Methodology for Estimating Economic Impacts of Highway Improvements: Two Case Studies in Texas

JESSE L. BUFFINGTON, LAURENCE M. CRANE, BURTON CLIFTON, AND JOHN SPEED

A methodological procedure that can be used by practitioners in estimating the economic impact of proposed highway improvements is outlined. The methodology is followed in measuring the impact of proposed improvements to U.S. Highway 287 in Wichita Falls and State Highway 199 in Tarrant County. Both have alternative routes that were evaluated. U.S. Highway 287 had two existing route alternatives, elevated and depressed express freeway lanes, and three bypass freeway route alternatives. State Highway 199 had one existing route freeway alternative and two bypass freeway alternatives. The State Highway 199 alternatives would affect Tarrant County and four to five cities, including Fort Worth. A summary of the results from these two case studies is reported. Benefit-cost ratios are calculated for the nonuser effects and the user effects measured in dollars. The objective was to estimate the economic effects resulting from implementing each alternative for each proposed highway improvement. The effects estimated are (a) impact on businesses, distinguishing between traffic-serving and other types of businesses; (b) impact on property values; (c) impact on new development; (d) impact on relocation and employment, including that caused by construction expenditures and loss of clientele; (e) impact on municipal tax revenues, and (f) impact on highway users. Data from previous studies, secondary sources, the Texas Department of Transportation, and the study areas, are used to make these estimates. The results will be used as supporting data in the environmental impact statements that will be presented at public hearings.

Highway improvements, whether for new highways or for existing routes, create changes in the local economy and how it functions. Some of these changes are temporary, lasting only during the construction period; others are long term because they result from the characteristics of the new facility. Rarely is an economic effect clearly all positive or all negative within a community.

PROBLEM STATEMENT AND BACKGROUND

Fort Worth

The Texas Department of Transportation's (TxDOT) District 2 is evaluating the proposed improvement of State Highway 199 in northwestern Tarrant County, Texas. This highway passes through four small "satellite" cities (Lakeside, Lake Worth, Sansom Park, and River Oaks) as it leads into Fort Worth and terminates at Interstate Highway 30 near downtown. Presently, the highway is a four-lane facility with undivided and divided at-grade sections having no access restrictions. The proposed facility is a full limited-access freeway with or without service roads. Three alternate routes are studied, and all three will affect four satellite cities plus Fort Worth and rural Tarrant County.

The following are the route alternatives: (a) Central Route—follows the existing route consisting of a sizeable strip of commercial development sprinkled with random vacant land. This alternative would require the acquisition of additional land, located primarily on only one side of the existing right of way. (b) North Route—would bypass Lake Worth and Sansom Park almost completely and pass mostly through undeveloped land and partially through several residential neighborhoods. (c) South Route—would bypass most of Lake Worth and pass through a large portion of vacant land and several residential neighborhoods. Most of the northern route and nearly half the southern route would pass through the city of Fort Worth.

Wichita Falls

TxDOT's District 3 is evaluating the proposed improvement of U.S. Highway 287 through the midtown of Wichita Falls. The highway segment under study is composed of two, one-way urban arterials in the midtown district, seven blocks long, controlled by a series of sequenced traffic lights at each block. U.S. 287 is improved as a freeway on both ends as it leaves the midtown area, creating a "design gap" in the primary arterial system.

Improvements are proposed to alleviate an unacceptable congestion and accident rate. Accidents are attributable to a violation of driver expectation as freeway traffic approaches the urban street section. There is a need for a continued freeway section for through traffic that will allow only access traffic on the urban section.

To alleviate these traffic problems, several facility options and alternative routes have been proposed. Three of the improvement alternatives are bypass routes. Although these new routes would follow existing streets where possible, extensive

J. L. Buffington and L. M. Crane, TTI/CE Building, Suite 609, Texas Transportation Institute, The Texas A&M University System, College Station, Tex. 77843-3135. B. Clifton, Texas Department of Transportation, P.O. Box 6868, Fort Worth, Tex. 76115. J. Speed, Texas Department of Transportation, P.O. Box 660, Wichita Falls, Tex. 76307-0660.

right-of-way acquisition displacements would be required. Two of these bypass routes would follow along portions of State Highway 240 (Eastside Drive), whereas the third would be a new location. The other two primary improvement alternatives would be to construct either a split elevated or a split depressed one-way section on Holliday and Broad Streets to carry through traffic, leaving a portion of existing roadway to carry local traffic. The elevated section alternative is separated into three secondary alternatives that deal with access ramps to cross streets and the alignment of the project on the north end.

STUDY OBJECTIVE

The study objective is to estimate the economic effects of the proposed route and/or design alternatives for State Highway 199 in Forth Worth and for U.S. Highway 287 in Wichita Falls. The following effects are to be estimated:

1. Impact on existing businesses, distinguishing between traffic-serving and other types of businesses,
2. Impact on new development,
3. Impact on employment, including that caused by construction expenditures and loss of clientele,
4. Impact on municipal tax revenues, and
5. Impact on highway users.

