Methods Used to Study Effects of the Lexington, Virginia, Bypass on Business Volumes and Composition

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This paper contains a description of the methods applied in pursuing a study of the economic effects of the U. S. Route 11 bypass at Lexington, Va., a town with a population presently estimated at 6,500. This study was limited to the effects of the bypass on business volumes and composition. The primary source of data was the state business license application, which indicates gross income and useful information on location and ownership. These data have been summarized and compared with various indices of economic activity. Effects of changes in the total economy have been identified and removed where possible.

Particular attention was devoted to the development of continuity in the data assembled. Exhaustive field checks and cross referencing of data sheets were employed. This study was designed to permit employment of classifications and comparisons which have been used in previous economic impact studies with the aim of testing their congruity. Machine data processing has been employed for experience, although the number of businesses is not sufficiently large to demand this refinement.

● DURING THE past few years, research agencies in several states have been conducting studies of the economic impact of highway improvements. In most of these studies special attention has been paid to the effects of the limited access feature. The Virginia Council of Highway Investigation and Research is currently conducting a comprehensive study of the economic effects of the U. S. Route 11 bypass at Lexington, Va. This study, now nearing completion, has been concerned with the impact of this highway improvement on business volumes and composition. Because this is the first economic impact study undertaken by the Virginia Department of Highways, it has the dual purpose of evaluating the economic effects of the Lexington Bypass and of developing methods for use in future studies. This paper is primarily concerned with reporting this development of method.

In preparation for the study, many reports of economic impact studies from other states were reviewed.[1] While these studies differed in the kinds of data used and the areas studied, there were many similarities in the techniques of study employed. The two techniques most frequently found were the "before and after" comparison and the "study and control area" comparison.[2] It was considered desirable to use an established technique in the Lexington study but no report or reference was found which contained an evaluation of the relative merits of the two methods of comparison, that is, "before and after" and "control and study area." Because of this it was decided to design the study to permit application of both methods of comparison to a common set of data while keeping the other factors of analysis simple and secondary. With this design it was hoped to reach an evaluation of the relative merits of the two techniques of com-

[1] The results of this review have been reported by the Virginia Council of Highway Investigation and Research in a publication entitled "Bibliography—The Economic Effects of Limited Access Highways and Bypasses," by Joseph W. Harrison.

[2] Both techniques have been employed in the well known group of studies conducted by the California Department of Highways as well as in studies made in Texas, Oregon and elsewhere. Because these techniques have been widely used it is not intended to refer to any particular study.

parison. The purpose of this paper is to present this evaluation together with a summary of the individual steps taken in the investigation. Data contained are for illustrative purposes and are not intended to represent results of the study which will be reported later.

The primary source of data for this study was the state business license application which indicates gross income and information about business type, location and ownership. These data were classified by business type and location, summarized and indices of change were computed. Using these indices, changes in the activity of the several business groups were compared by the two techniques described above. Where possible, supplementary data were employed in order to identify causes for trend changes noted.

For the reader who is unfamiliar with the study area, some background information may be helpful (1). Rockbridge County was formed in 1778 from two neighboring counties and named for the famous Natural Bridge of Virginia, found in its southern part. Lexington, founded a year earlier, became the county seat. In 1950 Rockbridge County had a population of 24,359, which included Lexington's 5,976. However, this figure did not include the City of Buena Vista, incorporated in 1892, which had a 1950 population of 5,214.

Rockbridge County (land area 604 sq mi) lies in a broad valley between the Allegheny Mountains on the northwest and the Blue Ridge Mountains to the southeast. About half of the total area is wooded; two national forests extend into the county. Several local industries utilize forest products. Mineral resources in commercial production include glass sand, limestone, quartzite, and brick clay. Tin, manganese, and iron ore have been mined in the past, and marble, granite, barite and shale are available. Agriculture and manufacturing are the chief sources of employment and income. The 1950 census reports that agriculture and allied pursuits occupied 25.2 percent of all employed persons in the county and manufacturing employed 25.7 percent. Fertile limestone soils make excellent pastures and sales of beef cattle, calves, hogs, and sheep produce the greatest portion of farm income. Dairy products are next in importance, then poultry, grain and hay crops, and in addition there are some very productive orchards. Manufacturing industries, chiefly in Buena Vista and Glasgow, produce a wide variety of products including textiles, wood products, paper and building materials.

A chronology of the bypass follows. Late in 1951, the Town Council of Lexington formally requested the Virginia Department of Highways to make a preliminary location survey and appropriated funds to cover the town's share of the costs. Plans were approved by the highway department and funds for rural construction allocated in May 1953. At that time, federal aid and state funds were made available for construction and right-of-way purchases within the town limits. Paving bids were received and the contract awarded in June. Bids were received for grading, drainage and structures, and contracts were awarded in November. Construction began in mid-December 1953 and the U. S. Route 11 bypass at Lexington, Va., was opened to public use on November 25, 1955.

COLLECTION AND CLASSIFICATION OF DATA

The primary source of data for this study was the business license application, required by the State Department of Taxation and normally retained on file for three years. Since these applications contain confidential information, special permission to use this information was granted by the Governor of Virginia, subject to the condition that it be handled in a confidential manner and that any report avoid disclosing the identity of the individual businessman and the volume of his business. In complying with these requirements, all data used in this paper have been summarized into groups, percentages, and indices.

From the files of the Rockbridge County Commissioner of the Revenue, the following information has been tabulated: name of licensee, name of business unit, mailing address of proprietor or business, location of business, change of location, type of ownership, change of ownership, date the business began, type of business, annual gross income, number of employees, and annual rental value of the business property. In

addition, annual sales of gasoline were tabulated. This information was available for gasoline retailers because they are required to report the number of gallons sold annually in order to qualify for a deduction of the state gasoline tax.

