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16. Abstract

This report presents an analysis of the effects of highway bypasses on the business activities of a sample of small Texas cities. An initial explanatory analysis (using a before-and-after method, matched pairs, and projected development) did not reveal a significant relationship between highway bypass construction and a change in business volumes. It can be concluded that business volumes in the more rapidly growing cities with imperfect infrastructure and relatively high local traffic benefit from highway bypass construction. On the other hand, initial econometric modeling demonstrated that a highway bypass can have a statistically significant negative effect on business volumes in the small Texas cities that were studied. The results of the econometric modeling show that the way in which a business community responds to a highway bypass is complex. The major factor determining business volumes is the city's population.

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by

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Research Report 1247-1

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Economic Impact of Highway Bypasses and Loops

conducted for the

Texas Department of Transportation

in cooperation with the

U.S. Department of Transportation
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by the

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October 1992

IMPLEMENTATION STATEMENT

The econometric models developed for total retail sales, gasoline service station sales, and restaurant sales can be used as an economic forecasting tool. In the transportation planning process, these models would be useful in evaluating highway bypass alternatives. These econometric models contribute valuable economic insights to the study of highway bypass effects on a small city. These insights are critically important in evaluating the economic consequences of a highway bypass. For the community at large, these results can inform local citizens about the possible negative effects related to highway improvements and can help the community develop strategies for economic positioning that could counteract and even leverage the construction of a new highway facility.

DISCLAIMERS

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented within. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration or the Texas Department of Transportation (TxDOT). This report does not constitute a standard, a specification, or regulation.

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BIDDING, OR PERMIT PURPOSES

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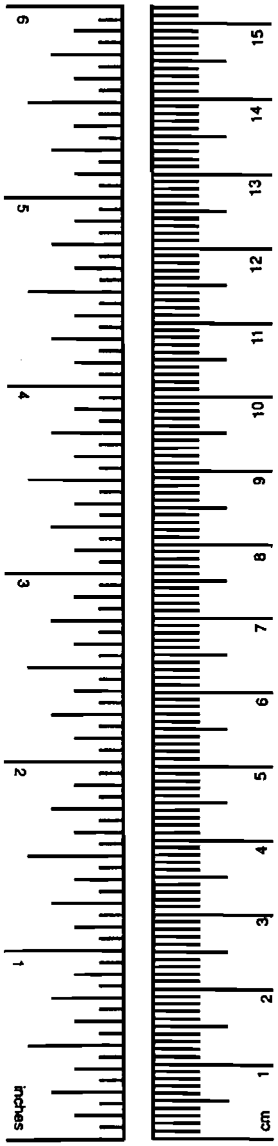
METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.54	centimeters	cm
ft	feet	0.3048	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.0929	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
mi^2	square miles	2.59	kilometers squared	km^2
ac	acres	0.395	hectares	ha
		MASS (weight)		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2,000 lb)	0.907	megagrams	Mg
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.0328	meters cubed	m^3
yd^3	cubic yards	0.0765	meters cubed	m^3

NOTE: Volumes greater than 1,000 L shall be shown in m^3.

Symbol	When You Know	Multiply by	To Find	Symbol
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
m^2	meters squared	1.20	square yards	yd^2
km^2	kilometers squared	0.39	square miles	mi^2
ha	hectares (10,000 m^2)	2.53	acres	ac
		MASS (weight)		
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1,000 kg)	1.103	short tons	T
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
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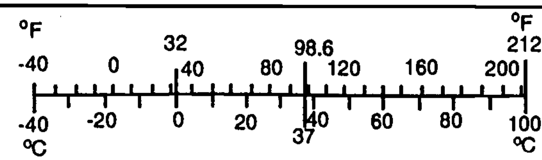
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



These factors conform to the requirement of FHWA Order 5190.1A.

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SUMMARY

This report presents several methodologies that were employed to explore the effects of highway bypasses on small cities in a rural setting. A data base was developed to conduct the analysis, containing pertinent variables for the purpose of the study. Initial exploratory analysis was preceded by the use of the projected development method to explore how business conditions react to a bypass. Econometric models were developed relating local business conditions to the characteristics of the city.

CHAPTER 1. INTRODUCTION

The problem of decreased service levels on major streets caused by growing through-traffic has been evident in many small cities for decades. The construction of highway bypasses around these cities has become a practical way to provide continuity of design (i.e., highway geometry and operating speed). This was a principal element that led to the construction of the interstate system.

During the past several decades, communities have feared that their local economies would be adversely affected by these highway bypass constructions. Business interests in the bypassed cities—concerned that the removal of through-traffic from major streets would undercut their sales and impair the economic health of their communities—have been vociferous in expressing their viewpoints. Protracted battles in public hearings and in court have been fought over the economic effects of highway bypass construction. These events have raised a number of questions: Does the economy of the bypassed city suffer from these new highways? What specific types of businesses are harmed, if any? What are the temporary economic effects and what are the long-term economic effects? For the community as a whole, what is the net effect of the highway bypass on economic activity?

REPORT OBJECTIVES

This report is designed to accomplish the following objectives:

(1) Explore and identify the primary economic effects of highway bypasses on business activities in small cities throughout Texas.
(2) Develop a procedure to estimate the economic effects of highway bypasses on local businesses at the city level, a procedure based on certain unique local conditions and factors.

The procedure for identifying economic effects will help transportation planners in evaluating bypass alternatives and assist highway personnel in their discussions with local officials and businesspersons.

STUDY METHOD

To begin this investigation, a working definition of a highway bypass is needed. For the purpose of this report, a highway bypass is that segment of a new highway that reroutes through-traffic around a central business district. The former route through the central business district is termed the bypassed route. Once the new segment of a highway that reroutes through-traffic around a central business district is linked with the bypassed route at the opposite side of the city, a bypass is formed. Of course, many bypasses do not conform to this idealized definition; consequently, additional criteria are needed to refine the working definition of a bypass. The following criteria are presented for consideration. A bypass is a new facility that provides improved service levels to through-traffic (i.e., traffic not destined for the bypassed city). It is not an existing facility that has been upgraded. More often than not, bypasses are built in proximity to both towns and cities. The interstate highway bypasses have been excluded from analysis in this report, since transportation planners and highway personnel are concerned mainly with the impact of planned and future bypasses rather than with the interstate highway system, which is virtually in place.

A literature review is presented in Chapter 2, which includes a discussion of the concepts, the methods, and previous findings related to the economic consequences of highway improvements in general and of highway bypasses in particular. The following questions are examined: Are transportation investments necessary for economic development? Do they provide an impetus for economic growth? Methodological approaches for the investigation of highway improvement impacts are reviewed. The review of the methodology includes the before-and-after method, the case study method, the survey and control area method, matched pairs analysis, projected development analysis, input-output analysis, and econometric models. The advantages and disadvantages of the various methods are discussed, and examples of recent applications are given.

Chapter 3 presents selected case studies of the effects of highway bypasses on business activities in small Texas cities. Site visits included interviews with businesspersons in Navasota, Grapeland, and Taylor. An inventory and categorization of highway bypasses in Texas is presented, based on a review of district highway traffic maps and county maps. In order to make a more detailed study, a sample of selected bypassed cities was constructed. The study method includes a comparison of the changes in the economies of the selected bypassed cities versus the changes in the economies of selected control cities with similar characteristics. A database was established to analyze statistical relationships between key economic variables, such as retail sales, and explanatory variables, such as highway characteristics. Highway-related businesses such as gas stations and restaurants were also studied.

Chapter 4 includes data validation and exploratory data analysis. Descriptive statistics are cited in order to compare bypassed and control cities as two independent groups of observations and as a set of paired observations. Selected methods include the before-and-after, the matched pairs, and the projected development analyses. The objective is to verify changes in business volumes vis-a-vis the highway bypass construction.

Econometric models are introduced in Chapter 5. In these models, an attempt is made to identify the economic effects of highway bypasses on business activities by examining both highway-related and non-highway-related factors. This chapter contains a detailed discussion of how the models were developed. The predictive accuracy of the best models is also tested using a "holdout" subsample, different from the data set used for calibration.

Finally, Chapter 6 includes a summary and a general discussion of the studies that have been undertaken. The conclusions and the recommendations derived from the studies include useful guidelines for transportation and economic planners involved in highway bypass studies.

CHAPTER 2. LITERATURE REVIEW

2.1 THE INFLUENCE OF TRANSPORTATION ON ECONOMIC DEVELOPMENT

Historically, transportation has been a vital component of almost every aspect of economic development. Transportation has made possible the extraction of resources, the specialization of industry, the commercialization of agriculture, and the rise of trade centers (Bell, 1990).

In the initial stages of economic growth, the construction of a modern transportation system can lead to a number of new economic opportunities. In the more advanced stages of economic growth, transportation is one of the many sectors into which productive investment may be channeled. The observed effects of initial transportation investments should not, however, be falsely projected as likely results of modern transportation (Drew, 1990).

Transportation investments may provide an impetus for business growth in manufacturing, service, wholesale, or retail sectors of the economy and may include the following:

(1) expanding existing businesses;
(2) attracting new businesses or labor to the corridor;
(3) deterring the growth of other businesses, especially those that depend on remoteness;
(4) reducing the cost of moving goods and raw materials, which may enhance the competitive position of existing businesses and thus encourage regional development and expansion;
(5) servicing interregional traffic flows, which can encourage the development of traffic-related businesses; and
(6) redistributing traffic patterns, which may depress economic development of areas whose traffic has been reduced.

The direct effects of transportation investment have indirect and induced effects on an economy, such as those occurring when new businesses hire more workers, who then spend money on consumer products and services. The resulting overall impact on business will be reflected in sales, income, employment, or other economic indicators (Perera, 1990).

Economic development has long been recognized as a rationale for transportation investment, but the nature of the relationship remains unclear (Hartgen et al, 1990). In fact, many studies have examined the relationship between transportation and economic development. However, the results of these studies are mixed.

A recent study by Lewis concluded that capital investment, including the development and maintenance of transportation infrastructure, offers one of the most effective known catalysts to improve productivity. Transportation investment can trigger technological innovation in private firms, with important economic gains that extend beyond those previously associated with infrastructure development. However, it must be recognized that all investment is not good investment. If one region grows at the expense of others without generating a net addition to the sum of all economic activity, there will be no contribution to economic growth and living standards for many will stagnate or decline (Lewis, 1991).

A summary analysis of the economic impact studies made in the 1970's and 1980's suggests that the evidence for economic growth through highway improvements is inconclusive. There is not conclusive evidence to support a statistical or causal relationship between regional economic growth and highway improvement. These economic impact studies generally concluded that many other local factors, besides highway improvements, significantly affect regional growth (Weisbrod, 1990).

However, the traditional view in the literature has been that the improvement of the transportation infrastructure is a necessary predecessor to economic development in a region, and some researchers have found that a significant relationship exists between highways and economic growth.

Expressway investments in northern England led to greater regional employment growth (Dodgson, 1974). In Connecticut, population and manufacturing employment increased more in towns close to the new turnpike than in towns that were further away (Gaegler et al, 1979). The effect of 65 nonmetropolitan interchanges on local economies in Kentucky was dramatic, even resulting in the creation of interchange villages on isolated vacant land (Moon, 1987). In Pennsylvania, it was determined that counties served by interstate highways had an advantage, with regard to both population and employment growth, over those counties not served by interstate highways. But the long-term effects of interstate highways, or their absence, were observed only in counties that were within 25 miles of a metropolitan area (Humphrey and Sell, 1975). At the state and local level, recent strategies for transportation planning have centered on the link between accessible transportation corridors and economic growth. Many states are developing and implementing corridor plans that upgrade selected highways to four-lane or interstate standards (Hartgen et al, 1990).

During the last decade, the traditional view of transportation and economic development has come under heavy criticism from a number of directions. It is generally acknowledged that there are few places in the United States where transportation infrastructure deficiencies strictly preclude economic activities (Sullivan, 1988). Empirical research in a number of countries provided a series of examples that called this traditional view into question. In particular, studies of transportation and economic development plans in the Soviet Union and China showed that transportation, rather than being a predecessor, could be concurrent with or a result of regional economic development. Similarly, research into the role of transportation in European and third world countries uncovered many instances in which the development of a transportation system for an underdeveloped region worsened rather than improved economic development differentials between the major cities and rural regions (Stephanedes, 1990).

Several studies have been unable to establish a positive relationship between economic development and transportation investments. Research conducted in the Atlantic region of Canada concluded that increased investment in transportation infrastructure and freight subsidies would attract few industries, due to the existence of a reasonably mature and properly maintained transportation system (Wilson et al, 1982). In a review of interstate system effects on minority communities, it was found that the presence of an interstate system did not attract new businesses (Steptoe and Thornton, 1986). Also, it has been shown that the effects of highway investment on an economy do not necessarily include the creation of long-term jobs, except in counties that already had a concentration of economic activity (Eagle and Stephanedes, 1986). Even more pessimistically, it has been claimed that the presence of an interstate highway system in and of itself does not ensure economic development. Briggs concluded that the interstate's role seems to have been to increase accessibility levels throughout the country (Briggs, 1981). In a study of transportation and economic growth for the Pacific Coast, it was concluded that most growth in the coastal area would come from small business starts and expansions in enterprises whose lack of proximity to major metropolitan markets could be tolerated, and that adequate transportation was important, but not the controlling factor, for future economic growth in the region (Sullivan, 1988).

Investing public funds in highway projects that are not efficient can actually reduce an area's economic development potential. An investment in transportation may reduce the transportation costs of various forms of economic activity, but it also requires a public expenditure. If the cost savings of a transportation investment do not exceed the expense of constructing and operating a highway, the highway and the increase in taxes and/or user charges that the highway entails may make the area less attractive to capital. Income redistribution is not always compatible with economic efficiency. Investing public funds in highways in declining regions to improve their economic development potential is unlikely to succeed because a political, economic, and social network has to be in place to attract capital of sufficient magnitude. The absence of these critical elements restricts what can be accomplished through transportation investments alone. It is also necessary to recognize that building or improving a particular stretch of road may reduce the benefits derived from existing highways (Forkenbrock et al, 1990).

To summarize, in a well-integrated economic system the effects of transportation improvements are complex and difficult to predict. The majority of the studies indicate that even though today's well-developed transportation system provides good accessibility, transportation improvements to that system no longer contribute significantly to economic development.

2.2 ECONOMIC EFFECTS OF HIGHWAY BYPASSES

Some road investments have been used to provide bypasses for towns, thus improving the flow of through-traffic. There are three important operational effects from highway bypasses:

(1) higher service levels for through-traffic,
(2) increased level of service and improved traffic safety on the bypassed route and local streets, and
(3) reduced or increased revenues for local business establishments.

A bypass makes it easier and more convenient for both local residents and intercity travelers. It also reduces noise and air pollution, and other deleterious effects of heavy-traffic. Importantly, higher service levels are not limited to the bypassed route. More parking spaces become available for local residents, and there may be shorter waits for service at businesses catering to motorists. For certain types of local businesses in communities that are congested from through-traffic, the rerouting of traffic may actually result in an increase of sales and income, since local residents may find it more convenient to shop downtown. The change in accessibility provided by bypasses will be felt by local businesses, but the change will not be felt equally by all establishments. Businesses that cater largely to the needs of transient motorists will be adversely affected if they remain near the old route. Businesses that service the needs of local residents may be relatively unharmed. Some businesses may even experience an increase in sales because of reduced congestion. For the community as a whole, the important issue is the net effect of the highway bypass on economic activity. Some individuals may gain and some may lose. However, bypasses can be justified because of the expectation that their net benefits to society as a whole outweigh their detrimental effects (Gamble and Davinroy, 1978).

The economic impact of a highway bypass can take many forms, such as a drop or an increase in retail sales, employment, personal income, and the population growth rate. Economic growth is perceived by the public as desirable insofar as it leads to greater employment, a greater selection of products and services, more cultural activity, higher income levels, a more vibrant atmosphere for private business investment, and greater public resources for investment in the local infrastructure. Usually, the economic impacts of highway bypasses have been measured by employment figures, retail sales, and personal income (McKain, 1965, and Weisbrod, 1990).

2.3 PREVIOUS STUDIES OF HIGHWAY BYPASS EFFECTS ON BUSINESS ACTIVITIES

Many highway bypass studies have explored the economic effects on small communities that were caused by rerouting a highway around the city to avoid conflicts and high traffic volumes in the central business or commercial district. A summary report by the Highway Research Board in 1966 analyzed the information on 70 previous highway bypass studies. This report tried, for example, to investigate whether retail sales were harmed by bypassing a city (Horwood et al, 1965).

The economic impact of highway bypasses seriously affected highway-oriented businesses (i.e., those providing fuel, food, and accommodations for travelers). To remain competitive, service stations and restaurants often successfully adjusted their merchandise and marketing to attract local trade. Although precluding economic loss in the long run, the realignment of a business is costly during the transition period. At any rate, service stations promoted tires, repairs, and parts, rather than gasoline. Restaurants switched to lunch and dinner, instead of emphasizing short orders. Motels and hotels, however, were unable to adjust as easily, and suffered the greatest losses. Valid results came from studies that included control areas in their analysis. It was found that even though bypassed cities of different sizes enjoyed gains in retail sales, there were, in fact, few or no economic effects from highway bypasses. Similarly, only about one-half of the losses for restaurants, reflected in the average change in sales, could be attributed to bypasses, because control area restaurants were also losing business during the study period. Although several variables acted as indicators of community economic conditions, their relationship to the bypass could not be established (Horwood et al, 1965).

Early studies indicated that cities with 5,000 or more inhabitants had a somewhat better chance of adjusting to the economic changes that the bypass produces. Greater benefits accrued to larger urban centers and to non-highway-oriented business sectors, presumably owing to decreased traffic volumes, greater pedestrian amenities in shopping areas, and an enlarged trade area. Small towns without a central business district may suffer substantially from a highway bypass (Horwood, 1965).

Based on a review of several Texas highway bypass studies, researchers found it very difficult to draw a relationship between highway bypass construction and changes in local business volumes. The non-traffic-oriented businesses had, in almost all cases, an increase in annual gross sales, while many traffic-serving businesses, such as service stations and motels, showed large decreases. The conclusion drawn from these bypass studies was that traffic-serving businesses seemed to be more affected by the highway facility than other businesses (Skorpa et al, 1974).

A study of 32 bypassed English cities, with bypass construction in the 1970's, identified the highway facility's effects on land use and town development. For the most part, the facility's effects were rather small. Land use changes occurred only when other more influential factors—land ownership, consumer demand, planning policies, and geographical features—were favorable. The largest bypass effect on land use and town development involved the location of new industry, which tended to locate near bypass access points, particularly if the bypass was part of a major national route. Warehousing companies, in particular, seemed attracted to new sites created near bypasses; but hotels, motels, and superstores were also attracted to such sites. Some small towns suffered a loss of trade, but generally the removal of through-traffic was seen as a benefit to shopping centers, with a subsequent increase in turnover and investment (Mackie, 1983).

Siccardi concluded that many factors influence the economy in a given area, too many to accurately determine statistically a specific highway effect. Although highway bypasses tend to cause a loss in business for traffic-oriented commercial properties such as restaurants and service stations, aggressive management practices by business owners in urban areas could rebuild turnover (Siccardi, 1986).

Limited definitive information is available in the literature on the effects of highway bypasses on business activities in small cities.

2.4 METHODS IN HIGHWAY IMPACT STUDIES

Traditionally, the before-and-after method and the case study analysis are most often used to study the effects of a new highway, although several researchers have used more sophisticated statistical approaches to determine the relationship between highway investment and economic development. These statistical analyses involve a survey and control area method, or are based on econometric models that relate a number of variables to changes in economic performance. Input-output models are one of the more frequently used methods for assessing the economic effects of transportation improvements. Projected development, or the interrupted time-series method, is documented in the literature, but is not used in highway impact studies.

These methods are described in more detail hereafter, along with their advantages and disadvantages. Also, examples of their recent use are given.

Before-and-After Method

The research design that has dominated highway impact studies is the before-and-after approach. In its simplest form, this design may be regarded as two snapshots, one preceding and the other following a transportation change. Observations are made, and the dependent variables are measured for the two periods assuming that other factors are constant; the differences of the values are considered to be the impact of the transportation change. However, it is clear that, over a long period of time, there will be many external influences affecting the variables being observed. In a simple before-and-after approach, an assumption is made that the change in a variable under observation is caused primarily by the transportation change. This assumption is violated when the observations are affected by influences other than those attributable to the transportation improvement under study (Drew, 1990).

The main advantage of the before-and-after approach is that it is simple to apply and easy to understand. The greatest disadvantage is that the method cannot relate the measured effect to any specific cause. The measured effect of the improvement will be equal regardless of the trends that preceded the implementation or modification of the highway facility (Skorpa et al, 1974). Most of the early highway bypass studies have used the before-and-after approach (Horwood et al, 1965; Whitehurst, 1965; Skorpa et al, 1974; and Mackie, 1983).

Case Studies

The case study approach deals with a rather detailed analysis of specific events. It is often combined with the before-and-after method. Detailed knowledge about the cause/effect relationship in a specific case may be obtained, but the findings cannot be directly generalized. The value of a case study lies in the opportunity for a detailed analysis, providing useful experience on which to base more general studies.

Opinion surveys can be seen as an extension of the case study approach. The opinion survey is a technique used to collect qualitative data to assess the depth of effects of transportation improvements. This method requires a carefully constructed questionnaire and interview instructions to avoid collecting biased data. Opinions do not normally form an accurate and objective arithmetical measurement of circumstances associated with highway construction.

The case study analysis has been used in many land use and land value studies. The case study approach has been used also in numerous studies dealing with highway improvements (Buffington, 1966) and transit improvements (Chui and Buffington, 1981).

Survey-and-Control-Area Method

The survey-and-control-area analysis is the method most commonly used to measure land value impacts. When used in combination with a study area-parallel band analysis, the survey and control area method is probably the most accurate technique for measuring impacts that are directly related to a transportation improvement. Studies have used this technique extensively in estimating the land value impacts of new radial freeways and interstate highway bypasses (McFarland, 1989).

Also, several studies have approached the problem of estimating highway effects by constructing control groups of areas lacking highway investments and comparing their economic conditions with those of areas receiving major highway investments (Forkenbrock et al, 1990).

Ideally, for the survey-and-control-area comparison, the procedure should follow the following scenario. An area near and similar to the highway facility is selected. This area should be far enough away from the highway facility to have remained unaffected by it. In theory, the two comparative areas should be exactly alike in all respects before the highway was built, and any differences between the areas since that time would be attributable to the influence of the highway. Making a valid comparison of the areas is difficult, since the researcher must decide which characteristics or factors should be approximately equal. This is, to a large extent, a matter of judgement.

The Connecticut Turnpike was constructed in 1958, primarily to stimulate development in eastern Connecticut, an area that had become economically depressed following the demise of the textile industry in the northeastern United States. The initial study of the turnpike's first five years concluded that the towns located close to the turnpike experienced faster economic growth than either the control towns or the towns located away from the turnpike (McKain, 1965). A second study focused on changes in employment, wages, population, retail sales, and property values. Using two groups of towns, that is, those towns within five miles of the highway and those towns more than five miles away, researchers confirmed the earlier finding—towns along the turnpike had performed better economically than towns further away from the turnpike. They also concluded that the benefits of the highway had spread throughout the area, that is, further than expected (Gaegler et al, 1979).

A study of the changes in manufacturing employment was conducted for 106 controlled-pair cities; some were on interstate highways, and others were not. It was found that intercity freeways stimulate manufacturing growth in regions where travel is impeded by congestion or topographic irregularities (Wheat, 1969).

An empirical examination was conducted on the relationships between freeway locations and migration and employment patterns for the years 1950 to 1975 in all U.S. metropolitan counties. Counties were classified into two groups: counties with freeways and counties without freeways. On average, counties with an interstate freeway experienced a higher rate of migration and employment growth. After controlling for other factors using regression models, it was found that the presence of a highway had only a weak to nonexistent economic effect in remote, underdeveloped rural areas (Briggs, 1981).

Survey-and-control-area approaches are criticized on several grounds. First, the selection of control and treatment groups is often difficult, and study results may be highly dependent upon the choice made. Second, many studies have used only a few variables to explain the differing growth rates of each group. Highways may be influential, but a number of other factors probably play a part in influencing growth rates, and these also should be taken into account. In practice, it is difficult to measure the presence of entrepreneurial activity and other phenomena related to local development. Finally, any relationship found by these studies is mainly one of association, not causation. One cannot be confident that highways lead to growth, rather than vice versa (Eagle and Stephanedes, 1987, and Forkenbrock et al, 1990).

Matched Pairs

A way, simultaneously, to increase confidence in study results and to possibly conduct studies less expensively was recently described by Hartgen

(1990) for transportation planning applications. The procedure, which is applicable to many problems in transportation, involves structuring the study as a comparison of matched pairs of observations, termed twins. Studies designed in this fashion are shown to have a much greater reliability at a much lower cost than similarly designed transportation studies. Twin studies are based on the principle of matched pairs of observations, which are monitored over time. Twins are actually a special case of a more general design in which observations in a sample are paired (correlated) both over time and across the design (doubly correlated) (Hartgen, 1990).

Projected Development

The projected development method attempts to estimate, based on past trends and data, what might have happened if the transportation improvement had not been made. This method attempts to control for the acceleration and deceleration in the variable under consideration. Since variables, such as business volumes, may change in any case regardless of highway improvements, the situation after the improvement cannot be directly compared to the situation before the improvement. It would then be reasonable to assert that the effect of the improvement is greater in cases where an existing downward trend is reversed than in cases where the trend is already upward, even though the measured net difference in the response variable is the same. To obtain a more meaningful estimate of the improvement impact, the situation after the highway improvement needs to be compared with a hypothetical projection of the before situation. Such a future projection can be based on time series data before the improvement. One caveat, of course, is that exogenous factors may be accelerating, reversing, or slowing the trend established before the improvement.

A conceptual impact model of a highway improvement measured by the projected development method is represented in Figure 2.1. The total improvement impact on a community over a time period measured by the projected development method is the area between the two curves. Different phases in the improvement planning and the implementation process may have different effects on the community response (Skorpa et al, 1974).

The principal elements of the projected development method are well documented (Holshouser, 1960, and Skorpa et al, 1974). However, no highway impact studies using the projected development method appear to have been published. A possible reason for this is that the researcher is handicapped in most cases by the lack of sufficient and appropriate data needed to perform a reliable projection.

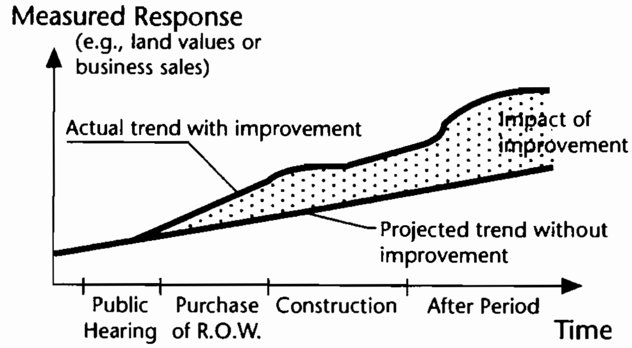


Figure 2.1 ***A conceptual impact model of a highway improvement measured by the projected development method***

Input - Output Analysis

Input-output (I-O), or inter-industry models, appeared in the 1930's with Leontieff's model of the American economy (Leontieff, 1936). Since then, the use of inter-industry analysis has become commonplace in the field of economics (Politano and Roadifer, 1989). Input-output analysis is now one of the most common approaches for assessing the secondary impacts of public sector development projects and programs (Drew, 1990).

Input-output models describe the interrelationships (or flows) of products and services between industries comprising the total economy (McFarland et al, 1989). In general, regional input-output models use an accounting framework called an input-output table, which shows the inputs purchased and the outputs sold for each industry. Direct requirement coefficients, which capture the input of goods and services required to produce a dollar of output, can be estimated from an I-O table. Direct requirement coefficients are the basis by which I-O multipliers are derived. I-O multipliers reflect the regional economic impact that would result from a change in the dollar output of a given industry. I-O tables have been constructed by surveying regional firms to determine their inputs and outputs (Beemiller, 1989).