DATA SOURCES

The primary data source is the transportation economics literature (*1–37*). Also, data were collected by TxDOT's District 2 and 3 personnel and the Texas Transportation Institute's (TTI) personnel through personal interviews and mail questionnaires. Limited data were used from the U.S. Bureau of Census, Texas Almanac, chambers of commerce, and city offices.

The literature also contains general studies that estimate the relationship between highway construction expenditures and employment (*38–40*). Findings from the general studies supplement and further support the case study findings.

GUIDELINES FOR ASSESSING ECONOMIC EFFECTS

There are several important guidelines to follow for assessing the effects of highway improvements:

1. Consider all the relevant highway and area characteristics in assessing the economic impacts.
2. Decide which of the above characteristics are significant variables in measuring economic impacts.
3. Consider the techniques available for estimating economic impacts.
4. Collect sufficient data on the characteristics of the proposed highway improvement to use in selecting the most comparable findings of prior studies to estimate economic effects. At a minimum, data from previous studies must be comparable in the following ways:
   - Type of highway improvement (design and route location),
   - Dominant abutting land use, and
   - Stage of land development in area (percent developed).

   When ideally comparable case study findings can't be found, the highway planner is forced to use subjective judgment in adjusting the impact estimates based on the findings of available studies.
5. Adjust the findings of previous case studies to fit the proposed improvement area and route characteristics.

IMPACT ON BUSINESS ACTIVITY

A review of literature was conducted to compile a range of effects experienced by the business communities in various Texas cities where highway improvements have been made. Factors compiled from the comparable literature, such as percentage of changes in the number of businesses, amount of gross sales, and uses and values of property were used to estimate the various effects (*1–35*). Two types of effects needed to be identified: (a) those that occurred during the construction period, and (b) those that occurred after construction was completed and the new highway facility was operational. These two factors affect businesses differently, depending on both location and business type classifications. The effects differ according to the proximity of the business to the construction zone and also to whether the business is primarily a traffic-serving or other type of retail or service business (*1–19*, *36*, *37*).

The methodology most often used in the literature to measure these effects is the before-after approach. Briefly, this procedure analyzes an area under an original set of conditions, constructs a highway improvement, and then reanalyzes the area to determine the impact of the improvement. In the reviewed studies, the before period includes a period 2 to 7 years before construction of the highway. To minimize the effect of factors external to the highway construction, a control area is often used to measure the general economic effects that are occurring, independent of the construction.

Table 1 is a summary of percentage effects on gross sales, as reported in the literature, that resulted from either upgrading or bypassing an existing highway system. This table shows that there is considerable variation between effects among comparable studies. Because the studies considered were not all closely comparable, it was concluded that the comparative weighted mean value was an appropriate measure to use in calculating the estimated gross sales change. The comparative weighted mean is based on a scaled judgment of the characteristics of the types of businesses involved on each route and how they compare with the cases cited in the literature.

An important component of the business analysis was to determine the number of businesses that would close, be displaced either partially or totally, or would open. Table 2 is a summary of business status changes compiled from reviewing published reports. This table was used to estimate the number of businesses that would close or remain open.

No clear procedure was addressed in the literature with regard to determining how many of the opening businesses were new construction as opposed to existing businesses that

TABLE 1 Summary of Abutting Business Gross Sales Impact as Reported in the Literature

	PERCENTAGE CHANGE OF IMPACT BY TYPE OF IMPROVEMENT							
	UPGRADING EXISTING HIGHWAY SYSTEM				BYPASSING EXISTING HIGHWAY			
	DURING CONSTRUCTION		BEFORE VS. AFTER CONSTRUCTION		DURING CONSTRUCTION		BEFORE VS. AFTER CONSTRUCTION	
BUSINESS ACTIVITY	Range	Weighted Mean	Range	Weighted Mean	Range	Weighted Mean	Range	Weighted Mean
Bypassed								
Traffic serving	N/A	N/A	N/A	N/A	N/A	N/A	-65 to +39	-11
Other retail/service	N/A	N/A	N/A	N/A	N/A	N/A	-15 to +55	+10
Remaining								
Traffic serving	-46 to +15	-11	-26 to +27	-6	-46 to +15	-11	-13 to +49	+9
Other retail/service	-32 to +10	-5	-39 to +19	-5	-32 to +10	-5	-13 to +49	+9
Partially								
Traffic serving	-43 to +17	-12	-23 to +5	-11	-43 to +17	-12	-23 to +5	-11
Other retail/service	-35 to +31	-4	-97 to +73	-2	-35 to +31	-4	-97 to +73	-2
Abutting								
Traffic serving	-45 to +16	-11	-25 to +18	-9	-45 to +16	-11	-19 to +26	-2
Other retail/service	-34 to +19	-5	-67 to +48	-4	-34 to +19	-5	-43 to +66	+6
Closed								
Traffic serving	N/A	N/A	-43 to +17	-12	N/A	N/A	-13 to +49	+9
Other retail/service	N/A	N/A	-35 to 31	-4	N/A	N/A	-13 to +49	+9
New								
Traffic serving	-43 to +17	-12	-23 to +5	-11	N/A	N/A	-13 to +49	+9
Other retail/service	-35 to +31	-4	-97 to +73	-2	N/A	N/A	-13 to +49	+9