During the process of collecting data, several questions arose which affected either the reliability of the data or the analysis thereof. First was the question of the accuracy of the data source. When submitted to the Commissioner of Revenue, the business license application bears a sworn statement of the accuracy of the information contained and is signed by the licensee. After some study it was agreed that the applications may contain some degree of inaccuracy, but it was presumed that the bias would be consistently downward for gross incomes and upward for gasoline sales. There is no ready means of identifying such a bias, if it exists; and it has been assumed that the information is accurate as attested by the sworn statement of the licensee. The next question arose when it became necessary to decide on the length of the study period. It is the policy of the Department of Taxation to destroy the business license applications after the third tax year has passed. This three year period was considered too short to permit a study of the economic changes which may occur after a highway improvement. For the present study, the problem was solved because the files of the Rockbridge County Commissioner of Revenue extended back for several years. Another difficulty was encountered in the disparity of information recorded on the license application from year to year. Aside from the information actually required for identification of a business and for assessment of the tax, revenue officers and applicants differed on the amount of supplementary information recorded. Most often omitted was the name of the business, information on location and ownership, number of employees and rental value of the property. Also, inconsistencies were found in the applications from year to year. The application was not always filed by the same person in succeeding years and the addresses and locations listed varied. Coupled with the omission of the business name, these inconsistencies sometimes indicated a new owner, a new business, or a new location; but more often not. These omissions and inconsistencies did not prevent the compilation of complete case histories but did extend the amount of time and effort required. Because some types of businesses are taxed on a flat rate basis and their license applications contain no other indicator of business volumes, these businesses were not included in the study. Finally, the use of annual data imposed certain restrictions upon the analysis.

The business license data does offer certain advantages in this type of study. The information is recorded in a standardized manner and is available for all the businesses in the state. In some cases, economic studies have been handicapped when one or several businesses have not permitted access to their records. This handicap is overcome by the use of business license data. All businesses, except those upon which a flat rate tax is imposed, may be included in a study and questions of sampling techniques may be avoided. Further, data can be collected quickly and inexpensively.

While the business license applications were the primary source of data the collection of secondary data was carried on concurrently. These contain records and measures of economic activity of the national economy and its several parts. All of these data were selected to present some information in relation to the economy of the study area. Several of these sources were: "Standard Industrial Classification Manual," "Directory of Virginia Manufacturing and Mining," "Economic Data," price and construction indices, "Survey of Current Business," "Census of Population," agricultural prices, maps, and annual totals of gasoline sold and tax paid in Virginia. From these sources, information was selected for comparison with the primary data.

Defining study and control areas for the project was a difficult problem. Here the term "study area" was used to indicate the geographic area(s) within which are included those businesses presumed to have been affected by the bypass. The term "control area" designates another geographic division of data to be used for comparison. The problem was resolved into one of selecting geographic areas which contain similar numbers of businesses carrying on similar activities in a similar sociological climate. Vital to this question was the choice of areas where data were available. In choosing Rockbridge County and several sub-areas, two needs were served: (1) the study and control areas contain similar groups of businesses within a similar geographical and

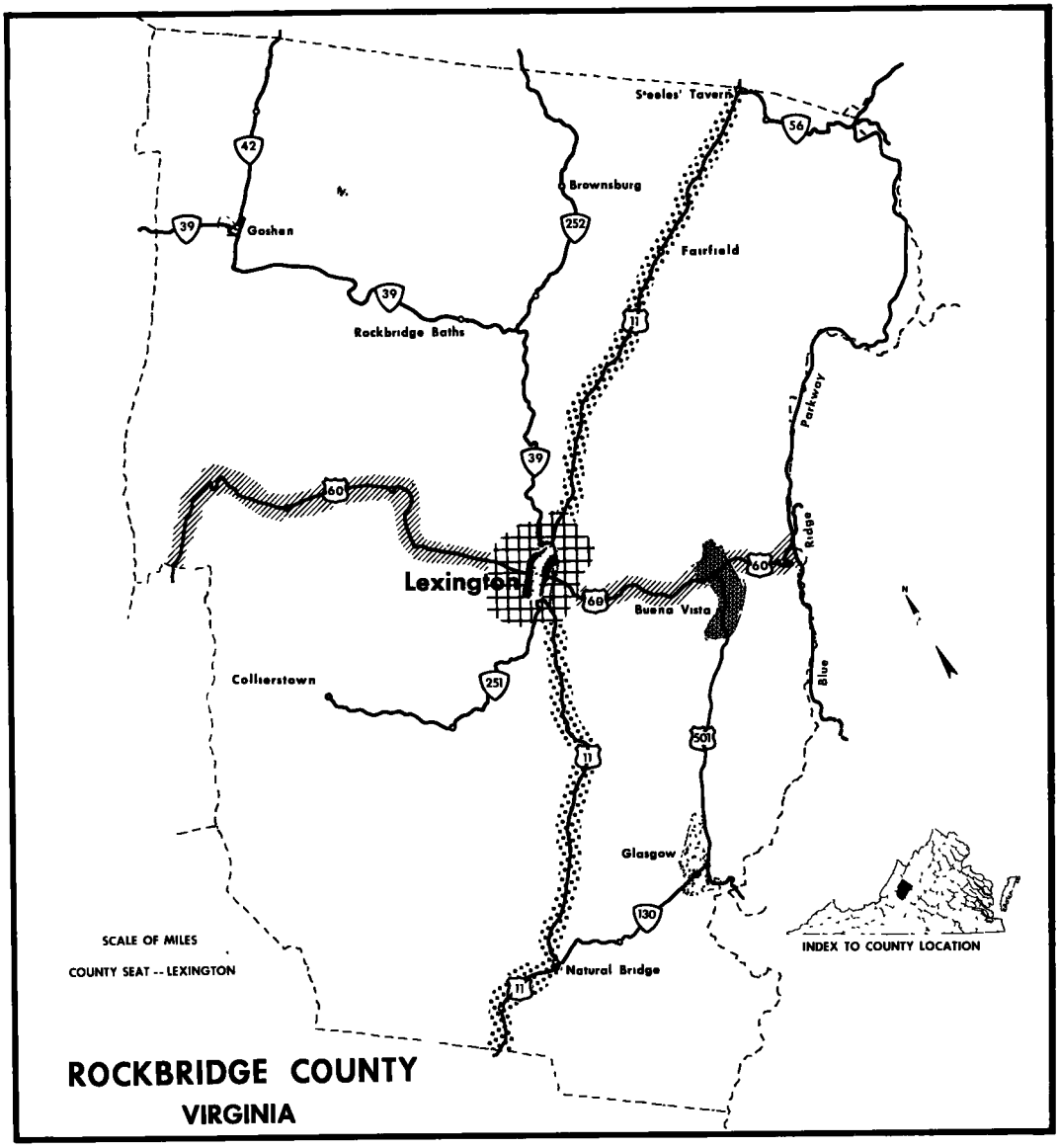

Figure 1. Study and control areas.

sociological sphere and (2) this choice permitted the application of the techniques of comparison described earlier. An attempt was made to test these techniques by comparing conclusions reached with the several combinations and disjunctions of study and control areas.

