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# RESEARCH RESULTS DIGEST

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### Economic Effects of Restricting Left Turns

*An NCHRP digest of the findings from the final report on NCHRP Project 25-4, "Economic Effects of Restricting Left Turns," conducted by Cambridge Systematics, Inc.; JHK & Associates, Inc.; and HBRS, Inc. Mr. Glen E. Weisbrod and Ms. Roanne Neuwirth were the Principal Investigators.*

#### INTRODUCTION

This digest will help analysts assess the effect of left-turn restrictions on businesses and describes ways to mitigate those effects. The digest will be of interest to those planning, designing, and constructing left-turn restrictions, regardless of whether the projects are permanent or temporary (in the latter case, being the result of construction or maintenance). The final report for this project will not be published but a copy has been sent to each state's DOT.

Restriction of left-turn access, particularly in heavily traveled commercial areas, has long caused friction between businesses and traffic engineers. Issues of customer access to local establishments often clash with the desire to reduce opportunities for accidents, improve speed and flow for through traffic, and reduce neighborhood traffic. Left-turn restriction projects have generated much public debate over the years, and some projects have been abandoned because of public protest.

Much of the public protest results from the belief by business and property owners that traffic volumes and accessibility can affect the prospects for business sales and profits. Improved operation on the arterial street may attract additional traffic and help stimulate the economic growth of the larger area. Accessibility is the ease with which vehicles of all kinds can arrive and depart from a site. Therefore, projects that propose to restrict access are assumed by business and property owners to threaten profits. On the other hand, it is also

clear that although pass-by access may be critical to the profit of some businesses (particularly those with substantial local competition), for others, it is not. The effects on businesses of changes in traffic volumes or accessibility from any specific left-turn restriction project are thus not simple to understand or predict. Differing objectives and expectations of effects have made it difficult for transportation planners and businesses to work together on traffic improvement projects.

Streets and highway systems have always served two functions—the movement of traffic and the service of land. At one end of the spectrum, local streets are planned to service land use almost to the exclusion of traffic movement. At the other end, freeways are designed to move traffic while providing virtually no service to abutting land. Intermediate roadway types usually serve both functions and the varying demands of each can create competition and conflict.

#### RESEARCH OBJECTIVE AND APPROACH

The objective of this research was to determine the economic effects on adjacent businesses and property owners because of restricting left-turn movements. The scope of the research included quantification and analysis of the economic effects on tenants and property owners (through a series of field studies) and development of procedures and tools for analyzing and predicting the effects of

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implementing left-turn restrictions on adjacent businesses to assist the planning, design, and evaluation of future projects. The degree to which economic losses (if any) experienced by a business were offset by economic gains somewhere else was also examined. This offset of business is especially relevant to many small retail establishments selling convenience goods for which the consumer can easily find an alternative establishment.

The approach used in this project included these steps: (1) identify case study sites representative of the different types of road designs and economic settings; (2) collect traffic, business sales, and other economic data before and after left-turn restrictions; (3) evaluate changes in business sales attributable to the turn restrictions; and (4) develop a predictive model for evaluation of left-turn restriction projects.

More than 250 agencies and organizations at the local, state, and federal levels were surveyed in an attempt to identify 20 case study sites, with projects that restricted left-turn access to adjacent businesses. Traffic and turning movement counts had to be available both before and after the project's implementation. The site also needed to be in a relatively busy commercial or retail area with economic and land use data available. Many responses were received; however, finding 20 case study sites would not have been possible without considerable effort beyond the scope of the work. The number of sites was reduced to nine, and additional traffic data and patron surveys were conducted to augment the case studies. The reduction in the number of sites severely reduced the statistical significance of the quantitative data and precluded the development of a predictive model for the effect of restricting left turns.

## LITERATURE REVIEW

The economic effect of left-turn restrictions has not been studied frequently or directly. The literature offers little that could be used to develop a model to measure the economic effects of left-turn restrictions; however, relevant findings included the following:

- Various highway bypass studies, including those at the Texas Transportation Institute and the University of North Carolina, indicate a relationship between loss of access to pass-by traffic and changes in business sales. Most of these studies, however, examined situations where a new bypass route redirected pass-by traffic; this is not necessarily the same as the situation studied here, where the access to the business is affected, but the business remains visible from the road.
- Several studies, mostly in the United Kingdom, show how food shopping and grocery store sales are affected by traffic network redistribution, particularly insofar as it affects the relative accessibility and travel times to competing alternatives. Additional surveys and models of shopping center destination choices in the United States have shown that, when there are alternatives

available, there is a clear relationship between travel time and/or travel distance and the choices that shoppers make about where to shop. This relationship suggests that left-turn restrictions, if they substantially increase travel time or distance for shoppers, could reduce patronage of the affected locations.

- Research on land use and trip making indicates that different land-use activities generate different trip-making characteristics and that there is substantial variation in the trip-making characteristics of a given land use. In addition, the ways in which land uses are located in relation to one another and the pedestrian amenities associated with these uses appear to have a significant relationship to overall levels of vehicular trip generation. Land-use mix and amenities appear to be important determinants of travel behavior, but this has not been quantified.
- Overall, findings on the effects of left-turn restrictions on businesses have been mixed and widely varied. In cases where businesses were surveyed, some experienced losses, some experienced gains, and some had no change. This mixed reaction to the left-turn restrictions was echoed in the interviews with business conducted in this project. There is also evidence that some negative effects are transitory. That is to say, some businesses experienced loss after initial implementation, but, after a few months, their patronage returned to normal.
- There is also evidence that effects depend on the extent to which businesses rely on "pass-by" traffic versus those that are "destination-oriented." Those businesses that are convenience-oriented (e.g., service stations and convenience marts) depend on pass-by traffic for much of their customer base and tend to be more adversely affected than other types of business because convenience products or services are more easily replaced if access is inconvenient. However, these convenience businesses also tend to relocate more easily from one location to another, which can result in higher profitability and a broader customer base.
- Much of the traffic-related literature tends to focus on intersection and roadway capacity and safety concerns, without much quantitative thought given to effects on the adjacent businesses. In general, it has been shown that restrictions of left turns along two-way undivided roadways to a limited number of clearly defined locations improves safety by reducing the number of left-turn and through vehicle conflict points. Left-turn restriction projects can also improve operations, as long as adequate provisions for left-turn storage are made at those locations where left turns are permitted.
- The literature shows that transportation access is only one of many factors that affect business location and the success of a particular business. Other factors (e.g., the type of business, the location and nature of the competition, the overall economic climate, and customers' sensitivity to price and quality) may all

determine whether a business loses or gains sales. Although a left-turn restriction may contribute to negative effects, the restriction alone does not have a straightforward relationship to sales losses.