Expenditures by highway agencies have secondary impacts on the economy, beyond providing new or better services. These impacts include employment, income, and production. Moreover, these secondary impacts are entirely traceable, that is, from the transportation sector to the other sectors of a regional economy. The methodology developed by Politano and Roadifer provides a useful extension of I-O analysis to the field of highway research. The methodology utilizes the input-output analysis to estimate the indirect and induced impacts of changes in user costs that are related to highway expenditure programs. Their REIMS model does the following:

(1) distributes the monetary investment among the relevant highway industries of the region;
(2) translates the efficiency, safety, and mobility improvements into equivalent monetary benefits;
(3) uses these investments and monetary benefits as inputs for the inter-industry multiplier matrices; and
(4) calculates the resulting impacts on the region's total economy (Politano and Roadifer, 1989).

In a national analysis, an interregional input-output model was developed to predict the impacts of hypothetical bridge construction projects in Japan (Amano and Fujita, 1970).

In Ontario, an input-output model was used to assess the initial, indirect, and induced economic impacts of 35 predefined typical road investment projects. This study focused on the economic impacts of highway construction expenditures, most notably on regional income and employment. A case study yielded a regional income multiplier of 1.82 (ratio of total impacts to initial, construction-only impacts) and an employment multiplier of 4.0. As noted, however, these estimates are gross, rather than net; they measure the appearance of change within the area adjacent to or near the highway improvement project, but not the less visible losses elsewhere (Allen et al, 1987).

A recent highway investment study used an input-output methodology to derive sector-specific economic multipliers. The Wisconsin DOT Highway 29/45 Corridor Study categorized the three basic sources of economic development resulting from a road investment. The three categories were expansion of existing firms, attraction of new firms, and an increase of tourist trade. And for each of these sources of development, direct effects (new business starts), indirect effects (business orders locally), and induced effects (employees spending their wages locally) were estimated (Weisbrod, 1990). However, these "economic development effects benefits" were added to the time savings of road travel, thus counting twice the benefits of the investment (Forkenbrock et al, 1990).

The real strength of input-output models is their ability to show the effects of changing transportation costs (e.g., through a highway investment) on the various sectors of an area's economy. However, the resultant "gains" are generally due to a change in the competitive strength of the affected area as measured against that of other areas of the country; they do not necessarily constitute new growth in itself. Input-output models have difficulty reflecting advances in technology. Most models are mathematical updates of past inter-industry purchase and sales volumes. That the input-output models are only mechanisms for gauging the size of economic impacts of highway bypass construction is a problem of great concern. The input-output models provide no real insight into why, for example, the lower transportation costs derived from highway investments lead to economic growth in the affected area. Because linear relationships are assumed, input-output models, typically, are ill-equipped to distinguish the effects of an upgraded highway on a small community versus the effects of an upgraded highway on a larger metropolitan area. The employment fluctuations that may occur, whereby smaller communities may actually lose jobs to larger communities as a result of the improved highway, are not reflected in the results of the input-output models (Forkenbrock et al, 1990).

The oversimplification of input coefficients and interregional trade flow coefficients has made the input-output models ineffective in expressing the feedback relationships between producers and the transportation system. Therefore, conventional I-O models may not accurately estimate the impacts of various highway investments (Drew, 1990).

Econometric Models

Econometric models provide an approach that attempts to isolate the economic impacts of highway construction by examining both highway-related and non-highway-related factors. The use of this approach is, of course, not limited to probing the economic effects of highway construction. The technique may also be used to analyze, in a more complete manner than the previous approaches, the complex cause-and-effect relationship between highway construction and a range of economic and demographic factors. Econometric models require more information about non-highway-related factors than other analysis techniques.

The dependent variable in the regression equation can be, for example, business volumes in the specific area to be studied, and the independent variables could include all of the relevant factors contributing to any part of the measured economic effect. In order to obtain a meaningful expression for the economic effect, researchers must represent quantitatively all of the factors included in the regression model. This creates difficulties when feasible proxies cannot be found for qualitative factors.

Econometric methods can be used to analyze data of two major types:

(1) Cross-sectional data, which consist of observations from different areas but for one point in time for each area.
(2) Time-series data, which consist of observations of the same area taken at different points in time.

Both methods, by definition, could exclude a large part of the available data from analysis. The cross-sectional method excludes any data collected over time, and the time-series method excludes data from all areas except the one under study. As a result, with either method, the analysis may not benefit from additional information, even when such information exists. Nevertheless, this limitation can be overcome by combining the two methods through the use of panel data, where data from different time periods and areas are pooled together.

A time-series approach was used to estimate the effect of highway investment on regions within New Brunswick, Canada, from 1951 to 1982. Predicted changes in regional per capita income were based on highway expenditures, but only a weak relationship was found (Wilson et al, 1985). A stepwise multivariate regression analysis was used to explain development patterns around rural interstate interchanges in Kentucky. Using as a measure of development the number and size of structures near the interchanges, a number of variables were found to be important in explaining development patterns. These variables included traffic volumes, distance to the nearest city, the amount of development before construction of the interchange, and the distance to the next interchange (Moon, 1987). In Georgia, a cross-sectional analysis was used with lagged variables to examine employment density and the presence of either interstate or county developmental highways. The results did not establish the existence of a statistical relationship between employment and either interstate or local developmental highways (Nelson, 1990).

In Minnesota, a time-series approach was used to investigate the relationship between state highway expenditures and changes in employment levels in 30 non-metropolitan counties for the years 1964 to 1982. Researchers found evidence of causality in that highway expenditures lead to temporary gains in jobs, with lasting increases only in counties close to metropolitan areas (Stephanedes and Eagle, 1986). Later, however, when grouping all 87 Minnesota counties, it was found that no overall relationship existed. For a subgroup of regional centers, highway expenditures did appear to lead to job growth (Eagle and Stephanedes, 1987).

An analysis of employment and income impacts derived from highway expenditures in Texas for specific highway improvements, such as bypasses, loops, and radials, was performed. Econometric models that were based on combined cross-sectional and time-series data showed statistically significant effects on employment and wages in the affected city or county. These impacts were derived from highway expenditures for bypass, loop, and radial improvements. The most influential independent variables in these models are the number of U.S. and state highways, the distance to a comparable-sized city or a larger city, the distance between the old and the new routes, and the population of the bypassed city (Buffington and Burke, 1989).

Econometric approaches have two general disadvantages. First, establishing causality between investment and development is still elusive. A statistical approach that determines the economic effects of highways will always raise questions about the meaning of causality. Do highways cause growth or vice versa? Even a time-series approach, like the one used by Eagle and Stephanedes, establishes only chronological time patterns: development came after road investment chronologically, but one cannot conclude that the investment caused the development. Moreover, road investments are typically announced with long lead times, that is, long before construction actually begins. Development patterns may be influenced not only during the investment period, but also during the planning stage of the highway (Straszheim, 1972; Eagle and Stephanedes, 1987; and Forkenbrock et al., 1990). Second, many econometric studies use only a few variables to explain growth; the process by which some areas grow faster than others is undoubtedly more complex than so simple an explanation (Forkenbrock, 1990).

It is important to underscore these econometric model limitations. Econometric model specification should be derived from the theory that a researcher has about the process. Econometric methods make sense only when used in connection with a theoretical framework, and thus are tools to test theories against actual observations.

2.5 CLOSURE

This chapter has included a discussion of the concepts, methods, and previous findings that govern the economic consequences of highway improvements in general and highway bypasses in particular.

Historically, transportation has been a vital component in almost every aspect of economic development. The majority of the recent studies indicate that today's transportation system provides good accessibility; improvements to that system no longer appear to contribute significantly to economic development. The literature on the effects of highway bypasses on business activities in small cities indicates that highway bypasses tend to cause a loss in activity to highway-oriented businesses.

Methods used in highway impact studies are described in detail. Also, examples of their recent applications are given. The case study method, the before-and-after method, matched pairs, projected development, and econometric models are selected for this report.

In Chapter 3, the case study method is used to provide first-hand experience with the economic impacts of highway bypasses in selected small cities. The before-and-after method, matched pairs, and the projected development approach are used to explore the database in Chapter 4. In Chapter 5, econometric models are developed in an attempt to isolate highway bypass effects by examining both highway-related and non-highway-related factors.

CHAPTER 3. DATA

This chapter focuses on several case studies of the effects of highway bypasses on business activities in small Texas cities. The selected case studies include documentation of the visits to selected sites and interviews with local businesspersons and community leaders. Highway bypasses in Texas are inventoried and categorized to identify those bypasses relevant to the report's objectives. In addition, a sample of bypasses and control cities is extracted, and the associated data collection procedure is described.

3.1 CASE STUDIES

The case studies in this section describe the effects of highway bypasses on business activities in small Texas cities. The case studies involve three cities with different population and economic characteristics—Navasota, Grapeland, and Taylor (Figure 3.1). These case studies provide experience on which more general studies can later be based.

The study methodology is as follows: first, a literature review of the published records of a selected city's history and economy is performed; second, changes over the last two decades in the number and the spatial distribution of highway-oriented businesses, which include service stations, restaurants, and motels, are traced by examining old telephone directories; and third, site visits including interviews with local businesspersons are conducted. The focus of these interviews is on the following topics: economic viability of the city, effect of the bypass on businesses, adjustment to the bypass, opinions regarding the desirability of the bypass, downtown improvement programs, land use changes, and traffic characteristics.

Navasota

Navasota is located in Grimes County in southeast Texas. Approximate mileage and directions from Navasota to major cities include the following: Austin (west), 115 miles; Bryan/College Station (north), 20 miles; Waco (north), 115 miles; and Houston (southeast), 70 miles. The distance to the nearest interstate intersection is 42 miles.

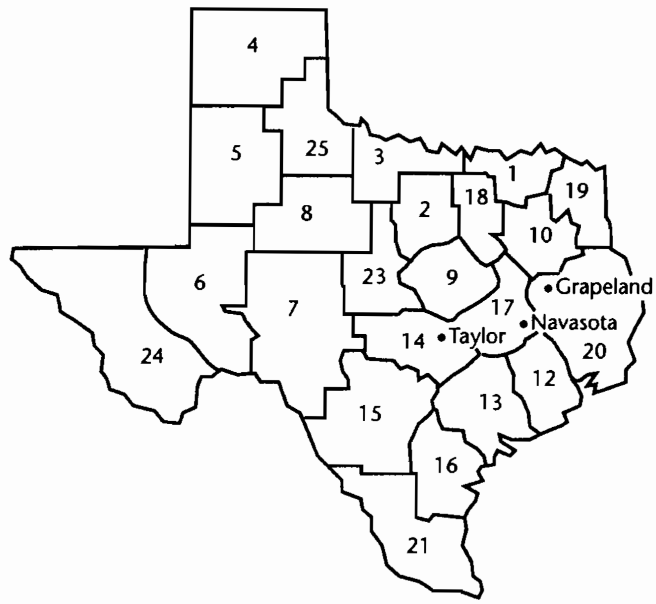


Figure 3.1 Small Texas cities selected for case studies

In 1972, a bypass was built for State Highway 6, which is the main north-south street (LaSalle Street) of Navasota. Washington Avenue, part of State Highway 105, is the most important business street in the east-west direction. In addition, Navasota is served by State Highway 90 (Figure 3.2). Currently, average daily traffic on the bypass varies between 7,400 and 13,000 vehicles, while the bypassed route has from 2,600 to 8,100 vehicles per day.

Navasota was settled in 1831 and established by the Texas legislature in 1866. There was fighting in Navasota during the Civil War, leading to partial destruction by fire in 1865. The railroad reached Navasota in 1860. In 1890, the city's population was 2,900. The first cottonseed oil mill in Texas was established in Navasota prior to 1880 (Texas Historical Association, 1952), and in September 1986 *Southern Living* wrote that cotton is what made Navasota prosperous. Later, the town almost went bankrupt when fields were abandoned because of a steep decline in cotton prices. The railroad revitalized the town, but then railroad transportation slowly died out. By 1970, the population of Grimes County had dropped to 12,000 from a high of 26,000 in 1900.

Southern Living wrote in its September 1986 edition that Navasota has been one of only 30 cities participating in the National Main Street Revitalization Project. There are more than 40 restored Victorian homes in the heart of the town, and 75 buildings in the main district are

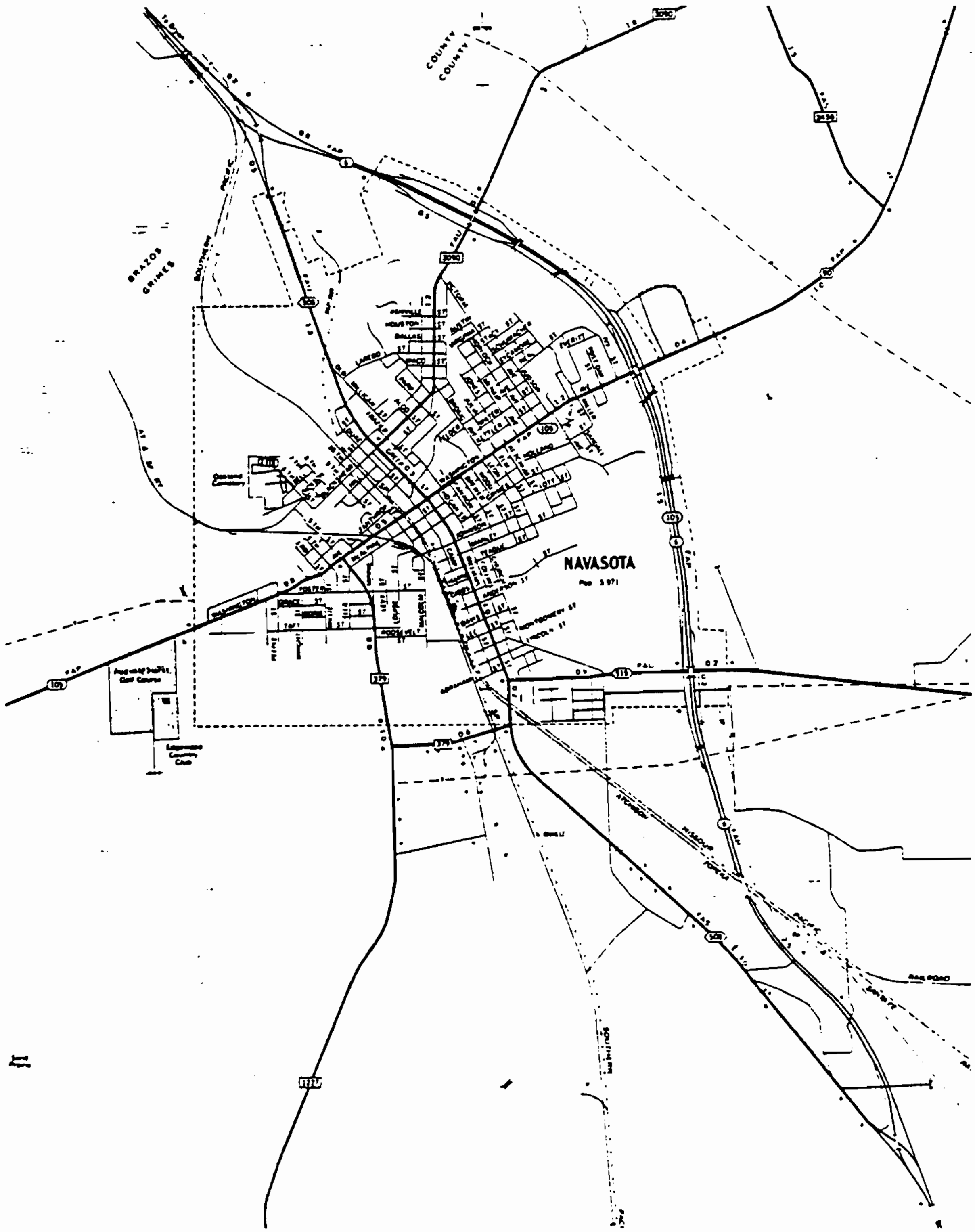


Figure 3.2 City map of Navasota

listed as historically or architecturally significant. Many of the homes have been designated as historic landmarks because of their association with the cotton and railroad industries. *Texas Monthly* chose Navasota as one of the state's top five small towns in 1980. An article in the *Fort-Worth Star-Telegram* on June 5, 1988, stated that two prison units, holding 2,350 prisoners, were built a few miles south of the city in 1980. Mayor Hugh Robinson said that the prisons were an economic lifesaver. The prisons are the largest employer in the area, providing 611 jobs.

Today, Navasota is an agricultural center for parts of three counties, and has varied manufacturing industries: food and wood processing. Grimes is the northernmost county of the Gulf Coast Region, where oil, gas, and petrochemical industries are dominant (*Texas Almanac 1990-1991*, 1989).

Population trends in Navasota and Grimes County over the past 50 years are illustrated in Table 3.1. Both Navasota and Grimes County have experienced first a decrease and then an increase in population. Navasota has increased its population continuously from 1960.

Table 3.1 ***Population in Navasota and Grimes County 1940 to 1990***

Year	Navasota	Grimes County	Percentage; Navasota of Grimes County
1940	6,138	21,960	27.9
1950	5,188	15,135	34.2
1960	4,937	12,709	38.8
1970	5,111	11,855	43.1
1980	5,971	13,580	43.9
1990	6,296	18,828	33.4

The graph in Figure 3.3 describes the number and changes in spatial distribution of highway-oriented businesses, which include service stations, restaurants, and motels, from 1965 to 1989. Highway-oriented businesses are divided into four groups:

(1) businesses along the old bypassed route,
(2) businesses along the bypass,
(3) businesses along the major perpendicular arterial, and
(4) businesses along other streets.

The number of service stations has decreased more than 50 percent in Navasota in the last 20 years, reflecting declining trends nationally. In 1971, service stations were concentrated along the main north-south route, LaSalle Street, which had 15 of the city's 21 service stations. Today, only 4 of a total of 9 service stations in Navasota are on LaSalle Street. At the same time, East Washington Avenue has seen an increase in its number of service stations from 3 to 4. On the other hand, the number of restaurants in Navasota increased from 7 in 1971 to 12 in 1989. It should be noted that only one of the restaurants that existed in the city in 1971 is still open. The bypass route now has 3 restaurants, the first of which was opened in 1981. In 1971, Navasota was served by only one motel; today it has 4. Three of the motels are located on the bypass, with the first opening in 1981.

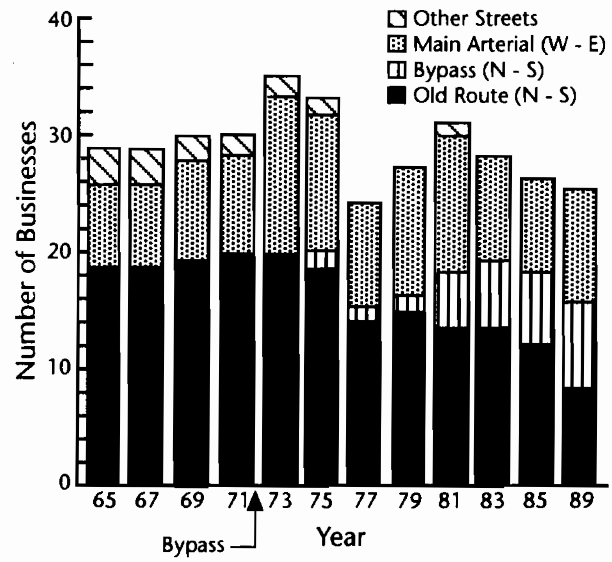


Figure 3.3 ***Number and changes in spatial distribution of highway-oriented businesses in Navasota from 1965 to 1989***

Interviews and Site Visit

The following paragraphs are a summary of the discussions on July 22, 1991, at the Grimes County Chamber of Commerce with Executive Vice-President Jane Miller and local businessmen Bill Miller and Elliot Goodwin.

Business in Navasota was based on agriculture up until the 1960's. As cotton lost its importance, the city had to look for new economic opportunities. Fortunately, Navasota has been able to create or attract new businesses, and today it has a strong economic base, whereas the rest of Grimes County is still heavily dependent on agriculture. Today, Navasota has 16 industries, many of which are located in the Industrial Park. Navasota's most important industrial products include steel products, vessel heads, and mobile homes. Two prison units, located 5 miles south of the city, employ more than 600 persons, many of them from Navasota. Despite the overall health of the Navasota economy, after nearby College Station opened a mall (20 miles from Navasota), Navasota did lose some local trade.

Businesses in Navasota can now be reached more easily. Today, there are about 10 establishments located along the bypass. Most of these are highway-oriented businesses, though other types of businesses are also located there, presumably because they could not find suitable sites in the downtown area. Frontage roads on the bypass have apparently assisted businesses. Downtown businesses experienced the effect of changed traffic patterns for a while, but many were, subsequently, able to refocus their businesses. The national discount house, Wal-Mart, located a store on the bypass in 1980. At first, the store negatively affected downtown businesses, though these seem to have later recovered. The 2 busy motels have been located along the bypass since the early 1980's. The lone motel on the bypassed route has survived by serving a different type of clientele from that which it previously served. The main reason for the decrease in the number of service stations is apparently not the bypass. According to the residents interviewed, it is the new state requirements for underground storage tanks. The total effect of the bypass was said to be "80 percent positive."

The Navasota Chamber of Commerce viewed the bypass both as a challenge and as an opportunity for the future, which led to the start of a campaign to recruit new businesses to Navasota. Several businesses along the bypassed route recovered by changing their market to serve more local trade or tourism. For example, the number of antique shops, typical for small historic cities, has increased from 1 to 20.

Public opinion in Navasota towards the bypass was mainly favorable, even prior to construction. There were no significant opposition groups. Community leaders were generally in favor, though 2 out of 3 members of the Bypass Committee were against in order to slow down the planning process. It was also recommended initially that the bypass be built on the other side of the city. Local government started to support the bypass aggressively during the later stages of the planning process. Community leaders realized that the bypass would improve the road system of the area for travel to the south (Houston) and to the north (Bryan/College Station). Thus, the quality of life of the city would be improved for businesses and local citizens. General opinion in Navasota held that the city was big enough to experience the bypass positively.

Recently, Navasota has successfully completed a three-year downtown improvement program as part of the National Main Street Revitalization Project, and is currently pursuing community development that will further assist its tourism industry. Many of the old downtown buildings have been renovated in recent years, which persuaded new businesses to locate in that historic part of the city. Festivals, articles in journals such as *Southern Living* and *Texas Highways,* and tourist attractions such as Victorian houses all played a part in drawing people back to the downtown area. The Chamber of Commerce also suggested that more advertisements be placed along the bypass to stimulate tourism and business in general.

Navasota has grown toward the bypass during the last 15 years, and the intersection of the bypass and State Highway 105 is now the busiest area for businesses. Some new developments have emerged along State Highway 105 on the west side. Land values have remained unaffected in Navasota, with the exception of the properties near the bypass. The city has extended its limits beyond the bypass.

In 1972, Navasota was the first bypassed city on the proposed Central Texas Expressway from Houston to Waco. Navasota was in favor of the bypass, and it even passed a bond to purchase the necessary right-of-way. Before 1972, the intersection of LaSalle Street and Washington Avenue was a bottleneck, especially during special events such as football games. In addition, heavy vehicles caused capacity, safety, and noise problems on the major streets. The bypass made traffic flow much easier in the downtown area. Today, local people tend not to use the bypass for their trips within the city.

Grapeland

Grapeland is a small city in eastern Texas situated in Houston County, 130 miles north of the Houston Metropolitan Area and 135 miles southeast of the Dallas-Forth Worth metroplex. Tyler is 70 miles north of Grapeland. The distance to the nearest interstate highway intersection is 47 miles.

Grapeland is served by one major highway, U.S. Highway 287, which is a north-south facility connecting Grapeland with Beaumont to the south and Wichita Falls to the north. A highway bypass was built in 1976. The former U.S. Highway 287 (Main Street) has remained an important business route (Figure 3.4). Traffic volumes on the Grapeland bypass are now about 3,000 vehicles daily, and on the bypassed route, traffic volumes are between 1,500 and 3,100 vehicles daily.

Grapeland was established in 1872, when the rail line was built through Houston County. The city was named for the prospective orchards and vineyards planned by its developers. Its population reached 200 by 1880. In the 1940's, Grapeland's economy was based on oil refineries and recycling plants as well as canning plants, cheese plants, and chamber mills (Texas Historical Association, 1952).

Today, the economy in Houston County is based on livestock, timber, manufacturing, and tourism. Grapeland is located in the East Texas Region. The economy of the region is built on its natural resources, such as timber, oil, gas, coal, and water (*Texas Almanac 1990-1991*, 1989).

Grapeland has experienced fluctuation in population as illustrated in Table 3.2.

Figure 3.5 shows the number and changes in spatial distribution of highway-oriented businesses, defined previously in the Navasota discussion. In Grapeland, the number of highway-oriented businesses has fluctuated. The bypass appears to have been responsible for some of the new businesses.

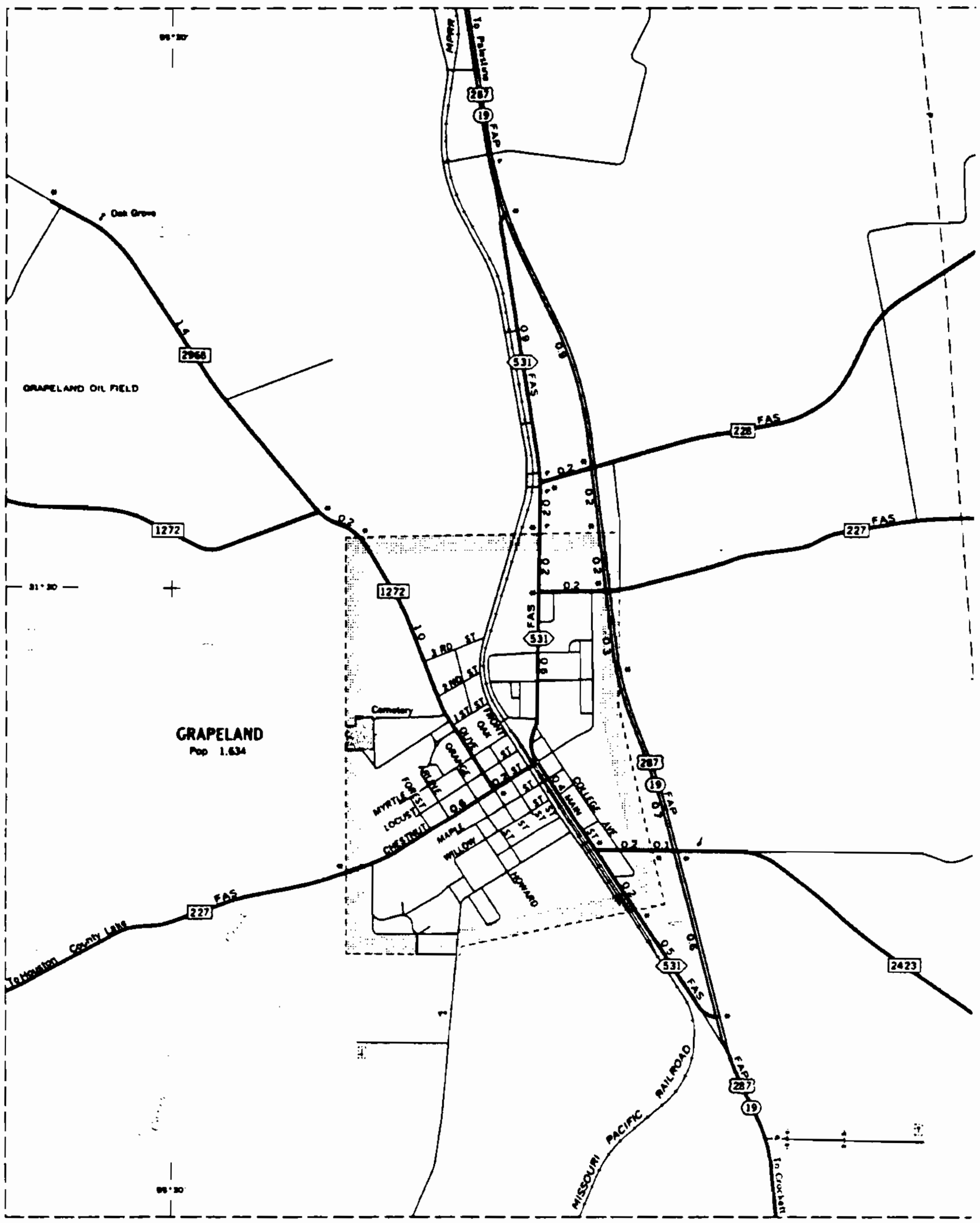


Figure 3.4 City map of Grapeland

Table 3.2 Population in Grapeland and Houston County from 1940 to 1990

Year	Grapeland	Houston County	Percentage; Grapeland of Houston County
1940	1,327	31,137	4.2
1950	1,358	22,825	5.9
1960	1,113	19,376	5.7
1970	1,211	17,850	6.7
1980	1,634	22,299	7.3
1990	1,450	21,375	6.7

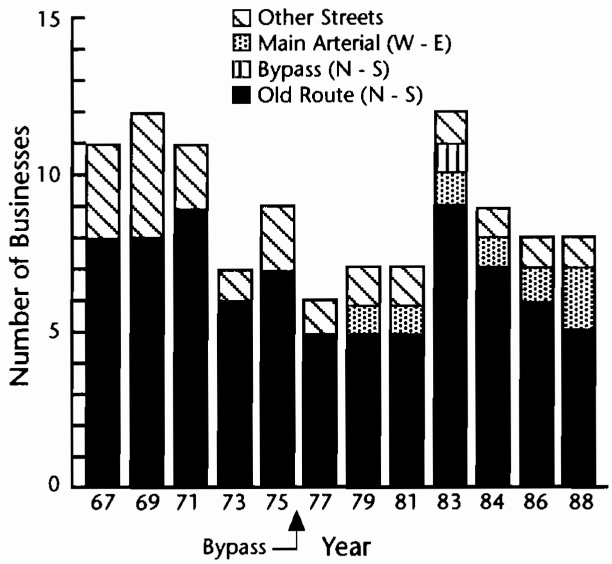


Figure 3.5 ***Number and changes in spatial distribution of highway-oriented businesses in Grapeland from 1967 to 1988***

Interview and Site Visit

On July 29, 1991, the Community Council Members were interviewed about their city's history and economy. A summary of that discussion follows.