The several areas are named and described below (see Fig. 1):

Area 1. Bypassed Business on U. S. Route 11 (Study Area)—those businesses abutting U. S. Route 11 and Main Street between the north and south termini of the bypass.

Area 2. Businesses within the Corporate Limits of Lexington (Study Area)—not including those in Area 1 above.

Area 3. Businesses within the Lexington Fringe Area (Study Area)—roughly defined as extending about one mile from the corporate limits in all directions, particularly defined to include businesses adjacent and near to the corporate limits, extending on each roadway so far as to include those which are grouped thickly around the Town of Lexington but to exclude those which are farther away and definitely rural in location.

Area 4. East-West Roadside Businesses (Control Area)—those businesses abutting on or adjacent to U. S. Route 60 east and west of Lexington, extending to the county line in both directions, not including businesses in other areas.

Area 5. North-South Roadside Businesses (Control Area)—those businesses abutting on or adjacent to U. S. Route 11 north and south of Lexington, extending to the county line in both directions not including businesses in other areas.

Area 6. Buena Vista (Municipal Control Area)—those businesses within the corporate limits of the City of Buena Vista.

Area 7. Rockbridge County (Rural Control Area)—all businesses not included in Areas 1 through 6.

It was recognized that the businesses in Area 1 are those likely to be most strongly influenced by the bypass. They constitute the primary study area. This area may not contain all the businesses formerly influenced by the through traffic which has been routed elsewhere. Area 2 contained the remainder of businesses in the Town of Lexington but still did not encompass all businesses directly within the economic influence of Lexington. Area 3 contained the businesses within a "short distance" of the Lexington corporate limits. Areas 1, 2, and 3 were jointly and separately conceived as study areas, though 2 and 3 have proven to have other value. The "short distance" in the description of Area 3 was loosely defined deliberately. Thought and discussion were devoted to seeking a more precise definition. Measuring frequency per mile of businesses, plotting curves of frequency versus distance from the corporate limits, measuring distance from the corporate limits and other means of more precise definition were discussed. It was concluded that the study and the geography are not so complex that they require these refinements. An observer, by driving along the highways leading away from Lexington in several directions, can readily see the businesses near Lexington and the open, rural countryside a little farther along. This kind of observation was employed in defining the "fringe area." Areas 4 and 5 are composed of roadside businesses on the two main highways which cross the county. The potential usefulness of these control areas was always judged on the basis of the number and kinds of businesses contained, keeping in mind the desired similarity to the Lexington business group. For some business groups these areas did contain sufficiently similar groups of businesses. Generally, Areas 4 and 5 were combined to form a roadside business control area. The independent City of Buena Vista was selected as a municipal control area. Notwithstanding the presence of industry, the city is quite like Lexington in its business composition. Both serve as centers of commerce for the rural agricultural county and they are similar in population. Lexington, with its historic landmarks, enjoys a considerable tourist trade, little of which passes through Buena Vista. Other towns in the county (Glasgow and Goshen) were not sufficiently large to have similar business compositions. In essence, Buena Vista was the only municipal area in Rockbridge County which could be compared with Lexington. Area 7 was defined to include all businesses in the county, not contained in the other study and control areas. These were mainly small, rural enterprises. This control area, in combination with others, permitted comparison of the bypassed town with the surrounding county. Indeed, the desire to make this methodological comparison was one of the bases for defining these study and control areas. In a future study it may be desirable to compare one county with another, hence using the remainder of the county as a control area permits a summary of Rockbridge County business volumes and composition during the study period.

Having defined study and control areas, it became necessary to categorize the businesses contained. While it may be interesting to know that all businesses in an area experienced change, it is more meaningful to know that certain types of businesses have experienced a greater or lesser degree of change than others. It was presumed that some businesses will be more strongly affected by highway relocation than will others, both in nature and degree. Businesses may be classified by any of several systems, depending upon the purpose of the classification. A telephone directory offers two such systems. In seeking meaningful classifications, systems used by other agencies have been reviewed and that used by the U. S. Bureau of the Budget has been selected. It offered the advantages of being a recognized standard system, adaptable to a small or large study, and designed for machine processing. Definitions for these business categories may be found in the "Standard Industrial Classification Manual."

As the study progressed, it became evident that precise information on the geographic locations of businesses would be required. The business license applications did not contain sufficient detail to permit certain identification. In the face of varying addresses and locations listed on the applications, precise knowledge of the location of a business was necessary to eliminate duplicate data sheets and to establish continuity of the data on business volumes. Further, this knowledge of location was necessary to assign data sheets to the several study and control areas. Several sources of information were used to accumulate information on business locations. An extensive field inventory of businesses was conducted through the whole county in June, 1957. Individual businesses were sighted and pertinent information recorded, including the route numbers, mileage from a known point, business name if shown and a description of the business with mention of the principal products or services. At the same time, each entry of the inventory was coded to a number written on a county map. In addition, other inventories and maps were used in this effort to establish business locations. Street maps were obtained for cities and towns included in the study. The U. S. Post Office Department furnished, on request, several copies of a map showing rural U. S. mail routes in the county. The result of these several steps was the selection of the seven study and control areas described earlier. Data sheets have been identified for businesses described in the field inventories and coded to indicate geographic location.

ANALYSIS OF THE DATA

Automotive Dealers and Service Stations

In choosing to analyze these business classifications first, several factors have been considered. Retailers of gasoline were readily identifiable because they are required to state gallons of gasoline sold (annually) in order to justify a deduction from taxable gross income. Secondly, information about the progress of this segment of the economy will be of immediate interest to those concerned with the economic effects of highways. Thirdly, for this business group, paired data (gross incomes and gallons sold) permitted a more detailed analysis than that possible for the remaining groups. Finally, the conclusions reached about this segment of the study indicated the kinds of information that might be gained from the remainder of the study.