## DATA COLLECTION

The project used three major data sources: traffic data, sales and employment data, and surveys of businesses and patrons. Additional sources of data, including property values, land use patterns, advertising, and other business costs, were also explored. Discussed below are the types of data desired from each source (except for the surveys which are discussed later), the type actually collected, and problems and issues identified in data collection.

### Traffic Data

Collection of traffic data was crucial to developing and calibrating a causal model to predict the effects of restrictive left turns on businesses. Over 250 agencies were surveyed to determine suitable case study sites. The survey inquired about the availability of the following traffic data, both before and after the completion of the left-turn restriction project: daily traffic volumes, turning movements (driveway counts), peak-hour traffic volumes, through/local split of traffic, truck percentage, type of right-of-way access control, level of service, and travel time data.

The traffic data available had the following shortcomings:

- Before-construction data were incomplete or unavailable for most locations. Data generally consisted of turning movement counts at some, but not all, locations.
- After-construction data were generally incomplete as well, sometimes consisting of data for different intersections from those for which before-construction data were available. In some instances, forecasts of conditions following restrictions, rather than actual field data, were all that were available.
- Different agencies use their data in different ways, resulting in difficulties in comparing data sets. For instance, counts conducted at one location began at 9:00 a.m., after the peak commuting hour is typically over.

Based on the survey of agencies, nine case study sites were identified for further analysis. Even for these sites, available transportation data was limited, and site visits were necessary to collect some of the missing "post-implementation" data.

Table 1 shows the number of sites that had each type of data available.

TABLE 1 Data availability

Type of Data	Before	After
Daily traffic volumes	9	5
Turning movements	2	1
Peak-hour traffic volumes	9	5
Through/local split of traffic	0	0
Truck percentage	9	9
Right-of-way description	8	9
Level of service	9	9
Travel time data	0	0

### Business Sales and Employment Data

A critical component to understanding the effects of left-turn restrictions is to analyze business activity at sites that have implemented left-turn restrictions and compare those trends with patterns in the larger area in which the sites are located. Business data were purchased from Dun & Bradstreet Information Services for the case study sites and for the surrounding urban areas for the years from 1980 to 1993. The analysis was restricted to retail and service businesses. Dun & Bradstreet was selected as the source for these data because it is the only source that can provide sales data at the individual store level, for all areas of the country over a period of years.

Dun & Bradstreet's *Dun's Market Identifiers* dataset contains a range of information on each business, including address, industrial classification, sales, and employment information, but has the following limitations:

- Data for some smaller businesses are updated biannually rather than annually.
- For chain stores, employment data, but not sales data, are available by location.
- A significant fee is charged for the data.

The Dun & Bradstreet data were used to examine four key issues: sales trends, employment trends, company entry and exit rates, and retail mix. It is important to look at these issues in the context of the economy of the larger area. Business activity at a location will reflect trends in the local and national economy, layoffs in the region, competition from nearby businesses, residential patterns of growth, and reduced or increased regional demand for certain goods and services. A control group approach was used to help account for these other factors.

The control group approach was accomplished by separating data for businesses directly affected by the left-turn restrictions from those that were not directly affected. This allowed the comparison of business activity changes in the case study corridor with changes in the larger region. Ideally, the control should be a similar type of roadway corridor with a similar mix of land uses and densities and similar traffic levels and patterns. In most of the case studies, no such "matched" comparison area could be identified, nor is it likely that sufficient data would have been available in

any case. The alternative of selecting a specific, but clearly mismatched, comparison area was unacceptable. Thus the rest of the metropolitan area was selected as a broad, albeit imperfect, comparison area.

For the nine case study sites, records on more than 9,200 businesses were analyzed over three points in time, covering periods of pre- and post-implementation of turn restrictions. This helped account for metropolitanwide or larger business cycles and trends. The analysis did **not** control for other apparent changes in business patterns resulting from shifts in population, employment, traffic, and business activity patterns within the metropolitan area.

### **Property Values and Transactions**

Property value data are often considered a good indicator of economic trends or effects; however, property value information is difficult to obtain and often not useful if it does exist.

Data on assessed values of properties were generally available from local governments. Unfortunately, these data often have significant problems of inconsistency over time. Often, relatively good information was available on the current value of the parcels but no historical data had been kept. Several properties that had not been resold were often not reassessed for many years, so current or trend data were not available. Some sites had had state- or locally mandated changes in assessment procedures and ratios—these changes made comparison of time-series data impossible. In addition, rezoning of land, re-parcelization of properties, and transfers of publicly owned lands were also found to complicate comparisons of changes in property value. Finally, many sites had relatively few ownership changes making it difficult to accumulate enough information for comparison.

Another way to estimate property value changes is to use real estate sales data as a measure of value. This approach has problems as well. First, there is no single source for nationwide data on commercial real-estate transactions. Regional sources are available and were contacted in this study, but only two of the nine case study sites were included in regional real-estate databases. The regional databases have limitations in that some cannot provide data about vacant land, because there must be a building involved for them to have a record of the transaction. Most do not maintain historic sales data—only data on current or recent sales. One regional source warned that some sales would probably be missed because many major roads have several names and many properties on major roads do not have street addresses.

Overall, it is useful to view commercial property values as being affected by four sets of factors: the revenue-generating potential of the site; the availability of alternative sites; zoning controls on allowable land uses; and local assessment and tax policies. As far as this study is concerned, the first set of factors is the only one affected by left-turn restrictions and that can be assessed more directly in terms of changes in store patronage and sales levels.