Grapeland is a business center for agricultural northern Houston County, where activity has shifted from farming to cattle raising over the past three decades. A steel plant is the biggest employer in Grapeland, providing almost 200 jobs. Today, the city has more businesses than 20 years ago; however, there is apparently no connection between the bypass and this economic growth. Many Grapeland citizens shop nearby, in a larger city, Crockett, 12 miles to the south. The city has no major tourist attractions, but many people from the Houston Metropolitan Area occasionally like to spend a peaceful weekend in Grapeland or maintain a vacation home there, making city streets busier.

The bypass split traffic on U.S. Highway 287 between the old and the new route. This resulted, on the whole, in low traffic volumes that appear to be insufficient to support highway-oriented businesses along either route. Today, there are fewer service stations and convenience stores in Grapeland than in the 1970's. None of the businesses from the pre-bypass period have survived. The bypass did not affect the motel on the bypassed route, because of loyalty by local customers.

Along the bypass, there are 7 establishments: a service station, a restaurant, an automobile dealer, a car wash, a furniture dealer, an antique shop, and a glass shop. Some downtown businesses have set up billboards along the highway outside the city to advertise their businesses to incoming traffic.

Only service station and restaurant owners opposed the highway bypass plan. The State Highway Department proposed 3 alternatives, and the city chose a bypass route just outside the city limits. The city thus managed to avoid the expenditure of having to purchase the right-of-way for the bypass, as well as the negative economic effects of having to widen the existing business route to a four-lane 55-miles-per-hour highway. Opinions regarding the desirability of the bypass stayed generally favorable, as they were before the bypass opened.

So far, no particular downtown improvement programs have been carried out. Annual events of Grapeland include the Bluegrass and Peanut Festivals, which attract up to 5,000 people.

The bypass is located, mainly, outside city limits. The city's area has been about one square mile for quite a long period. Recently, houses have been built just outside the city limits.

The Grapeland bypass was part of the project to upgrade U.S. Highway 287 to four lanes in Houston County. In the mid-1970's, moderate traffic volumes did not cause either serious traffic congestion or safety problems. Although traffic safety was not a critical issue, people now feel safer shopping in the downtown area.

Taylor

Taylor is located in the middle of Texas, 35 miles northeast of Austin. The distance to the nearest interstate highway intersection is 17 miles at Round Rock, where U.S. Highway 79 starts. Highway 79 runs through Taylor and on to Shreveport, Louisiana. Taylor is also served in the south-north direction by State Highway 95, which is Taylor's most important business street, also called Main Street. The bypass for U.S. Highway 79 was opened in 1974 (Figure 3.6). Average daily traffic on the bypass varies now from 3,200 to 3,800 vehicles, and on the bypassed route, traffic volumes are between 5,500 and 7,800 vehicles per day.

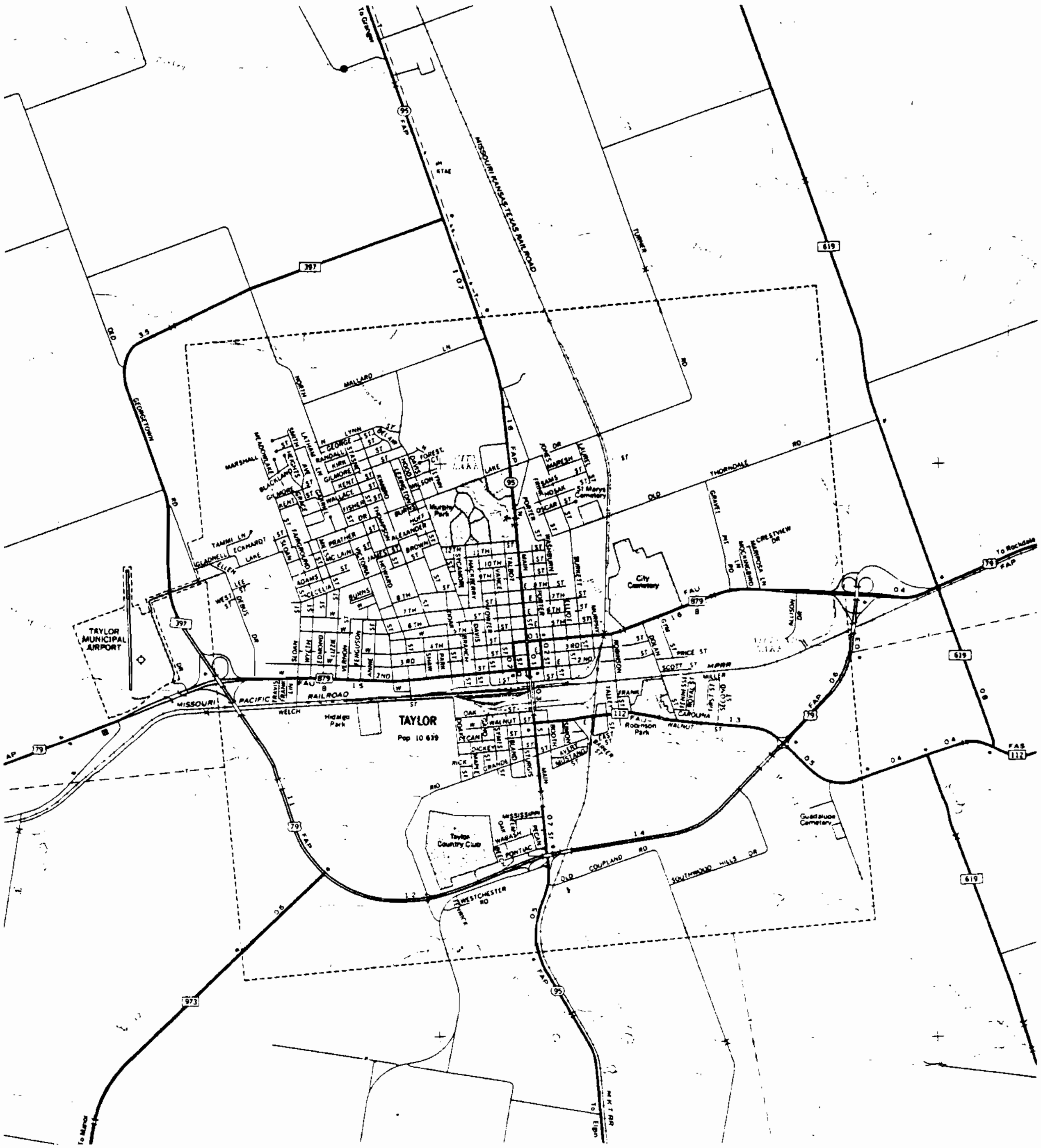


Figure 3.6 City map of Taylor

Taylor was laid out at the junction of railroads in 1876. During its early life, Taylor was dependent upon the railroads, being both a division point and a repair center. Its population was 4,200 in 1900, an indication of the city's rapid growth. Since 1900, Taylor has maintained a slow but steady growth (Texas Historical Association, 1952). *East Texas* magazine wrote in September 1939 that Taylor was known as the "World's greatest inland cotton market."

Southwest Airline magazine wrote in 1984 that Taylor has not experienced the Houston-like booms of nearby Georgetown and Round Rock (Hamilton, 1984). The *Fort-Worth Star-Telegram* reported on July 24, 1983, that downtown Taylor was not the bustling retail center that it had once been, many buildings being vacant. Low-interest renovation loans were made available to restore old buildings in the hope of bringing Main Street back to life. Most residents did their shopping on the strip north of town where a discount store and several smaller shops located.

Taylor's main industries include the manufacturing of picture frames and furniture as well as cottonseed and meat processing. Manufacturing, agribusiness (sorghum, wheat, corn, wheat, and cattle), and education are the main economic factors in Williamson County, which is part of the Austin Metropolitan Area. Williamson County is in the Central Corridor Region, which has long been the site of both federal and state government and higher education. More recently, high-tech manufacturing and services have grown more important to the central corridor economy (*Texas Almanac 1990-1991*, 1989).

During the last two decades, the increase in population has been tremendous in Williamson county, but Taylor has only experienced relatively slow growth (Table 3.3).

Table 3.3 ***Population in Taylor and Williamson County from 1940 to 1990***

Year	Taylor	Williamson County	Percentage; Taylor of Williamson County
1940	7,875	41,698	18.8
1950	9,071	38,853	23.3
1960	9,434	35,044	26.9
1970	9,616	37,310	25.7
1980	10,619	76,521	13.8
1990	11,472	139,551	8.2

West 2nd Street and East 4th Street used to form U.S. Highway 79 through the downtown of Taylor, and that route is still the most important east-west street. Main Street (State Highway 95) is a business street laid out in the north-south direction. Figure 3.7 describes changes in the spatial distribution of highway-oriented businesses in Taylor from 1965 to 1989. A distinct displacement has occurred from the bypassed route to North Main Street. There are no business establishments on the bypass at present.

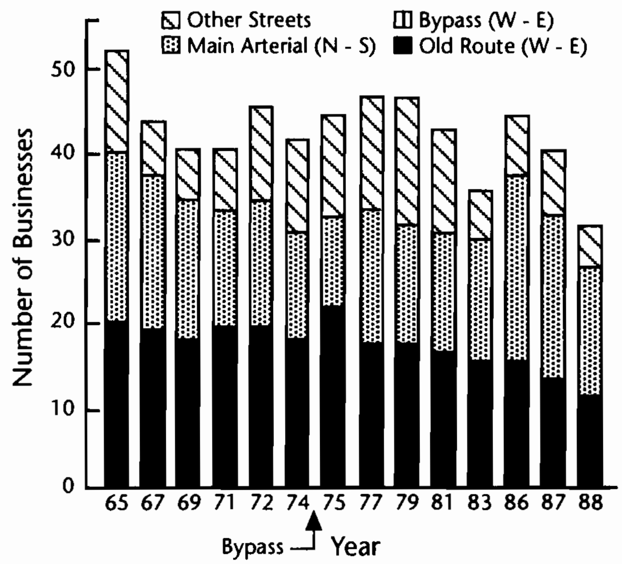


Figure 3.7 ***Number and changes in spatial distribution of highway-oriented businesses in Taylor 1965-1989***

Because of the bypass and general declining trends nationally, the number of service stations has decreased in Taylor by one-half relative to the situation immediately preceding the construction of the bypass. The most dramatic decrease of service stations has been on the bypassed route, West 2nd Street - East 4th Street. The number of restaurants has been fluctuating between 15 and 26 over the past 25 years. At the same time, there has been a shift in the location of these establishments from the bypassed route to the North Main Street area. The number of motels has been very stable in Taylor during the last 20 years, varying from 4 to 5.

Interview and Site Visit

The following summary is based on discussions held August 8, 1991, at the Taylor Chamber of Commerce with Executive Vice-President Wayne Mackley and local businesspersons.

Taylor is an agricultural and industrial center in eastern Williamson County. With their city located in the Austin Metropolitan Area, residents of Taylor tend to do their shopping in nearby cities. Taylor is also dependent, to some extent, on the overall economic vitality of the metropolitan area. Taylor has been able to maintain steady but slow growth, except when the recession struck 5 years ago. Picture frame manufacturer Intercraft Industry Inc., the world's market leader, has the largest payroll in Taylor, with 600 employees.

Taylor's businesses have never been dependent on through-traffic of U.S. Highway 79. Therefore, for highway-oriented businesses, losses have been insignificant after the 1974 construction of the bypass. Business closures were not related to the bypass. A motel was built at the junction of the old and new routes some years after the opening of the bypass. The location of a Wal-Mart discount store on the north side of the city probably hurt downtown businesses much more seriously than the bypass. The store attracted a lot of traffic as well.

There are currently no businesses on the bypass, because of its far-away location and imperfect utilities. Traditionally, only a few businesses have located on the south side of the city.

People in Taylor favored the bypass, believing the highway construction project was in the interest of the city's welfare. Driving would be easier because of the bypass.

About 5 years ago, the city of Taylor, with the help of local banks, developed a downtown beautification plan. The idea was to revitalize the city's downtown as a cultural and financial center. However, only minor improvements were implemented. The Rattlesnake Sacking, the International Championship Barbecue Cookoff, and the Farm & Ranch Show are major local events, which attract from 4,000 to 5,000 people to downtown Taylor.

The bypass does not appear to have affected land use patterns in Taylor. New businesses have continued to locate mainly on State Highway 95 in north Taylor.

Traffic projections in the 1960's indicated that the city would face, in the near future, almost intolerable conditions both for through-traffic and for local traffic. The bypass was seen as the most practical solution to this problem. The bypass is the first stage of a planned loop around Taylor. From the standpoint of the local citizen, congestion was not a big problem on old U.S. Highway 79 before the bypass. Traffic volumes on the bypass are still low; local residents tend not to use the bypass on trips that take them outside the city.

Summary of Key Findings

The general findings that follow are based primarily on the Navasota, Grapeland, and Taylor case studies, as well as on site visits and interviews in Alvord, Bowie, and Littlefield (discussed in more detail in Research Report 1247-2).

1. In general, the findings do not suggest that a strong relationship exists between a bypass and economic growth or decline in a city. Changes in regional economic factors such as agriculture and the oil industry have a much stronger effect on local businesses.
2. The visited communities were generally in favor of the bypass even as the bypass was in the planning stage. Only owners of highway-oriented businesses resisted bypass construction, in the belief that a large number of their customers would be lost. Today, about two decades after the construction of these bypasses, the bypasses are viewed, generally, as a positive development.
3. Many gas stations have closed on the bypassed route, reflecting general declining trends nationally. Also, downtown businesses experienced a temporary decline in sales following the opening of the bypass. Most affected businesses restructured their stores to capture a greater share of the local market. The opening of a major national discount store was claimed to harm small downtown businesses more than the bypass.
4. A highway bypass means easier access for customers to businesses. A few years after the opening of a bypass, new highway-oriented businesses such as gas stations, restaurants, and motels started to locate on the bypass.
5. A highway bypass in a small city is usually part of a longer highway improvement project. This new facility gives citizens of small cities better access to nearby larger cities that have a better variety of businesses.
6. There is a strong tendency for businesses to cluster around intersections of the bypass with other major highways, forming the busiest commercial center of the city in that area.

3.2 INVENTORY OF HIGHWAY BYPASSES IN TEXAS

A segment of a new facility that reroutes through-traffic around a central business district is, for this study, the working definition of a highway bypass. The bypass is completed once it links up with the bypassed route on the opposite side of the city. Interstate highways are excluded from the study. A review of highway traffic maps and county maps at the Texas Department of Transportation revealed a total of 103 bypasses in Texas with characteristics relevant to the working definition and the report's objectives (Figure 3.8 and Appendix 1).

Highway bypasses can be categorized by highway characteristics, year of construction, geographical location, and population characteristics.

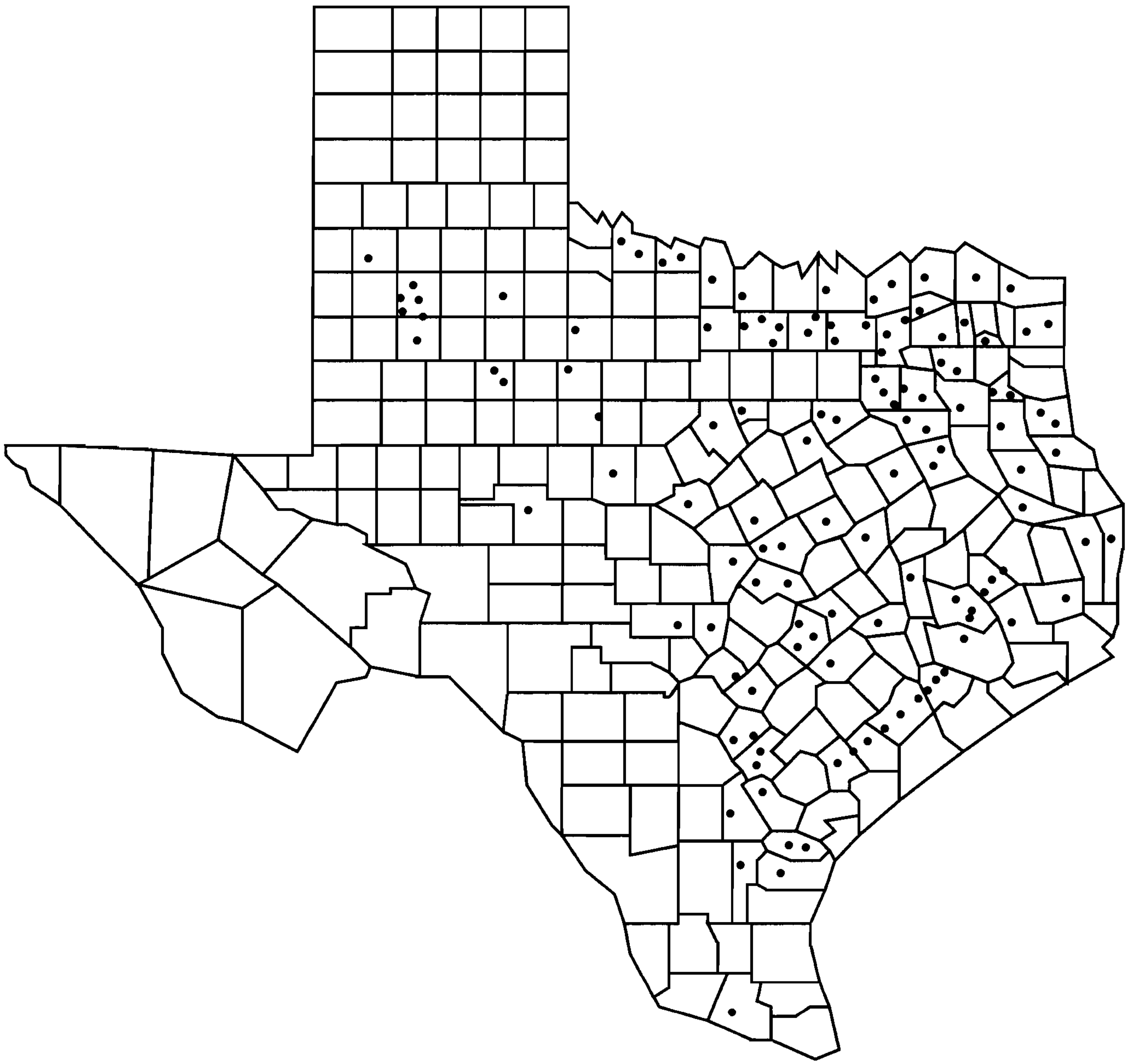


Figure 3.8 Highway bypasses in Texas with characteristics relevant to the working definition

Highway Characteristics

Based on a review of the district highway traffic maps and county maps, the following types of highway bypasses were identified: a standard bypass, a multiple-highway bypass, a multiple-city bypass, and a loop.

Standard Bypass

Cities which have only one highway bypass compatible with the definition are said to have a standard bypass. All bypasses illustrated in the preceding case studies are standard bypasses (Figures 3.2, 3.4, and 3.6). There are currently 90 standard bypasses in Texas. These bypasses are relevant to the objectives of this report. The remaining bypasses are those located in the vicinity of the cities with more than one bypass. These bypasses are called multiple-highway bypasses.

Multiple-Highway Bypasses

In some cases, an interstate highway as well as a state or U.S. highway bypasses a city. Usually, the interstate was constructed before the U.S. or state highway and serves a different driver population. There is a distinction between highways serving parallel routes and highways serving perpendicular routes. Interstate highways (as noted previously) are outside the principal focus of this study, although bypasses that are perpendicular to an interstate were reviewed for possible inclusion in the study. There are 7 bypasses which fit this classification.

In some cases a second U.S. or state highway bypass was built after the original bypass. This is often the first stage in the development of a loop. Figure 3.9 illustrates this type of bypass. Currently, there are 6 bypasses in Texas which fit this classification.

Multiple-City Bypass

The characteristics of the multiple-city bypass are similar to the characteristics of a standard bypass, with one exception: for the multiple-city bypass, more than one city is bypassed. Generally, the bypassed cities are in close proximity to each other. Consequently, it is difficult to assess the economic effects on a single location, since the cities may be interdependent. The multiple-city bypass is illustrated in Figure 3.10. There are 6 of

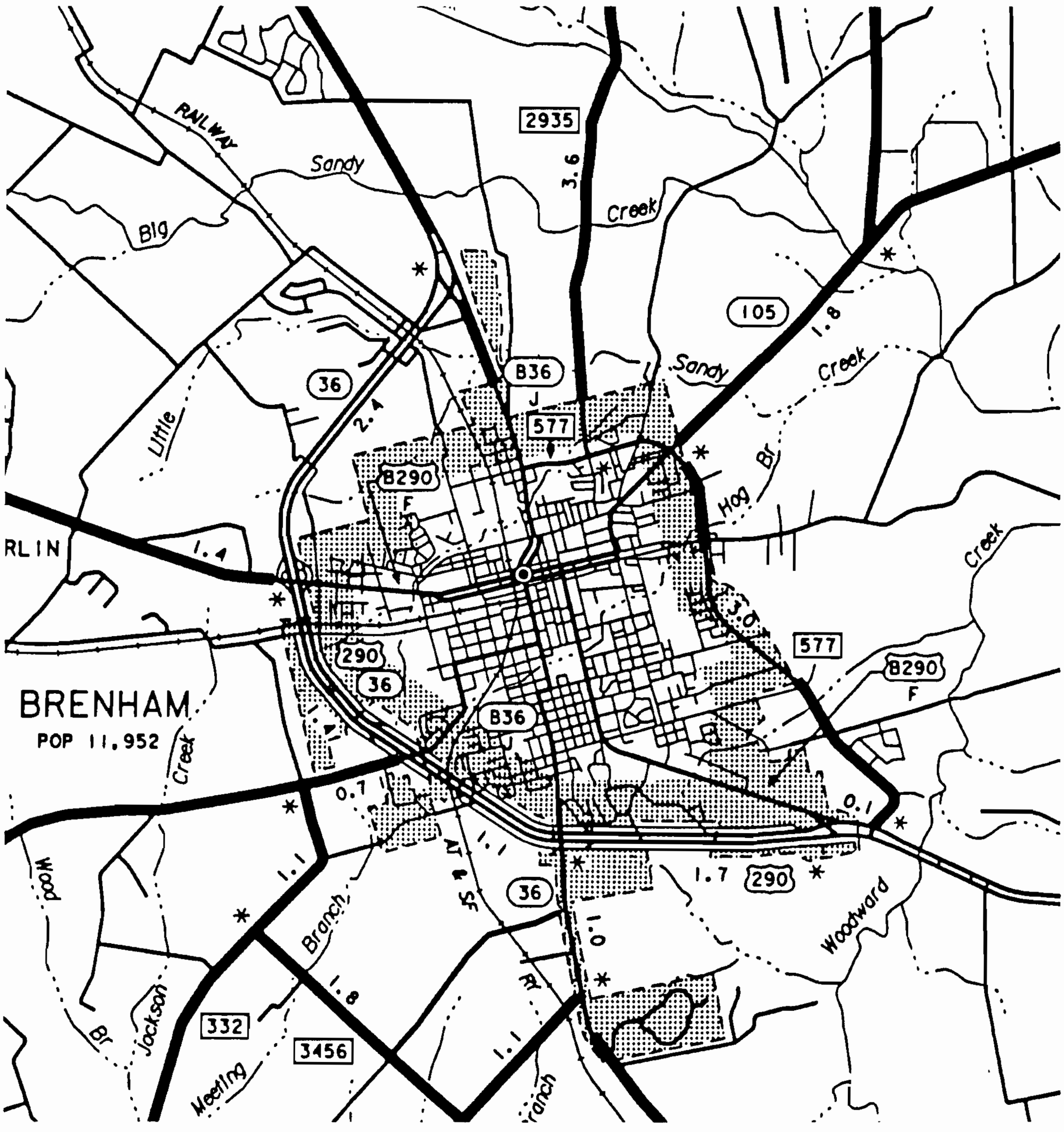


Figure 3.9 An example of multiple-highway bypasses (City of Brenham, U.S. Highway 290 and State Highway 36)

these bypasses, and because of their interdependencies they are not included in the analyses.

Loop

Loops are a designated portion of the highway. They are typically formed by connecting two or more bypasses, or they are independent facilities around the city (Figure 3.11). Loops are most often associated with areas of rapid development and/or large populations. Land values and land use associated with loops are very much different than those associated with bypasses. Because of these facts and the focus of the objectives, loops fall outside the scope of this report.

Year of Bypass Construction

In the database developed for this report, the year that a given bypass was opened is taken as the year in which traffic volumes for the bypass are listed for the first time on the highway traffic maps. The number of bypasses opened per year are illustrated in Figure 3.12. Only 5 cities had a bypass before 1950. Most bypasses in Texas were built between the late 1950's and the early 1970's.