In describing the analysis of service station data, it will be useful to state some definitions. Service stations are described as those retail businesses for which the sale of gasoline is the primary source of income, group number 554 of the "Standard Industrial Classification Manual." This definition, if rigidly applied, would have excluded some de facto service stations if they had gained considerable income from automotive service, repair and other secondary service station activity. In this analysis, the author has judged which retail gasoline outlets to include based on a personal knowledge of the business and from supplementary data such as the detailed field inventory of businesses previously described, telephone directories, and tax records. The term automotive dealer is here used to describe those businesses which, though they sell gasoline at retail, have another business activity as their primary source of income. These businesses include new and used auto dealers, auto repair garages, and retailers of automotive accessories and parts. These groups are defined in greater detail in the "Standard Industrial Classification Manual" as groups numbered 551, 552, 553, 559, and 753.

TABLE 1

TABULATIONS OF GROSS INCOMES OF SERVICE STATIONS (Reported in dollars)

Areas	Before						During Construction						After		
	1952			1953			1954			1955			1956		
	Gross Incomes	No.	I	Gross Incomes	No.	I	Gross Incomes	No.	I	Gross Incomes	No.	I	Gross Incomes	No.	I
Study															
Primary	610,425	9	100	630,898	9	103	628,694	9	103	631,114	9	103	473,458	10	78
Secondary	281,471	9	100	274,835	9	94	324,895	10	115	412,597	10	147	543,888	10	193
Control															
Roadside	492,585	21	100	616,724	20	125	616,561	21	125	656,247	21	133	711,413	20	144
Municipal	386,929	10	100	473,493	11	122	518,062	11	134	521,234	11	135	653,928	12	169
County	1,423,359	62	100	1,666,505	63	117	1,747,193	67	123	1,932,342	68	136	2,201,647	67	155

No. = Number of businesses included in tabulations.

I = Index, a simple relative of gross incomes in a given year compared to gross incomes in a base year (1952). For Area 1 and 2,

$$I_{53} = \frac{\text{gross incomes - 1953}}{\text{gross incomes - 1952}} = 103$$

In this part of the analysis it has been necessary to amend slightly the definitions of study and control areas. This has been done to avoid disclosure of information from which could be deduced the gross income of a business; to eliminate changes in gross incomes of an area due only to change in a single business unit whose gross income dominated a small area; or to establish a control area of meaningful size and composition. In each case, the redefinition has been accomplished by combining areas previously described. For this discussion, the following areas will be used. Areas 1 and 2 have been combined to constitute the principal study area, Area 3 remains as earlier defined—the secondary study area. Areas 4 and 5 have been combined to form a roadside business control area. Area 6 remains as before, the municipal control area. By combining Areas 4, 5, 6 and 7, a comparison of the study areas with the "remainder of the county" is made possible.

Service Stations

As a first step in the analysis of these data, gross incomes and gallons of gasoline sold per year were totalled for each study and control area. The data on service stations are presented in Tables 1 and 2. The years 1952 and 1953 constitute the "before" period, the building of the bypass took place during 1954 and 1955, and the data reported for 1956 represents the first full year of business activity after the bypass was opened to the public. As stated earlier, in each step in the analysis, an attempt has been made to parallel the "before and after" and "control area" methods of comparison used in other studies. For the former comparison, data for 1952 and 1953 in the study areas has been compared with data for the same areas in 1956. For the latter comparison, data for the study areas has been compared with that for the control areas. First the "before and after" picture will be discussed. The index of change of gross incomes is a simple relative of gross incomes in a given year compared to gross incomes in the base year (1952). Figure 2 presents indices for the several areas.

Businesses in the principal study area sold fewer gallons and grossed less income after the bypass was opened than in the "before" period. At the same time, those in the secondary study area enjoyed considerable increases in sales and gross incomes.

TABLE 2

TABULATIONS OF GALLONS OF GASOLINE SOLD BY SERVICE STATIONS

Areas	Before						During Construction						After		
	1952			1953			1954			1955			1956		
	Gallons	No.	I	Gallons	No.	I	Gallons	No.	I	Gallons	No.	I	Gallons	No.	I
Study															
Primary	1,607,946	9	100	1,609,018	9	100	1,540,401	9	96	1,449,698	9	90	1,038,348	10	65
Secondary	722,252	9	100	700,482	9	97	786,798	10	109	1,015,142	10	141	1,288,962	10	178
Control															
Roadside	1,029,111	21	100	1,303,019	20	127	1,311,106	21	127	1,220,977	21	119	1,359,931	20	132
Municipal	800,267	10	100	898,318	11	112	1,045,481	11	131	1,061,656	11	133	1,181,908	12	148
County	2,693,896	62	100	3,091,781	63	115	3,329,970	67	124	3,467,099	68	129	3,851,701	67	143

No. = Number of businesses included in tabulations.

I = Index, a simple relative of gallons sold in a given year compared to gallons sold in a base year (1952). For Area 1 and 2,