### **Vacancy Rates**

Another potential measure for understanding the economic effects of left-turn restrictions is the vacancy rate for properties in the corridor. Local planning and economic development officials, along with real estate representatives and property owners in the case study sites, were contacted to locate sources for this information. None of the public agencies at any of the sites maintained data on vacancy rates for specific sites. The real estate community also did not track vacancy rates for specific areas or groups of properties. For most of the sites, subjective impressions of the relative level of vacancy rates were obtained from business interviews.

### **Land Use**

None of the jurisdictions in the case-study areas maintained land-use information in a time series for specific parcels and businesses. Land-use and zoning maps with information on individual parcels were sometimes available, but these maps were not updated regularly and historic maps were often not readily available. Reports on development trends and patterns were often available for entire regions but not for specific sites or parcels. Again, these reports were usually prepared sporadically, without a systematic approach suitable for analyzing trends.

### **Capital Investment**

Data collection on renovations and new construction was planned, but building permit and other information was seldom available on a site-specific basis. Also, many of the sources for building permits focus on housing starts rather than commercial construction. Although the agencies did collect information when issuing building permits for construction projects, they generally did not track trends or prepare the data in a site-specific format.

## **STATISTICAL ANALYSIS RESULTS**

Trends in sales, employment, and company turnover in the sites analyzed provided valuable information about possible effects of left-turn restrictions on business. There was considerable variation in the trends by site. During and after construction of left-turn restrictions, sales and employment often increased more slowly within the sites than in the surrounding regions. At some sites, the number of companies entering versus exiting was slightly lower in the sites than in the surrounding regions. Although companies continued to locate at these sites, sales actually dropped for companies as a whole and for individual companies that had existed before construction as well. However, at other sites, sales performed better at the location of the left-turn restrictions than elsewhere in the larger region.

Factors affecting the local economy (e.g., local company layoffs, competition, regional demand for goods and services) were also influencing the sites at the same time that left-turn restrictions were implemented. Therefore, the data do not produce a clear relationship between restrictions and changes in companies, sales, and employment. Further, change did not occur in a consistent pattern for all sites. For example, sales and employment levels in one industry declined dramatically after construction at some sites and increased at other sites.

The overall effect of left-turn restrictions can theoretically be measured by comparing changes in sales or employment for businesses affected by restrictions with those that were not. If the turn restrictions stunt business growth, one would find a smaller percentage increase in sales in the affected area than in surrounding areas. This provides a picture of the overall economic effect; however, because other factors influence sales and employment or interact with the turn restrictions, the effect of the restrictions cannot be measured by this simple comparison of changes. Considering research to date, it is reasonable to think that turn restrictions may greatly influence some types of businesses while having little effect on others. Similarly, businesses in urban areas may be affected differently than those in suburban areas, and the effects may vary as business density changes.

Data on more than 9,200 businesses (820 in the areas affected by the turn restrictions and 8406 in the comparison areas) were analyzed. The net business entry data showed a statistically significant (at a 90 percent confidence level) lower business entry rate for gasoline stations, hotels/motels, and non-durable retail stores (a category that covers clothing, specialty stores, and lawn/garden centers) in the project areas than that in the comparison areas. For other types of businesses, the analysis did not show a statistically significant difference between net business entry for the areas affected by the left-turn restrictions and the comparison areas. Even when there were reductions in the number of businesses however, the evidence suggests that overall business activity was merely shifted locationally within a broader area, rather than lost from it. Figures 1 through 4 illustrate the variability in net business entry rate between sites and between types of business.

An analysis of changes in sales for each type of business showed a statistically significant reduction in sales for nondurable retail stores and gasoline stations and a significant increase in sales for grocery stores. Other types of businesses did not show any significant change.

## PATRON SURVEY FINDINGS

Patron surveys were conducted at six sites to determine how the turn restrictions had altered patrons' travel behavior. The survey was designed to determine patrons' awareness of

the turn restriction and traffic pattern changes; the effects on their travel time, distance, and route; and the effects on store visitation and shopping behavior. The following business types were included in the patron survey sites: gas station, motel, restaurant, art gallery, furniture store, department store, bowling alley, garden center, and carpet outlet. Of the 237 patrons approached, only 47 percent were aware of the implemented project to restrict left turns.

Of those that were aware of the advent of turn restrictions, 48 percent had visited the businesses prior to the left-turn restriction. The average travel time to reach the business was the same for 63 percent of these patrons, longer for 5 percent, and shorter for 2 percent (30 percent did not respond to this question). Eighty percent estimated that they visit the business at the same frequency as before the left-turn restriction while 19 percent visit less frequently. Reasons given for visiting less frequently include the business was now less convenient (30 percent), increased travel times (30 percent), other businesses (particularly restaurants) were better (30 percent), or another business was more convenient (10 percent).

Eighty-four percent of the surveyed patrons made a U-turn or some other multiple-turn maneuver to get to or leave the business. This indicates a willingness to travel out of the way to visit the business. Of course, this was a self-selected sample because those who were not willing to travel out of their way to visit the business would not show up in the sample.

## INTERVIEW FINDINGS

An important component of the data collection effort was to interview three groups of affected people: economic development and planning officials, owners of businesses next to the left-turn restriction sites, and property owners and real estate professionals. The purpose of these interviews was to

- Understand the context in which the restrictions were implemented, both from a traffic policy viewpoint, and from a larger economic and land-use planning viewpoint;
- Gather information on business views of the nature of effects and gather any data on expenditures that could support the other data collection efforts; and
- Gather information on real estate trends inside and outside the corridor.

More than 200 people were contacted and between 6 and 21 interviews were conducted for each site. It was difficult to locate planning officials or businesses who were interested or willing to talk with the research team regarding effects. Some did not have the time; others were not interested in the study; some thought themselves unqualified to comment; and several interviewed believed that there were no effects and that the study did not apply to them. This type of response was not surprising. Businesses that are

not aware of a traffic restriction or that have not experienced problems are often not inclined to participate in an interview. Businesses that are having difficulties also tend to blame public works projects for their troubles, when, in fact, other factors often contribute to the specific problems. Therefore, while the interviews provide valuable information, they may be biased and are subjective.

