that serve the local demand, and in the sister cities urban areas next to these entry systems.

IMPLEMENTATION OF THE SECTOR CONCEPT

The sector analysis concept was implemented in this project; the first results, which are the determination of the sector boundaries, are discussed in Chapter 6 of this report. After identification the economic activity centers along the border, the southbound traffic at existing binational entry systems was assessed to further assist in verifying the economic activity centers, as well as to start the process of determining sector boundaries. The latter are further refined using existing transborder origin and destination patterns, which provide information on traffic diversion areas associated with sector boundaries. Some sectors identified in Chapter 6 (see Table 6.4) are located outside economic activity centers (these were defined to provide a continuous division of the entire border into sectors); the predicted demand and/or revenue for any new binational entry system in sectors 1, 3, 7, 9, 11, 13, 14, 15, and 17 is not significant for current conditions. Accurate long-term predictions for these regions are very difficult to make at this point; they must be based on a specific study that predicts land use, business and other socioeconomic developments in these areas, as well as updated origin and destination patterns encompassing these areas.

The sector analysis concept is iterative by definition, and sector boundaries defined based on the methodology used in Chapter 6 can be a starting point for a more detailed analysis. On the other hand, the changes in the preliminary boundaries as defined in Table 6.4 require extremely detailed analyses that are not part of the scope of a transportation needs study.

ADDITIONAL RECOMMENDATIONS

There are three potential areas the Texas Turnpike Authority (TTA) can pursue on the border (other than the construction of toll roads). Toll roads may be a possibility if much heavier loads were allowed, as is the norm in Mexico, where up to 130,000 pounds (59,020 kg) are allowed on certain types of trucks. However, the availability of the interstate system in El Paso and the South Texas region would seem to undermine the economic viability of toll roads. NAFTA will require harmonization of legal truck loads on public roads; this will probably create a market for private toll roads that accept higher load limits.

Joint ventures with local jurisdictions could also be pursued. The process for obtaining approval for new bridge facilities is tedious and expensive. Many smaller cities and counties with numerous unincorporated areas might be amenable to joint ventures with TTA to construct new bridges where traffic is increasing. New bridges do not have to have commercial port of entry facilities for trucks to be viable. Specifically, many new, smaller bridges could be constructed

between Brownsville and Laredo in the more rural areas. Construction of new bridges in the area would also be a spur to commercial development and job creation in an area of otherwise high unemployment.

As discussed in previous reports in this series, the construction of additional bridges over the Rio Grande is not always the best way to improve transborder traffic circulation. Construction of high-occupancy vehicle and mass transit facilities seems a more efficient solution in many cases. Urban area congestion, delays, and pollution associated with binational entry systems could be alleviated by increasing the availability of mass transportation between border communities, either through increasing occupancy or through buses and light rail. It is much easier to obtain permits to expand existing bridges than it is to obtain permits for new facilities. In communities like Brownsville, McAllen, Laredo, and some of the other smaller cities in the Lower Rio Grande Valley, adding lanes to existing bridges for mass transportation would seem to be viable both economically and from a policy viewpoint. TTA could enter into joint ventures with local governments, transit authorities, and with Mexican partners to construct, operate, and maintain international mass transit service. ISTEA strongly recommends mass transit, and federal funding for start-up costs and operating costs could be available from this source.

Because the Mexican railroad is severely undercapitalized, and given the expanding volume of U.S.-Mexico trade, binational rail bridges and facilities represent a significant opportunity. TTA, if it is legally allowed to do so, could act as a central agent for all the rail providers in negotiating with the Mexican rail service to move goods, particularly along the Monterrey-Fort Worth axis. As it presently stands, each of the railroads in the U.S. has their own lines and bridges. It would seem opportune to examine the feasibility of constructing new rail lines to better serve the developing intermodal facilities on both sides of the border.

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APPENDIX A:

GLOSSARY

GLOSSARY

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highways and Transportation Officials (Associación Americana de Representantes Estatales de Carreteras y Transportes)
ABI	Automated Broker Interface (Interface Automatizada de Agentes Aduanales)
ACR	Automatic Cumulative Recorders
ADT	Average Daily Traffic
Aduana Fronteriza	Mexican Customs
AFIS	Automated Fingerprint Identification System (Sistema Automatizado de Identificación de Huellas Digitales)
AMS	Automated Manifest System (Sistema Automatizado de Manifestos)
APHIS	Animal and Plant Health Inspection Service (Servicio de Inspección Sanitaria de Animales y Plantas)
ATR	Automatic Traffic Recorders (Estaciones Automatizadas de Aforo de Vehículos)
AVC	Automatic Vehicle Classification (Estaciones Automatizadas de Clasificación de Vehículos)
Binational Entry System	A system comprised by the boundary between two countries, and the border stations and inspection facilities in both countries (Sistema Binacional de Entrada).
Binational Bridge Entry System	A binational entry system where the two countries are linked by a bridge.
Binational Dam Entry System	A binational entry system where the two countries are linked by a dam.
Border Crossing	A binational entry system where the border is only an imaginary line (Cruze Fronterizo, Cruze Internacional).
BOTA	Bridge of the Americas, El Paso, Texas (Puente Cordova, Juarez,)
BRINSAP	Bridge Inventory, Inspection and Appraisal Program (Programa de inspección e Inventario de Puentes)

CAPUFE	Caminos y Puentes Federales de Ingresos y Servicios Conexos (Federal Toll Roads, Bridges and Related Services)
Caseta	Booth
Cd.	Ciudad (city)
CES	Centralized Inspection Station (Estación Centralizada de Inspección)
CET	Contraband Enforcement Team (Agentes de Control de Contrabando)
Chih.	Chihuahua
CILA	Comisión Internacional de Límites y Aguas (International Boundary and Water Commission)
CIS	Central Index System (Sistema Central de Información)
Coah.	Coahuila
CRA	Charles Rivers Associates
CTR	Center for Transportation Research (Centro para la Investigación del Transporte)
DBMS	Data Base Management System
DEA	Drug Enforcement Agency (Agencia de Control de Drogas)
DGF	Dirección General de Fronteras (General Office of Borders)
DOT	Department of Transportation (Departamento del Transporte)
DPF	Departamento de Puertos Fronterizos (Department of Border Ports)
DPS	Department of Public Safety (Departamento de Seguridad Publica)
Economic Activity Center	Areas with the same range of socioeconomic indicators such as population, retail sales, employment by industry, and maquiladora activity (Centros de Actividad Economica).
EOIR	Executive Office for Immigration Review (Oficina Ejecutiva de Inmigración)
EPA	Environmental Protection Agency (Agencia de Protección Ambiental)
ETZ	Extra-territorial Zone (Zona Extraterritorial)
FDA	Food and Drug Administration (Departamento de Alimentos y Drogas)
FHWA	Federal Highway Administration (Departamento de Carreteras Federales)

FIDENOR	Fideicomiso Para el Desarrollo del Norte del Estado de Nuevo León (The Development Trust of Northern Nuevo Leon)
FNM	Ferrocarriles Nacionales de Mexico (National Railroads of Mexico)
FWS	Fish and Wildlife Service (Departamento de Pesca y Vida Silvestre)
GAO	General Accounting Office (equivalente norteamericano a la Secretaría de Hacienda y Crédito Público)
Garita	Checkpoint
GATT	General Agreement on Tariffs and Trade (Acuerdo General de Tarifas y Comercio)
GIPSF	Grupo Intersecretarial de Puertos y Servicios Fronterizos (Inter-Departmental Group of Border Ports and Services)
GNB	Good Neighbor Bridge (Puente Reforma), El Paso, Texas
GSA	General Services Administration (Departamento de Servicios Generales)
IBWC	International Boundary and Water Commission (Comisión Internacional de Límites y Aguas)
I&C	Inspection and Control (Inspección y Control)
ICC	Interstate Commerce Commission (Comisión Interestatal de Comercio)
IM3	Institute for Manufacturing and Materials Management (Instituto de Manufactura y Administración de Materiales).
INEGI	Instituto Nacional de Geografía y Estadistica
Ing.	Ingeniero (Engineer)
INS	Immigration and Naturalization Service (Servicio de Inmigración y Naturalización)
ISTEA	Intermodal Surface Transportation Efficiency Act (Acta para la Eficientación del Transporte Intermodal Superficial)
K9	Trained dogs used at the border (Designación de los perros entrenados utilizados en la frontera)
LDF	Laredo Development Foundation (Fundación para el Desarrollo de Laredo)
Lic.	Licenciado (a college graduate in Law, Business Administration, Marketing, and other related areas)