TABLE 2 Comparative Analysis of Change in Status of Businesses Previously Studied by Route Location[1]

	PERCENT OF BEFORE CONSTRUCTION BUSINESSES	
Business Type	Range	Weighted Mean
OLD ROUTE		
Traffic Serving		
Remaining	64-100	82
Closing	0-36	18
Opening	3-33	17
Nontraffic Serving		
Remaining	75-100	87
Closing	0-25	13
Opening	0-86	34
NEW ROUTE		
Traffic Serving		
Remaining	0-3	.4
Closing	0-3	.4
Opening	0-27	11
Nontraffic Serving		
Remaining	0-8	1
Closing	0-8	1
Opening	0-17	6
COMBINED ROUTE		
Traffic Serving		
Remaining	64-100	82
Closing	0-36	18
Opening	7-60	29
Nontraffic Serving		
Remaining	75-100	88
Closed	0-25	12
Opening	0-88	40

[1] Based on following Texas Transportation Institute by studies: 4,5,7,8,9,10,14 and 15.

were closed but that began operating after the commencement of the study period. Thus, it was assumed that existing businesses that were closed remained closed throughout the study period. The only exception is for those businesses that were vacant or closed at the commencement of the study that would be totally displaced during the construction period. These closed businesses were subtracted from the after closed business totals. Those that were opening were truly new business constructions and not merely existing closed business that began operations or existing businesses that changed ownership.

The findings from the literature review, as summarized in Tables 1 and 2, and data from the sources described in the data section were used to estimate the 1989 gross business sales. The estimating methodology contains several steps:

1. Classify the businesses in the study according to business type based on standard industrial classification (SIC) code. Business type refers to whether they were primarily traffic-serving, or nontraffic-serving retail and/or service-oriented businesses, independent of the proposed routes.
2. Classify each business according to its location, and determine its comparability to the case studies in the literature. This was done for each proposed route alternative. The status of each business is determined according to each route alternate.
3. Estimate the average gross sales per business for all businesses of each SIC code. This was done by using 1989 gross sales data obtained from the State Comptroller's Office.
4. Multiply the number of businesses by type and status, as determined in Steps 1 and 2, by the average gross sales per business of the corresponding type, as determined in Step 3, to generate the total gross sales of all businesses of that type and status.
5. Adjust the gross sales amounts and number of businesses to account for closing businesses and new opening businesses; also for those businesses either totally or partially displaced. The data summarized in Tables 3 and 4 were used to estimate these effects. The number of new businesses generated were allocated according to existing sales volume and adjusted according to the lengths of the old and new highway segments.
6. Apply the appropriate percentage change amounts from Tables 1 and 2 to the gross sales figures calculated in Steps 4 and 5. The result of these calculations is the estimated percentage changes and estimated actual amounts that would occur both during and after construction. This step was repeated for each business classification, alternative route, and status classification.

IMPACT ON LAND USE, DEVELOPMENT, AND PROPERTY VALUES

There is a close relationship between land uses and land values. If land values change, land use usually changes later. Previous studies have shown that a new freeway in an area will change the accessibility to abutting or nearby properties. Increased accessibility causes a change in the during- and after-construction period land values, thereby changing the land uses. The speed of a change will largely depend on the types of abutting and nonabutting use and how densely they are developed. The presence of an adequate cross street or

TABLE 3 Summary of Before- and After-Construction Period Nonuser Effects, and User and Nonuser Benefits and Costs of Proposed U.S. Highway 287 Improvement

NON-USER IMPACTS	ALT. 1	ALT. 2	ALT. 3	ALT.4	ALT.5[2]
Business gross sales ($ mil)	+8.5	+5.9	+17.1	-1.9	+1.2
Improved properties (%)	-3.0	-4.0	+18.0	+8.0	+12.0
Land value ($ mil)	+35.4	+32.9	+37.3	+39.6	+41.7
Tax Revenues ($th)	+209.0	+191.0	+247.0	+189.0	+240.0
Relocation (#)	-45.0	-50.0	-14.0	-6.0	-7.0
Employment (#th)	+5.4	+7.1	+6.2	+4.0	+2.3
Income to economy ($mil)	+407.0	+550.0	+468.0	+298.0	+224.0
BENEFITS AND COSTS					
Users[3]					
Benefits ($mil)	728	658	624	952	952
Costs ($mil.)	114	159	125	78	42
Benefit/Cost Ratio	6.4	4.1	5.0	12.2	22.7
Non-Users[4]					
Benefits ($mil)	451	590	523	435	267
Costs ($mil)	114	159	125	78	42
Benefit/Cost Ratio	4.0	3.7	4.2	5.6	6.4

[1] Impacts of abutting properties, businesses and residents, and the general impacts resulting from highway construction expenditures. Nonabutting impacts are not estimated.

[2] An average of alternatives 5A, 5B, and 5C.

[3] Benefits accruing directly to highway users.

[4] Combined dollar impact on abutting business sales, land values, tax revenues, and income to economy.