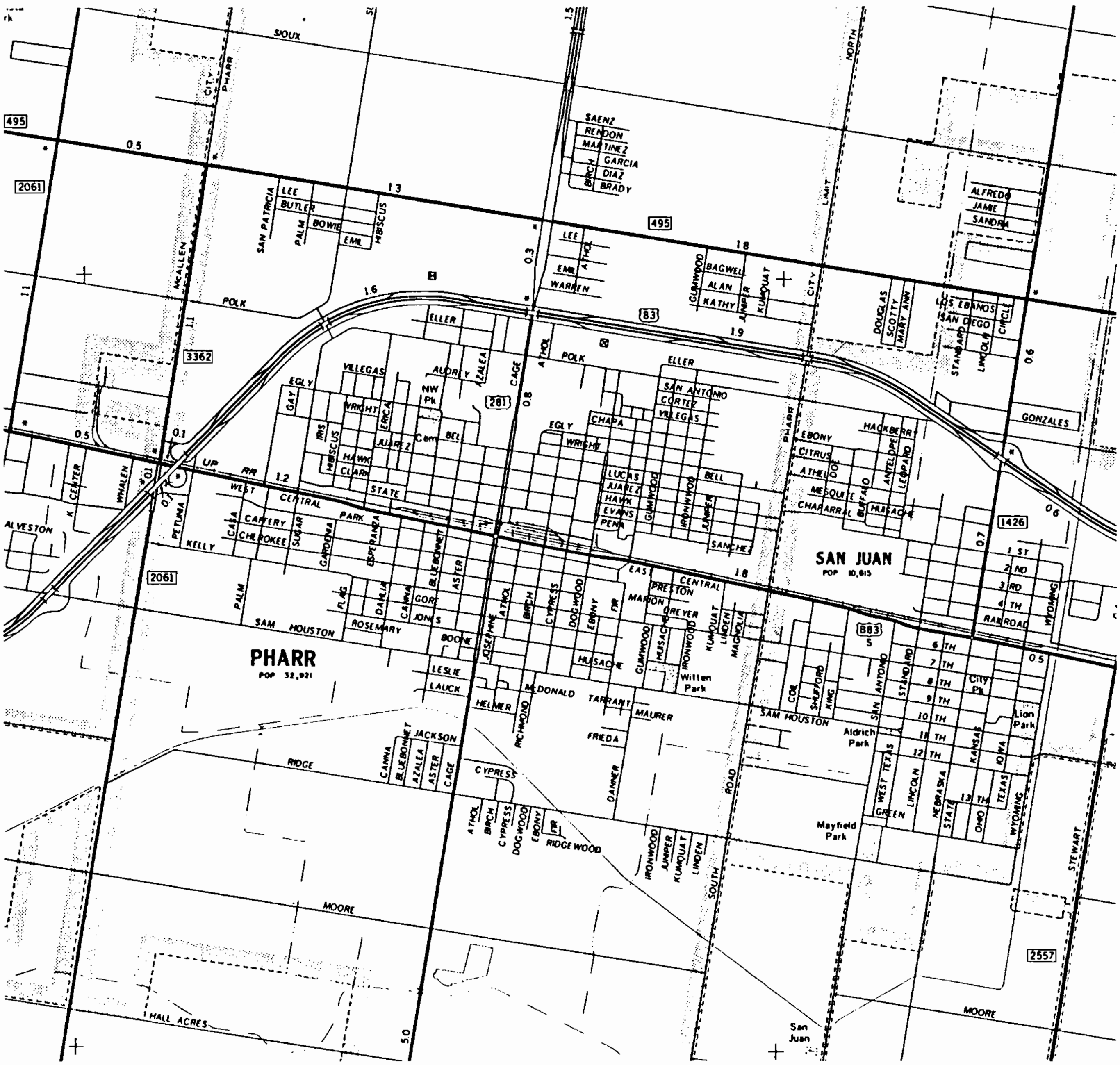


Figure 3.10 An example of a multiple-city bypass (Cities of Pharr and San Juan, U.S. Highway 83)

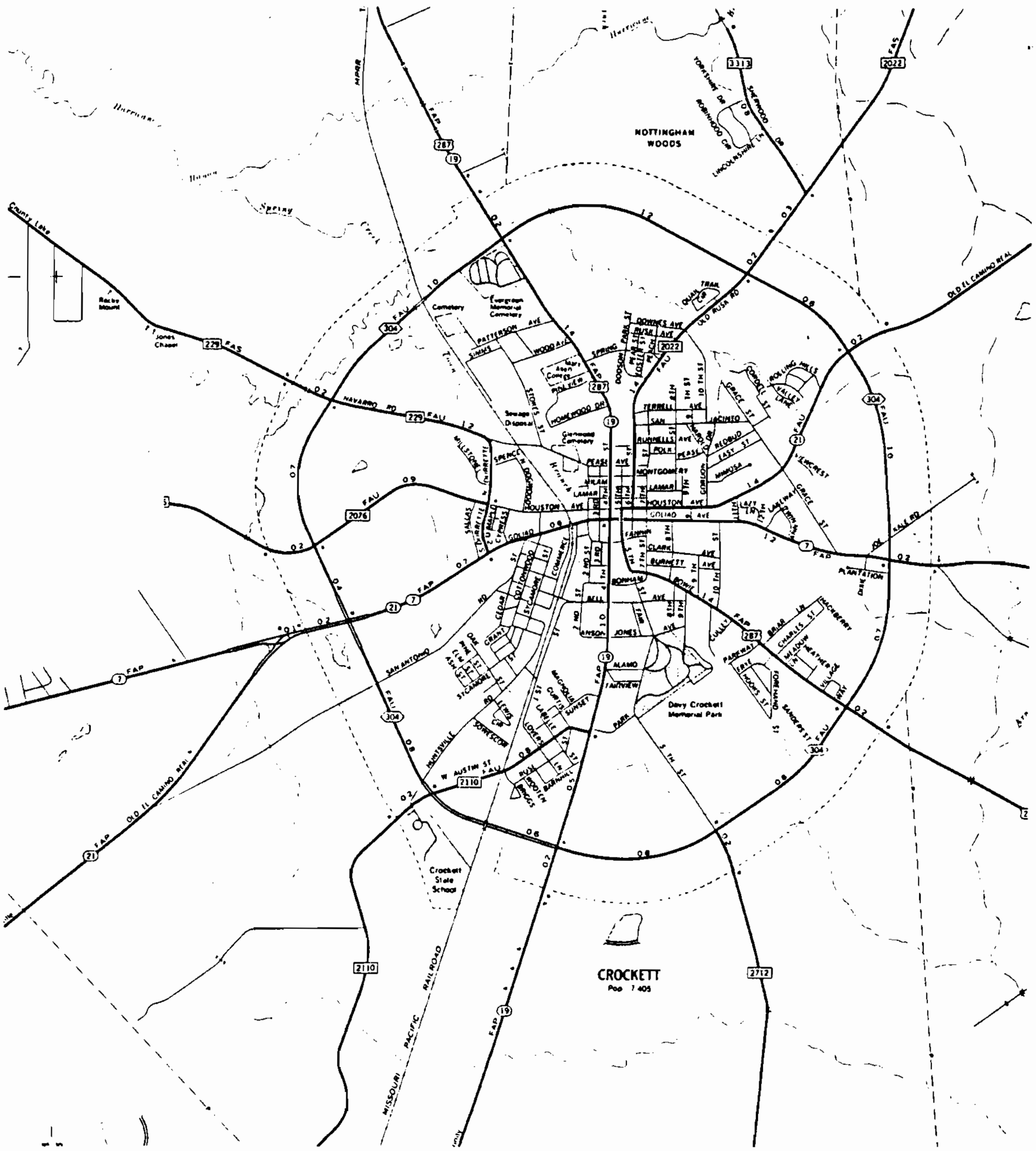


Figure 3.11 An example of a loop (City of Crockett, Loop 304)

Since then, construction of highway bypasses has been declining, averaging 1 or 2 bypasses a year in the 1980's.

Geographical Location

Bypasses can also be categorized according to location. Most of the highway bypasses are in the densely populated northern and eastern parst of Texas or near the Gulf Coast. There are few bypasses in the western part of the state. In general, bypasses are located in densely populated areas, with high traffic volumes (Figure 3.8).

Population Characteristics

Figure 3.13 describes the number of bypasses in relation to the population of the bypassed city at the time the bypass was opened. The population data are based on the U.S. Census and information from the *Texas Almanac*. Almost one-half (49 out of 103) of the bypasses are in cities with a population of 2,500 or less. Another half (51 out of 103) of the bypasses are in cities with a population varying from 2,500 to 25,000. Only three cities with more than 25,000 people have a highway bypass that is consistent with the working definition of a bypass. It is interesting to note that highway bypasses built after 1980 are all in small cities with a population less than 7,500.

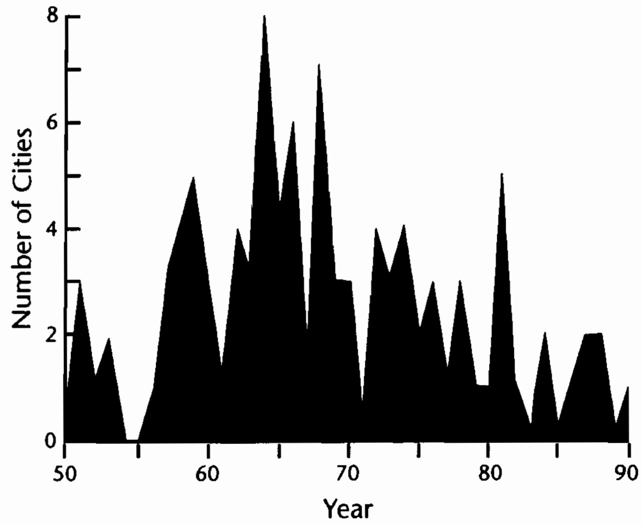


Figure 3.12 ***Number of bypasses opened per year in Texas***

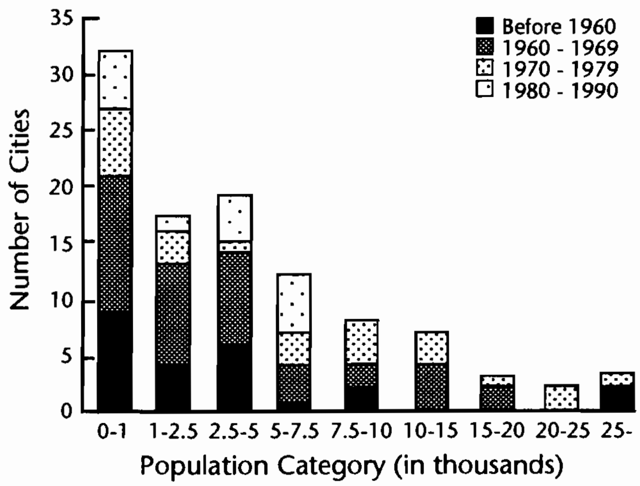


Figure 3.13 ***Population categories of the bypassed Texas cities which have a highway bypass with characteristics relevant to the working definition***

3.3 SAMPLE

A sample based on the inventory of bypasses was developed. The following cities were excluded from the sample:

(1) cities with multiple-highway bypasses,
(2) cities whose populations, at the time the bypass was constructed, were below 2,500 or over 25,000, and
(3) cities in which the bypass opened before 1960 or later than 1979.

These exclusions were the result of data limitations. In this report, the effects of highway bypasses in cities with a population of 25,000 and over are not examined, because, currently, only 6 Texas cities in this category are without a bypass. Another study preference was that a relatively long before-and-after period should be examined to find the long-term effects of highway bypasses on business activities. Therefore, bypasses constructed in the 1950's and 1980's were excluded from the sample. The sample consists of 23 bypassed cities (Table 3.4).

It was also decided to compare changes in the economies of the bypassed city to the changes in selected control areas. The control city and the bypassed city should ideally have the following characteristics in common prior to the bypass being opened: highway district, proximity to a larger city, economic base, amount and trend of retail sales, population size and growth trend, and highway network characteristics. Two to six possible control cities were evaluated for each bypassed city, and the city with the most similar characteristics was selected for this purpose. In most cases, it was not possible to find a perfect control city. Some of the main discrepancies were as follows: large difference in population size, proximity to an interstate highway, and different trends in retail sales (either different direction or different slope). The total sample consists of 46 cities including control cities (Table 3.4).

3.4 THE DATABASE

A database was developed to provide a statistical basis for establishing a relationship between key descriptors of business activity in a city and the characteristics of a city's highway network and geographical location that are thought to influence this activity.

In capturing changes in business activity, previous studies found that retail sales and service receipts provide especially good short-term indicators. When a change such as the construction of a highway bypass takes place in a certain area, it is reflected almost immediately in retail sales. Later, as the organizational structure of a business begins to adjust to revenue shifts, other changes in the business's structure can be expected. Establishments such as department stores and shops are the most permanent elements of the local retail structure, because the capital expenses involved in opening or closing them make them relatively insensitive to short-term changes. Another possible indicator for measuring changes in business activity would be an examination of business payrolls. Hiring or laying off workers is less expensive than opening or closing new units.

It was also found, in the literature review, that in retail trade and services there are many highway-oriented businesses such as gasoline stations, restaurants, and hotels. The U.S. Census was found to be the most accurate and reliable data source for business volumes from the 1940's until the present. Unfortunately, the census has hotel receipts only for those cities with 4 or more hotels. Most of the small cities in the sample have 3 hotels or less, and, therefore, this indicator of business activity was disregarded. An excellent source of information for historical sales is the Texas Comptroller's Department. These data are available on a county, city, or zip-code level according to Standard Industrial Classification (SIC) codes. Unfortunately, only information from the first quarter of 1984 and onwards is available in this format. Therefore, this data source could not be used in this report. The resultant database has the following indicators for business activities: total retail sales (variable name in the database is TOTALRETAIL), retail sales in gasoline stations (GASSTATIONS), retail sales in eating and drinking places (RESTAURANTS), and service receipts (SERVICES). The original volumes were corrected for inflation to 1987 dollars using the Consumer Price Index.

Economic, geographic, and highway related explanatory variables in the database are listed in Table 5 by name and with a brief description. The data for explanatory variables were collected mainly for the purpose of econometric analysis in Chapter 5. The most valuable explanatory variables were derived from reviewed articles and from observations at site visits. Previous literature indicates that retail sales and service receipts are highly dependent on population, income, and geographical location. Variables closely related to a bypass were collected in an effort to capture the effect of the bypass. The growth rates per capita of Gross National Product were introduced to filter out the effect of short-term and long-term national trends in productivity.

Table 3.4 Bypassed and control cities in the sample

City Number	Bypass City	County	District	Control City	County	District
1	Bonham	Fannin	1	Clarksville	Red River	1
2	Bridgeport	Wise	2	Comanche	Comanche	23
3	Vernon	Wilbarger	3	Graham	Young	3
4	Electra	Wichita	3	Childress	Childress	25
5	Henrietta	Clay	3	Memphis	Hall	25
6	Bowie	Montague	3	Nocona	Montaque	3
7	Littlefield	Lamb	5	Post	Garza	5
8	Slaton	Lubbock	5	Brownfield	Terry	5
9	Tahoka	Lynn	5	Morton	Cochran	5
10	Snyder	Scurry	8	Stamford	Jones	8
11	Alvin	Brazoria	12	Angleton	Brazoria	12
12	Wharton	Wharton	13	Bay City	Matagorda	13
13	El Campo	Wharton	13	Eagle Lake	Colorado	13
14	Edna	Jackson	13	Cuero	DeWitt	13
15	Taylor	Williamson	14	Lockhart	Caldwell	14
16	Bastrop	Bastrop	14	Giddings	Lee	14
17	Beeville	Bee	16	Alice	Jim Wells	16
18	Teague	Freestone	17	Hearne	Robertson	17
19	Navasota	Grimes	17	Cameron	Milam	17
20	Atlanta	Cass	19	Gilmer	Upshur	19
21	Silsbee	Hardin	20	Liberty	Liberty	20
22	Edinburg	Hidalgo	21	Rio Grande City	Starr	21
23	Coleman	Coleman	23	Brady	McCulloch	23

Table 3.5 Explanatory variables in the database

Variable Name	Explanation
POPULATION	In the city area.
INCOME	Average personal income per capita in the county in 1987 dollars.
GROWTH1	The growth rate per capita of real Gross National Product in the U.S.A. during the period between year t and t-1.
GROWTH5	The growth rate per capita of real Gross National Product in the U.S.A. during the period between year t and t-5.
LARGERCITY	Distance in miles to a city of a larger size within the state.
METRO-AREA	= 1, if the city is located in the metropolitan area; otherwise 0.
US	Number of incoming U.S. highways to the city.
STATE	Number of incoming State highways to the city.
ADT-TOTAL	Average daily traffic volumes on incoming highways.
LENGTHOLD	Length of an old bypassed route in miles.
LENGTHNEW	Length of a bypass in miles.
DISTANCE	The average distance in miles between a bypass and bypassed route.
CLASS	Classification of the bypass (U.S. highway = 1, State highway = 0).
ADT-BYPASS	Average daily traffic volumes on the bypass.
SPLIT	The percentage of traffic diverted from the bypassed route to the bypass.
ACCESS	Access t ype for the bypass (= 1 if a bypass has limited access and grade separation; otherwise 0).
YEAR	Year for the data.

The U.S. Department of Commerce, Bureau of Census uses the SIC code to categorize retail trade activity. The retail trade division includes establishments engaged in selling merchandise for personal or household consumption and rendering services incidental to the sale of the goods. In general, retail establishments are classified according to the principal lines of commodities sold or the usual trade designation. In this study, two categories, which previous studies have found to be in the highway-oriented sales category, were included for a more detailed examination. One of the two categories is gas stations (SIC-code 554). The stations are primarily engaged in selling gasoline and lubricating oils. These establishments frequently sell other merchandise, such as tires, batteries, and automobile parts, or they perform minor repair work. Gasoline stations combined with other activities (such as grocery stores, convenience stores, and carwashes) are classified according to their primary activity. The second category is eating and drinking places (SIC-code 58). These places include retail establishments selling prepared foods and drinks for consumption on the premises, as well as lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption.

The service division includes establishments primarily engaged in providing a wide variety of services for individuals, businesses, government establishments, and other organizations. Hotels and other lodging places; establishments providing personal, business, repair, and amusement services; health, legal, engineering, and other professional services; educational institutions; membership organizations; and other miscellaneous services are included.

The database contains annual data over six periods for each city, three observations before and three observations after bypass construction. The actual data years for which data were obtained were determined by the information available through the U.S. Census. Retail sales and service receipt volumes are available at the city level approximately every fifth year. The actual data years available for this study, are as follows: 1948, 1954, 1958, 1963, 1967, 1972, 1977, 1982, and 1987. For example, if the city was bypassed in 1968, the database has observations for the years 1958, 1963, and 1967 for the before period and for the years 1972, 1977, and 1982 for the after period. However, if a city was bypassed in 1977 or later, only two observations could be obtained for it and for its control city for the "after" period.

Some of the data for certain explanatory variables do not perfectly match all of the above data years. These data were adjusted by interpolating between the two actual data years.

The following data sources were used: U.S. Department of Commerce, Bureau of Census (population, retail trade, service receipts, and Gross National Product), *Texas Almanac* (personal income), county maps (highway characteristics), and the annual road and traffic maps of the Texas Department of Transportation (TxDOT) (traffic volumes).

3.5 CLOSURE

This chapter presented the findings of three case studies in Navasota, Grapeland, and Taylor. An inventory and categorization of highway bypasses in Texas was presented. A sample of selected bypassed cities and control cities was taken for further analysis. A database was established to provide a basis for the investigation of relationships between key economic variables and several explanatory variables.

Case studies provided direct experience and insights into the economic effects of highway bypasses; they also provided a useful basis for more general studies. When congestion caused by through-traffic was relieved on major local streets, a bypass was seen as a positive development by local citizens.

The next chapter includes data validation and exploratory data analysis. Descriptive statistics are cited in order to compare bypassed and control cities as two independent groups of observations and as a set of paired observations. The objective is to verify changes in business volumes vis-a-vis highway bypass construction.

CHAPTER 4. EXPLORATORY DATA ANALYSIS

This chapter examines the data by using some of the methods discussed in the literature review. First, descriptive statistics are given to compare bypassed and control cities as two groups and to find general trends over the study period. The second part of the chapter explores differences in the development for paired observations. Finally, predicted trends are compared to actual business volumes using the projected development method.

4.1 DESCRIPTIVE STATISTICS

Bypassed and Control City Group Comparison

At the beginning of the study, summary descriptive statistics were calculated for the variables in the database to examine the overall similarity of bypassed and control cities for the period before the opening of a bypass. Table 4.1 shows the means, standard deviations, and medians of all the observations for the before period for comparable variables.

It is important to remember that observations represent many different decades, depending on when a bypass was opened. Each city has three observations, one for each consecutive five-year interval preceding the bypass opening.

The mean values of the variables in Table 4.1 for bypassed and control cities as two groups are approximately the same. The most noticeable difference is in average daily traffic (ADT) volumes on incoming highways; bypassed cities have on average 33 percent more traffic. There is also a slight difference in population; bypassed cities have 15 percent more inhabitants. Means for other variables in Table 4.1 are almost similar for these two groups. Because of the moderate difference in population between the two groups, it was decided to list the per person values for business volumes rather than total city values.

Table 4.2 shows the means, standard deviations, and medians of all observations for the after period for comparable variables in the database. Observations are from different decades depending on when the bypass was opened. Mean values for bypassed and control city groups are also listed for the after period and are almost identical for all variables except ADT on incoming highways and population. Traffic volumes are on average 39 percent higher, and population is on average 11 percent higher, for the bypassed city group.

Table 4.1 Means, standard deviations, and medians for dependent and key explanatory variables for the before period

	Bypassed Cities			Control Cities		
	Mean	Standard Deviation	Median	Mean	Standard Deviation	Median
Total Retail Sales/Person	6,783	2,165	6,249	6,494	1,837	6,003
Gas Station Sales/Person	576	199	532	587	188	561
Restaurant Sales/Person	269	110	254	268	98	246
Service Receipts/Person	494	202	459	500	282	466
Income/Person	5,264	1,549	5,323	4,890	1,353	4,934
Population	6,981	3,974	6,142	6,088	3,812	5,459
Distance to Larger City	26	12	24	29	11	29
Number of Highways	4.1	1.1	4	3.8	1.1	4
ADT, Incoming Highways	13,630	5,660	13,490	10,220	4,440	9,040

Table 4.2 Means, standard deviations, and medians for dependent and key explanatory variables for the after period

	Bypassed Cities			Control Cities		
	Mean	Standard Deviation	Median	Mean	Standard Deviation	Median
Total Retail Sales/Person	7,435	2,480	7,278	7,073	2,102	6,668
Gas Station Sales/Person	604	249	577	612	284	587
Restaurant Sales/Person	343	166	344	339	144	321
Service Receipts/Person	1,009	684	830	1,027	813	771
Income/Person	7,455	2,144	7,639	6,950	1,861	6,647
Population	7,641	4,800	6,602	6,859	4,521	5,550
Distance to Larger City	26	12	25	29	11	29
Number of Highways	4.1	1.1	4	4.0	1.2	4
ADT, Incoming Highways	21,710	9,910	20,280	15,590	7,700	13,180
ADT, Bypass	5,320	2,900	4,970	–	–	–
Diverted Traffic, %	61	17	67	–	–	–

Selected bypass related variables are also listed in Table 4.2. Values for the variable "diverted traffic" indicate that, in most cases, more than half of the traffic was diverted from the bypassed route to the bypass. Also, with further calculations (dividing "diverted traffic" by total ADT on incoming highways), it can be seen that traffic volumes on the bypass represent on average about 25 percent of the total traffic on incoming highways.

In order to draw statistical conclusions concerning the differences between the mean values for the bypassed cities and control cities as two groups, t-tests were performed for the two means (bypassed city group and control city group) of the variables listed in Tables 4.1 and 4.2.

The differences in the means of the key variables for the group of bypassed cities and for the group of control cities were tested. The null hypothesis (H_0) is that the means of the key variables for the bypassed city group and control city group are the same. In this case, H_0 will be rejected at the 0.05 level, if a t-value is greater than 2.00. The t-test results for the comparison of differences in means between bypassed and control city groups are shown in Table 4.3. The differences between bypassed and control groups are minor and insignificant, except for the variable ADT on all incoming highways. The difference in this variable is very significant already for the before period; the bypass did not cause any notable change. Higher traffic volumes in the bypassed cities were, presumably, one of the reasons to construct the bypass in the first place.

Table 4.3 The t-test for the differences in the means of key variable for bypassed and control city groups (bypassed - control)

	t-Value	
Variable	Before Period	After Period
Total Retail Sales/Person	0.84	0.90
Gas Station Sales/Person	−0.33	−0.17
Restaurant Sales/Person	0.05	0.50
Service Receipts/Person	−0.14	−0.13
Income/Person	1.51	1.44
Population	1.34	0.96
ADT, Incoming Highways	3.93*	3.95*

*Significant at the 0.05 level

General Trends in Business Volumes

The consequences of exogenous variables on general business trends can be much more significant than the effect of a bypass construction. Several figures (4.1 through 4.5) were prepared in order to ascertain growth patterns in business volumes during the entire study period from 1948 to 1987. These figures help in understanding the importance and nature of macroeconomic effects. The figures are for control cities only, to eliminate the possible "contamination" by the effect of the bypass construction on general trends.

Figure 4.1 illustrates total retail sales per person over the study period. There is considerable variation in these sales volumes for all data years, and no consistent trend is apparent from these data. This is somewhat surprising, since the literature review indicated that the substantial growth of per capita retail sales over the years had been stimulated mostly by the increase in income.

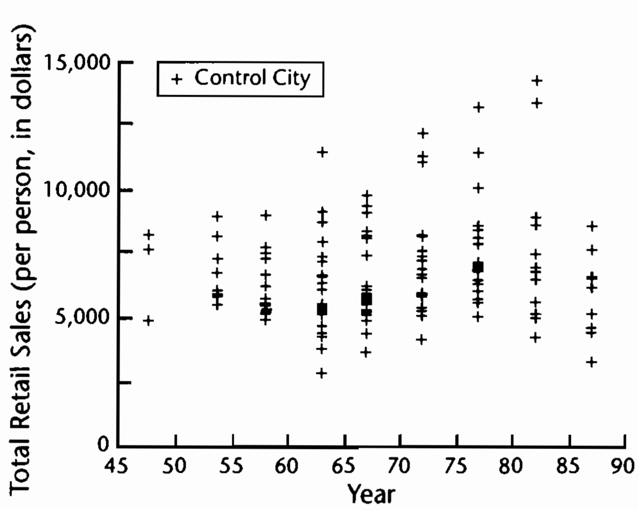


Figure 4.1 ***Total retail sales per person for control cities over the study period***

Gas station sales per person can be seen in Figure 4.2. The general trend was upward until the late 1960's, apparently because of the growth in automobile ownership. A reversal of the trend has been caused mainly by more energy-efficient automobiles. Also, the variation between different cities is wide for this variable, and, therefore, the curve is not a very good fit.

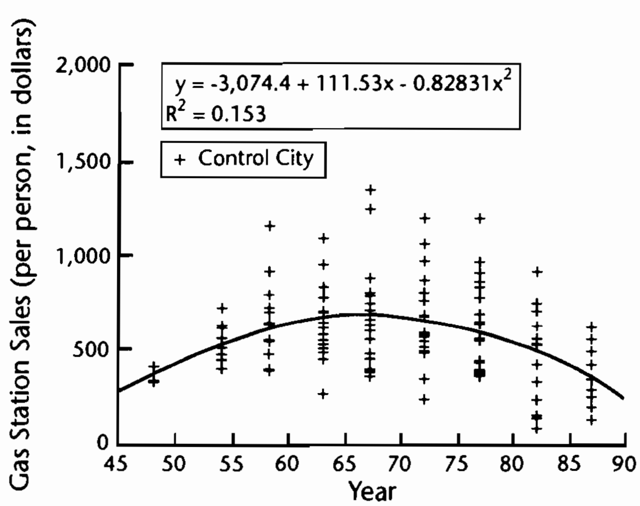


Figure 4.2 ***Gas station sales per person for control cities over the study period***

Restaurant sales have generally increased since the late 1950's (Figure 4.3). The general trend formed in Figure 4.2 is affected by observations all over the scale. These gains in restaurant sales have resulted, presumably, from the substantial growth of per capita income, as well as from changing lifestyles.

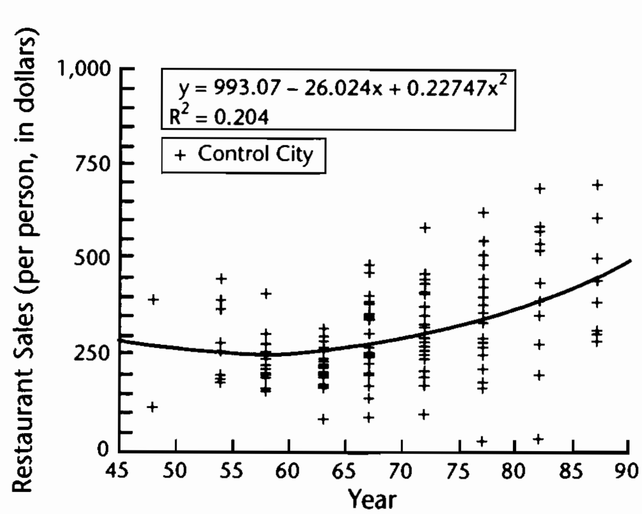


Figure 4.3 ***Restaurant sales per person for control cities over the study period***

The trend for service receipts per person is more noticeable, although variation between different cities remains (Figure 4.4). An exponential curve had the best fit for the observations in the database. Lifestyle changes, the increasing complexity of equipment, and proliferation of new services have brought about the exponential growth for services.

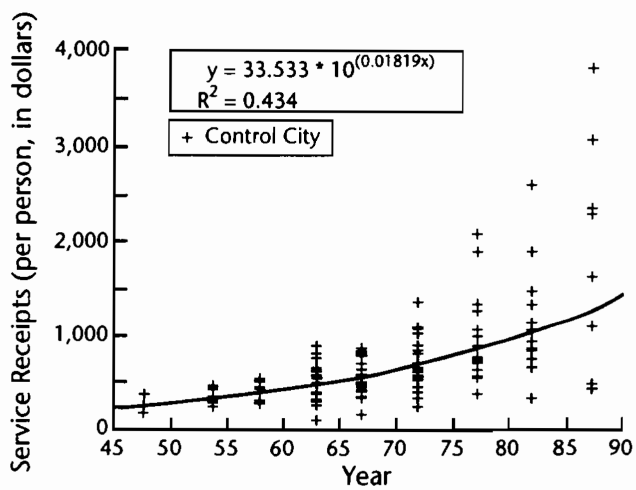


Figure 4.4 ***Service receipts per person for control cities over the study period***

One important explanatory variable, income per capita, was given a similar examination (Figure 4.5), because the literature review indicated that sales were affected by income; business activity depends on how much people have to spend. The income trend helps to explain changes in business activities over the years. Figure 4.5 shows a clear upward trend over the study period.