LLTV	Low Light Level Television, a type of surveillance camera used by US border patrol. (televisón de bajo nivel de luz, un tipo de camera de vigilancia utilizada por la patrulla fronteriza de Estados Unidos)
MEX	Mexican Federal Highway (designación de las carreteras federales mexicanas).
NAFTA	North American Free Trade Agreement (Tratado de Libre Comercio)
NCIC	National Criminal Information Computer (computadora nacional de informacíon criminal).
N.L.	Nuevo León
O/D	Origin and Destination (Orígen y Destino)
PHS	Public Health Service (Servicio Público de Salud)
PDN	Paso Del Norte Bridge, El Paso, Texas
PDP	Project Development Plan (Plan de Desarrollo de Proyetos)
POE	Port of Entry: A place where the entry of people and goods is allowed from one country to the other after going through inspection agencies, such as customs, immigration, etc. A port of entry could be comprised of one or more binational entry systems under the jurisdiction of one port.
POV	Privately Owned Vehicle (vehículo particular)
Port of Entry (POE)	A place where the entry of people and goods is allowed from one country to the other after going through inspection agencies, such as customs, immigration, etc. A port of entry could be comprised of one or more binational entry systems under the jurisdiction of one port.
PPQ	Plant Protection and Quarantine (Protección y Quarentena de Plantas)
Presa	Dam
Puerto Fronterizo	The Mexican facilities of a binational entry system. This is not the Spanish equivalent of "port of entry."
SAAI	Sistema de Automatización Aduanero Integral (Integrated System of Customs Automation)
SARH	Secretaría de Agricultura y Recursos Hidráulicos (Department of Agriculture and Water Resources).
SCT	Secretaría de Comunicaciones y Transportes (Department of Communications and Transportation).

SDS	SAS data set
Sector	Sphere of influence of an economic activiy center where the potential demand (and revenue) of any new transportation artery falls within a certain range that has no elasticity with respect to the sector boundaries. (sector).
Sectur	Secretaría de Turismo (Department of Tourism)
SED	Shippers Export Declaration (Declaracíon de Exportación)
SEDESOL	Secretaría de Daesarrollo Social (Department of Social Development).
SG	Secretaría de Gobernación (Department of the Interior).
SH	State Highway (designacion de carreteras estatales en Texas)
SHCP	Secretaría de Hacienda y Crédito Público (Department of Treasury and Public Finance).
SP	Southern Pacific Railroad (Ferrocarril del Pacífico Sur)
SRE	Secretaría de Relaciones Exteriores (Department of Foreign Affairs).
Supercrossing	A multimodal binational entry system served by up-to-date equipment designed to efficiently handle commercial traffic, as well as to speed up the border crossing procedures for both commercial and non-commercial traffic (Cruze del futuro)
TAM.	Tamaulipas/Road in Tamaulipas
TAMP	Tamaulipas
TIB	Temporary Importation Under Bond (Importación Temporal con Depósito de Fianza)
TIP	Transportation Improvement Program (Programa de Mejoramiento del Transporte)
TLC	Tratado de Libre Comercio Norteamericano (NAFTA).
Trade Corridor	The area encompassing all possible existing and idealized commercial routes between two major commodity production and/or attraction areas.
Traffic Generating Areas	Same as Economic Activity Center
Transborder	(1) Movement of people and / or goods across the border, as in "transborder traffic," or (2) Database developed by the Center for Transportation Research

Transborder Activity Center	An Economic Activity Center encompassing both sides of the border
Transportation Corridor	The area encompassing existing and idealized routes between a major area of traffic production and a major area of traffic attraction.
TRC	Texas Railroad Commission (Comisión de Ferrocarriles de Texas)
TTA	Texas Turnpike Authority (Departamento de Infrestructura de Cuota de Texas)
TTI	Texas Transportation Institute (Instituto del Transporte de Texas)
TxDOT	Texas Department of Transportation (Departamento del Transporte de Texas)
UP	Union Pacific Railroad ("Union Pacific" Ferrocarril)
USCG	United States Coast Guard
USCS	United States Customs Service (Departamento de Aduanas)
USDA	United Stated Department of Agriculture (Departamento de Agricultura)
UTEP	University of Texas at El Paso
VS	Veterinary Service (Servicio Veterinario)
WIM	Weight in Motion
WSA	Wilbur Smith Associates

APPENDIX B:
QUESTIONNAIRES

O/D SURVEY Eagle Pass — Southbound Traffic

Date:_____

Time

6-7	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7

RECORD
Vehicle type (circle one)

AUTO

RECORD
Number of persons in the auto (including driver) 1 2 3 4 5 6 7 8+
(circle one)

ASK
In which U.S. city or town did you start your trip today?
¿En que ciudad de Estados Unidos comenzó usted su viaje?

Del Rio Eagle Pass
Comstock Loma Alta
Carta Valley Bracketville
Uvalde San Antonio
Laughlin San Angelo
(write city name or circle one)

Which Mexican city or town is your destination?
¿A que ciudad en Mexico se dirige?