TABLE 4 Summary of Before- and After-Construction Period Nonuser Effects, and User and Nonuser Benefits and Costs of Proposed State Highway 199 Improvement

NON-USER IMPACTS	CENTRAL	NORTH	SOUTH
Business gross sales ($mil)	-14	+32	+27
Improved Properties (%)	-48	+4	-19
Land value ($mil)	+14	+10	+12
City/County Tax Revenues ($th)	+68	+185	+212
Relocation (#)	-302	-166	-385
Employment (#th)	+6.1	+7.7	+7.0
Income to Economy ($mil)	+473	+581	+528
BENEFITS AND COSTS			
Users[2]			
Benefits ($mil)	582	545	668
Costs ($mil.)	146	177	176
Benefit/Cost Ratio	4.0	3.1	3.8
Non-Users[3]			
Benefits ($mil)	473	624	568
Costs ($mil)	146	177	176
Benefit/Cost Ratio	3.2	3.5	3.2

[1] Impacts of abutting properties, businesses and residents and the general impacts resulting from highway construction expenditures. Nonabutting impacts are not estimated.

[2] Benefits accruing directly to highway users.

[3] Combined dollar impact on abutting business sales, land values, tax revenues, and income to economy.

road system that frequently interchanges with the new facility will heavily influence the distance from the improved highway that land values and land uses will be affected.

District right-of-way personnel furnished an estimate of the amount of right of way that would be needed for each alternative, and what property improvements that would be taken by type of improved property. Prior studies were used to estimate the number of new improved properties of each type for each alternative. Most of these studies are summarized in other publications (*11,13,21*).

The land value analysis uses the same study strip for each route alternative as defined in the land use analysis. The estimated value of the existing abutting property serves as the base for estimating the proposed route effects on property values and represents the value of the abutting property immediately after the taking of right of way. It is assumed that the land uses and values of the new abutting property are the same as those of the existing abutting property. The value of the property that would be taken for right of way is estimated separately and subtracted from the before-construction value of the newly abutting strip of properties. It is difficult to determine the after-taking use and value of the newly created abutting properties, especially since some of these properties will be remainders of partial takings.

Accordingly, the following procedural steps are used to estimate the existing/new abutting property effects of each route alternate being studied:

1. Estimate the present land value of the existing/new abutting strip of land along each side of the proposed route and the corresponding bypassed portion. The width of the abutting strip is assumed to be 150 ft for residential use and 300 ft for all other uses. The estimated square-foot values of abutting land in each use are based on a compromise between the right-of-way cost estimates made by the district personnel and estimates made by several private appraisers and/or real estate sales persons. The before-construction abutting land values are calculated by multiplying the total square footage of land in each use by the corresponding compromise square-foot values.

2. Estimate the present value of improved properties in each route alternative's abutting strip of land defined in Step 1. These estimates are based primarily on the district's estimated whole taking building values of each land use along each route alternate. The average value of the improved whole taking properties for each land use and route alternative is multiplied by the total number of properties of the corresponding land use group and route alternative to arrive at the estimated total value of the improvements of the property within the study strip.

3. Estimate the total before-construction period value of the abutting strip of properties along the proposed routes and the corresponding bypassed portion of the existing highway by adding the total value of the land calculated in Step 1 to the total value of improvements calculated in Step 2. No adjustment is made for possible damages to small irregular partial takings.

4. Estimate the value of the new improvements for each alternative by type of land use. The average value of existing whole taking improvements estimated in Step 2 is multiplied by the number of new businesses to arrive at an estimated total value of buildings to be occupied by the new commercial/industrial businesses. For new commercial/industrial businesses, it is assumed that such a value is a compromise between the value of a new building and a renovated existing building. Probably 50 percent of these new businesses would

locate in existing renovated buildings. The estimated number of new residences is multiplied by the average whole value of existing residential improvements to be taken to arrive at a total value of all new residential improvements.

5. Estimate the increased value of the vacant land where the new improvements will be placed. It is assumed that only one-half of the new commercial/industrial businesses will need a new lot in which to place a new building. It is also assumed that the size of a commercial lot is 100 ft wide and 300 ft deep. The differential value per square foot between vacant land and commercial land estimated in Step 1 is multiplied by the total lot square footage and then multiplied by the number of new businesses needing a lot, to arrive at the total value of the newly created commercial land. The estimated value of the new residences is assumed to include the lot value. Therefore, no increase in lot value is calculated for new residences. For new public/nonprofit organization buildings, the assumption is made that all will need new buildings and thus need new lots that are 100 ft wide and 300 ft deep. Again, the differential square-foot value between vacant land and the value of public land is multiplied by the total square footage of each new lot and then multiplied by the number of new public/nonprofit lots to arrive at a total value of new public/nonprofit lots.

6. Estimate the total value of new improved properties by adding the total value of the buildings estimated in Step 4 to the total value on the increased value of the land needed for the new buildings estimated in Step 5.