### **Economic Development and Planning Officials**

Economic development and planning officials provided an overview of the economic climate and the effect of restrictions on businesses along the roadway. Most economic development and planning officials interviewed believed that the left-turn restrictions had few or no negative effects on business activity in the project corridor. At many of the sites, officials believed that improved traffic flow and safety stemming from the turn restrictions eventually increased business activity in the corridors. In some cases, planners reported effects, either positive or negative, on sales, but believed that the changes resulted from other factors, such as the overall economy or other development activity nearby. Some planners reported that they received or had heard about complaints from the local residents and businesses regarding the restriction before implementation. One planner believed that the public perceived safety in the site as a serious problem. The safety improvements resulting from the turn restriction appeared to be attracting more shoppers to the area.

One official thought that while, overall, there were no negative effects on areawide business levels because of a median barrier, those establishments at mid-block locations and the smaller "mom and pop" type businesses were sensitive to the resulting changes in the traffic patterns.

### **Owners of Businesses Next to Left-Turn Restriction Sites**

Many of the business owners and managers willing to be interviewed provided detailed information about their perceptions of the effects of restrictions, including change in the number of customers and loss or gain of sales. The responses by the businesses interviewed ranged widely. Some establishments experienced a strong upturn in sales; other shops perceived that the left-turn restriction put them out of business. Of the 113 businesses completing interviews, 46 percent believed that the left-turn restriction had a negative effect on them, 33 percent believed there was no effect, and 14 percent said they experienced a positive effect after the restrictions were implemented.

Several businesses reported that, immediately after the implementation of the restrictions, their sales declined, but eventually increased again. One business owner said that after 2 years his sales surpassed his previous sales.

Several businesses stated that they increased advertising in order to remain competitive despite the increased access difficulties.

On several occasions, the interviews suggested that some businesses that reported losses because of the left-turn restrictions were ready to go out of business before the project was implemented or were going out of business for other reasons. This is consistent with studies done regarding economic effects and retail turnover and underscores how difficult it is to associate cause and effect.

### **Property Owners and Real Estate Professionals**

Property owners and real estate professionals provided information about changes in land values and rental or sales potential of land in the corridors. As with the businesses interviewed, property owners and real estate professionals perceived a range of effects resulting from the restrictions.

In one instance, the area adjacent to the left-turn restriction was largely vacant of development prior to the implementation of the project. Since the project, the land has filled in steadily. The professional interviewed attributed the rapid increase in development to a favorable change in zoning restrictions, the location of major super store or anchor activities in the vicinity, and the amount of available land. He did not attribute the development of the vacant land to the restriction or indicate the restriction had any effect either way.

Several property owners/managers and real estate professionals believed that vacancy rates in their properties increased and that the value of rental property decreased after the left-turn restrictions. These property owners attributed the losses to reduced customers resulting from left-turn restrictions. Only one person interviewed was able to provide a numerical value; he claimed his rents dropped from \$6.50 to \$5.00 per square foot. Several others felt that the left-turn restrictions did not affect property values, rental rates, or vacancies.

### **Interview Summary**

The perceived magnitude of business loss or gain because of the left-turn restrictions ranged greatly. Overall, planning and economic development officials tend to view effects on corridors with left-turn restrictions as less of a problem than the businesses interviewed in the same area. The types of variables that appear to affect the level of effects of left-turn restrictions include the local economic conditions, the nature of the business, its location in the corridor, and the purpose of the left-turn restrictions. The interview results support the findings from earlier studies. Economic activity depends on several factors—left-turn access is only one of them. Some types of businesses and locations appear to be more sensitive to loss of left-turn access than others. These qualitative findings provide important insight into how left-turn restrictions are perceived to affect businesses.

### *Local Economic Conditions*

The business interviews indicate that the broader economic context within which each business operates is very important in understanding the implications of trends in sales activity. Several businesses recognized the role of the broader economy in the pattern of their sales. They acknowledged that economic slowdowns or booms in the region, state, or nation all contributed to economic trends in the area and at their businesses. This was confirmed by interviews with planning officials. The types of factors cited as contributing to sales changes also included cyclical economic changes, nearby company layoffs or hirings, regional supply and demand, and competition from businesses outside the corridor.

### *Nature of Business*

Comments from business owners indicate that businesses that are primary destinations for customers (e.g., car dealerships, furniture stores, department stores, supermarkets, and building or electrical supply stores) may be less affected than businesses depending on pass-by traffic (e.g., gas stations, fast food restaurants, and ice cream or donut shops). This may be because of unique merchandise or service or the customer's loyalty to the establishment.

### *Location Within the Corridor*

Most of the businesses interviewed identified location and accessibility as key elements influencing the level of effect that left-turn restrictions had on business activity. A customer who needs to drive past a destination and make a U-turn is less likely to patronize a business than a customer who can access a business directly at an intersection. As shown in Table 2, businesses located at an intersection (including jughandles and U-turn junctures) generally report less negative effect than those located mid-block.

A prime business location at a left-turn location may put a business at an advantage over its competitors, which may have become less accessible because of turn restrictions. Therefore, although the overall sales for a particular type of business may remain the same within the corridor, stores in prime locations may increase their proportions of those sales. Several property owners and managers suggested that restrictions changed the structure of property values because of the proximity of certain shops to unrestricted left turns. Left-turn restrictions may reduce the value of some properties, increase the value of others, but overall, the value in the corridor usually increases.

### *Purpose of the Left-Turn Restrictions*

The purpose of the project influences the perception of the effects. Left turns are restricted for two primary reasons: to improve through-traffic flow and to reduce accidents. The

sites studied were implemented for some balance of these two reasons, but generally more for one than the other. There is some evidence to suggest that in those cases where safety was publicly perceived to be a serious problem, the left-turn restrictions actually increased the number of customers coming into an area. In those cases, the safety problem was serious enough to have deterred customers from going to the businesses adjacent to the project and, therefore, the restriction improved safety and allowed the customers to return.