$$I_{53} = \frac{\text{gallons sold - 1953}}{\text{gallons sold - 1952}} = 100$$

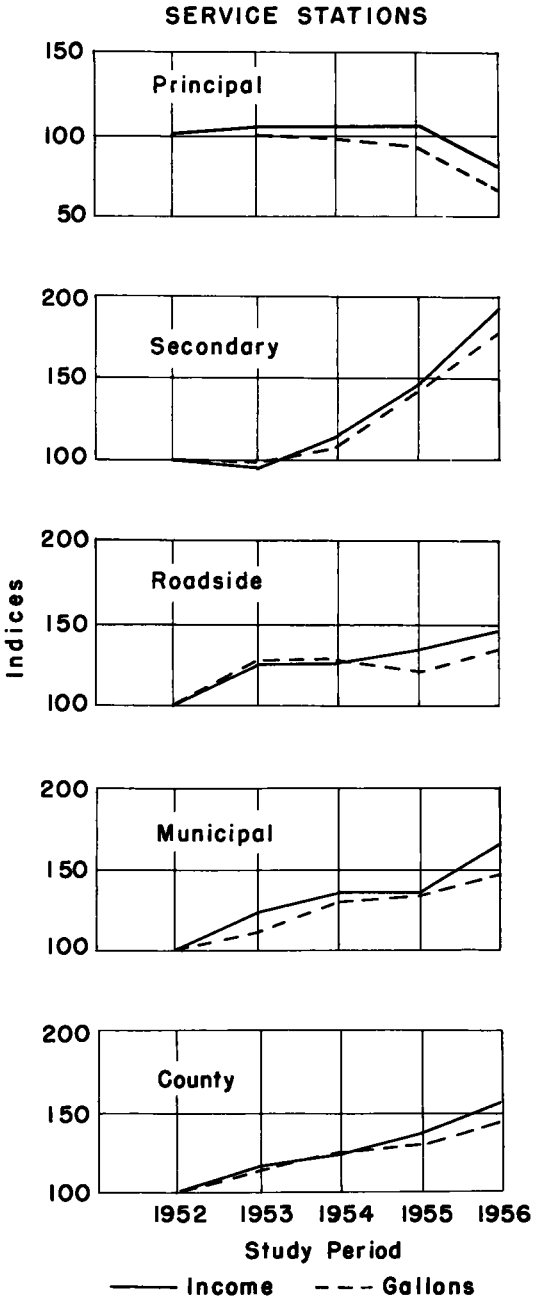

Figure 2. Indices of gross income and gallons by areas.

If no further analysis were made, a considerable loss of business for the bypassed businesses might be claimed. However, further study has indicated the existence of at least two other factors. In seeking to discover reasons for the increases in the fringe area, it has been found that this area contains the principal growth potential of the town. There is practically no land area within the town available and desirable for commercial expansion. Growth of business and residential areas adjacent to the town has been significant and is expected to continue. During the study period, four new businesses were started in the fringe area while only one was started in the primary study area. During the period, two businesses changed location from the principal to the secondary study area. Three businesses ceased operations; of the two that were in the secondary study area one ceased operation at the death of the proprietor and the other for unknown reasons. These changes have contributed to and substantially account for the greater relative increases of sales and gross incomes of service stations in the fringe area. The other factor was found in the trend of decreasing gasoline sales in the principal study area. The data in hand does not indicate the reasons for this trend but does show that it began not later than in the year 1953. It cannot be determined if this trend began earlier because earlier business years are not included in this study. By plotting the index of gallons sold in this area on semi-log graph paper, a slightly increasing rate of decreasing sales was indicated. The total decreases increased in a geometric progression, by extending this progression to the end of the study period, it is estimated that the factors causing the trend account for a decrease in sales of 19 percent while other factors, including the rerouting of traffic, account for the remaining 16 percent of decreased sales. In applying a similar analysis to gross incomes, it was found that the index of gross incomes closely followed that of sales for service stations as was expected, since by definition their primary source of income is the sale of gasoline. At this point, it may be observed that expansion of the service station group in the fringe area was a major factor in the increases of sales of gasoline and of gross incomes. In the primary study area, a trend of undetermined causes was believed to have influenced the sales and gross incomes more than did other factors, including the relocation of the highway. Speculation on the "undetermined causes" of the trend seems to indicate that they are reciprocal to the causes for the increases in the fringe area, namely,

TABLE 3

TABULATIONS OF GROSS INCOMES OF AUTOMOTIVE DEALERS (Reported in dollars)

Areas	Before						During Construction						After		
	1952			1953			1954			1955			1956		
	Gross Incomes	No.	I	Gross Incomes	No.	I	Gross Incomes	No.	I	Gross Incomes	No.	I	Gross Incomes	No.	I
Study															
Primary	1,007,666	7	100	1,234,969	7	123	1,015,339	7	101	1,577,403	7	157	1,453,228	7	144
Secondary	752,996	7	100	808,439	7	107	838,055	8	111	922,102	8	122	861,690	8	114
Control															
Roadside	471,371	11	100	428,355	11	91	477,414	13	101	452,070	13	96	482,086	12	102
Municipal	1,458,877	9	100	1,575,884	8	108	1,716,603	9	118	2,090,883	10	143	1,755,166	9	120
County	3,127,742	56	100	3,244,754	56	104	3,365,568	57	108	3,716,373	55	119	3,371,119	49	108

No. = Number of businesses, I = Index.

growth of businesses in the secondary study area attracting trade from within the town. There seems to be no way to support this assumption from the data, yet it remains a possibility.

For this group of businesses, comparison between study and control areas yields little information not already observed. The control areas showed steady trends of increasing gasoline sales and gross incomes. Though none of the control areas experienced increases as great as were found in the secondary study area, the municipal control area increases were significant. This area, Buena Vista, seems to have shared the expansion of business with the Lexington fringe area. Three new service stations opened during the period while only one went out of business. Evidence of growth potential is found in the numbers of new residences, new and remodeled stores, and the existence of land suitable for commercial use.

Automotive Dealers

This classification contains the remainder of businesses which are identifiable in the tax records as "retailers of gasoline." This analysis will conclude the use of paired data. These businesses differ from service stations in that gasoline sales do not constitute the primary income source. Tables 3 and 4 present tabulations of gross incomes and gasoline sales. Figure 3 pictures the indices by areas.

In both study areas, this business group enjoyed significant increases in gross incomes. In Lexington, because it is a business center in the county, this business group is largely composed of new and used car dealers. As such enterprises do not normally attract the transient motorist, the greater relative increases of gross incomes in the principal study area are considered to reflect the state of the automobile market. On the other hand, this same group in the fringe area is made up of other types of automotive business—generally smaller ones. Though gasoline sales are of minor significance to these businesses, it is interesting to note that the trend of decreasing sales of gasoline in the primary study area has also affected gasoline sales by automotive dealers. This seems to affirm the existence of some "other factors" which have been influencing gasoline sales in Lexington. Because of the peculiarities of the composition of this business group in the several areas, comparisons with the control areas are restricted. The municipal control area—Buena Vista—automotive group is like that in Lexington. This group reported increased incomes during the study period but significantly less than were reported in the primary study area. The secondary and roadside areas con-

TABLE 4

TABULATIONS OF GALLONS OF GASOLINE SOLD BY AUTOMOTIVE DEALERS

Areas	Before						During Construction						After		
	1952			1953			1954			1955			1956		
	Gallons	No.	I	Gallons	No.	I	Gallons	No.	I	Gallons	No.	I	Gallons	No.	I
Study															
Primary	207,863	7	100	211,452	7	102	194,626	7	94	197,615	7	95	179,032	7	86
Secondary	215,751	7	100	216,846	7	101	239,864	8	111	244,483	8	113	210,171	8	97
Control															
Roadside	218,541	11	100	193,991	11	89	217,558	13	100	218,994	13	100	204,319	12	93
Municipal	321,919	9	100	315,531	8	98	327,665	9	102	344,032	10	107	311,975	9	97
County	1,080,742	56	100	1,090,769	56	101	1,132,091	57	105	1,201,870	55	111	1,190,962	49	110