7. Determine the appropriate percentage changes to be used in estimating the expected, before versus after, construction period property values. The results from previous studies were evaluated and the results from the most comparable studies were used to arrive at appropriate range and mean values in which to choose a percentage to use to estimate the before-versus-after effects. These percentages are based primarily on the Texas studies referenced under each table. Most of these studies are summarized in other publications (*11,13,21*). These studies represent a construction period of about 3 years and an after-construction period of from 5 to 8 years. All the chosen percentages, based on the findings of these studies, seemed reasonable and are based on a general comparison of the specific characteristics of each route alternative in relation to the percentage range obtained from the most comparable prior studies (*23,33*).

8. Estimate the total before (instead of after) construction period property effects of each route by multiplying the appropriate percentage change by the total before value of the property abutting the proposed route and/or bypassed portion of the existing route. It is assumed that only one-third of the total impact would occur in the during-construction period. The value of the proposed right-of-way takings is subtracted from the total after-period property value, and the value of the new property is added to the total.

IMPACT ON TAX REVENUES

An indirect benefit to communities whose land values and gross business sales have been increased because of highway improvements is the subsequent effect on the tax base and tax revenues. However, during the construction period, when business accessibility may be adversely affected, the sales tax revenues could be decreased. Also a community's long-term sales tax revenues could be permanently affected if the highway improvement permanently decreased the volume of taxable sales within their boundaries. This report does not account for possible increases in demand on tax revenues caused by increases in growth and development. Consequently, the tax effects in this report are gross impacts.

The data used to estimate the gross taxable sales base are the same as those used previously to generate the gross sales. The percent of gross sales that is taxable was obtained from the state comptroller's office for each SIC code. The gross sales for each business was multiplied by this percentage rate to arrive at the amount of retail sales that were taxable. This amount of taxable retail sales can then be multiplied by the tax rates for the city to estimate the dollar amount of tax revenue. The same procedure is used to calculate the sales tax revenue generated from the wholesale and manufacturing firms operating within the parameters of the study routes.

A similar procedure is followed in estimating the property tax revenues. The data for the property tax calculations are the same as those used to calculate the impact on property values. To estimate the property tax revenue, the property tax base is multiplied by the property tax rate for the city.

IMPACT ON RELOCATION EMPLOYMENT AND INCOME

This section covers the impact of the proposed routes on relocation of businesses and residents and changes in employment and personal income. Each of these types of effects can have a significant effect on the businesses and residents in the study area, especially those abutting the existing or proposed routes. They are discussed separately below.

Relocation Impact

Relocation costs and effects on those displaced by the right-of-way takings of any highway project are of major concern and need to be considered in the decision process. The estimated effects of relocation are obtained from several previous relocation studies done in Texas (*21–23, 36, 37*).

Employment Impact

Each proposed route alternative would have a significant employment effect on the area under study. As part of the total impact, a portion would be because of the net change (existing businesses before construction less displaced businesses, plus new businesses after construction) in employment by businesses located abutting the existing and proposed routes. Another portion would be employment resulting from expenditures by the highway contractor to build the new facility and from expenditures by building contractors to build new or renovate old businesses and residences. The abutting businesses and residences are considered to have chosen their locations because of a new highway route (*38–40*).

Estimating Methodology

To estimate the impact on business employment, the following steps were taken:

1. Separate the affected firms (existing, displaced, or new) into two groups: commercial firms and industrial firms. Industrial firms usually have more employees than commercial firms, thus the employment of both groups is estimated separately.
2. Estimate the number of employees of the two groups of firms for the before- and after-construction periods. Use the average number of employees per firm, for each group of firms operating in the city, for each route. Compute this from the latest U.S. Bureau of Census data.
3. Add the estimated number of employees of commercial firms and industrial firms by city for each route.

To estimate the employment impact of highway, residential, and commercial/industrial building construction, the following steps should be taken:

1. Estimate the total construction cost for each route and the total construction cost of commercial/industrial buildings and single-family residences for each route. The route construction cost estimates are broken down based on the miles of each route in each city. For building costs, only whole building values are used to calculate an average building value for commercial/industrial buildings and for single-family residences. It is assumed that half the new businesses will occupy renovated buildings, and half will occupy new buildings. Therefore, the average of whole existing structures is a reasonable compromise value for the buildings occupied by the new businesses. All new residential buildings are assumed to be single-family structures.
2. Estimate the number of employees that might be generated because of each type of construction. The latest (1989) input-output model estimates of the "full-effect" employment multipliers are obtained from a report published by the Texas Comptroller of Public Accounts (*39*). These multipliers are adjusted to 1986 values by the Consumer Price Index. The appropriate adjusted multiplier, which represents the number of employees generated by each 1 million dollars of construction expenditures, is then multiplied by the corresponding total construction expenditures to obtain the estimated number of employees employed. Caution should be exercised not to assume that all the construction employment effects estimated by using the input-output multipliers will occur in the local area. If all the funds for these expenditures come from outside the local communities involved and are spent in those communities to hire local labor and buy locally produced materials, then most of the employment effects may occur in the local area. The employment effects from locally generated funds for building construction are more difficult to measure and trace through the economy.