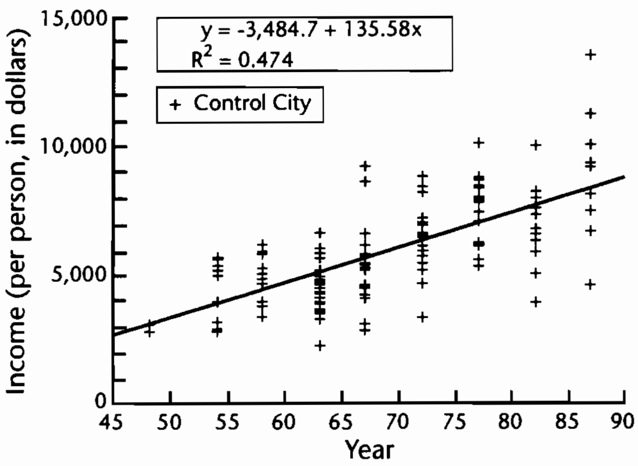


Figure 4.5 ***Income per capita for control cities over the study period***

4.2 MATCHED PAIRS

The database consists of observations for bypassed cities and for carefully selected control cities. Control cities were chosen in such a way that key explanatory variables had approximately the same values during the before period. In the selection of a control city as described in Section 3.3, particular attention was given to characteristics such as geographical location, economic base, amount and trend of sales, population size and growth trend, and highway network elements. Therefore, it is appropriate to assume that observations are paired for these matched cities.

A t-test was conducted for these paired observations for all dependent variables and for two explanatory variables, namely, for income per person and for population. Because of the significant difference in population size with some pairs, it was decided that per capita values for business volumes would be used instead of total city values for business volumes. In order to gain a broad viewpoint, a paired t-test for matched cities was performed for four time periods as follows:

(1) a time period from six to ten years before the bypass was opened,
(2) a time period from one to five years before the bypass was opened,
(3) a time period one to five years after the bypass was opened, and
(4) a time period six to ten years after the bypass was opened.

It is important to remember that these observations are dependent upon when a bypass was opened and that they represent different decades. The significance of the differences between the paired observations was tested. The null hypothesis (H_0) is that the mean of the differences for paired observations would be zero; in other words, paired observations are equal. In this case H_0 will be rejected at the 0.05 level, if the calculated t-value is greater than 2.07.

The t-values in Table 4.4 show no statistically significant differences in business volumes for paired observations either for the before or for the after period. This result confirms the appropriateness of the control cities and that the construction of highway bypasses has not significantly affected business volumes. However, it is interesting to note the negative signs for all means in business volumes for the time period just after the bypass was opened (time period (3)). This can be interpreted as a slightly negative effect of highway bypass construction on business volumes. Means and t-values for personal income and city population have positive signs in every time period, indicating slightly higher values for bypassed cities over the entire study period; two values for personal income are almost statistically significant.

The next step is to test the significance of the difference between consecutive observations:

$$\Delta Y_i = Y_{i,t} - Y_{i,t-5}$$

where i subscripts paired cities and t is a year in the database. The database contains observations for every fifth year. ΔY is the measure of the difference between consecutive observations for paired cities. In other words, this was a test of the differences in growth rate. Values for the control cities were subtracted from the corresponding values for the bypassed cities. Therefore, positive values mean that business volumes for bypassed cities were growing faster than those for control cities. Both total and per capita values were included in the comparison shown in Table 4.5. It is also reasonable to compare total city values, because the interest in this case, is in the growth rate, and, therefore, the differences in the city size for matched cities do not cause disparity in the values.

Table 4.5 has three blocks as follows:

(1) period before the bypass—both observations t and t-5 are from the before period;
(2) before-and-after comparison—observation t is from the after period and observation t-5 is from the before period; and

Table 4.4 Paired t-test for matched cities (bypassed - control). Mean differences between paired observations with corresponding standard errors and t-values

Time Period	Variable	Mean	Standard Error	t-Value
(1) Six to ten years before the bypass was opened	Total Retail Sales/Person	277	1,887	0.70
	Gas Station Sales/Person	-27	141	-0.91
	Restaurant Sales/Person	25	125	0.95
	Service Receipts/Person	-5	207	-0.11
	Income/Person	483	1,166	1.98
	Population	900	4,026	1.07
(2) One to five years before the bypass was opened	Total Retail Sales/Person	415	1,686	1.18
	Gas Station Sales/Person	10	285	0.16
	Restaurant Sales/Person	-20	145	-0.66
	Service Receipts/Person	-22	532	-0.19
	Income/Person	204	797	1.22
	Population	871	4,784	0.87
(3) One to five years after the bypass was opened	Total Retail Sales/Person	-167	2,008	-0.39
	Gas Station Sales/Person	-48	231	-0.99
	Restaurant Sales/Person	-4	98	-0.19
	Service Receipts/Person	-63	403	-0.74
	Income/Person	338	851	1.90
	Population	961	4,117	1.11
(4) Six to ten years after the bypass was opened	Total Retail Sales/Person	696	2,408	1.38
	Gas Station Sales/Person	-68	400	-0.81
	Restaurant Sales/Person	11	160	0.32
	Service Receipts/Person	-82	917	-0.42
	Income/Person	348	1,093	1.52
	Population	1,030	5,252	0.94

Number of paired observations: 23

(3) period after the bypass—both observation t and observation t-5 are from the after period.

The null hypothesis (H_0) is that the mean of the differences for consecutive paired observations is zero; in other words, growth rates for paired observations are equal. In this case, H_0 will be rejected at the 0.05 level if the computed t-value for the sample is greater than 2.07.

During the before period, the average growth rates for the matched cities were almost identical, as can be seen from the t-values, which all have absolute values less than 0.50 (top block in Table 4.5). This result confirms the appropriateness of the control cities selected. The next block in Table 4.5 describes growth rates in the periods immediately preceding and immediately following the bypass opening. Means are not significantly different from zero, with the exception of restaurant sales, which were growing faster for bypassed cities than for control cities. Finally, the last block in Table 4.5 examines growth rates during the after period by comparing first and second observations for the after period. Again, the results of the paired t-test are not conclusive about the effect of a highway bypass on local business activities in small cities. However, one significant value that can be observed is the value for total retail sales per person, which had a higher growth rate for the bypassed cities during the after period.

Generally speaking, Table 4.5 does not reveal different growth rates in total business volumes between the paired cities. However, significant differences for per capita values suggest that cities in some cases have benefited from bypass construction.

Table 4.5 ***Paired t-test for matched cities (bypassed - control). Mean differences between consecutive observations (change in a five- year time interval) for paired observations with corresponding standard errors and t-values***

Time Interval	Variable	Mean	Standard Error	t-Value
(1) Before Bypass				
First observation: 6 to 10 years before	Total Retail Sales	-1,286	12,868	0.47
	Gas Station Sales	102	1,646	0.29
	Restaurant Sales	15	1,233	0.05
	Service Receipts	622	7,916	0.37
	Total Retail Sales/Person	-139	1,460	-0.45
Second observation: 1 to 5 years before	Gas Station Sales/Person	13	254	0.24
	Restaurant Sales/Person	4	142	0.13
	Service Receipts/Person	25	552	0.21
	Income/Person	45	1,167	0.18
	Population	-43	749	-0.27
(2) Before - After				
First observation: 1 to 5 years before	Total Retail Sales	45	9,861	0.02
	Gas Station Sales	-122	1,770	0.33
	Restaurant Sales	269	1,106	1.16
	Service Receipts	264	2,842	0.44
	Total Retail Sales/Person	-138	1,369	-0.48
Second observation: 1 to 5 years before	Gas Station Sales/Person	-37	244	-0.72
	Restaurant Sales/Person	45	116	1.86
	Service Receipts/Person	17	282	0.28
	Income/Person	279	1,112	1.20
	Population	28	333	0.40
(3) After Bypass				
First observation: 1 to 5 years before	Total Retail Sales	1,640	15,271	0.51
	Gas Station Sales	372	1,344	1.32
	Restaurant Sales	-240	1,302	-0.87
	Service Receipts	-63	5,069	-0.05
	Total Retail Sales/Person	583	1,027	2.72*
Second observation: 5 to 10 years before	Gas Station Sales/Person	59	219	1.29
	Restaurant Sales/Person	-15	130	-0.55
	Service Receipts/Person	41	260	0.75
	Income/Person	-133	1,228	-0.51
	Population	-89	1,041	-0.41

* Significant at the 0.05 Level
Number of paired observations: 23

4.3 PROJECTED DEVELOPMENT

As discussed in Section 2.4, the projected development method involves a comparison between the situation that actually exists after a highway bypass has been constructed with a hypothetical projection of a before situation. A projection of total retail sales was made for each bypassed city from the before period observations. This projection was based on three total retail sales volumes in the database (U.S. Census, 1948-1987) plus three additional sales volumes (for the intermediate years between Census data) estimated from the county data (County Business Patterns, 1948-1987). Given these six values for the before period, the trend in total retail sales over time was estimated for the period preceding the opening of the bypass. Two specifications for the trend line were tested: a linear model of the form

$$Y_i = \alpha + \beta X_i + \varepsilon_i$$

and a geometric series model of the form

$$Y_i = \alpha \beta X_i + \varepsilon_i$$

where i subscripts a city, Y is the measure of total retail sales for a given year X, α and β are parameters to be estimated, and ε is an error term.

The goodness of fit was defined by the coefficient of determination, R^2. The model with a higher R^2-value was chosen to represent the trend for the before period. In most cases, the R^2-value was higher than 0.75. The projected future sales volumes were calculated by extrapolating the before period trend.

Actual Sales Volumes Versus Projected Values

In the analysis, the actual volumes were first compared to the expected values by calculating the ratio of these two numbers. For example, if this ratio is greater than 1.0, actual sales were greater than could be expected from the projection. In this case, a bypass would have positively influenced business volumes in a city.

Figure 4.6 depicts the ratios calculated for total retail sales (shown on the y-axis) plotted against the corresponding number of years elapsed since the bypass was opened (on the x-axis). Figure 4.6 suggests that general trends established during the before period observations did not appear to hold during the after period. Data points are scattered over the scale; they do not allow general conclusions regarding the effect of a bypass on sales volumes. About half of the points correspond to values greater than 1.0, while the other half are below 1.0.

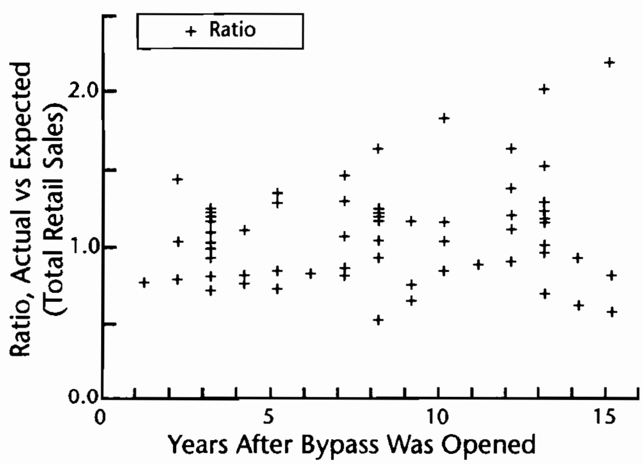


Figure 4.6 ***Ratios between actual volumes and projected volumes for total retail sales***

City Categorization

Next, individual cities were examined more closely, using the projected development method. The bypassed cities were first categorized according to the direction of the sales trend during the before period. In 15 cities, the trend was upward; in 5 cities, downward; and for 3 cities, no definitive direction could be established. In the last case, the fit of the observations to the trend line was too poor, or sales volumes remained virtually flat over time (Appendix 2).

The expected values were then compared to three actual after period values in the database. Three different situations are possible:

(1) actual values are higher than expected,
(2) actual values are lower than expected, or
(3) some of the observations are higher and some are lower than expected.

It can be claimed that in case:

(1) a bypass has a positive effect on business volumes in a city; in case
(2) the effect is negative; and, finally, in case
(3) the result is so mixed that no conclusions can be made.

After excluding cities with unclear trends during the before or after periods, the remaining cities fell into three groups. These groups are the following:

(1) A positive trend is exhibited over the before period, and actual sales volumes are higher than expected during the after period. The cities of Bonham, Bridgeport, Alvin, Taylor, and Edinburg are in this category. This is a favorable case. The data for the the city of Bonham are given in Figure 4.7 as an example.

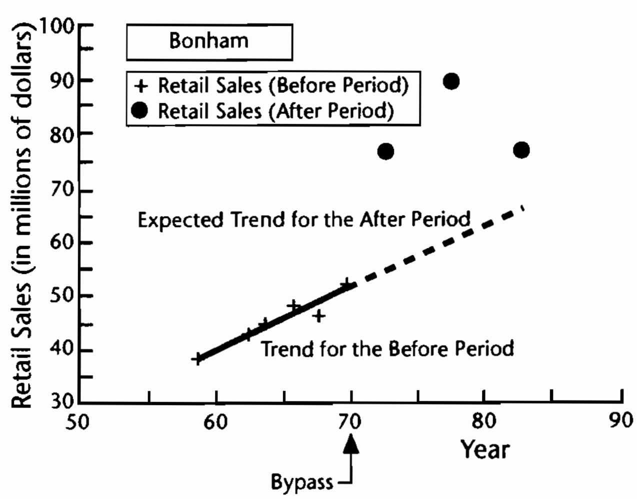


Figure 4.7 ***Total retail sales for the city of Bonham. An example of a positive trend for the before period and of sales volumes higher than expected for the after period***

(2) A positive trend exhibited during the before period, but actual sales volumes are lower than expected for the after period. The cities of Bowie, Slaton, Wharton, Navasota, Silsbee, and Coleman are in this group. These cities experienced losses coincidentally with the period following the construction of the bypass. Data for the city of Navasota are given as an example of this group in Figure 4.8.

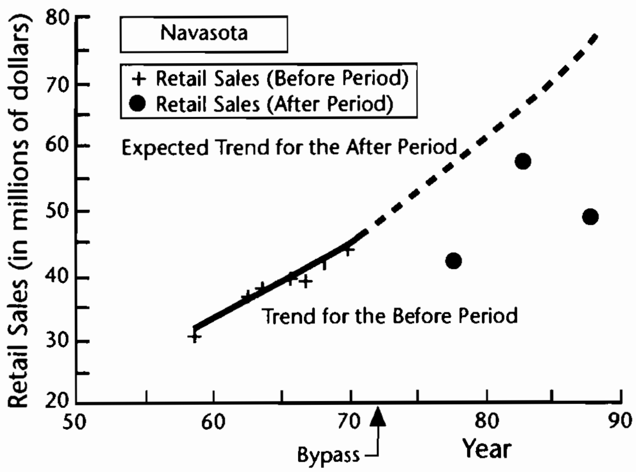


Figure 4.8 ***Total retail sales for the city of Navasota. An example of a positive trend for the before period and of sales volumes lower than expected for the after period***

(3) A negative trend is exhibited for the before period, but actual sales volumes were higher than expected for the after period. Electra and Atlanta are cities in this category. These cities also gained from the highway bypass. An example of this case is Atlanta, where an existing downward trend was reversed (Figure 4.9).

Groups (1) and (2) were subjected to further examination, in an attempt to seek explanations for why some cities experienced higher sales (Group 1) while other cities had lower sales (Group 2) for the after period than could be expected, when the trend was upwards for all these cities during the before period. All the variables in the database were carefully examined to find differences between these two groups. Most of the variables in the database had approximately the same means for the two groups, and values of most variables seemed to be widely scattered. However, additional calculations (of annual growth rates) revealed that a few variables have different typical values for these two groups (Table 4.6). The numbers in Table 4.6 represent the range between one standard deviation below and above the mean.

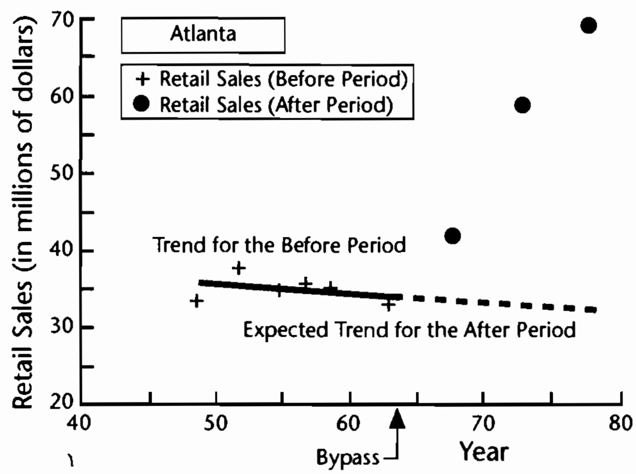


Figure 4.9 ***Total retail sales for the city of Atlanta. An example of a negative trend for the before period and of sales volumes higher than expected for the after period***

However, Table 4.6 does not fully reveal different values for the two groups in question. While examining these typical values, one has to remember that all these cities performed well during the before period. The annual increase for some explanatory variables such as population, income, and ADT was slightly higher during the before period for cities which experienced higher sales than projected for the after period. In addition, some explanatory variables related to the bypass—such as ADT on the bypass, the percentage of diverted traffic from the bypassed route to the bypass, bypass class, and access type—gave slightly different typical values for these two groups. Retail sales were higher than expected for cities whose bypass was a state highway, had unlimited access, and had low traffic volumes.

Based on this analysis, it can be concluded that retail sales in fast-growing cities with inadequate infrastructure and with a high proportion of local traffic may be boosted by highway bypass construction.

Table 4.6 Interrupted time-series analysis. Typical values for key variables for city groups which have different trends for the after period

Variable	Typical Values for Cities with Higher Sales than Expected	Typical Values for Cities with Lower Sales than Expected
Annual Sales/Person*	$5,000 – $7,000	$6,000 – $14,000
Population Increase/Year*	0% – 4%	0% – 2%
Income Increase/Year*	1% – 4%	0% – 3%
ADT Increase/Year*	3% – 6%	1% – 5%
ADT on Bypass**	1,000 – 5,000	3,000 – 7,000
Diverted traffic**	20% – 50%	40% – 70%
Bypass Class	State (3/5)[1]	U.S. (5/6)[2]
Access Unlimited, Bypass	Yes (4/5)[1]	–[3]

*Before Period, **After Period

[1] Three (four) out of total five cities in this group

[2] Five out of total six cities in this group

[3] No typical values

4.4 CLOSURE

In this chapter, descriptive statistics confirmed the similarities of bypassed and control cities in the period before the opening of a bypass.

Several tests of significance were conducted for paired observations. Generally speaking, the results did not give any significantly different business volumes or growth rates for paired cities. However, significant differences for per capita values suggest that cities, in some cases, have benefited from bypass construction. It is important to remember that such tests of significance do not reveal whether there is a difference or a relationship between more than one variable at the same time.

Using the projected development method, the situation after a highway bypass construction was compared with a hypothetical projection of total retail sales for the after period. Cities were categorized according to their performance for the after period, which was then compared to the projection. The following findings were derived from the analysis:

(1) cities exhibiting fast growth prior to the bypass being built, with relatively low retail sales per capita, appear to have experienced positively the highway bypass, and
(2) a highway bypass with low traffic volumes and unlimited access will assist in this positive development.

In the next chapter, econometric models are introduced, in an attempt to identify the economic effects of highway bypasses on economic activities by examining both highway-related and non-highway-related factors.

CHAPTER 5. ECONOMETRIC MODELING

One purpose of this report is to develop a business activity prediction equation. This chapter presents multivariate regression models that were developed to explain the following measures of business activity: total retail sales, gas station sales, restaurant sales, and service receipts in small cities. First, the expected influence of explanatory variables on business activities is discussed. After developing the regression models mentioned above, differences between small and large cities are compared. Finally, the models' use as a predictive tool is tested.

Generally speaking, the tests performed in Chapter 4 could not relate a significant change in overall business volumes to the opening of a highway bypass. Therefore, it is useful to develop multiple regression models through which the relationship between a dependent variable and a set of explanatory variables can be analyzed. This analysis uses the ordinary least squares method to estimate the values of the model coefficients that minimize the sum of squared residuals.

The regression models for business activities enable the analyst to include all relevant economical, geographical, and traffic-related variables in the same equation. All observations in the database were included for further examination. The regression analyses of the data are based on the following general model:

$$Y_{it} = \beta' X_{it} + \varepsilon_i + u_{it},$$

where the subscript i denotes a city and t a data year; Y_{it} is the measure of business activity (total retail sales, gas station sales, restaurant sales, or service receipts); X_{it} is a vector of the explanatory variables for a given city and a year; b is a vector of parameters to be estimated; u_{it} is an error term of the usual type, with mean 0, and constant variance σ^2; and ε_i is a city-specific error term, which represents city-related differences in culture, economic base, geography, etc., that change very slowly over time and are not captured by explanatory variables in the model. Initially, models are estimated ignoring the ε_i terms. Next, city-specific dummy variables are included, and those exhibiting the highest statistical significance in the estimation results (based on the t-statistic values) are retained in the "final" preferred model.

5.1 EXPECTED INFLUENCE OF EXPLANATORY VARIABLES ON BUSINESS ACTIVITIES

The components of vector X_{it} in the general model are a subset of the following variables contained in the database: POPULATION, INCOME, GROWTH1, GROWTH5, LARGERCITY, METRO-AREA, HIGHWAYS, ADT-TOTAL, LENGTHOLD, LENGTHNEW, DISTANCE, CLASS, ADT-BYPASS, SPLIT, ACCESS, and YEAR.

Descriptions of these variables are given in Chapter 3, Table 5. The explanatory variables can be divided into four groups: economic, geographic, traffic, and bypass-related. The existing literature indicates that population change exerts a strong effect on the business infrastructure serving the local area. POPULATION is expected to be the most important single variable in explaining retail sales—more people, more sales. Population has historically had less effect on the service sector than on retailing, because other factors, for the most part, have stimulated the demand for services. However, POPULATION is expected to have considerable explanatory power for service receipts. INCOME is included in the regression models as a second important explanatory variable, because business activity depends not only on how many people there are in a small city, but also on how much they have to spend. Attributes GROWTH1 and GROWTH5 describe changes in the macroeconomic conditions and give the growth rates per capita real Gross National Product in the United States during the period between t and t-1, as well as between t and t-5, respectively. It is expected that business volumes will be higher during an economic boom (GROWTH1 and GROWTH5 should be positive) and lower during a recession (GROWTH1 and GROWTH5 should be negative).

The distance to a city of an equal or a larger size (LARGERCITY) should have a positive effect on business volumes, since the further away a larger city lies, the more reason people will have to shop in their own city. If a small city lies in a METRO-AREA, a negative effect on business volumes is expected, since large metropolitan areas generally offer a better variety of business establishments.

Other important factors affecting business volumes include traffic-related attributes. Transportation improvements allow rural residents to travel further. A larger number of U.S. and state highways entering a city (HIGHWAYS) and higher average daily traffic volumes on incoming highways (ADT-TOTAL) are expected to indicate higher business volumes in a city.

The last group of variables was included in the database in order to capture the effect of a highway bypass on business volumes in a small city. All of these variables have zero values for the control cities as well as for the bypassed cities in the before period, with the exception of two dummy variables. The first of these is CLASS, which classifies bypasses into two categories: U.S. (CLASS=1) and state (CLASS=0) highways. It is very difficult to determine *a priori* if a highway bypass class has any significant effects on business volumes. The other dummy variable is ACCESS type for the highway bypass (=1, if a bypass has limited access and grade separation; otherwise 0). It is expected that access limitations would prevent new businesses from locating on the bypass, and, therefore, the coefficient of this attribute should have a negative sign. High traffic volumes on the bypass (ADT-BYPASS) mean that more people pass local businesses, and, therefore, this attribute is expected to have a negative sign. The percentage of traffic diverted from the bypassed route to the bypass (SPLIT) is correlated with the previous variable and should also have a negative sign. The last three bypass attributes deal with the bypass configuration. It is expected that longer bypass routes (LENGTHNEW) transfer more traffic from business areas, lessening business volumes, and that longer old routes (LENGTHOLD) help to keep traffic in the downtown business areas. A bypass located further away from the city (DISTANCE) is expected to cause greater losses for businesses.

The data year (YEAR) is also included as a possible explanatory variable in the model, since in previous chapters an overall annual increase has been found in business volume trends, with the exception of gas station sales. The latter reached a peak in the late 1960's. A reversal of the trend is caused mainly by more energy efficient automobiles. An overall gas station sales trend (YEAR), shown in Figure 4.2, is used as an explanatory variable for gas station sales.

5.2 TOTAL RETAIL SALES

Retailing is often an important component of the local business infrastructure in small cities. Several models were tested that explain total retail sales in a small city. POPULATION and INCOME were considered as, theoretically, the most important explanatory variables. When a simple regression analysis was performed for total retail sales, it was found that a moderately high 74.4 percent (R^2) of total variation was explained by the POPULATION variable alone, as illustrated in Model 1 in Table 5.1. All the remaining variables were checked in order to identify those that should be included in the final model specification. The result of this analysis is reported under Model 3 in Table 5.1. All variables excluded from the final specification had either insignificant t-values, a coefficient with an implausible sign, a high multicollinearity with a variable already in the model, or a minimal contribution to R^2.

The low value of the Durbin-Watson statistic (0.990) for Model 3 indicates that some auto-correlation is present in the model. Autocorrelation is a condition in which the stochastic disturbance terms are not independent of one another, but are serially correlated through time, leading to an incorrect measure of the error variance. One result of autocorrelation is that the standard errors are biased downwards, leading one to conclude that the coefficient estimates are more precise. Generally, this occurs when the data include observations of the same entity at different times. The autocorrelation in this model is apparently due to the exclusion of relevant variables from the model specification, resulting in shared unobservable components across time periods.

To decrease autocorrelation and to control for inter-city differences, the most significant dummy variables were included in the model. City-specific dummy variables C22 (city number 22 indicates the bypassed city of Silsbee), C23 (the bypassed city of Edinburg), and C101 (the control city of Clarksville) were found to be statistically most different from the reference city, city number 1 (the bypassed city of Bonham) and were added to the final model, presented as Model 4 in Table 15.1. The dummy variables in the final model take into account the following special characteristics of the cities: Silsbee (C22) is a major trade center with high retail sales; Edinburg (C23) is a city on the border with Mexico with low income per capita; and Clarksville (C101) is a small county seat city, which has higher per capita sales than the other cities in the sample. With these dummy variables, it was possible to capture part of the inter-city differences not found by other explanatory variables in the model. Autocorrelation was thereby reduced; the Durbin-Watson statistic increased to 1.167, removing it as a serious concern.

Model 4 in Table 5.1 describes the attributes found to be important in explaining total retail sales in a small city. The most significant variable is POPULATION, as expected from the results of Model 1. The INCOME variable was less significant when the city-specific indicator variables were included. It should be noted that INCOME was taken in this specification as the average per capita income in a county and as such may not fully explain buying power in a small city.

The LARGERCITY variable describes the geographical location of a city relative to other cities. This attribute was modified to a binary indicator variable. It was found that the distance to a larger city has a positive effect on retail sales only if a city is situated at least twenty miles away. If a larger city is very close, it is easy for shoppers to drive a few miles and thereby reach a greater variety of business establishments. In this model, LARGERCITY is a binary indicator variable equal to 1, if the distance to a larger city is twenty miles or more; it is equal to 0 otherwise.

Two traffic-related attributes are included in Model 4. ADT-TOTAL proved to be an important variable in explaining retail activity in a small city. Another significant traffic system characteristic effect is the bypass variable ACCESS. This attribute shows that a bypass has a significantly negative effect on total retail sales in cases where the geometric characteristics of the facility limit access. The estimated coefficient of the ACCESS variable indicates, with further calculations based on the mean values of the variables and corresponding estimated coefficients (-12,402 / -14,495 + 5.561 * 7,641 + 0.576 * 7,455 + 3,027 * 1 +1.305 * 21,170 – 12,402 = -0.242) that the decrease in sales is on average about 20 percent per city in the cases where access is limited on the bypass. Ten cities in the sample have bypasses with limited access.