Businesses seem to be more at odds with left-turn restriction projects intended to improve traffic speed and flow. Higher traffic speeds and fewer opportunities to stop make it harder for impulse-type businesses to attract customers driving through. Non-destination businesses want customers to travel at slower, not faster, speeds in front of their establishments. On the other hand, some destination businesses noted that increased traffic speeds allowed customers from further away to access their establishment, increasing their market base.

## **SUMMARY OF FINDINGS**

The statistical analyses conducted with the available data indicate that left-turn restrictions affect different types of business differently. Gas stations, non-durable goods retailers, and service businesses appear to be the most likely to be adversely affected; where restricted, these businesses showed the largest sales declines, and the highest rates of business failures. By contrast, grocery stores and restaurants appeared to benefit from the restrictions, showing increased sales and decreased business failures.

The survey and interview results present a mixed picture. In some instances, business owners believed that the left-turn restrictions reduced access to their stores and resulted in lost business. In other cases, business owners reported the turn restrictions decreased congestion and improved traffic flow to the point where their market areas actually expanded. These business owners felt that customers were traveling to their stores from farther away than prior to the restrictions.

Businesses at mid-block locations (i.e., away from intersections) perceived the left-turn restrictions as more detrimental than did businesses at intersections or other points where left turns were permitted. In some cases, left-turn restrictions appeared to cause a portion of sales to shift from the restricted to the unrestricted business locations within the study corridor.

The patron survey indicates that, although many customers' travel patterns to reach businesses changed as a result of the left-turn restrictions, most customers continued



**TABLE 2 Business interview and patron survey results: perceived effect of left-turn restrictions on business based on interviews**

Business Type	Mid-Block Location	Location with Left-Turn Access
Fast Food Delivery	Positive	Positive
Electrical Supplies	None	Positive
Bowling Alley, Regional Mall		Positive
Auto Repair		Positive or None
Carpet Store	None	None
Beauty/Hair Salon, Bread Baking Company, Car Dealership, Diner, Interior Decorating, Health Food Store, Hotel, Mobile Home Sales, Museum, Tire Sales/Service, Trailer Park, Video Store, Wholesale Lumber	None	
Copy Service, Sports Equipment		None
Supermarket	None or Negative	Positive
Motel, Restaurant	None or Negative	
Real Estate Broker	Negative	Positive
Department Store	Negative	Positive or None
Auto Parts/Supplies, Gas Station	Negative	None
Art Gallery, Audio/Car Stereo, Bicycle Shop, Building Supplies, Deli/Sandwich Shop, Fast Food, Fishing Supplies, Flea Market, Garden/Lawn Supplies, Gift Shop, Gourmet Food, Ice Cream/Yogurt Shop, Industrial/Agricultural Equipment, Oil Changing Service, Party Supplies, Pawn Shop, Pharmacy, Recreational Vehicle Sales, Used Car Dealership	Negative	

to patronize the businesses with the same frequency after the restrictions were in place.

## ANALYSIS FRAMEWORK

A principal objective of this project was to develop a predictive model for evaluation of left-turn restriction projects. The analysis conducted for this project showed that prediction of effects depends on the collection of local transportation and economic data which are not always available. Thus, an analysis framework was developed that can be used in estimating effects. This framework is divided into 14 steps (several of which are optional depending on data availability and analysis needs). A spreadsheet was also developed for this project. A simple example to illustrate the use of the framework is included in italics.

### Step 1. Project Definition

The first step is to identify and describe the type of roadway project that is to be studied in terms of the following information:

- **Design of Turn Restrictions**—This refers to how the left turns are controlled, including signs and markings, physical separations, continuous left-turn lanes, jughandles, grade separations, and other;
- **Scale of Project**—Information pertaining to the scale of the project, including distance affected and limits of project, number of mid-block turns restricted, number of intersection turns restricted, and average distance between allowable turn locations; and
- **Other Project Components**—Other information necessary, including road widenings, curb-cut restrictions, signalization improvements, lane channelization improvements, and improvement of local circulator streets.

Such information identifies which trips and turning movements may be affected. In addition, this information will identify whether the affected businesses are located mid-block or at an intersection and if the potential effects are restricted to locations along the affected roadways or encompass businesses on adjacent roadways. Ultimately, this information will be used to identify the breadth and mix of businesses where access may be affected.

The specific locations of the permissible left-turn movements before and after completion of the project are useful for identifying the specific locations affected and the additional distances required to access those sites.

*Example: A 4.2-mile-long undivided highway for which a raised median is proposed. Median cuts will be located, on average, 600 feet apart, eliminating 12 current mid-block left-turn locations and 8 intersection left-turn locations. The project will also improve the signalization and provide lane channelization. A survey of the businesses within the project limits has been made.*

## Step 2. Transportation Project Purpose

The second step is to identify the purpose of the planned turn restriction. Defining a purpose for a project has important implications for the type of economic effects to be studied. If, for example, the primary purpose of the project is to improve safety or transportation system performance, the potential for adverse effects on adjacent businesses should be viewed as an unavoidable consequence for which measures should be implemented to mitigate effects. If, on the other hand, major improvements are expected in travel times and accessibility to the location, then there is a potential for growth of existing businesses and attraction of new businesses. For a project with a combination of purposes, it is important to focus on the more critical aspects of the project to help understand the possible effects. Reasons for implementing a turn restriction include

- Improved safety;
- Increased travel speeds or reduced travel times;
- Increased traffic throughput (perhaps to reduce congestion elsewhere);
- Increased capacity for future traffic growth; and
- Upgrading of the roadway to design standards.

*Example: The principal purpose of the project is to improve safety.*

## Step 3. Project Location

The third step is to clarify the scale of the project effect area. The **primary effect area** is the area in which accessibility to businesses is affected. It is defined in terms of the length and width of the roadway corridor affected. Depending on the road system, the primary effect area may include nearby side streets. A **secondary effect area** could also be defined, encompassing the portions of the regional transportation system where traffic volumes or level of service may be affected. Finally, an **agency interest area** could be defined. This could include part of a city, the entire city, a metropolitan area, a county, or a state.