No. = Number of businesses, I = Index

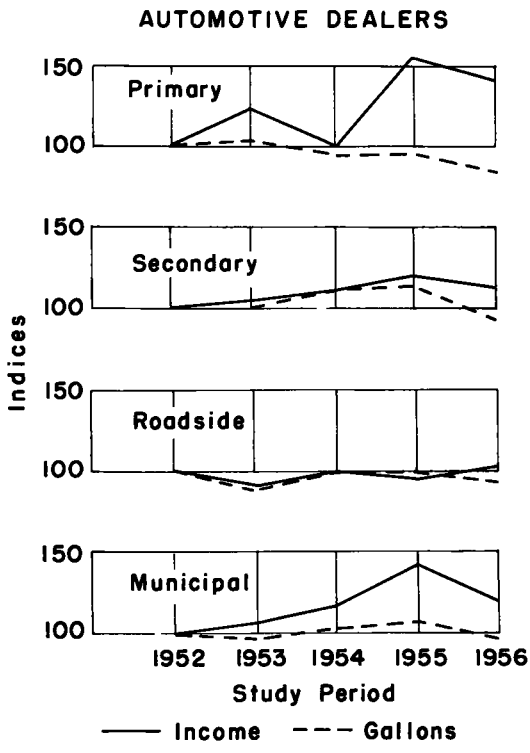

Figure 3. Indices of gross income and gallons by areas.

tain similar business groups and may be compared. The fringe area businesses reported greater than base year incomes in each succeeding year while the roadside businesses reported greater decreases than increases. Comparison with the county area is not considered meaningful because of dissimilar business compositions.

Before closing the discussion of data on "gasoline retailers," a final comparison is made. Table 5 shows indices of total gallons of gasoline sold in Rockbridge County during the study period by all service stations and all other gasoline retailers compared with an index of total sales in the state. It is observed that gasoline sales by service stations in Rockbridge County did parallel sales in the whole state. Further, this confirms the reliability of the total data collected for gasoline retailers.

Notes on Methods

This section presents some details of the analyses which were applied to the preceding data. Because a retailer of gasoline, if he does not wish to claim the deduction, is not required to state gasoline sold when declaring gross income for tax purposes, a few data sheets did not indicate gasoline sales for each year of the study period. When indices of change of gallons sold by areas were computed, the lines presented an inconsistent picture. An accurate means of estimating gallons sold was sought, based on gross incomes as the known values.

A scattergram, plotted from all known pairs of data (X = gross incomes and Y = gallons), showed a strong linear relationship with a ratio of approximately 2 to 1. Another less strong linear pattern appeared with a ratio of less than 1 to 1. Very few pairs of data plotted between these patterns except near the intersection of the coordinates (that is, when the paired values were small numbers of dollars and gallons). Examination of the data sheets revealed that the data plotting in the former scatter pattern represented those businesses which have as a primary source of income the sale of gasoline—service stations. The latter scatter pattern collected together the data of those businesses which derive their primary incomes from sale of new and used autos, accessories, parts, automotive repairs and services but which also sell gasoline.

Based on the strength and separation of these two patterns, an attempt was made to compute values for the linear equation ($y = a + bx$) which would permit estimating gallons of gasoline sold when gross income is known. Values were computed for each area from data sheets, selected by the investigator to represent de facto service stations. Estimates were made for individual businesses and were checked for accuracy with the standard error of the estimate

$$SE = \sqrt{\frac{(Y - Yc)^2}{N}}$$

TABLE 5

GASOLINE SALES COMPARED WITH STATE TOTALS BY INDICES OF GALLONS

Business Group	1952	1953	1954	1955	1956
County Service Stations	100	108	113	118	123
Automotive Dealers	100	101	104	109	105
Total Sales	100	106	111	116	119
State Total Sales	100	105	108	118	125

where N is the number of pairs of known data, Y is the known number of gallons sold and Yc is the computed number of gallons sold. It had been decided that estimates which exceeded one standard error would be rejected. It was found that too many estimates for individual businesses did not fit this criterion. In rechecking computations and the selection of data sheets, a ratio of gallons sold to gross income was computed for each year on every data sheet. These ratios confirmed the apparent selectivity of the scattergram and showed several errors in the investigator's judgment in selecting data sheets purporting to represent service stations. It was decided that the criterion of one standard error was too rigid for estimates of an individual business and it was then realized that estimates by this method may be expected to be accurate only for groups of data. It was then decided to use this method to estimate by areas, and to check these estimates against the sums of gallons actually reported and against separate estimates based on the sums reported when adjusted for the individual business by the mean ratio of gallons to dollars in previous and/or subsequent years. This decision is appropriate since no information may be reported for a single business and all will be reported in terms of totals by areas.

TABLE 6

SLOPE OF THE REGRESSION LINE (b) BY AREAS

Area	Service Stations	Other Gasoline Retailers
1	2.345	0.01186
2	2.262	0.01512
3	1.661	0.01716
4	2 179	0.3247
5	2.520	0.3360
6	1.614	0 01612
7	1.722	0.3718

Two linear equations ($Y = a + bx$) have been solved for each area, one representing service stations and the second representing other businesses selling gasoline at retail. The slope of the line (b), the values of which are shown in Table 6, in each case has confirmed the effectiveness of the ratio between gallons and gross income in identifying service stations within a group of gasoline retailers.

As anticipated from the scattergram, the values for b are greater than one for service stations and less than one for other retailers. With these linear equations, estimates of gallons sold per area per year were computed and compared with totals of gallons reported with and without the individual business ratio adjustment. These estimates were satisfactorily accurate and have been used to confirm the accuracy of the totals presented in Tables 2 and 4 from which the analysis was made.