Table 5.1 ***Estimated coefficients and corresponding t-values for total retail sales models***

Variable	Model 1		Model 2		Model 3		Model 4	
INTERCEPT	3,283	(1.75)	-15,721	(-5.36)	-15,153	(-5.41)	**-14,495**	(-5.99)
POPULATION	6.505	(28.17)	4.493	(15.82)	4.684	(18.14)	**5.561**	(22.84)
INCOME			1.220	(2.56)	1.326	(2.87)	**0.576**	(1.41)
LARGERCITY			5,610	(3.06)	5,081	(2.85)	**3,027**	(1.81)
ADT-TOTAL			1.561	(8.30)	1.388	(9.01)	**1.305**	(9.76)
ADT-BYPASS			-1.713	(-4.08)				
ACCESS					-1,7034	(-5.87)	**-12,402**	(-4.91)
C22							**31,470**	(5.88)
C23							**-44,747**	(-7.09)
C101							**15,186**	(3.21)
F		793		256		275		**248**
C.V.		33.8		28.0		27.2		23.2
R^2		0.747		**0.829**		0.839		**0.883**
Durbin-Watson		0.773		0.952		0.990		**1.167**

Number of observations: 270

Also of interest are those variables that were left out of the final model specification. The variable ADT-BYPASS (traffic volumes on the bypass) was found to have a meaningful significance only if the variable ACCESS is excluded from the specification (see Model 2 in Table 5.1). This seems to confirm the overall negative effect of a highway bypass on retail sales in the cities in the sample. Interestingly, a national economic boom or recession did not significantly influence total retail sales (insignificant coefficients of the variables GROWTH1 and GROWTH5).

A model with five explanatory variables model is relatively convenient to interpret and to use. This preferred model has attributes from all the main categories: economic development, geographical location, and highway characteristics, as well as bypass-related characteristics.

5.3 HIGHWAY-ORIENTED BUSINESSES

In this section, econometric models similar to those described in the previous section are developed to explain highway-oriented sales, namely, gas station sales and restaurant sales.

Gas Station Sales

The estimated parameters and corresponding t-statistics of the preferred model specification for gas station sales are shown under Model 4 in Table 5.2.

The most significant variable in explaining gas station sales is POPULATION, which by itself can explain about 67.0 percent of the total variation in gas station sales (Model 1). Only a rather minor increase in R^2-value (to 0.739) was achieved by adding five statistically significant explanatory variables and one very significant city-specific dummy variable in the final model (Model 4 in Table 5.2). This may be because of the reversal trend (caused mainly by more energy efficient automobiles) established in Figure 4.2. This phenomenon cannot be explained successfully using the variables in the database. The overall trend (YEAR) was included as an explanatory variable in the preferred model and proved to be quite significant.

INCOME was found to be a significant attribute. The nature of gasoline station sales also explains the significance of two highway-related variables in the model: the number of incoming highways (HIGHWAYS) and the traffic volumes on these highways (ADT-TOTAL). Higher traffic volumes will definitely cause higher sales volumes for gasoline stations.

The final attribute included in Model 4 is traffic volume on the bypass, ADT-BYPASS. It is statistically significant and indicates that a highway bypass had a negative effect on overall gasoline station sales in the sampled cities. This variable indicates, in principle, that the more traffic is diverted to the bypass from the bypassed route, the lower gas sales can be expected in a city. The variable ADT-BYPASS indicates, by calculating an estimate based on the mean values of the variables and the corresponding estimated coefficients, (-0.131 * 5,320 / -4,390 – 4.596 * 600.5 + 0.438 * 7,641 + 0.205 * 7,455 + 0.0544 * 21,170 – 0.131 * 5,320 = -0.156) that a highway bypass causes on average about a 15 percent decrease in gasoline station sales in a small city.

Table 5.2 Estimated coefficients and corresponding t-values for gas station sales models

Variable	Model 1		Model 2		Model 3		Model 4	
INTERCEPT	516	(2.88)	-3,362	(-4.63)	-4,435	(-5.64)	**-4,390**	**(-5.74)**
YEAR			4.485	(4.54)	4.738	(4.70)	**4.596**	**(4.69)**
POPULATION	0.514	(23.34)	0.506	(23.94)	0.437	(14.61)	**0.438**	**(15.05)**
INCOME			0.231	(4.89)	0.200	(3.93)	**0.205**	**(4.14)**
HIGHWAYS					177	(2.24)	**182**	**(2.37)**
ADT-TOTAL					0.0569	(2.75)	**0.0544**	**(2.70)**
ADT-BYPASS					-0.105	(-2.35)	**-0.131**	**(-2.98)**
C13							**2,344**	**(3.96)**
F		544		213		114		**106**
C.V.		38.2		36.2		35.3		**34.4**
R^2		0.670		0.706		0.724		**0.739**
Durbin-Watson		1.266		1.288		1.365		**1.407**

Year = -3,074 + 111.5*YEAR – 0.8283*(YEAR)^2
Number of observations: 270

It can be noted that none of the geographical location attributes was found to have a significant effect on gas station sales.

Restaurant Sales

The estimated parameters and corresponding t-statistics of the preferred model specification for restaurant sales in a small city are shown as Model 3 in Table 5.3.

Again, POPULATION is the most significant variable. The traffic volume on incoming highways (ADT-TOTAL) is also a very strong factor. The only new variable is METRO-AREA, which appears to have a significant negative effect. Apparently, a greater variety of restaurants in a nearby large metropolitan area reduces sales in small cities. Also, the other economic variable, INCOME, is significant.

The highway bypass-related variable, ADT-BYPASS, has a significant negative effect on restaurant sales. Additional calculation based on the mean values of the variables and the corresponding estimated coefficients (-0.0674 * 5,320 / -1,827 + 0.336 * 7,641 + 0.062 * 7,455 -296 * 0 + 0.106 * 21,710 – 0.0674 * 5,320 = -0.114) suggests that a highway bypass is associated on average with a 10 to 15 percent decrease of restaurant sales in a small city.

Table 5.3 ***Estimated coefficients and corresponding t-values for restaurant sales models***

Variable	Model 1		Model 2		Model 3	
INTERCEPT	-788	(-5.97)	-2,007	(-10.08)	**-1,827**	**(-9.68)**
POPULATION	0.452	(28.16)	0.330	(17.05)	**0.336**	**(17.33)**
INCOME			0.111	(3.40)	**0.062**	**(1.94)**
METRO-AREA			-602	(-3.51)	**-296**	**(1.77)**
ADT-TOTAL			0.103	(7.95)	**0.106**	**(8.57)**
ADT-BYPASS			-0.0821	(-2.83)	**-0.0674**	**(-2.42)**
C23					**-1,704**	**(-3.54)**
C112					**-1,022**	**(-2.75)**
C113					**1,745**	**(4.51)**
F		792		259		**193**
C.V.		48.4		39.9		**37.1**
R^2		0.747		0.830		**0.855**
Durbin-Watson		0.937		0.946		**1.060**

Number of observations: 270

5.4 SERVICE RECEIPTS

Finally, a regression model was developed to explain service receipts in a small city. The same kind of econometric modeling procedure described in Section 5.2 is used to specify a model for service receipts.

Again, several models were tested. Residual plots from a linear model specification indicated the presence of heteroskedasticity and nonlinearity. Heteroskedasticity refers to a situation where residuals do not all have the same variance. The functional form was transformed to a logarithm (ln-ln) form, eliminating heteroskedasticity and giving a significantly better R^2-value, which is illustrated in Table 5.4.

Model 5 in Table 5.4 shows the key attributes with estimated coefficients and corresponding t-statistics. In this model the new variable NEARBY-CITY is coded as 0, if the distance to a larger city is less than twenty miles; otherwise the variable NEARBYCITY is equal to the variable LARGER-CITY, where LARGERCITY is the variable in the database, and indicates the distance in miles from a bypassed or control city to a larger city. The new variable NEARBYCITY means that the geographical location of a city leads to higher service receipts in a small city only if a larger city is further than twenty miles away. With longer distances, the positive effect still increases gradually.

As expected, POPULATION is again the most significant variable, though this time population alone explains only 48.8 percent of the variation in service receipts. By adding five more explanatory variables, transforming to In-In form, and including three city-specific dummy variables, the explanatory power of the model increased significantly, as the R^2 improved to 0.881.

Table 5.4 ***Estimated coefficients and corresponding t-values for service receipts models***

Variable	Model 1		Model 2		Model 3		Model 4 In-In		Model 5 In-In	
INTERCEPT	-4,841	(-5.92)	-10,263	(-7.74)	-8,699	(-7.56)	-10.04	(-13.31)	**-8.78**	**(-12.08)**
YEAR							0.0215	(6.09)	**0.0243**	**(7.03)**
POPULATION	1.610	(15.98)	1.026	(8.29)	0.514	(4.33)	1.119	(17.52)	**1.022**	**(15.99)**
INCOME			0.462	(2.08)	0.508	(2.66)	0.486	(5.35)	**0.388**	**(4.35)**
NEARBYCITY							0.00270	(1.83)	**0.00303**	**(2.26)**
ADT-TOTAL			0.463	(6.19)	0.533	(8.23)	0.290	(3.79)	**0.315**	**(4.36)**
ACCESS			-4184	(2.96)	-3,679	(-3.13)	-0.171	(-2.05)	**-0.116**	**(-1.54)**
C6									**-0.671**	**(-4.34)**
C118					25,515	(9.74)			**0.545**	**(3.55)**
C119									**-0.870**	**(-5.08)**
F		255		95		122		253		**215**
C.V.		113.7		102.2		87.8		4.6		**4.1**
R^2		0.488		0.590		0.698		0.852		**0.881**
Durbin-Watson		0.972		0.859		1.031		1.121		**1.248**

Number of observations: 270

INCOME level also has a very significant influence on service receipts. Furthermore, service receipts are apparently traffic-related, based on the significance of the ADT-TOTAL variable. Also, an increasing trend captured by the linear variable YEAR was found to be significant.

The last traffic characteristic found to have a significant effect on service receipts is the variable ACCESS. This variable shows, as expected, that a bypass has a significantly negative effect on service receipts in cases where the geometric characteristics of the facility provide for limited access. In some models tested for service receipts, the variable DISTANCE (between a bypass and a bypassed route) proved to be significant and negative, although it was excluded from the final model.

5.5 SEGMENTATION BY POPULATION

The literature review indicated that cities with larger populations have a somewhat better chance of adjusting to the economic changes which may be induced by the bypass. To examine this hypothesis, the database was divided into two parts: small cities with a population of less than 6,000 at the time when the bypass was opened, and cities with more than 6,000 inhabitants, referred to as large cities in the remainder of this section. These groups consist of 25 and 21 cities, respectively. The comparison was performed by calibrating the preferred model specifications described in the previous sections (Tables 5.1 through 5.4) for each group separately. The equations have the same format, and, therefore, the results are easily comparable.

The statistical significance of the coefficients for the two models is inferred from the t-values. This is the major method to compare the two regressions made for the two population groups. Also, a pairwise comparison of individual coefficients for the two models is performed. The null hypothesis, that the paired coefficients of the models for the two population groups are the same, is tested at the 0.05 significance level.

One of the popular methods of testing differences between two regressions is the F-test. This test is based on the assumptions that the residuals of two different models are distributed normally with zero mean and constant or homoscedastic variance and that the residuals of the two regressions are independently distributed. If the computed F-value exceeds the critical F-value, the hypothesis that the regressions are the same is rejected (Gujarati, 1988). In these cases, the critical F-values are 2.06 for the models with seven parameters and 2.14 for the models with six parameters.

Table 5.5 shows the estimation results of the total retail sales models for the two population groups. The preferred model from Table 5.1 is also included to facilitate the comparison. The t-values of the t-statistics for the various coefficients are almost identical for the two population groups. The only difference seems to be in the variable INCOME, which has an insignificant value for small cities. The negative effect of a highway bypass which was established by the variable ACCESS is very significant in both cases, and no difference related to the bypass can be established between the two population groups.

Table 5.5 ***Estimated coefficients and corresponding t-values for total retail sales models calibrated for two population groups***

Variable	All Cities	Small Cities	Large Cities
INTERCEPT	-14,495 (-5.99)	-3,529 (-1.39)	-17,749 (-3.16)
POPULATION	5.561 (22.84)	5.262 (8.75)	4.408 (9.72)
INCOME	0.576 (1.41)	-0.351 (-1.12)	1.476 (1.86)
LARGECITY	3,027 (1.81)	2,765 (2.12)	7,545 (2.07)
ADT-TOTAL	1.305 (9.76)	0.821 (6.50)	1.631 (7.09)
ACCESS	-12,402 (-4.91)	-7,411 (-3.31)	-5,767 (-3.87)
C22	31,470 (5.88)		28,059 (3.87)
C23	-44,747 (-7.09)		-34,225 (-3.72)
C101	15,186 (3.21)	14,760 (5.42)	
F	248	54	77
C.V.	23.2	22.6	19.2
R^2	0.883	0.700	0.827
Durbin-Watson	1.167	1.085	1.314

Number of observations:
- All cities 270
- Small cities 149
- Large cities 121

The computed F-value, 11.67, for the total retail sales models in Table 5.5 exceeds the critical value, and, therefore, it can be concluded that the two regressions are different. The pairwise comparison of individual coefficients indicate that the difference in the coefficients for the ADT-TOTAL variable is statistically significant; total retail sales are less dependent on traffic in small cities.

The comparison of gas station sales between small and large cities can be seen in Table 5.6 with corresponding coefficients and t-statistics. The t-statistics indicate that small cities are more dependent on incoming traffic and that a highway bypass has somewhat more negative effect on business volumes. It should also be noted that the INCOME and HIGHWAYS variables are not statistically significant in the model for small cities.

The computed F-value, 4.70, for the gas station sales models in Table 5.6 exceeds the critical value, and, therefore, it can be concluded that the two regressions are different. The pairwise comparison of individual coefficients indicates that the difference in the coefficients for the INCOME variable is statistically significant; gas station sales are less dependent on residents' income levels in small cities.

Table 5.6 ***Estimated coefficients and corresponding t-values for gas station sales models calibrated for two population groups***

Variable	All Cities	Small Cities	Large Cities
INTERCEPT	-4,390 (-5.74)	-3,218 (-5.37)	-5,012 (-2.96)
YEAR	4,596 (4.69)	4.955 (6.80)	4.520 (2.11)
POPULATION	0.438 (15.05)	0.534 (8.01)	0.363 (6.42)
INCOME	0.205 (4.14)	0.020 (0.51)	0.356 (3.39)
HIGHWAYS	182 (2.37)	-6 (-0.09)	320 (2.28)
ADT-TOTAL	0.0544 (2.70)	0.0600 (3.02)	0.0656 (1.86)
ACCESS	-0.131 (-2.98)	-0.114 (-2.85)	-0.133 (-1.74)
C13	2,344 (3.90)		1,922 (2.37)
F	106	30	24
C.V.	34.4	32.2	30.2
R^2	0739	0.567	0.603
Durbin-Watson	1.407	1.707	1.402

YEAR = -3,074 + 111.5*YEAR - 0.8283*(YEAR)^2
Number of observations:
- All cities 270
- Small cities 149
- Large cities 121

Table 5.7 ***Estimated coefficients and corresponding t-values for restaurant sales models calibrated for two population groups***

Variable	All Cities	Small Cities	Large Cities
INTERCEPT	-1,827 (-9.68)	-761 (-4.37)	-2,738 (-7.02)
POPULATION	0.336 (17.33)	0.322 (8.45)	0.273 (8.16)
INCOME	0.0621 (1.94)	0.0459 (2.12)	0.111 (1.93)
METRO	-296 (-1.77)	-283 (-1.93)	-807 (-3.15)
ADT-TOTAL	0.106 (8.57)	0.029 (2.87)	0.176 (9.10)
ADT-BYPASS	-0.0674 (-2.42)	-0.034 (-1.54)	-0.076 (-1.77)
C23	-1,704 (-3.54)		-1,587 (-2.57)
C112	-1,022 (-2.75)		-1,081 (-2.50)
C113	1,745 (4.51)		1,453 (3.24)
F	193	31	94
C.V.	37.1	39.6	25.9
R^2	0.855	0.527	0.869
Durbin-Watson	1.060	1.129	1.355

Number of observations:
- All cities 270
- Small cities 149
- Large cities 121

Table 5.7 shows the estimation results for the models of restaurant sales for the two population groups. The t-statistics are much the same for these two population groups. The most noticeable difference seems to be in the ADT-TOTAL variable, which is more significant for large cities.

The computed F-value, 17.77, for the restaurant sales models in Table 5.7 exceeds the critical value, and, therefore, it can be concluded that the two regressions are different. The pairwise comparison of individual coefficients indicate that the difference in the coefficients for the ADT-TOTAL variable is statistically significant; restaurant sales are less dependent on traffic in small cities than in the larger cities.

Finally, service receipts of small and large cities are compared in Table 5.8. The t-statistics show that traffic volumes on incoming highways do not have statistically significant effects on service receipts in small cities. Large cities exhibit much the same significance in all the explanatory variables which were established in the original modeling work for all cities. Table 5.8 also indicates that the effect of a highway bypass on service receipts is only slightly negative for small cities, as illustrated by the variable ACCESS.

The computed F-value, 6.75, for the service receipts models in Table 5.8 exceeds the critical value, and, therefore, it can be concluded that the two regressions are different. The pairwise comparison of individual coefficients indicates that the difference in the coefficients for the ADT-TOTAL variable is statistically significant; service receipts are less dependent on traffic in small cities.

In summary, the negative effect of a highway bypass on total retail sales and highway-oriented retail sales was found to be about the same size for both small and large cities. In small cities, a highway bypass does not have a significant negative effect on service receipts, whereas large cities were found to suffer losses because of a bypass. Population was the most significant explanatory variable in all models. Retail sales and service receipts are less dependent on traffic in small cities. The compared regression models for the two population groups are statistically different.

5.6 MODEL APPLICATIONS

Once estimates of the parameters of an econometric model are available, the model can be employed to forecast the dependent variable, if the associated values of the explanatory variables are given. Next, the predictive accuracy of the developed models is tested on cities outside the original sample. All Texas cities with populations between 2,500 and 25,000, bypassed during the period 1980 to 1986, were included in the test group. The test group consists of five cities: Gatesville, Marlin, Livingston, Smithville, and Sinton. Data for 1987 business volumes and necessary explanatory variables were obtained from the same sources used in the original sample (Table 5.9).

Table 5.8 ***Estimated coefficients and corresponding t-values for service receipts models calibrated for two population groups***

Variable	All Cities	Small Cities	Large Cities
INTERCEPT	-8.78 (-12.08)	-6.38 (-4.15)	-10.13 (-8.15)
YEAR	0.0243 (7.03)	0.0242 (4.53)	0.0231 (5.50)
POPULATION	1.022 (15.99)	1.104 (6.46)	0.817 (7.12)
INCOME	0.388 (4.35)	0.298 (2.16)	0.419 (3.58)
NEARBYCITY	0.00303 (2.26)	0.00355 (1.53)	0.00396 (2.37)
ADT-TOTAL	0.315 (4.36)	0.063 (0.61)	0.626 (6.02)
ACCESS	-0.116 (-1.54)	-0.148 (-1.27)	-0.213 (-2.25)
C6	-0.671 (-4.34)	-0.562 (-3.24)	
C118	0.545 (3.55)		0.582 (4.15)
C123	-0.870 (-5.08)		-0.749 (-4.57)
F	21.5	53	130
C.V.	4.1	4.7	3.1
R^2	0.881	0.727	0.902
Durbin-Watson	1.248	1.357	1.398

Number of observations:
- All cities 270
- Small cities 149
- Large cities 121

The average percentage prediction error, using the developed models, was 14 percent for total retail sales, 23 percent for gas station sales, 8 percent for restaurant sales, and 46 percent for service receipts (Table 5.10). Estimates for Sinton were significantly worse than those for the other cities. While calculating a 90 percent confidence interval for the model regression lines, it was noted that all predictions, except two, namely, service receipt estimates for the cities of Livingston and Smithville, were in that region. Therefore, 90 percent of the estimates were in the model's 90 percent confidence interval, which is the expected proportion (Figures 5.1 through 5.4). It is interesting to note the total retail sales prediction accuracy for the city of Livingston, which had extremely high per capita volumes in 1987.

Figure 5.1 ***Estimated retail sales with a 90 percent confidence interval versus actual retail sales for the test group cities***

Table 5.9 ***Data for model applications, 1987 values***

City	Gainesville	Marlin	Livingston	Smithville	Sinton
POPULATION	9,922	6,599	4,991	3,278	5,697
INCOME	10,921	11,028	10,866	11,042	10,936
METRO-AREA	1	0	0	0	1
LARGERCITY	30	27	29	11	19
HIGHWAYS	4	4	5	3	4
ADT-BYPASS	14,200	14,600	55,400	16,700	28,900
ACCESS	3,000	4,300	13,700	6,600	8,100
	1	1	0	1	1

Table 5.10 ***Model applications—actual and estimated business volumes for test group cities***

City	Gainesville	Marlin	Livingston	Smithville	Sinton
Total Retail Sales					
Estimate	56,127	38,232	94,842	19,485	48,797
Actual	49,719	34,115	85,341	18,708	33,129
Difference	+6,408	+417	+9,501	+777	+15,668
Difference (%)	+11	+12	+11	+4	+32
Gas Station Sales					
Estimate	4,954	3,372	3,805	1,552	3,239
Actual	4,697	2,552	3,354	2,169	5,214
Difference	+217	-820	+451	-617	-1,975
Difference (%)	+4	+32	+13	-28	-37
Restaurant Sales					
Estimate	3,191	2,332	7,447	1,285	2,987
Actual	2,993	2,498	7,962	1,263	2,422
Difference	+198	-166	-515	+22	+565
Difference (%)	+6	-6	-6	+1	+23
Service Receipts					
Estimate	11,310	7,480	9,707	3,519	7,331
Actual	10,178	8,836	24,026	1,743	5,067
Difference	+1,132	-1,356	-14,319	+1,776	+2.264
Difference (%)	+10	-15	-59	+101	+44

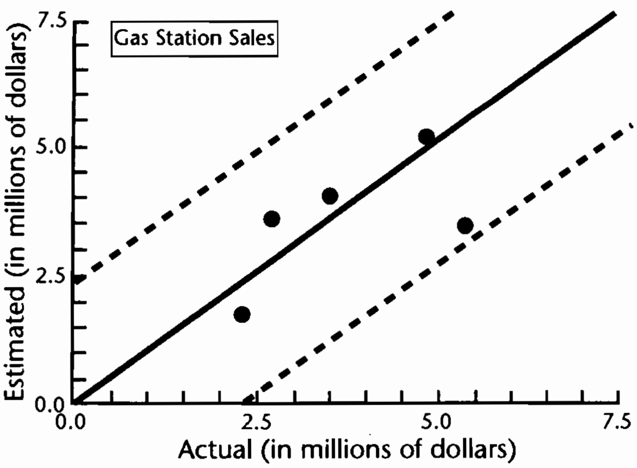


Figure 5.2 ***Estimated gas station sales with a 90 percent confidence interval versus actual gas station sales for the test group cities***

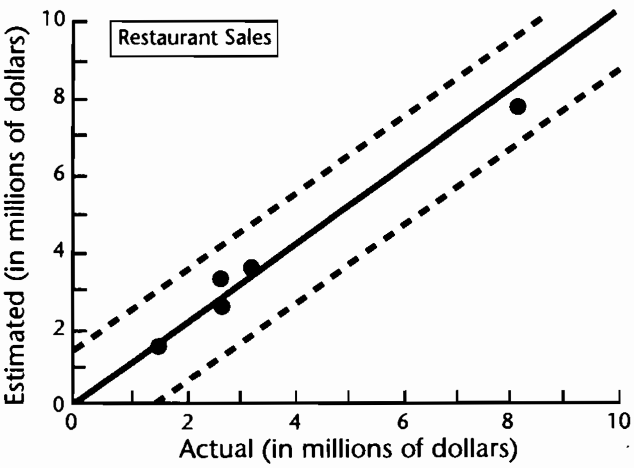


Figure 5.3 ***Estimated restaurant sales with a 90 percent confidence interval versus actual restaurant sales for the test group cities***

The model's prediction accuracy for a test group was also analyzed by calculating the coefficient of variation, defined as the root mean square error of the estimates relative to the mean actual value for the test group. This was compared to the coefficient of variation in the original preferred model. Table 5.11 shows the results of this model validation. The test group estimates gave the same average variation for business volumes that were noted in the original modeling work for total retail sales and gasoline station sales. Restaurant sales estimates were significantly better than expected and service receipts were worse than expected.

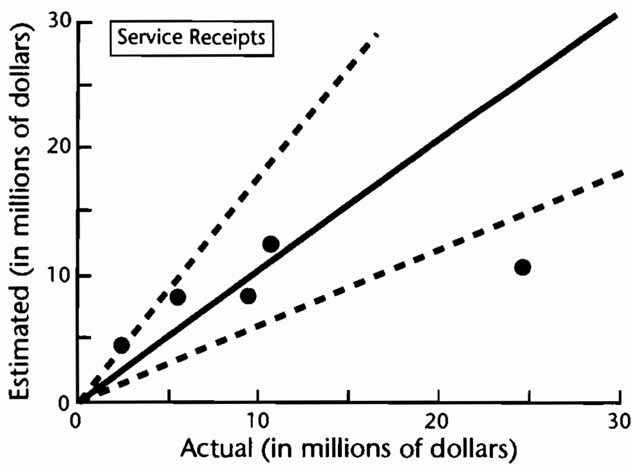


Figure 5.4 ***Estimated service receipts with a 90 percent confidence interval versus actual service receipts for the test group cities***

Table 5.11 ***Model validation. Coefficient of variation with preferred model for original sample and test group***

Model	Coefficient of Variation: Sample	Coefficient of Variation: Test Group
Total Retail Sales	23.2	22.4
Gas Station Sales	34.4	31.7
Restaurant Sales	37.1	11.7
Service Receipts (In-In)	4.1	6.8

5.7 CLOSURE

In this chapter, several econometric models were presented to explain retail sales and service receipts as indicators of business activity in a small city.

In all models, the population of a city was the dominant explanatory variable determining business activity. Also, income per capita and average daily traffic on incoming highways were statistically significant variables.

The most important implication of these studies is that a highway bypass caused a statistically significant negative effect on the business activities in the cities of the sample. The negative effects of a highway bypass on total retail sales and highway-oriented retail sales were found to be equally statistically significant for all cities under 25,000 in population. In cities under 6,000, a highway bypass does not have a significant negative effect on service receipts, whereas cities greater than 6,000 were found to suffer losses because of a bypass. Business volumes in the smaller cities were found to be less dependent on traffic.

CHAPTER 6. STUDY FINDINGS

The first section of this chapter is a summary of the results of this report. In the second section study results are compared to previous findings. The third and fourth sections of Chapter 6 outline the conclusions and recommendations.

6.1 SUMMARY

This report has presented an analysis of the effects of highway bypasses on the business activities in a sample of small Texas cities with a population varying from 2,500 to 25,000. For the purpose of this study, a highway bypass was that segment of a new highway that rerouted through-traffic around a central business district. Interstate highway bypasses were excluded from the analysis.

A database was developed to conduct the analysis and contained several economic variables that could be affected by highway bypass construction. The database also contained highway system and geographic considerations which could independently affect these economic variables. The data were analyzed using four major methods. An initial explanatory analysis (using the before-and-after method and matched pairs) did not reveal a significant relationship between highway bypass construction and a change in business activity.

The projected development method revealed important insights into how business conditions react to a highway bypass. It was found that fast-growing cities prior to the bypass construction, with relatively low retail sales per capita, will experience positive growth after bypass construction. A highway bypass with low traffic volumes and unlimited access can assist this positive development.

The database was further elaborated with more formal models, which related a number of variables to changes in the economic activity of the city. It was possible to create fairly accurate econometric models to predict total retail sales, highway-oriented sales, and service receipts based on certain unique local conditions and factors.

The results of the econometric study show that the way in which a business community responds to a highway bypass is complex. Overall, business volumes for each category for a given city are mainly a function of the city's population rather than of external traffic. However, average daily traffic volumes on incoming highways had significant explanatory power, as did per capita income. The most important implication of the econometric models was that highway bypasses are associated with a statistically significant negative effect on business volumes in the small Texas cities that were studied.

The projected development method approach identified factors which influence the direction of the effect of a highway bypass on retail sales in a small city. The econometric model specification for total retail sales did reflect the conclusions of the projected development method. The results of these two models are consistent.

6.2 DISCUSSION

In this study, the economic effects of highway bypasses in small Texas cities were measured in terms of business volumes. The most significant results, statistically, were obtained with econometric models that related business volume indicators to explanatory variables.