*Example: The primary effect area of the project is the corridor. A secondary effect area is defined as the county (with the region as the agency interest area).*

## Step 4. Purpose of this Analysis

The analysis methodology will be affected by the purpose of the analysis. The most common reasons for analyzing the effects of left-turn restrictions are

- To identify the types of existing businesses that may be at risk of immediate economic hardship. This may be desired for an Environmental Effect Statement, but it also provides a basis for selecting measures to mitigate the potential hardship. **If this is the only purpose of the analysis, Steps 9, 10, and 11 may be skipped.**
- To forecast the short-term effect on sales or jobs. This provides a basis for targeting and defining effect mitigation measures.
- To estimate the net long-term effects of the project on business attraction and sales. This estimate can then be used for cost-benefit calculations—either to test whether the project should proceed or to compare a proposed project against geographic and project design alternatives. A complete cost-benefit analysis would consider the likely reduction in crashes because of the left-turn restrictions.

*Example: The project analysis will consider the risk of economic hardship and the short-term and long-term effect on sales and employment.*

## Step 5. Base Case

The expected economic effects of any project can only be measured in comparison with some base case. There are two different options for the base case:

- Base case assumes status quo (e.g., no physical change in the road system); or
- Base case assumes some other type of transportation system improvement (e.g., road expansion or signalization) would occur in the absence of the left-turn restriction.

Years for the before and after project analysis also must be selected.

*Example: The project analysis will use the current situation as a base case. Pre-project data will be from 1989 and post-project data will be for 1999.*

## Step 6. Basic Economic and Traffic Data

As a prerequisite for analysis, the base case and any alternative scenarios must include specifications of basic economic and transportation data, including

- Inventory of businesses in the primary effect area, classified by type of business, for before and after the project. (This can be assembled based on a walk-

through or a drive-by survey, from local tax records, or purchased from Dun & Bradstreet or another private marketing service.)

- Estimate of the magnitude of project effects on overall traffic volume and traffic speeds in the primary effect area for pre-construction and post-construction. This should be done as part of the project development process. (Traffic volumes can be obtained from turning movement and link volume counts. Effects can be predicted using the *Highway Capacity Manual* or other techniques.)
- Estimate of the magnitude of project effects on travel distance, travel cost, and travel time, before and after the project, for access to and egress from the affected businesses in the primary effect area. (This requires some assumptions or data concerning trip origins and destinations.)
- Estimate of the overall growth in the project area. This can be based on the expected growth in population, employment, and building development.

*Example: In both 1989 and 1999, the density of the project area is assumed to be high. The growth in the project and metropolitan areas is assumed to be moderate, while growth in competing areas is assumed to be high. The analysis will only consider the effect on convenience grocery stores of which there are three in the corridor.*

*The traffic is expected to increase from 20,000 to 22,000 ADT because of improved traffic conditions. If the restrictions are implemented, the speed in the corridor is expected to improve from 32 mph to 38 mph, resulting in an improvement in level of service from C to B. The speed is estimated to remain the same if the left-turn restrictions are not implemented.*

*The left-turn restrictions are expected to add 480 feet to the average trip length and 25 seconds to the average travel time (assuming 35 percent of the traffic is right in, right out; 25 percent right in, left out; 15 percent left in, left out; and 25 percent left in, right out).*

*Over the 10-year period, the population in the project area is expected to grow by 24 percent, the employment by 23 percent, and the building space by 28 percent. A simple average of these numbers produces an expected 10-year growth of 25 percent.*

### Step 7. Additional Economic Data

In addition to the Step 6 data, the evaluation of potential economic risk requires additional data or assumptions relative to the magnitude of business sales and the level of employment associated with the inventory of adjacent businesses. Sales and employment should be distinguished by type of business.

The data can be collected through a local business survey, government tax department sources, or private data files such as Dun & Bradstreet. Alternatively, it is possible to use state or local averages for sales per store and

employees per store, which can be calculated from the U.S. Census of Retail Trade.

*Example: Based on statewide averages, the three convenience stores are expected to employ 18 people and generate \$1,800,000 in annual sales.*

### Step 8. Shopper Profile

Information is necessary, or assumptions need to be made, regarding the type of merchandise sold. A profile of the customers attracted to the potentially affected businesses needs to be developed. To collect this information, one of the following sources should be employed:

- Survey of business patrons to determine where they came from, where they are heading to, whether their stop at this store was a “convenience” or “impulse” stop en route or a primary or secondary trip destination, and how often they stop at the store.
- Survey of business managers to determine where their customers come from, the extent to which they perceive their customers are making the stop at their store as a “convenience” or “impulse” stop en route or as a primary or secondary trip destination, and the frequency of repeat customers.
- Adoption of defaults for the percentage of business visitation and sales that are sensitive to changes in relative levels of accessibility (i.e., business activity which is convenience oriented and for which there are viable competing alternative destinations nearby). Defaults for percentage of convenience trips have been estimated based on the data collected in this project, as shown in Table 3. Defaults for daily trips per store are derived from the *ITE Trip Generation Manual*. These defaults should be adjusted if the business has a loyal customer base or prices are substantially different from those of competitors.

TABLE 3 Trip characteristics

Business Type	Convenience Trips (%)	Trips per Store
Hotels	20	126
Specialty Stores	20	3120
Services	30	1560
Supermarkets	40	2898
Durable Goods	40	696
Restaurants	50	2130
General Merchandise	65	1660
Convenience Stores	95	1774
Gas Stations	95	748

*Example: It is assumed that the three convenience stores generate 5,322 daily trips. Ninety-five percent of these trips are based on convenience of the location rather than the attractiveness of the store.*

**Step 9. Shopping Alternatives Data Collection (Optional, See Step 4)**

If the analysis includes a prediction of the total short-term or long-term effect on business sales or jobs, then the following additional data should be collected for use in the Step 10 gravity model analysis:

- A profile of competing business alternatives (number and location of destinations outside and inside of the primary effect area) for each type of business;
- Estimates of the relative accessibility (mean travel time) to each of the business alternatives, by type of business; and
- Estimates of the relative customer attractiveness for each of the alternative business destinations (measured in store area or sales volume, including a rating of their suitability as substitutes), by type of business.