A second point worth mention is the use of a price index to remove from the reported annual gross incomes of service stations whatever change was due only to a change in the selling price of gasoline. This was accomplished by a commonly used "deflation" technique (2). An index of gasoline prices was required. The optimum index would be that compiled from prices of gasoline sold in Rockbridge County during the study period; such information was not available and would be too costly to compile at this time. As an alternative, an index was computed from retail gasoline prices of 50 cities of the United States (3) to which were added federal and state taxes applicable in Virginia. It is recognized that this index may not be the best measure of changes in gasoline prices that have occurred in the study area; however, it is believed that this evaluation is meaningful. Recognizing the limitations of the index, the "deflation" technique was employed in the belief that the adjustment constituted a step in the right direction and that the constant dollar gross incomes would describe the changes in gross incomes of service stations more accurately than the unadjusted figures. These adjusted gross incomes were used as an aid in evaluating changes indicated, but are not presented in the tables or charts of this paper for several reasons. While the constant dollar gross incomes derived were slightly lower than the reported incomes, as expected, indices of the two sets of gross income figures were still distinctly similar, a result of the narrow range of price changes of the index used. In addition, the objection, that an index of city prices does not represent the study area prices with sufficient accuracy, is avoided. Finally, in presenting the data on graphs, the indices of adjusted incomes were so nearly coincident with indices of gallons sold that they detracted from the simplicity of the graphs. This near coincidence adds nothing to the analysis since service stations are defined as gaining their income primarily from selling gasoline.

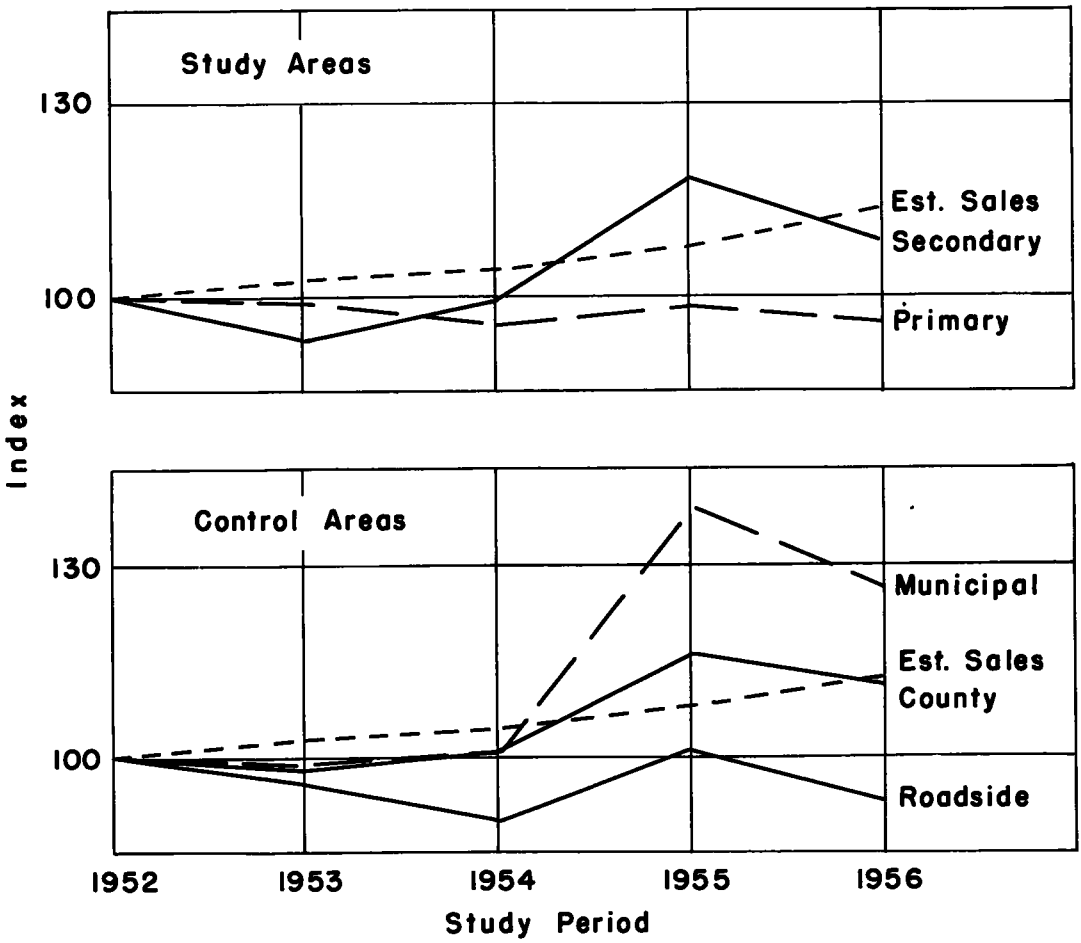

Figure 4. Indices of restaurant gross incomes by areas compared with index of estimated sales of restaurants from "Survey of Current Business."

Restaurants

The choice of restaurants as the next subject of analysis was prompted by essentially the same reasons that dictated the choice of service stations earlier. Though not as readily identifiable as service stations and automotive dealers, this category presented no special problems of identification and was, in fact, more typical of the total data collected than were the two groups of gasoline retailers. Restaurants were chosen as typical of businesses for which the license applications indicate only gross incomes.

TABLE 7

TABULATIONS OF GROSS INCOMES OF RESTAURANTS

	Before						During Construction						After		
	1952			1953			1954			1955			1956		
Areas	Gross Incomes	No.	I	Gross Incomes	No.	I	Gross Incomes	No.	I	Gross Incomes	No.	I	Gross Incomes	No.	I
Study															
Primary	497,398	12	100	494,944	12	100	475,174	12	96	490,305	12	99	477,936	12	96
Secondary	247,174	8	100	228,192	7	92	246,425	9	100	292,360	10	118	268,144	9	109
Control															
Roadside	267,199	11	100	257,136	10	96	238,577	11	89	269,366	13	101	248,399	10	93
Municipal	216,595	8	100	214,178	6	99	218,933	8	101	300,624	10	139	274,184	10	127
County	593,461	27	100	581,723	23	98	598,453	27	101	685,435	30	116	660,095	29	111

No. = Number of businesses, I = Index

For this analysis, businesses in Area 1 will be considered the primary study area. Those in Areas 2 and 3 have been combined to constitute the secondary study area. The roadside, municipal, and county control areas remain as previously described. Table 7 summarizes the data for restaurants and Figure 4 presents an index of gross incomes reported and, for comparison, an index of seasonally adjusted estimated sales of eating and drinking places published by the U. S. Department of Commerce (3). As stated before, this statistic is computed from an estimate on a nationwide scale based on a sampling of the business group. The index is not offered as a measure of what local restaurant sales should or could have been.