The prediction accuracy of the models was tested using cities outside the original sample. The average percentage error for predicting business volumes was 23 percent, which confirmed the models' usefulness as a predictive tool. The models could be improved by adding explanatory variables into the database that are more closely related to a city's economic development.

Econometric models confirmed that many other local factors, besides highway improvement, come into play to affect economic growth, as stated by Weisbrod (1990). The main findings of this study are that business volumes in a small city can be explained, mostly, by non-bypass-related variables. Still, a highway bypass had a small, yet statistically significantly negative effect on sales volumes. These results match, for the most part, the findings of studies made in the 1960's, 1970's, and 1980's (Horwood et al, 1965; Skorpa et al, 1974; and Siccardi, 1986).

Previous studies found that highway-oriented businesses such as service stations and restaurants are the most affected by highway bypasses (Horwood et al., 1965; Skorpa et al., 1974; and Siccardi, 1986). This study indicated that highway-oriented sales did not suffer more than all retail sales combined, on average.

Early studies indicated that cities with small populations suffered substantially more from highway bypasses (Horwood, 1965, and Mackie, 1983). The results of this study show that the econometric model specifications for two populations groups are statistically different. However, the negative effect of a highway bypass was found to have equal significance for all cities under 25,000 in population.

6.3 CONCLUSIONS

The following conclusions are derived from the analyses made in this report:

1. If traffic flow and local access is improved by reducing through-traffic on major streets, a highway bypass will be seen as a positive development by local citizens.
2. A highway bypass may cause a decrease in business volumes in small cities. However, other important local factors appear to affect business activities more seriously. The way in which a business community responds to a highway bypass is complex.
3. Business volumes in fast-growing cities with inadequate infrastructure and with a high proportion of local traffic may be boosted by highway bypass construction.
4. A combined cross-sectional and time-series database can form the basis for the development of a fairly accurate econometric model to predict total retail sales, gasoline service station sales, restaurant sales, and service receipts. Population is the most important explanatory variable; income per capita and traffic volumes on incoming highways also have significant effects on the equations. A highway bypass-related variable, such as bypass traffic volumes or bypass access limitations, brought a minor but statistically significant decrease to business volumes in bypassed cities.

REFERENCES

Allen, B. L., D. W. Butterfield, A. Kazakov, M. L. Kliman, A. A. Kubursi, and J. D. Welland, "Measuring Economic Stimulation from Capital Investment In Transportation," Transportation Research Record 1197, Transportation Research Board, Washington, D.C., 1988.

Amano, Kozo, and Masahisa Fujita, "A Long Run Economic Effect Analysis of Alternative Transportation Facility Plans—Regional and National," Journal of Regional Science, Vol 10, No. 3, 1970.

Andersen, S. Johann, "Traffic and Spatial Impacts and the Classification of Small Highway Bypassed Cities," Thesis for the Degree of Master of Science in Engineering, The University of Texas at Austin, May 1992.

Beemiller, Richard M., "A Hybrid Approach to Estimating Economic Impacts Using the Regional Input-Output Modeling System (RIMS II)," paper presented at the 1989 Transportation Research Board Conference on Transportation and Economic Development, Williamsburg, Virginia, November 1989.

Bell, Michael, and Eran Feitelson, "Bottlenecks and Flexibility: Key Concepts for Identifying Economic Development Impacts of Transportation Services," Transportation Research Record 1274, Transportation Research Board, Washington, D.C., 1990.

Briggs, Ronald, "Interstate Highway System and Development in Nonmetropolitan Areas," Transportation Research Record 812, Transportation Research Board, Washington, D.C., 1981.

Buffington, Jesse L., "An Economic Impact Study of Interstate Highway 35E on Waxahachie, Texas," Research Report 46, Texas Transportation Institute, College Station, Texas, 1966.

Buffington, Jesse, and Dock Burke, "Employment and Income Impacts of Highway Expenditures on Bypass, Loop and Radial Highway Improvements," Research Report 1066-F, Texas Transportation Institute, College Station, Texas, 1981.

Chui, Margaret K., and Jesse L. Buffington, "A Generalized Approach of Short Range Transit Alternatives," Research Report 1106-3, Texas Transporation Institute, College Station, Texas, November 1989.

Dodgson, J. S., "Motorway Investment, Industrial Transport Costs and Subregional Growth: A Case Study of the M62," Regional Studies, Vol 8, 1974.

Drew, Donald R., "Overview of Methodology, Conference of Transportation and Economic Development," Transportation Research Record 1274, Transportation Research Board, Washington, D.C., 1990a.

Drew, Donald R., "Conference Summary, Conference of Transportation and Economic Development," Transportation Research Record 1274, Transportation Research Board, Washington, D.C., 1990b.

Eagle, David, and Yorgos J. Stephanedes, "Dynamic Highway Impacts on Economic Development," Transportation Research Record 1116, Transportation Research Board, Washington, D.C., 1987.

Forkenbrock, David J., Thomas F. Pogue, Norman S. J. Foster, and David J. Finnegan, "Road Investment to Foster Local Economic Development," The Public Policy Center, University of Iowa, Iowa City, Iowa, 1990.

Gaegler, Annette M., James W. March, and Paul Weiner, "Dynamic Social and Economic Effects of the Connecticut Turnpike," Transportation Research Record 716, Transportation Research Board, Washington, D.C., 1979.

Gamble, Hays B., and Thomas B. Davinroy, "Benefical Effects Associated with Freeway Construction: Environmental, Social and Economic," National Cooperative Highway Research Program Report 193, Transportation Research Board, Washington, D.C., 1978.

Hartgen, David T., "Twin Studies: Applications to Transportation Analysis," paper presented at the 69th Annual Meeting of Transportation Research Board, Washington, D.C., 1989.

Hartgen, David T., Alfred W. Stuart, Wayne A. Walcott, and James W. Clay, "Role of Transportation in Manufacturers' Satisfaction with Locations," Transportation Research Record 1274, Transportation Research Board, Washington, D.C., 1990.

Horwood, Edgar, Carl Zellner, and Richard Ludwig, "Community Consequences of Highway Improvement," National Cooperative Highway Research Program Report 18, Highway Research Board, Washington, D.C., 1965.

Horwood, Edgar, "Community Consequences of Highway Improvement," National Cooperative Highway Research Record 96, Highway Research Board, Washington, D.C., 1965.

Humphrey, Craig R., and Ralph A. Sell, "The Impact of Controlled Access Highways in Population Growth in Pennsylvania Nonmetropolitan Communities, 1940-1970," Rural Sociology, Vol 40, 1975.

Leontieff, Wassily W., "Quantitative Input-Output Relations in the Economic System of the United States," The Review of Economics and Statistics, August 1936.

Lewis, David, "Primer on Transportation Productivity and Economic Development," National Cooperative Highway Research Program Report 342, Transportation Research Board, Washington, D.C., 1991.

McFarland, William F., Dock Burke, Jeffrey Memmott, and Jesse L. Buffington, "Economic Analysis of Transportation Expenditures: A Literature Review," Research Report 1106-2, Texas Transportation Institute, College Station, Texas, November 1989.

McKain, Walter, "Community Response to Highway Improvement," Highway Research Record 96, Highway Research Board, Washington, D.C., 1965.

Mackie, A .M., "Effect of By-passes on Town Development and Land Use," Planning and Transpotration Research, Summer Annual Meeting, Volume P239, London, England, 1983.

Moon, Henry E., Jr., "Interstate Highway Interchanges Reshape Rural Communities," Rural Development Perspectives, Vol 4, No. 1, October 1987.

Nelson, Arthur C., "Investigating the Association Between Developmental Highways and Economic Development in Georgia," paper presented at the 69th Annual Meeting of Transportation Research Board, Washington, D.C., January 1990.

Perera, Max H., "Framework for Classifying and Evaluating Economic Impacts Caused by a Transportation Improvement," Transportation Research Record 1274, Transportation Research Board, Washington, D.C., 1990.

Politano, Arturo L., and Carol J. Roadifer, "REIHMS: A Prototype Model for Regional Economic Analysis of Highway Projects and Systems," Transportation Research Record 1229, Transportation Research Board, Washington, D.C., 1989.

Siccardi, A. J., "Economic Effects of Transit and Highway Construction and Rehabilitation," Journal of Transportation Engineering, Vol 112, No. 1, January 1986.

Skorpa, Lidvard, Richard Dodge, C. Michael Walton, and John Huddleston, "Transportation Impact Research: A Review of Previous Studies and a Recommended Methodology for the Study of Rural Communities," Council for Advanced Transportation Studies, The University of Texas at Austin, March 1974.

Stephandes, Yorgos, and David M. Eagle, "Time-Series Analysis of Interactions Between Transportation and Manufacturing and Retail Employment," Transportation Research Record 1074, Transportation Research Board, Washington, D.C., 1986.

Stephandes, Yorgos J., "Distributional Effects of State Highway Investment on Local and Regional Development," Transportation Research Record 1274, Transportation Research Board, Washington, D.C., 1990.

Steptoe, R., and C. Thornton, "Differential Influence of an Interstate Highway on the Growth and Development of Low-Income Minority Communities," Transportation Research Record 1074, Transportation Research Board, Washington, D.C., 1986.

Straszheim, Mahlon R., "Researching the Role of Transportation in Regional Development," Land Economics, Vol 48, No. 3, 1972.

Sullivan, Edward C., "Transportation and Economic Development on the Pacific Coast," ITS Review, Vol 12, No. 1, 1988.

Texas Almanac 1990-1991, Published by the Dallas Morning News, Dallas, Texas, 1989.

Texas Historical Association, The Handbook of Texas, Volume 2, Austin, Texas, 1952.

Weisbrod, Glen E., and James Beckwith, "Measuring Economic Development Benefits for Highway Decision Making: The Wisconsion Case," paper presented at the 69th Annual Meeting of Transportation Research Board, Washington, D.C., January 1990.

Wheat, Leonard A., "The Effects of Modern Highways on Urban Manufacturing Growths," Highway Research Record 277, Highway Research Board, Washington, D.C., 1969.

Whitehurst, Clinton H., "The Road Around: A Study of the Economic Impact of Highway Bypasses on Rural South Carolina Cities and Towns," Clemson College, South Carolina, 1965.

Wilson, Frank R., Albert M. Stevens, and Timothy R. Holyoke, "Impact of Transportation on Regional Development," Transportation Research Record 851, Transportation Research Board, Washington, D.C., 1982.

Wilson, F. R., G. M. Graham, and Mohammed Aboul-Ela, "Highway Investment as a Regional Policy Tool," Transportation Research Record 1046, Transportation Research Board, Washington, D.C., 1985.

APPENDIX 1

LIST OF BYPASSED CITIES IN TEXAS

City	*Population in the year bypass was opened*	*Highway*	*County*	*Year bypass was opened*
District 1				
Whitesboro	2,839	US 377, US 82	Grayson	1968, 1973
Randolph	70 (-87 population)	State 121	Fannin	1967
Cooper	2,249	State 24	Delta	1968
Emory	613	US 69	Rains	1964
Sulphur Springs	10,049	IH-30, State 19	Hopkins	1956, 1966
Greenville	22,047	IH-30, US 69	Hunt	1959, 1970
Commerce	5,809	State 24	Hunt	1958
Quinlan	614	State 34	Hunt	1957
Bonham	7,698	State 121	Fannin	1970
District 2				
Antelope	65 (-87)	US 281	Jack	1959
Alvord	942	US 287	Wise	1982
Decatur	3,531	US 287, US 380	Wise	1961
Rhome	410	US 287	Wise	1972
Bridgeport	3,376	US 380	Wise	1964
Granbury	2,375	US 377	Hood	1966
Stephenville	7,743	US 377, US 281	Erath	1962
District 3				
Vernon	11,798	US 287	Wilbarger	1965
Oklaunion	138 (-87)	US 287	Wilbarger	1959
Electra	3,981	US 287	Wichita	1969
Henrietta	2,947	US 287	Clay	1972
Jolly	183 (-87)	US 287	Clay	1964
Bowie	5,627	US 287	Montague	1978
District 4				
Lefors	835	State 273	Gray	1966

City	*Population in the year bypass was opened*	*Highway*	*County*	*Year bypass was opened*
District 5				
Littlefield	6,937	US 84	Lamb	1966
Shallowater	1,102	US 84	Lubbock	1963
Slaton	6,574	US 84	Lubbock	1964
Wolfforth	597	US 82	Lubbock	1960
Tahoka	2,967	US 87	Lynn	1968
District 6				
–				
District 7				
Christoval	216 (-87)	US 277	Tom Green	1987
District 8				
Weinert	254	US 277	Haskell	1976
Snyder	12,778	US 84	Scurry	1964
Hermleigh	200 (-87)	US 84	Scurry	1962
Stamford	4,496	US 277	Jones	1987
Abilene	85,888	IH-20,US 83	Taylor	1959
District 9				
Covington	230	State 171	Hill	1975
Gatesville	6,727	State 36	Coryell	1986
Killeen	40,899	US 190	Bell	1975
Marlin	7,099	State 6	Falls	1980
Temple	29,429	State 36, US 190	Bell	1958
		IH-35		1959
District 10				
Canton	3,518 (-87)	State 64	Van Zandt	1988
Larue	160 (-87)	US 175	Henderson	before 1945
Palestine	14,194	US 79	Anderson	1964
Neches	114 (-87)	US 79	Anderson	1959
District 11				
Nacogdoches	18,596	US 59	Nacogdoches	1966
Grapeland	1,465	US 287	Houston	1976
Shephard	1,165	US 59	San Jacinto	1965
Livingstone	5,074	US 59	Polk	1981
Goodrich	350 (-87)	US 59	Polk	1963
District 12				
Splendora	190	US 59	Montgomery	1968
Beasly	434	US 59	Fort Bend	1981
Kendleton	653	US 59	Fort Bend	1981
Alvin	7,654	State 35	Brazoria	1964

District 13

La Grange	4,155 (-87)	State 71	Fayette	1990
Wharton	8,342	US 59	Wharton	1974
Pierce	49 (-87)	US 59	Wharton	1973
El Campo	9,133	US 59	Wharton	1973
Hungerford	179 (-87)	US 59	Wharton	1969
Louise	310 (-87)	US 59	Wharton	1978
Hillje	51 (-87)	US 59	Wharton	1978
Edna	5,459	US 59	Jackson	1974
Ganado	1,692	US 59	Jackson	1974

District 14

Johnson City	642	US 281	Blanco	1962
Briggs	92 (-87)	US 183	Burnet	1957
Liberty Hill	300 (-87)	State 29	Williamson	1958
Taylor	10,017	US 79	Williamson	1974
Lexington	603 (-50)	US 77	Lee	before 1950
Elgin	3,168 (-50)	US 290	Bastrop	before 1950
Bastrop	3,001	State 71	Bastrop	1960
Smithville	4,399	State 71	Bastrop	1984

District 15

Floresville	1,949 (-50)	US 181	Wilson	before 1950
Stockdale	1,122	US 87	Wilson	1965
New Braunfels	16,745	IH-35, State46	Comal	1960, 1965
Seguin	16,318	IH-10, State 123	Guadalupe	1969, 1972

District 16

Kenedy	4,254	US181	Karnes	1953
Karnes City	2,620	US 181	Karnes	1953
Beeville	13,826	US 181	Bee	1973
Gregory	1,354	US 181, State 35	San Patricio	1952, 1952
Sinton	6,037	US 77	San Patricio	1981
Robstown	9,071	US 77	Nueces	1956

District 17

Brenham	7,660	US 290, State 36	Washington	1959, 1964
Teague	2,728	US84	Freestone	1960
Navasota	5,283	State 6	Grimes	1972

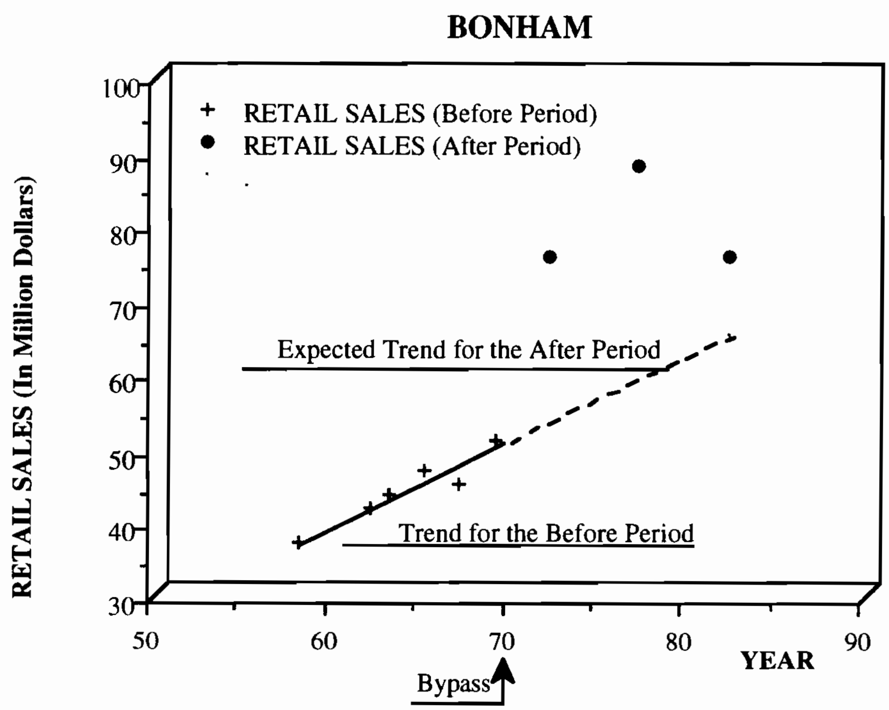
District 18

Celina	1,263	State 289	Collin	1969
Prosper	436	State 289	Collin	1966
Blue Ridge	462	State 78	Collin	1981
Pilot Point	1,581	US 377	Denton	1968
Aubrey	573	US 377	Denton	1962
Midlothian	2,162	US 67	Ellis	1968
Kaufman	2,775	US 175	Kaufman	1957
Kemp	1,214	US 175	Kaufman	1984
Waxahachie	14,155	IH-35E, US 287	Ellis	1961, 1976

City	*Population in the year bypass was opened*	*Highway*	*County*	*Year bypass was opened*
District 19				
De Kalb	2,104	US 259	Bowie	1964
Pittsburg	3,207	US 271	Camp	1951
Atlanta	4,355	US 59	Cass	1963
Beckville	558	State 149	Panola	1951
District 20				
Newton	1,529	State 87	Newton	1970
Silsbee	7,643	US 96	Hardin	1979
Cleveland	6,339	US 59	Liberty	1988
Jasper	4,792	US 190	Jasper	1958
District 21				
Edinburg	22,001	US 281	Hidalgo	1977
District 23				
Goldthwaite	1,548	US 84	Mills	1951
Coleman	5,761	US 84	Coleman	1968
District 24				
–				
District 25				
Spur	2,183 (-50)	State 70	Dickens	before 1950

APPENDIX 2

Total retail sales trends for the bypassed cities; trend for the period before the highway bypass was opened and expected trend for the after period



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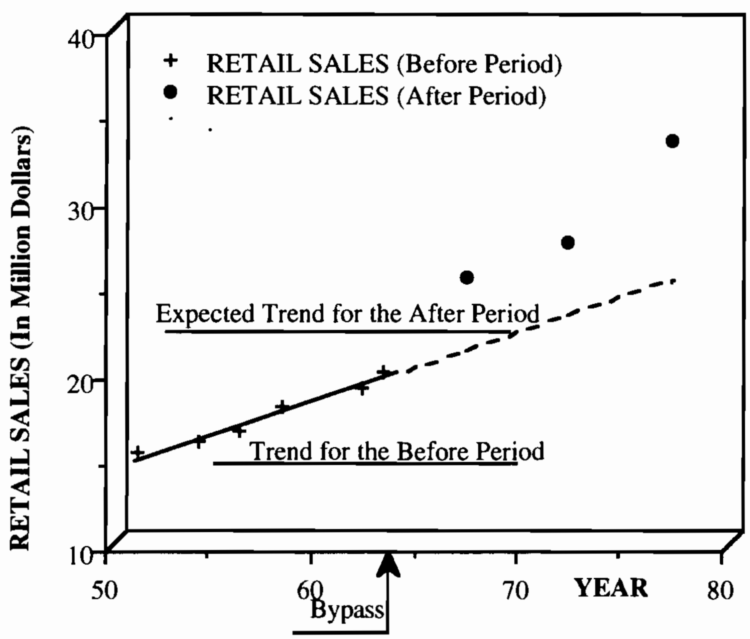

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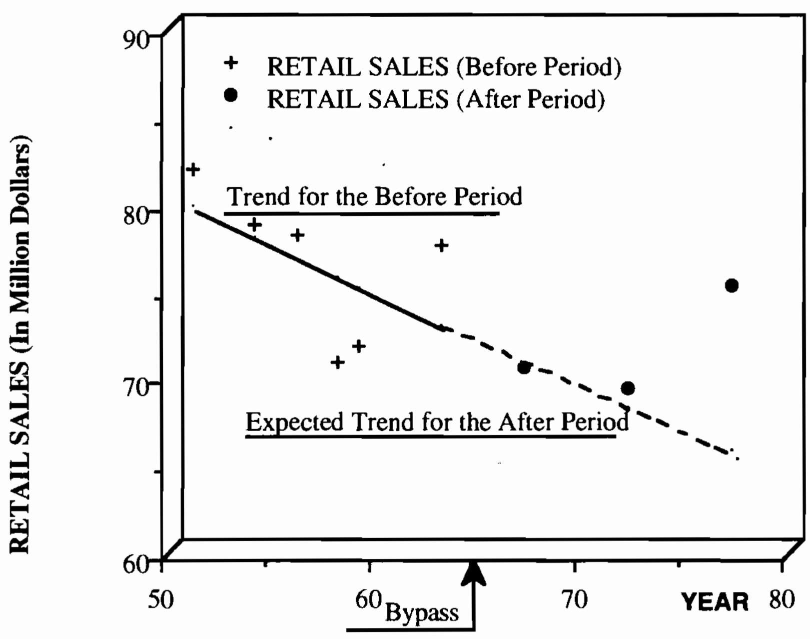
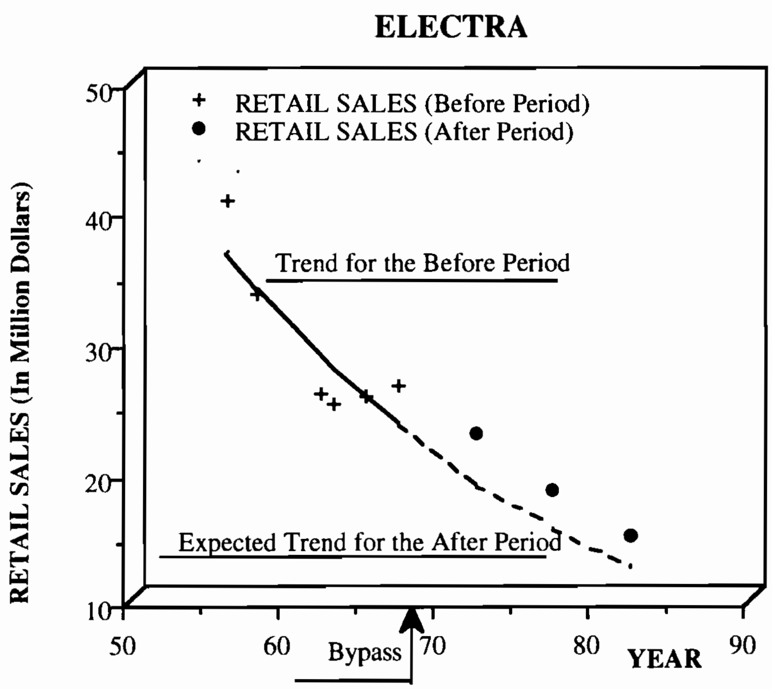
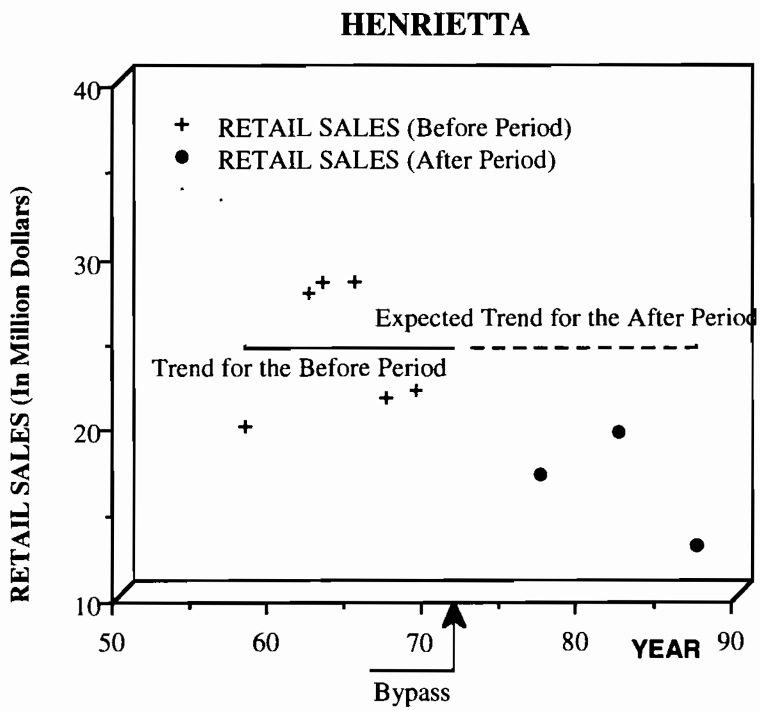
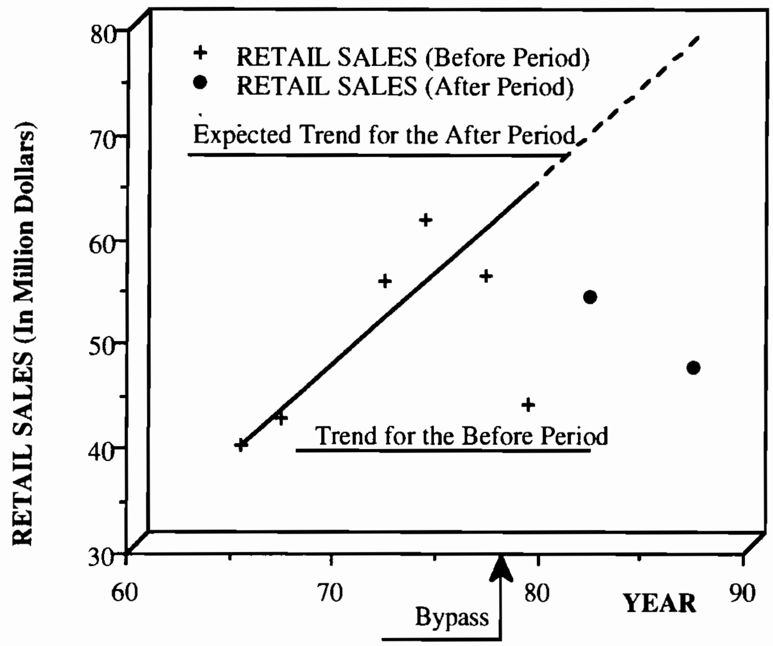



ELECTRA
RETAIL SALES (Before Period)
RETAIL SALES (After Period)
Trend for the Before Period
Expected Trend for the After Period
RETAIL SALES (In Million Dollars)
50
40
30
20
10
50
60
70
80
90
Bypass
YEAR


HENRIETTA
RETAIL SALES (Before Period)
RETAIL SALES (After Period)
Expected Trend for the After Period
Trend for the Before Period
RETAIL SALES (In Million Dollars)
40
30
20
10
50
60
70
80
90
YEAR
Bypass