*Example: Two alternative shopping areas are identified for the analysis. Assumptions for the customer attractiveness of each site (expressed in 1000 sq. ft.) and mean travel cost (in minutes of travel time) are as follows:*

	Project	Alt 1	Alt 2
Attraction	6	2	8
Travel Time	5	6	12

**Step 10. Gravity Model Calculation (Optional, See Step 4)**

This step is needed if the analysis includes a prediction of the total short-term or long-term effect on business sales or jobs. This step estimates the trip destination shifts among competing alternatives. The attractiveness and travel times from Step 9 are used in a gravity model calculation to assess how the distribution of destination choices is affected. The gravity model approach is used to calculate the shares of trips stopping at destinations in the project effect corridor for both the base and proposed cases. If available, a regional, corridor, or urban area travel model should be used to determine the trip distribution.

*Example: The following are the gravity functions (attraction/cost<sup>2</sup>) and the calculated market share for each site.*

	Project	Alt 1	Alt 2
Gravity Function	0.24	0.06	0.06
Market Share	68%	16%	16%

*Because the left-turn restrictions will increase the mean travel time from 5 to 5½ minutes, the effect of the restrictions will be to reduce the gravity function from 0.24 to 0.20, resulting in a new market share of 62 percent, an 8.5 percent decrease.*

**Step 11. Business Change Because of Traffic Volume Change (Optional, See Step 4)**

This step is needed if the analysis includes a prediction of the total short-term or long-term effect on business sales or jobs. This step estimates the effect of the increased traffic on business by combining the information on growth of traffic volumes from Step 6 and the percentage of convenience trips from Step 8.

*Example: A 10 percent growth in ADT is expected as a result of improved traffic conditions. For convenience stores, it is estimated that 95 percent of the trips are convenience based. The increase in trips because of increased traffic is 10 percent x 95 percent = 9.5 percent.*

**Step 12. Business Vulnerability**

For this step, indicators of business vulnerability to losses from left-turn restrictions are calculated. This calculation is based on two steps: determination of the effect of reduced access and determination of the effect of increased traffic volumes. The effect of reduced access is a direct result of Steps 9 and 10. If Steps 9 and 10 were not conducted, estimates of the effect must be made.

In this project, data were collected at nine sites to estimate the effect on business of restricting left turns. Figures 1 through 4 show the change in the number of operating businesses, both in the project area and in the surrounding area. Overall, they show a very wide range of differing effects—sometimes there is a loss in the number of businesses; at other times there is no loss and even a gain in the number of businesses after the imposition of left-turn restrictions. The variance in these statistics and the difficulty in accounting for exogenous developments make the use of Steps 9 and 10 to generate the effect of reduction of access greatly preferable to the use of default values.

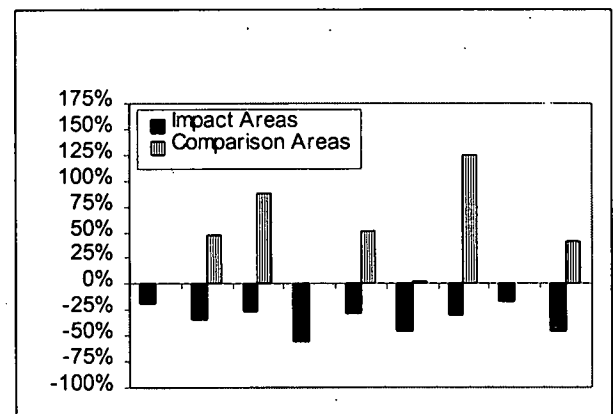


Figure 1. Gas station—gross percent change.

increase business by 9.5 percent. The joint effect is  $(1 - 0.085) \times (1 + 0.095) - 1 = 0.2$  percent.

**Step 13. Potential Short-Term Change for Existing Business**

The basic result of this step is to estimate the potential short-term effects on adjacent business sales because of left-turn restrictions, by type of business. This is calculated by multiplying the business vulnerability indicators determined in Step 12 by the sales profile of existing businesses from Step 7.

*Example:* For the three convenience stores, the left-turn restrictions could result in a 0.2 percent gain in sales (\$1,800,000 to \$1,804,000). This is not expected to result in any change in employment (0.2 percent of 18 will not require additional staffing).

**Step 14. Forecast Medium/Long-Term Change in Business**

This step provides a forecast of the overall long-term effect on business in the primary project effect area. These results are calculated by applying both the business vulnerability indicators from Step 12 and the expected growth in the area from Step 6 to the sales profile of existing business from Step 7.

The estimates of potential business effect provided in Steps 12 through 14 must be interpreted with care. They do not represent forecasts of local business change; rather, they represent estimates of potential local business vulnerability and opportunity. Actual changes in business sales can also vary widely and can be affected by individual business marketing as well as effect mitigation activities. In the long run, any localized changes in business are likely to be the result of activity relocations, so there may be no net effect at a broader regionwide level.

*Example:* By 1999, the convenience store sales are expected to grow to \$2,255,000, a 25 percent growth (\$1,800,000 x 1.002 x 1.25). Employment is expected to grow to 23, a 28 percent growth.

**MITIGATION PROGRAM**

An important step in the planning process is to use what has been learned about the effects of left turn restrictions to develop a program to mitigate any potential negative effects. This study has shown that some types of businesses in mid-block locations seem to be affected more than those that are located at intersections or points where left turns are still permitted.