At the outset, it was found that the restaurant businesses reported greater proportional changes in gross incomes from year to year than did the two business groups discussed earlier. Also, there were considerably fewer changes in ownership reported. Although restaurants, like service stations, serve the motoring public, it is apparent from the data that they are subject to substantially different economic influences. For this group, the "before and after" comparison yields little meaningful information. It can be seen that the Main Street (Area 1) businesses reported decreased gross incomes after the bypass was opened while those nearby (Areas 2 and 3) reported incomes greater than "before." The gross income picture becomes meaningful when the control areas are studied also. Observe that businesses in all areas reported incomes in 1953 less than in 1952; in 1955 all areas reported increases, and in 1956 all areas again reported incomes less than the previous year. The same pattern of changes in gross incomes was reported by all restaurants in Rockbridge County during the study period. It is concluded that if the bypass had any effect on this business group, it is obscured by the effects of another influence, not identifiable from this data source, which affected the whole county in a like manner.

CONCLUSIONS

Although the purpose of this paper has been to describe methods employed in this study, it has been necessary to make the description in terms of the actual data. There follows a summary of the conclusions of this portion of the study; first concerning the effects of the Lexington Bypass, and second concerning the methods of the study.

It has been observed that the bypassed service stations experienced decreased sales of gasoline and gross incomes. One contributing factor was found in the town's growth beyond the corporate limits, hence away from the bypassed Main Street business area. These growth areas have attracted more new businesses than the downtown area and some businesses moved from downtown to the fringe area. It is apparent that the fringe area has also attracted customers from the downtown area, all of which accounts for some of the decrease in incomes of the bypassed businesses. A portion of the remainder of the decreases is attributed to a trend of undetermined causes which is apparent as early as 1953. There remains a residuum of decreases in "the year after" which is attributed to all other factors, including the relocation of traffic.

No indication has been found that automotive dealers have been influenced by the bypass. This is to be expected since the normal trade of these businesses is carried on with local residents. Few tourists buy a car enroute and they require parts, accessories and repairs relatively infrequently.

Restaurants in the whole county reported the same patterns of increases and decreases of gross incomes. There was no indication in these data that the bypass exerted any separate influence on this business group.

Several conclusions about the methods employed in this study are offered. It has been found that the information gained from the state business license applications has indicated changes which occurred but was not sufficient to identify all of the causes of the changes. The personal knowledge of the investigator and his continuing contact with the study area and people who know it well have been indispensable but not sufficient. A longer study period would be helpful, expecially in the analysis of trends and in view of the use of annual data. Further sources of secondary data are required to permit more complete identification of the causes of changes found.

One of the principal purposes of the study and the aim of this paper has been to test

the congruity of the "before and after" and "study-control area" comparisons. Each of these methods has been well-defined and widely used in the past. Comparison of conclusions reached with these two techniques shows no indication of contradiction but rather shows a complementary relationship. The "before and after" technique is the simpler of the two and requires less data but is limited in its scope. While the "study-control area" approach is a little more complex and requires more data in proportion to the number of control areas employed, it does permit a more complete analysis. This technique, in fact, contains all the data required by the former comparison plus those for the control areas. It is considered that the "study-control area" method of study is preferable because of the more complete analysis possible. In this study, the wider range of comparisons of the "study-control area" technique has revealed more meaningful conclusions than those gained from the "before and after" comparison.

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Discussion

CLAUDE A. ROTHROCK, Ohio Department of Highways—The stated aim of the paper is to compare and evaluate the methods used, that is, the "Before and After Study" and the "Study and Control Area Study." The results show that the author's conclusion that the comparison of the two techniques show no consequential differences in results, is well established. Either method alone would have led to a similar evaluation of the end results, that the economic consequences of the bypass was a loss of business to certain elements of business (depending upon their proximity to the main highway in the bypassed area), and to other elements there appeared to be no changes attributable to the bypass. The kinds of business studied were limited to those expressly expected to be affected by the facility.

The results of the study indicate the probability that, in areas of similar economic composition, the fears of restaurant owners and most automobile service stations and probably some other businesses, that bypasses cause a loss of sales are not well founded although such a conclusion is not warranted from the results of only one study. Regardless of the results, information such as produced by the present study, and others made for the same purpose, should be useful in hearings on proposed bypasses.

One of the principal virtues of the study is the apparently complete objectiveness of its approach. The impression gained from a great many of such studies, supposedly

made to determine effects of highway changes, is that many have not been quite so impartial in their aim. The present case does show by both, the before and after and control area techniques, that establishments on the bypassed main line whose principal income was from the sale of gasoline suffered an actual loss of business, with a strong inference being that the bypass was responsible. It would be of considerable interest to investigate to what extent the owners of these businesses have re-established themselves in some other zone, and in such a case what was the actual net result in profit or loss by reason of such a change. It would also be of interest to determine to what extent the owners of affected businesses have diversified their lines and the consequences of such diversification. To accomplish this would require an extension of the study in time.

Another correlation that might yield information of value for application and comparison to other cases, is with the traffic volumes before and after. A "before and after" traffic survey might be revealing. Usually it is found that the removal of a certain element of the traffic volumes from a main highway, say that part consisting of through or bypassable traffic, is followed by an intensification of local traffic so that volumes remain at, or rapidly arise up to, the original volumes. In such a case the customer potential for the fronting businesses should remain about as originally, and losses of sales should be chargeable to some other cause.

The investigator has made use of data which had been submitted for other purposes than the study but made available, although with some restrictions, for the study purpose. It may be a source peculiar to Virginia and not similarly available in other states. It is to be hoped that similar studies might be anticipated with planning in advance of the fact, so that the sources of data can be assessed and refined if possible.

All in all the present study is a valuable contribution in the field, and, in combination with other such examinations, should be of considerable general value. To be of specific value in an engineering economic analysis an effort should be made to put an absolute money value on the consequences, rather than an index, so that the total value of the consequences can be sifted through the framework of an engineering economic determination of the justification of the project.