Construction Expenditure Output Impact

Construction expenditures to build highway improvements and buildings for businesses and residences produce not only an employment impact but also an output, or total demand effect. Total output multipliers have been developed by the Texas Input-Output Model to estimate these effects (*39*). As this construction money circulates through the local, state, and even national economy it may produce three levels of effects: (a) the direct impact of the actual expenditures, (b) the indirect impact in supply industries, and (c) the induced impact of increased consumer spending. If the source of the employment impact expenditures is from outside the local area, most of the final-demand output effects may be realized. The amount of the output impact received locally depends on how much is spent for local labor, services, and supplies. The appropriate multipliers are multiplied by the amount of each expenditure type to yield the final output estimates.

IMPACT ON HIGHWAY USERS

Users of a highway system experience what is called highway user costs. These costs are classified into three types: (a) time or delay costs, (b) vehicle operating costs, and (c) accident costs. One way to justify improving a segment of an existing highway or bypassing the existing segment with a new segment is to show that the money required to pay for and maintain the improvement will produce an even greater dollar amount of user cost savings. The third version of Highway Economic Evaluation Model (HEEM-III) is used to estimate the user cost savings (*41*).

SUMMARY OF FINDINGS AND ACCEPTANCE BY TxDOT

The summary of findings for the case studies shows how estimates of the various nonuser impacts (effects other than those affecting motorists) can be helpful in deciding which route alternative should be selected. They show the extent to which nonuser impact estimates agree with the user, or motorists impact estimates, in selecting a route alternative. The findings for the two case studies are summarized separately below. They are presented in greater detail in the full reports (*42,43*).

Wichita Falls

Table 3 shows the estimates of the nonuser construction effects and the total net benefits and costs for user and nonuser effects for each proposed route alternative for U.S. Highway 287. Alternative 2 would produce the most positive employment and income impact. Alternative 3 would produce the most positive business sales and improved property and tax revenue impact. Alternative 4 would produce the least relocation impact, and Alternative 5 would produce the most positive abutting land value impact.

The user benefits are divided by the highway improvement costs to arrive at a benefit-cost ratio for each alternative. The same procedure is followed for the nonuser benefits. There is considerable agreement among the two sets of

TABLE 5 Estimated Nonuser Benefits to Affected Municipalities and Benefit-Cost Ratios from Proposed State Highway 199 Improvement

MUNICIPALITY	CENTRAL		NORTH		SOUTH	
	BENEFIT	RATIO	BENEFIT	RATIO	BENEFIT	RATIO
Lake Worth ($mil)	65	2.2	31	N/A	88	2.8
Sansom Park ($mil)	88	3.1	67	3.8	104	3.2
Fort Worth ($mil)	232	4.1	417	3.4	263	3.3
Tarrant County ($mil)	53	2.7	57	2.5	55	6.8
River Oaks ($mil)	19	2.8	33	4.1	35	4.3
Lakeside ($mil)	18	3.9	19	9.1	22	3.9

[1] Combined dollar impact on abutting business sales, land values, tax revenues, and income to economy.

benefit-cost ratios (i.e., those representing highway user effects and those representing nonuser effects). The same route alternative, Alternative 5, has the largest benefit-cost ratio for each type of effect. Also Alternative 2 has the smallest ratio and Alternative 4 has the next highest benefit-cost ratio.

Fort Worth

Table 4 shows the estimates of the nonuser construction effects and the total net benefits and costs for user and nonuser effect for each proposed alternative of State Highway 199. Not all nonuser effects select the same alternative. The north bypass alternative would produce the most positive or least negative impact on five of the seven nonuser effects estimated. The central route alternative would most positively affect abutting land values. The south route alternative would most positively affect city and county tax revenues.

User benefits and costs for the south route alternative would produce the most benefits of the three route alternatives, but since the central route alternative would produce the second highest benefits and would cost the least to build, it would yield the highest benefit-cost ratio of the three route alternatives. The north route would produce the lowest benefit-cost ratio. Although it would cost the most to build, the north route would produce proportionately more benefits than the central or the south route alternative.

Since both analyses use the same costs (i.e., right-of-way, relocation, and construction costs), the differences in the magnitude of the user versus the nonuser benefits are responsible for the two analyses having a different route alternative with the highest benefit-cost ratio.

Table 5 presents the results of the nonuser impact analysis on the municipalities affected and the combined dollar benefits and the nonuser ratios of benefits to costs for each proposed route. The cities of Lake Worth, Sansom Park, River Oaks, and Lakeside would be most positively affected by the south route. The city of Fort Worth and Tarrant County would be most positively affected by the north route. The central route alternative would not positively affect any of the municipalities. The south route alternative would produce the highest benefit-cost ratio for the cities of Lake Worth, Sansom Park, and Lakeside. The north route alternative would produce the highest benefit-cost ratio for the city of River Oaks and Tarrant County. The central route alternative would produce the highest benefit-cost ratio for the city of Fort Worth.