The effects of loss of access to retail and commercial establishments have also been studied in the context of construction of infrastructure projects, where direct access is affected, but only for a limited time. Lessons learned from

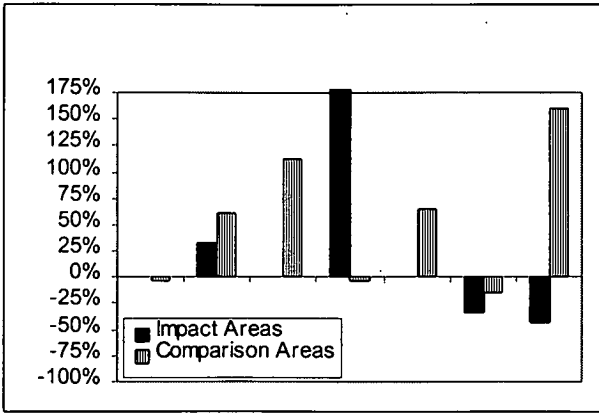


Figure 2. Motels/hotels—gross percent change.

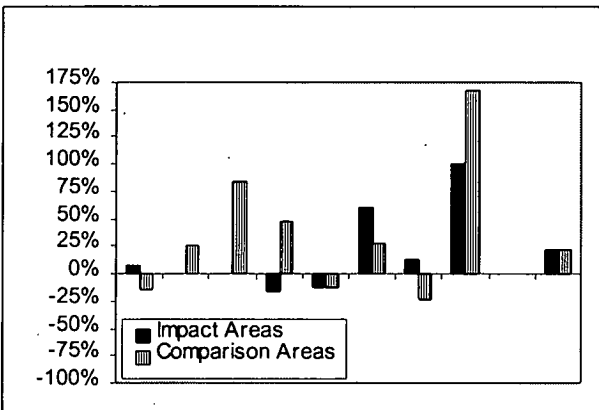


Figure 3. Nondurable retail—gross percent change.

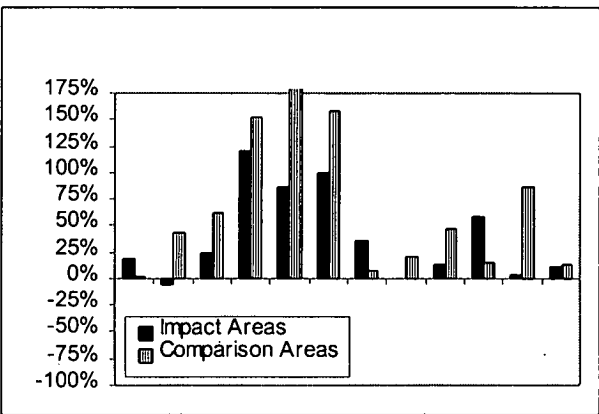


Figure 4. All retail—gross percent change.

The effect of increased traffic is a direct result of Step 11. To obtain the joint effect, the two adjustments are combined in a multiplicative manner.

*Example:* Based on Steps 9 and 10, it is expected that the left-turn restriction will reduce current business by 8.5 percent. Step 11 indicates that the increased traffic will

this project and other transportation construction projects show that steps can be taken to ease the problems that might result from the reduction in access to a given business. Some physical measures that help mitigate the effect of left-turn restrictions are providing good alternate routes, carefully locating median openings to minimize additional travel, and providing safe conditions for U-turns at median openings and intersections. The following are components of a mitigation program that may be implemented to assist in reducing potential negative effects, although each project and situation will be different.

### **Information Dissemination**

Systematic, thorough dissemination of information is critical to reducing a potential loss in customers or sales for businesses in the vicinity of the left-turn restriction. Such dissemination keeps the public fully informed about what changes will occur, how and when they will occur, and what the new access path will be. This can include preparation of flyers and newspaper articles describing the project prior to its completion; preparation of maps indicating the location of all of the establishments and the points of access under the new project; addition of signs at numerous points along the roadway, including well in advance of where the change occurs; and assistance with increasing the visibility for affected establishments, through larger store signs or other visual improvements. Studies and interviews of businesses and customers have shown that it is much easier for both businesses and customers to adjust to changes if they have enough time to prepare and if they have sufficient information to easily make the change.

For example, if several mid-block businesses will be affected by an upcoming left-turn restriction project, the implementing agency can provide road signs that clearly identify the point at which to turn to access those specific establishments, so it is not confusing for motorists. This will make it easier for customers to continue to visit the establishment and will help to calm business fears about the project's effect.

### **Community Participation**

Involving the business community and other affected groups early in the planning process for a left-turn restriction project is important. Involving the potentially affected parties in designing a program helps to mitigate problems and helps to alleviate fears that nothing will be done to assist them. A task force can be established to represent business interests and to serve as a liaison between the businesses and the agency during and after implementation.

### **Monitoring Program**

It is important to monitor the effects of the project on businesses in the affected area and whether the mitigation program seems to be working.

### *Business Sales Tracking*

One way to identify changes in business activity is to monitor sales at establishments before, during, and after completion of construction. There are several ways to do this. A survey of businesses to determine the levels of sales before and during the construction will note any changes in levels. Alternatively, sales tax receipts from the Department of Revenue can be tabulated to track business sales changes. Yet another method is to conduct sidewalk counts and sidewalk shopper surveys concerning retail spending patterns. The business task force could survey businesses by telephone before implementation, during implementation, and periodically after implementation. Some businesses are reluctant to report sales data—the involvement of the business task force may help encourage businesses to participate, particularly when they understand that the data will be used to understand the effect of the left-turn restrictions and to mitigate any negative effects.

### *Patron Behavior Survey*

It is also helpful to determine whether the restriction has affected patron behavior and attitudes and whether signs and other publicity information is reaching the public. The patron interview survey should reach the patrons at key access points—areas adjacent to and within the construction area during construction. The survey can be used to determine whether the construction is deterring patrons from visiting the establishment, where they are going instead, whether the signs are clear, and what may encourage them to patronize the affected businesses.

### **AVAILABILITY OF REPORT**

The final report for this project will not be published but is available for purchase on microfiche from the Transportation Research Board (202/334-3214). The spreadsheet developed by the contractor for the Analysis Framework is available on the description of NCHRP Project 25-4 on the World Wide Web at <http://www2.nas.edu/trbcrp>.

These **Digests** are issued in order to increase awareness of research results emanating from projects in the CRP. Persons wanting to pursue the project subject matter in greater depth should contact the Cooperative Research Programs Staff, Transportation Research Board, 2101 Constitution Ave., NW, Washington, DC 20418.

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