Ciudad Acuña Sabinas
Piedras Negras Monclova
Jimenez Saltillo
Allende Monterrey
(write city name or circle one)

Is this a business trip? yes no
¿Es esto un viaje de trabajo o negocio?

TRUCK

RECORD
Number of axles: 2 3 4 5 6 7 8+
(circle one)

ASK
Where was the last U.S. city or town in which you picked up or dropped off cargo?
¿En que ciudad de Estados Unidos recogió o entregó usted su carga por última vez?

Del Rio Eagle Pass
Comstock Loma Alta
Carta Valley Bracketville
Uvalde San Antonio
Laughlin San Angelo
(write city name or circle one)

In which Mexican city or town will you make your first delivery or first pick up cargo?
¿Cual va ser la primer ciudad de Mexico donde entregará o recogerá usted su carga?

Ciudad Acuña Sabinas
Piedras Negras Monclova
Jimenez Saltillo
Allende Monterrey
(write city name or circle one)

ASK ALL

How often do you make this trip_____per day week month year
¿Quantas veces por dia o por semana o por mes.. realiza usted este viaje?

RECORD

License Plate: State_____ USA Mexico Other /Unknown
(circle one)

Exhibit B.1. Sample survey form used for Segment 2 bridges

O/D SURVEY Hidalgo/Reynosa - Southbound Traffic

Date:_____ Time_____

6-7	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7

RECORD

Vehicle type (circle one)

AUTO

Number of persons in the auto (including driver) 1 2 3 4 5 6 7 8+ (circle one)

ASK

In which U.S. city or town did you start your trip today?
off cargo?

_____

McAllen	Mission	Pharr
Edinburg	Hidalgo	San Juan
Alamo	Donna	Weslaco
Mercedes	Harlingen	La Feria
San Benito	Brownsville	

ASK

Which Mexican city or town is your destination?

_____

Reynosa	Rio Bravo	
Diaz Ordaz	Monterrey	
Matamoros	Valle Hermoso	
Camargo	Miguel Aleman	
Victoria	General Bravo	

ASK

What is the purpose of your trip? Work-Business Recreation School Shopping Other No Response (circle one)

ASK ALL

How often do you make this trip_____per day week month

check here if this is only time making trip

RECORD

License Plate: State _____ USA Mexico Other /Unknown (circle one)

TX _____

Tamp _____

TRUCK

Number of axles: 2 3 4 5 6 7 8+ (circle one)

ASK

Where was the last U.S. city or town in which you picked up or dropped

_____

McAllen	Mission	Pharr
Edinburg	Hidalgo	San Juan
Alamo	Donna	Weslaco
Mercedes	Harlingen	La Feria
San Benito	Brownsville	

ASK

In which Mexican city or town will you make your first delivery or first pick up of cargo?

_____

Reynosa	Rio Bravo	
Diaz Ordaz	Monterrey	
Matamoros	Valle Hermoso	
Camargo	Miguel Aleman	
Victoria	General Bravo	

Exhibit B.2. Sample survey form for Hidalgo Bridge

O/D SURVEY Gateway Bridge — Southbound TrafficCenter for Transportation Research
Date:_____ **U.T. Austin**

Time	6-7	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7

AUTO

Number of persons:	1	2	3	4	5	6	7	8+

TRUCK: Loaded / Empty / Tractor

Number of axles:	2	3	4	5	6	7	8+

From	Airport	Port	Manuf. Plant	Warehouse
To	Airport	Port	Manuf. Plant	Warehouse

ASK: Origin of Trip _____

Alamo	Bayview	Brownsville	Donna	Edinburg	Harlingen	Hidalgo
La Feria	Los Fresnos	McAllen	Mercedes	Mission	Pharr	Port Isabel
Progreso	Rangerville	Raymondville	San Benito	San Juan	South Padre	Weslaco

ASK: Destination of Trip _____

Anáhuac	El Rosario	Empalme	General Bravo	Las Flores	Matamoros	Monterrey
Nvo. Progreso	Reynosa	Rio Bravo	San Fernando	Tampico	Valle Hermoso	Victoria

ASK: What is the purpose of your trip? FROM TO

Work-Business	Recreation	School	Shopping	Doctor	Taxi	Other

ASK: Freq. of trips?	/day	/week	/month	/year	first time	

License Plate	TX	TAMPS	NL	Other State

Exhibit B.3. Sample survey form for Brownsville and Progreso Bridges