BOWIE



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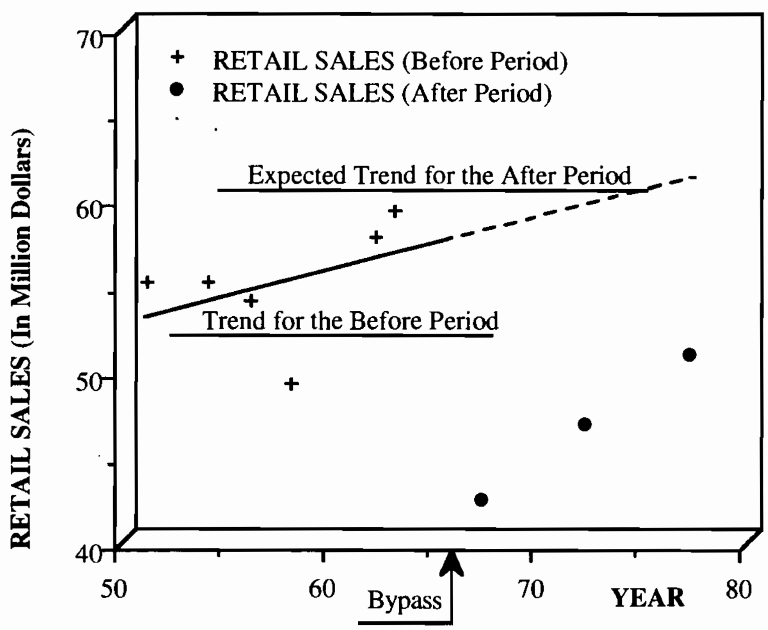
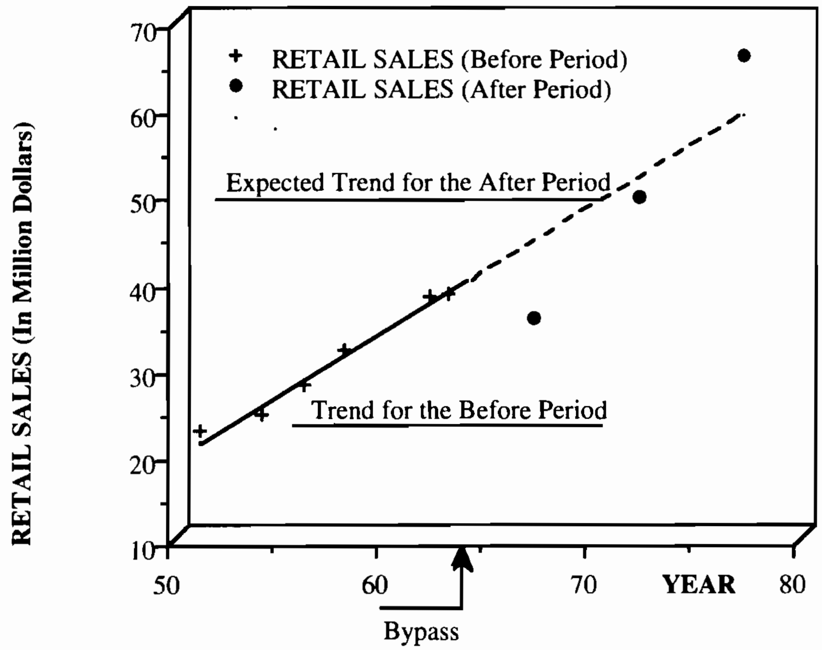


SLATON



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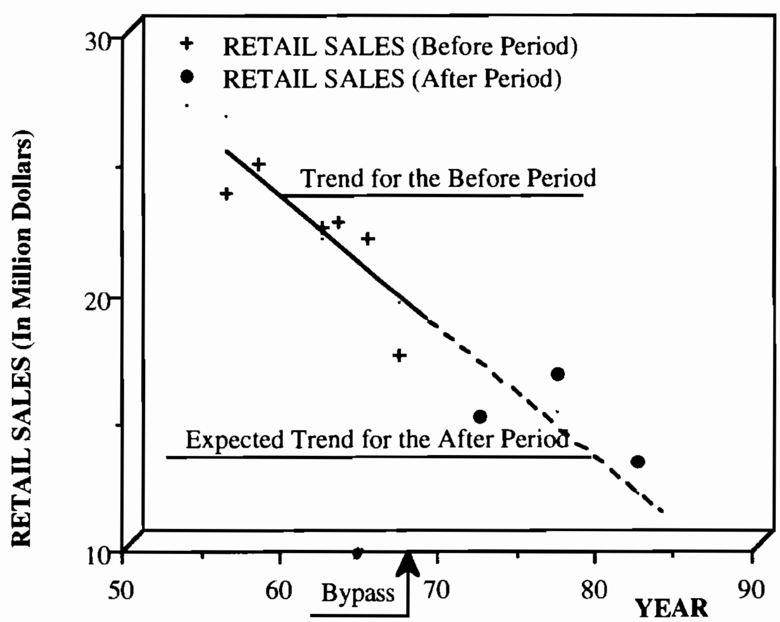
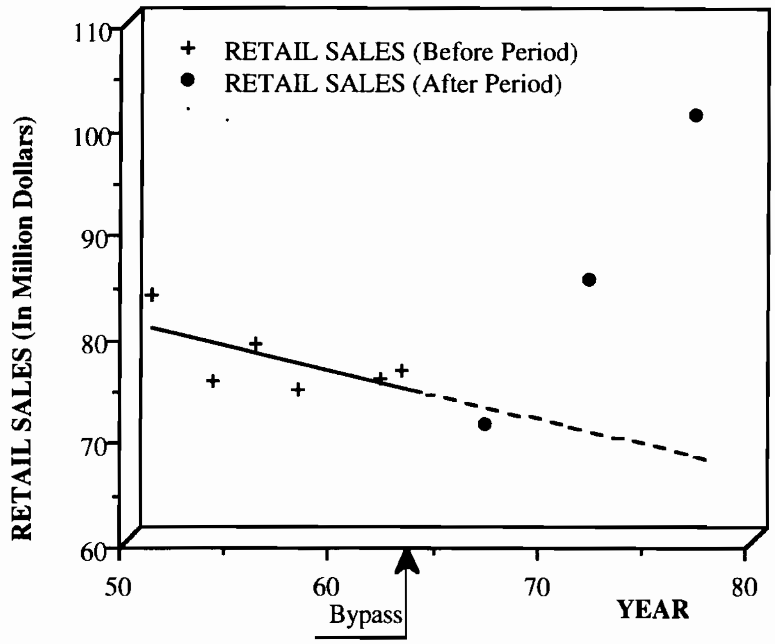
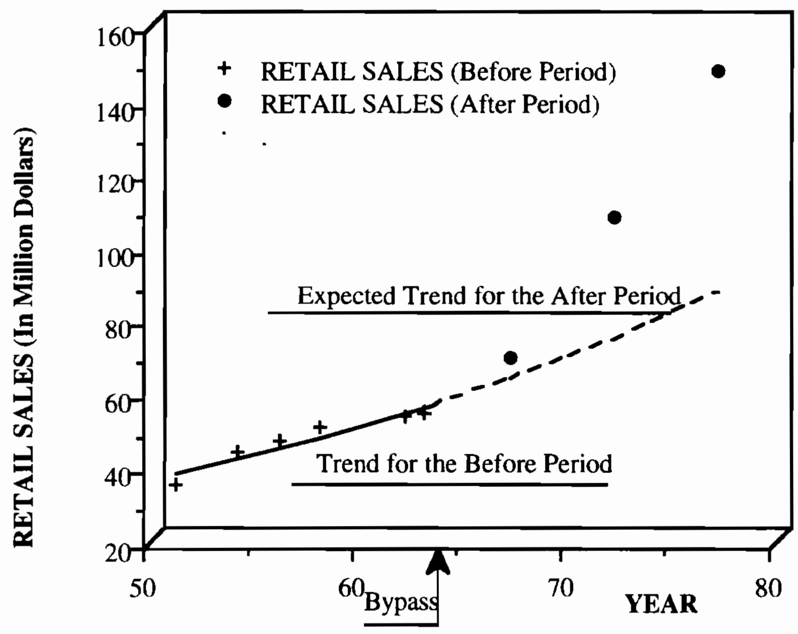


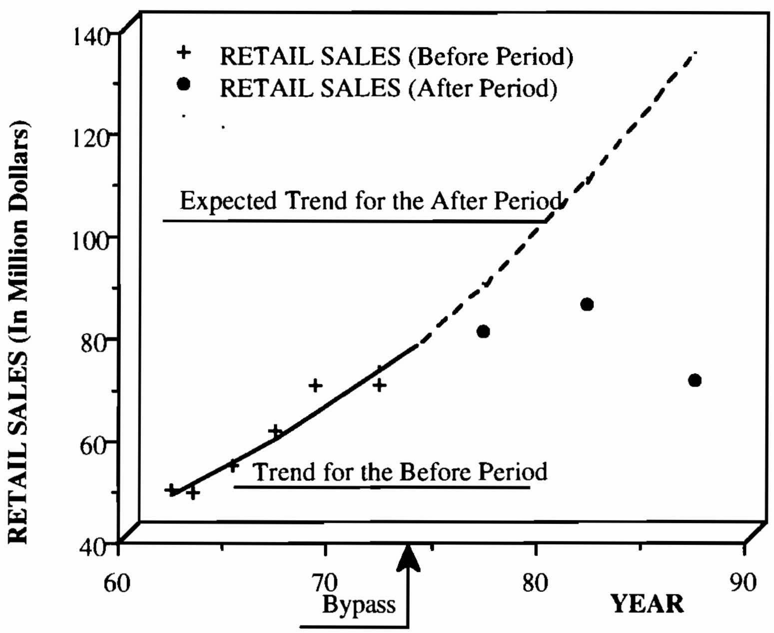
SNYDER



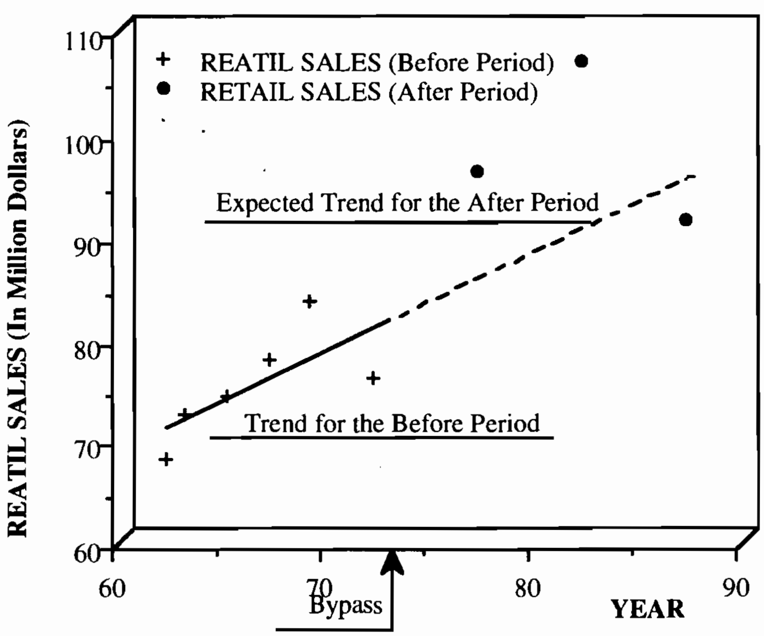
ALVIN



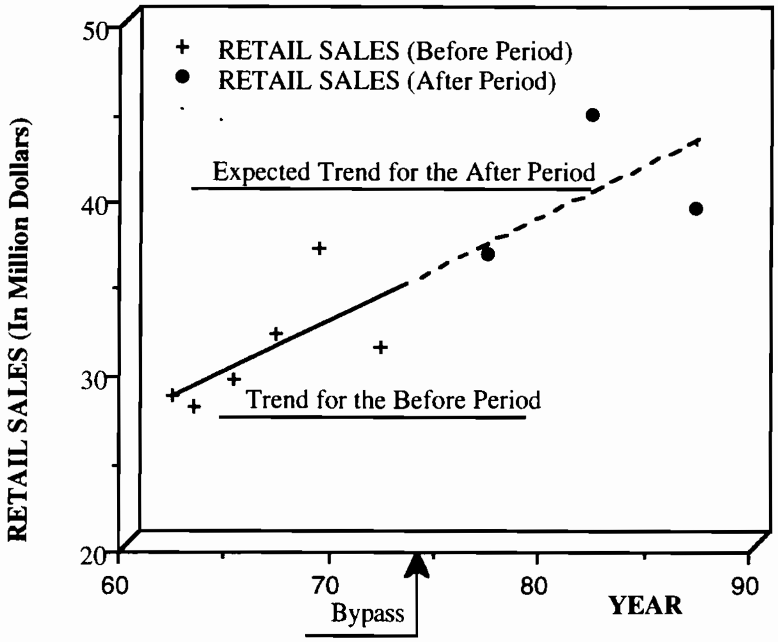
WHARTON



EL CAMPO

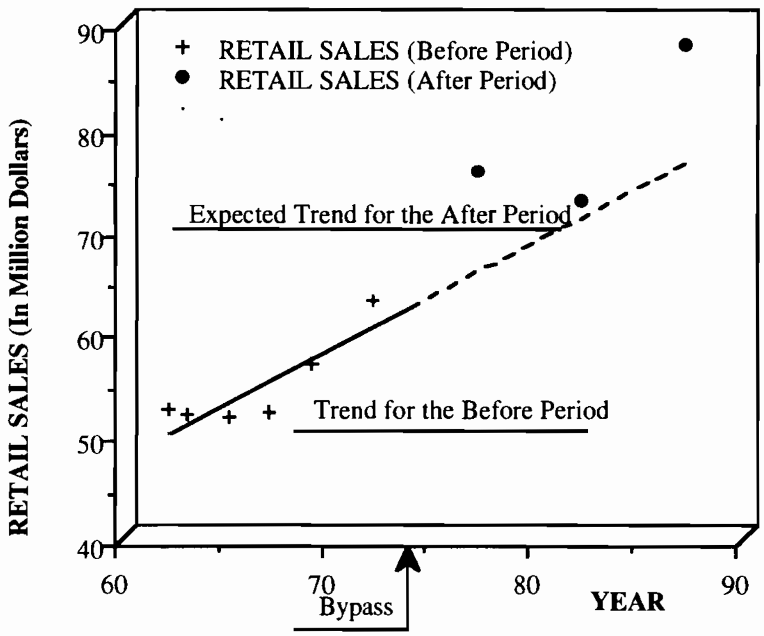


EDNA



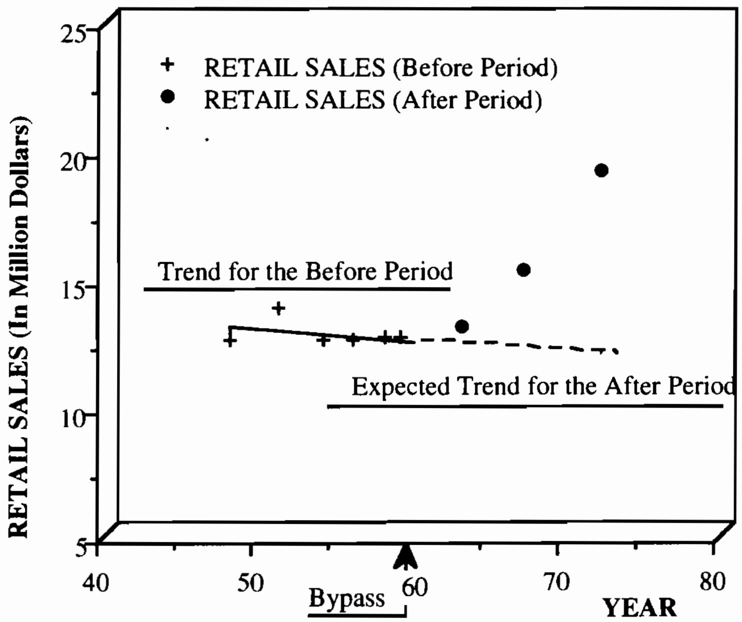
RETAIL SALES (In Million Dollars)
50
40
30
20
+ RETAIL SALES (Before Period)
● RETAIL SALES (After Period)
Expected Trend for the After Period
Trend for the Before Period
60
70
80
90
Bypass
YEAR

TAYLOR



RETAIL SALES (In Million Dollars)
90
80
70
60
50
40
+ RETAIL SALES (Before Period)
● RETAIL SALES (After Period)
Expected Trend for the After Period
Trend for the Before Period
60
70
80
90
Bypass
YEAR

BASTROP



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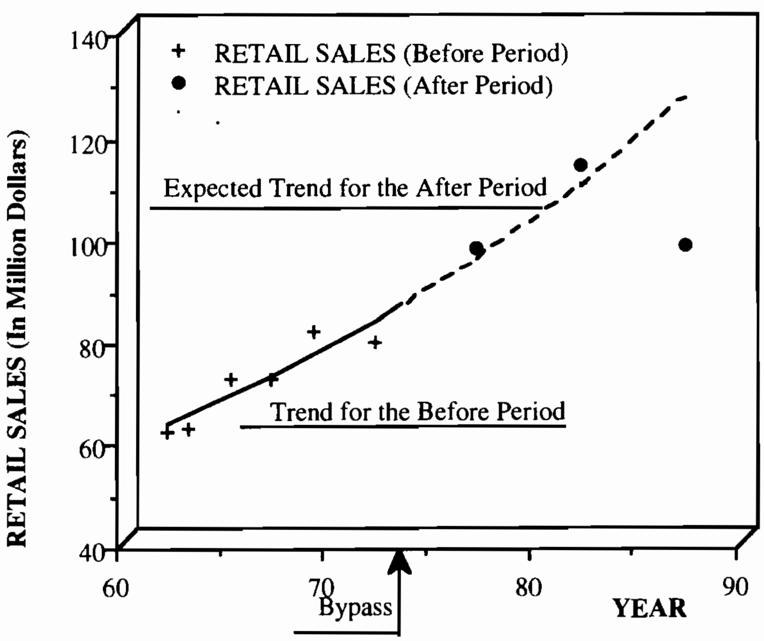
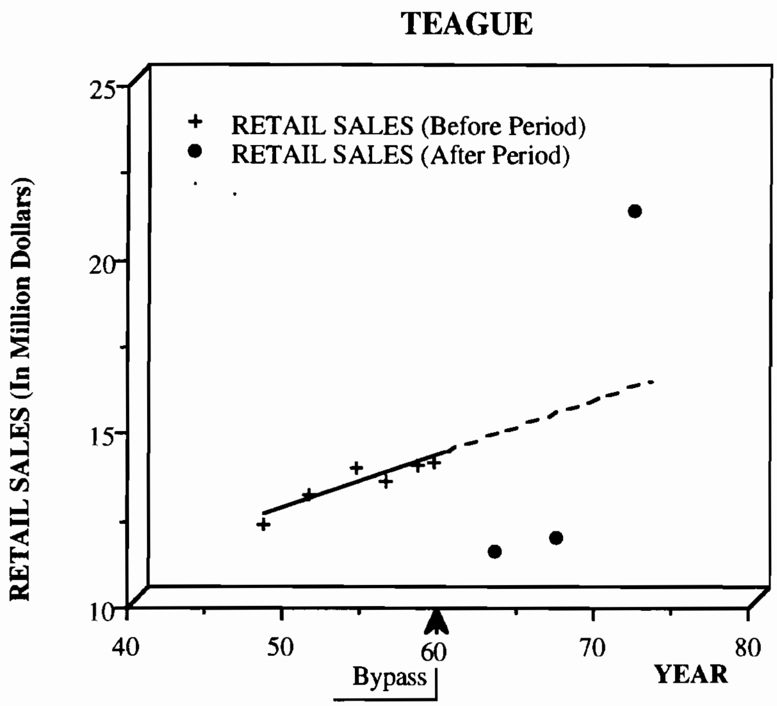
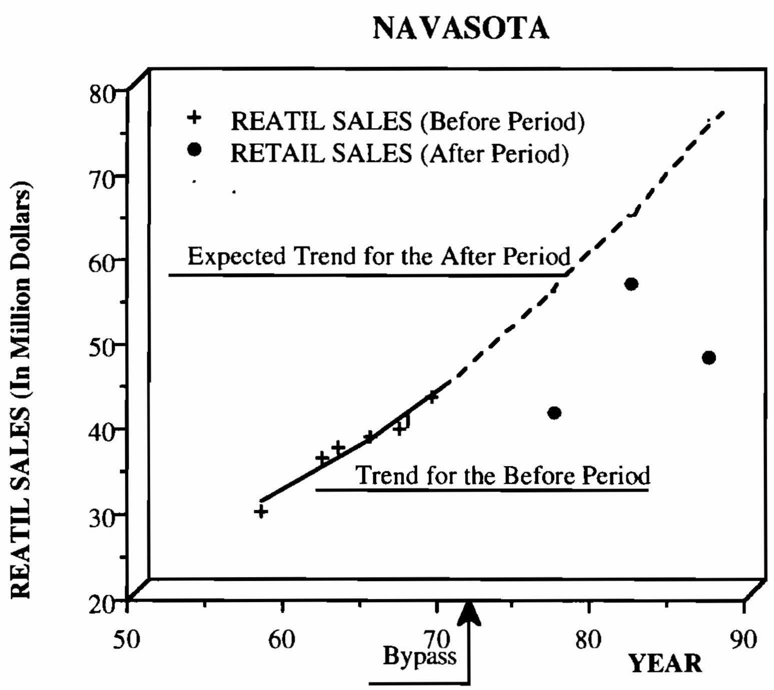
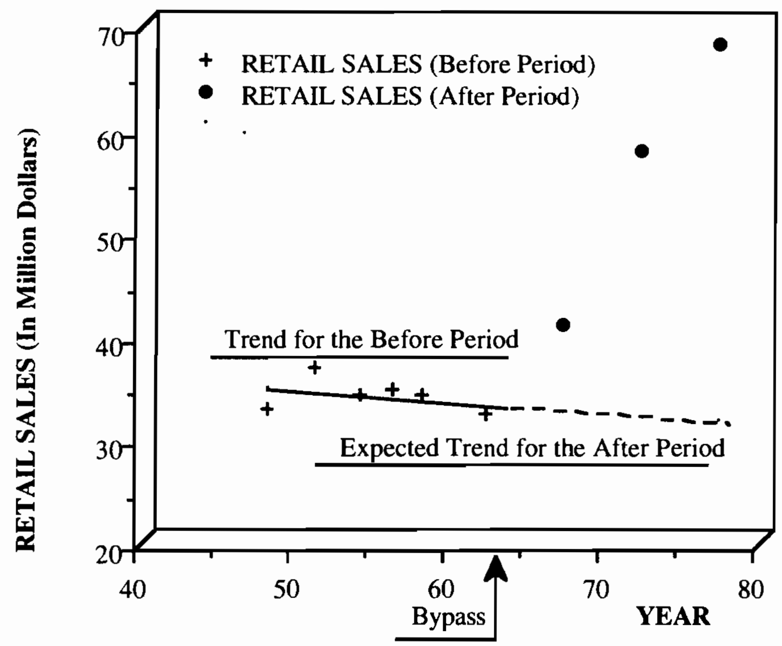



TEAGUE
RETAIL SALES (Before Period)
RETAIL SALES (After Period)
RETAIL SALES (In Million Dollars)
10
15
20
25
40
50
60
70
80
YEAR
Bypass


NAVASOTA
REATIL SALES (Before Period)
RETAIL SALES (After Period)
Expected Trend for the After Period
Trend for the Before Period
REATIL SALES (In Million Dollars)
20
30
40
50
60
70
80
50
60
70
80
90
YEAR
Bypass

ATLANTA



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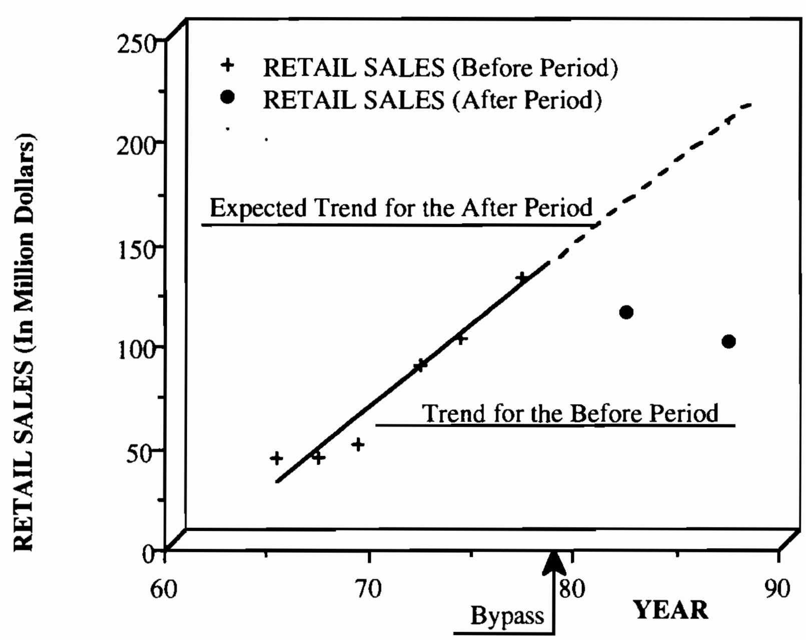
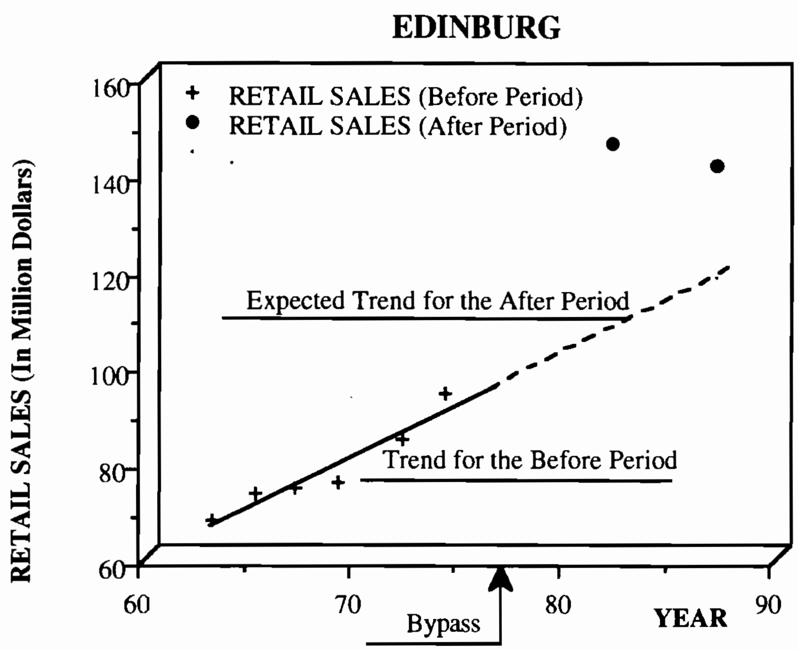
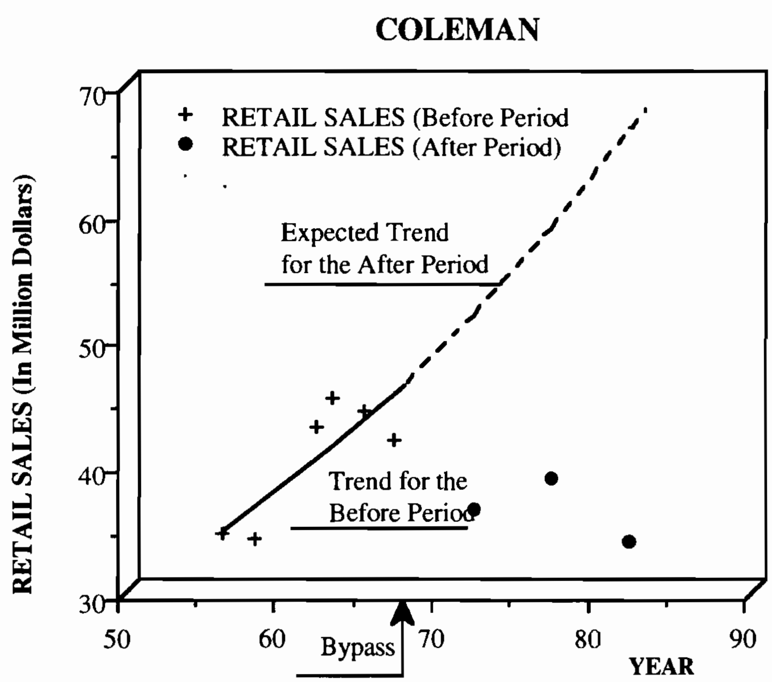



EDINBURG
RETAIL SALES (In Million Dollars)
160
140
120
100
80
60
+ RETAIL SALES (Before Period)
● RETAIL SALES (After Period)
Expected Trend for the After Period
Trend for the Before Period
60
70
80
90
Bypass
YEAR


COLEMAN
RETAIL SALES (In Million Dollars)
70
60
50
40
30
+ RETAIL SALES (Before Period
● RETAIL SALES (After Period)
Expected Trend
for the After Period
Trend for the
Before Period
50
60
70
80
90
Bypass
YEAR