CONCLUSIONS AND COMMENTS

The following are conclusions reached from a review of the findings of the two case studies:

1. The findings of the Wichita Falls study support the selection of an existing route, Alternative 5, for improving U.S. Highway 287. The Fort Worth study supports the selection of a bypass alternative, specifically the north route alternative, to improve State Highway 199.
2. The number of business and residential displacements along the existing route significantly affected the magnitude of the effects of existing route alternatives. The existing route alternatives for the U.S. Highway 287 improvement would displace very few businesses and residents. The existing route alternative to improve State Highway 199 would displace more businesses and residents combined than either of the bypass alternatives.
3. The final selection of a route should emphasize minimizing the total number of displacements, especially business displacements.
4. If the proposed improvements are approved for construction, it is recommended that each project be studied to determine the actual construction and after-construction economic affects.

The following are some comments from the two districts:

1. The Wichita Falls District has accepted the findings and conclusions as meeting the criteria necessary for inclusion in the environmental assessment for the U.S. Highway 287 project. The only concern about the methodology has been the difficulty in determining the number of businesses that would simply relocate to an improved route, as opposed to entirely new businesses locating along a new route. This concern is more applicable in an economy like that of Wichita Falls, which is relatively small, isolated, and without significant long-term growth. The findings appeared to be consistent, overall, with observed patterns in the existing Wichita Falls economy.
2. The Fort Worth District is incorporating data from the economic study into the Environmental Impact Statement for the State Highway 199 project. Final selection of the preferred alternative for a project should be based on full and careful comparison of the pertinent data on social, economic, environmental, and engineering considerations related to the project. A choice must be made, and the governing considerations

are a matter of judgment for each specific project, but the process should consider these factors. Engineering considerations are brought into the study during formulation of each alternative, since no tentative alternative would be considered further unless it met minimum engineering requirements. This economic study has provided valuable data on which to base comparison of the alternatives. The conclusions from the economic study may not coincide with the ultimate project conclusions, but the economic data will have a strong influence on the route selection.

REFERENCES

1. E. M. Horwood, C. A. Zellner, and R. L. Ludwig. *NCHRP Report 18: Community Consequences of Highway Improvement*. HRB, National Research Council, Washington, D.C., 1965, 37 pp.
2. H. B. Gamble and T. B. Davinroy. *NCHRP Report 193: Beneficial Effects Associated with Freeway Construction: Environmental, Social, and Economic*. TRB, National Research Council, Washington, D.C., 1978, 110 pp.
3. C. V. Wooten and H. G. Mueth. Economic Impact Study, Temple, Texas. *Bulletin 14*. Texas Transportation Institute, College Station, 1960.
4. J. L. Buffington and H. G. Mueth. Economic Impact Restudy, Temple, Texas. *Bulletin 27*. Texas Transportation Institute, College Station, 1964.
5. J. L. Buffington. Economic Impact Study, Rural Area East of Houston, Texas. *Bulletin 37*. Texas Transportation Institute, College Station, 1967.
6. J. L. Buffington. Economic Impact Study, Chambers County, Texas. *Bulletin 39*. Texas Transportation Institute, College Station, 1967.
7. J. L. Buffington. Economic Impact Study, Huntsville, Texas. *Bulletin 38*. Texas Transportation Institute, College Station, 1967.
8. J. L. Buffington. Economic Impact Study, Conroe, Texas. *Bulletin 40*. Texas Transportation Institute, College Station, 1967.
9. J. L. Buffington. Economic Impact Study, Waxahachie, Texas. *Bulletin 35*. Texas Transportation Institute, College Station, 1966.
10. J. L. Buffington. Economic Impact Study, Merkel, Texas. *Bulletin 36*. Texas Transportation Institute, College Station, 1966.
11. J. L. Buffington. The Economic Impact of Interstate Highway Bypasses. *Texas Transportation Researcher*, Vol. 4, No. 1, 1968, p. 6.
12. J. L. Buffington, W. F. McFarland, J. L. Memmott, and K. N. Womack. *Estimated Impact of Widening U.S. Highway 80 (Marshall Avenue) in Longview, Texas*. Technical Report 1, Research Study 01990. Texas Transportation Institute, College Station, 1987, 65 pp.
13. *Social and Economic Effects of Highways*. FHWA, U.S. Department of Transportation, 1976, p. 250.
14. J. L. Buffington. Economic Impact Study, Rockwall, Texas. *Bulletin 24*. Texas Transportation Institute, College Station, 1963.
15. J. L. Buffington. Economic Impact Restudy, Austin, Texas. *Bulletin 26*. Texas Transportation Institute, College Station, 1964.
16. L. Skorpa, R. Dodge, C. M. Walton, and J. 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, 1984, 64 pp.
17. C. V. Wooten, H. G. Mueth, N. J. Rowan, and T. G. Williams. A Median Study in Baytown, Texas. *Bulletin No. 29*. Research Report 8-1. Texas Transportation Institute, College Station, 1964.
18. C. V. Wooten, H. G. Mueth, N. J. Rowan, and T. G. Williams. A Median Study in Pleasanton, Texas. *Bulletin No. 30*. Research Report 8-2. Texas Transportation Institute, College Station, 1964.
19. C. V. Wooten, H. G. Mueth, N. J. Rowan, and T. G. Williams. A Median Study in San Antonio, Texas. *Bulletin No. 31*. Research Report 8-3. Texas Transportation Institute, College Station, 1964.
20. R. H. Thompson and W. G. Adkins. Some Economic Effects of the Suburban Portion of North Central Expressway, Dallas, Texas. *Bulletin No. 15*. Texas Transportation Institute, College Station, 1961.
21. J. L. Buffington, C. W. Herndon, and M. E. Weiss. *Non-User Impacts of Different Highway Designs as Measured by Land Use and Land Value Changes*. Research Report 225-2. Texas Transportation Institute, College Station, 1978.
22. J. L. Buffington, H. G. Mueth, D. L. Schafer, R. Pledger, and C. Bullion. *Attitudes, Opinions, and Experiences of Residents Displaced by Highways Under the 1970 Relocation Assistance Program*. Research Report 159-1. Texas Transportation Institute, College Station, 1974.
23. J. L. Buffington, D. Burke, W. G. Adkins, and H. G. Mueth. *Experiences and Opinions of Residents Along Elevated, Depressed, and On-Grade Freeway Sections in Houston, Texas*. Research Report 148-1. Texas Transportation Institute, College Station, 1971.
24. R. B. Palmquist. Impact of Highway Improvements on Property Values in Washington State. In *Transportation Research Record 887*, TRB, National Research Council, Washington, D.C.
25. J. E. Burkhardt. Socioeconomic Reactions to Highway Development. In *Transportation Research Record 991*, TRB, National Research Council, Washington, D.C., 1984.
26. J. A. Mullins III, E. J. Washington, and R. W. Stokes. Land Use Impacts of the Houston Transitway System. In *Transportation Research Record 1237*, TRB, National Research Council, Washington, D.C., 1989.
27. C. J. Langley, Jr. Adverse Impacts of the Washington Beltway on Residential Property Values. *Land Economics*, Vol. 52, No. 1, Feb. 1976.
28. R. Duke. The Effects of a Depressed Expressway—A Detroit Case Study. *The Appraisal Journal*, October 1958, pp. 487–507.
29. *The Effect of the Louisville Watterson Expressway on Land Use and Land Values*. Bureau of Business Research, College of Commerce, University of Kentucky, Lexington, 1960.
30. R. H. Thompson, W. G. Adkins, and J. E. Frierson. *A Preliminary Study of the Economic Impact of Stemmons Freeway—A Section of Interstate 35E, Dallas, Texas*. Report E 59-60. Texas Transportation Institute, College Station, 1960.
31. G. E. Bardwell and P. R. Merry. Measuring the Economic Impact of Limited Access Highway on Communities, Land Use, and Land Value. *Bulletin 268*. HRB, National Research Council, Washington, D.C., 1960, pp. 37–73.
32. *Certain Economic Effects of the Lexington Northern Belt Line*. Bureau of Business Research, University of Kentucky, Lexington, 1960.
33. W. G. Adkins and A. W. Tieken. Economic Impacts of Expressways in San Antonio. *Bulletin II*. Texas Transportation Institute, College Station, Aug. 1958.
34. W. G. Adkins. *Effects of the Dallas Central Expressway on Land Values and Land Use*. Bulletin 6. Texas Transportation Institute, College Station, 1957.
35. J. C. Yu and J. L. Allison. A Methodology for Forecasting Beltroute Corridor Land Use Impacts. *Transportation Research Record 1046*, TRB, National Research Council, Washington, D.C., 1985, pp. 59–62.
36. J. L. Buffington, D. L. Schafer, and C. Bullion. *Attitudes, Opinions, and Experiences of Business and Institutional Relocatees Displaced by Highways Under the 1970 Relocation Assistance Program*. Research Report 159-2. Texas Transportation Institute, College Station, 1974.
37. J. L. Buffington. *Consequences of Freeway Displacement to Urban Residents in Low Valued Housing*. Research Report 148-3. Texas Transportation Institute, College Station, 1973.
38. J. L. Buffington and D. Burke. *Employment and Income Impacts of Highway Expenditures on Bypass, Loop and Radial Highway Improvements*. Research Report 1106-3. Texas Transportation Institute, College Station, 1989.
39. Texas Comptroller of Public Accounts. *The Texas Input-Output Model*, 1986 Update. Dec. 1989.
40. Mills, Florence. Effects of Beltways on the Location of Residences and Selected Workplaces. *Transportation Research Rec-*

ord 812, TRB, National Research Council, Washington, D.C., 1981, pp. 26–33.
41. J. L. Memmott. *The HEEM-III Benefit-Cost Computer Program*. Research Report 1128-1F. Texas Transportation Institute, College Station, Nov. 1990.
42. J. L. Buffington, L. M. Crane, and R. Salleh. *Estimated Economic Impact of the Proposed Improvement of State Highway 199 in Tarrant County, Texas*. Research Report 1904-2F. Texas Transportation Institute, College Station, March 11, 1991.
43. J. L. Buffington, L. M. Crane, K. N. Womack, and R. Salleh. *Economic Assessment of the Proposed Improvement of U.S. Highway 287 in Wichita Falls, Texas*. Research Report 1915-1F. Texas Transportation Institute, College Station, June 1, 1991.

Publication of this paper sponsored by Committee on Social and Economic Factors of Transportation.