A CRITICAL REVIEW

OF

"Community Effects of Highways Reflected by Property Values"

by

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PREFACE

The following review of "Community Effects of Highways Reflected by Property Values"* is intended to provide the highway administrator with a brief, easily digestible summary of the findings presented in that report. In addition, those findings and conclusions which can be accepted without qualification are separated from those findings which warrant more deliberation.

The reviewed report was prepared by Hays Gamble, C. John Langley, Jr., Owen Sauerlender, and other researchers from Pennsylvania State University, who attempted to determine the extent to which certain effects of limited access highways alter the value of residential real estate.

*Gamble, Hays B., C. John Langley, Jr., Robert D. Pashek, Owen H. Sauerlender, Richard D. Twark, and Roger H. Downing, "Community Effects of Highways Reflected by Property Values," DOT-FH-11-7800, The Pennsylvania State University, The Institute for Research on Land and Water Resources, University Park, Pa., August 1973.

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INTRODUCTION

"Community Effects of Highways Reflected by Property Values" was prepared by the Institute for Research on Land and Water Resources of Pennsylvania State University. The study was requested by the Federal Highway Administration and represents one of the most rigorous attempts to quantify, in dollar terms, the effect of a limited access highway on the residential property values of an abutting community in an urban setting.

SELECTION OF STUDY AREAS

A simple economic concept underlies the approach followed by the authors, namely, that effects such as changes in accessibility and and noise and air pollution, will be capitalized into the market value of residential land. In other words, a parcel of residential property which had previously been valued at $25,000 may, after the completion of a new freeway, have a premium of $1,500 added because of a reduction in the time-cost to the resident in traveling to and from work. This benefit is known as an accessibility premium. There is another part to the capitalization picture; there are highway generated noise and air pollutants which may detract from a residential property's appeal. The extent to which they detract will help determine, along with accessibility, whether property values rise, fall, or remain the same when a limited access highway traverses a neighborhood.

Gamble, et al. chose four communities as study areas. The use of the selection criteria listed below enabled them to hold constant a number of variables which, if not controlled, could be expected to bias estimates of the effects of noise pollution, air pollution, and accessibility on property values.

1. The highway must be limited access with a high traffic volume.

2. The highway should have been constructed through an already developed or developing community.

3. The entire study area should lie in the same political jurisdiction.

4. There should be no significant non-highway sources of air or noise pollution in close proximity to the study area.

5. The area should extend back from the highway for about one mile to ensure that part of the community studied has little or no highway pollutants.

6. There should be two miles between interchanges and no part of the study area should be closer than one-half mile by road to an interchange.

7. The study area should not be close to another limited access facility or major highway corridor.

On the basis of these criteria the following four communities were selected for study: Bogota, New Jersey; Towson, Maryland; Rosedale, Maryland; and North Springfield, Virginia.

DATA COLLECTION

Data were gathered on the noise and air pollution levels in each community both for abutting properties and for properties at increasing distances from the highway. The details of the noise measurement techniques and estimation are not presented here, however, the reviewer's colleagues have assured him that the procedures used are reliable.

Gamble and his colleagues chose an interesting measure for noise. Rather than representing noise pollution as the equivalent, continuous, noise level on an energy basis, they chose Noise Pollution Level (NPL), which equals the noise level on an energy basis plus a measure of the augmentation of annoyance when fluctuations of noise levels occur. This NPL was used as a measure of noise because it can be obtained more accurately than L_{10} or L_{50}, the decibel noise levels exceeded respectively 10% and 50% of the time.

By using regression analysis, data from household questionnaires which classified noise on the basis of degree of annoyance were compared with actual NPL measurements for each community. The researchers found a significant statistical relationship between the degree of annoyance and the measured NPL. Furthermore, the regression equations were found to be very good predictors of actual NPL's. It is clear from these tests that measured NPL's are a good monitor of perceived noise from highway traffic, and therefore are appropriate to test the extent to which noise annoyance alters residential property values.

An approach similar to that taken with the measurement of perceived and measured noise was taken in collecting data on air pollution. Measurements of different types of air pollution were taken at varying distances from the highway. Also, household questionnaires were distributed among the inhabitants of each community to obtain comments on the amount of dust and dirt in the air. An analysis of the relationship between measured air pollution and perceived annoyance due to highway generated air pollutants did not show any significant relationship. The lack of a statistically significant relationship prompted the researchers to drop the air pollution variable from the list of highway variables which might affect property values.

Property value data gathered were the bona fide real estate transactions occurring in each of the study areas for the years 1969 to 1971 inclusive as obtained from public records in the respective county courthouses. A total of 324 property sales records were obtained. In addition to these, sales data were obtained for 84 properties in various locations throughout Fairfax County for the purpose of determining the positive effects of I-495 on property values from regional accessibility.

RESULTS OF DATA ANALYSIS

The noise data together with data on traffic volume, speed, and mix were processed and, by applying an NCHRP methodology,[1/] noise pollution level contour lines were drawn showing the variation in noise level reductions with distance from the highway. The maximum and minimum ambient NPL's and the distances from the highway at which the NPL was reduced to ambient are given in Table 1.

TABLE 1

MAXIMUM AND AMBIENT NOISE LEVELS IN STUDY AREAS

Area	Maximum	Ambient	Distance in Feet to the Ambient Level	
			Minimum	Maximum
Bogota, New Jersey	80	70	100	600
North Springfield, Va.	85	55	900	1,150
Rosedale, Maryland	90	60	800	1,200
Towson, Maryland	85	55	550	900

[1/] "Highway Noise", NCHRP Reports 78 and 117.

Further analysis of the data indicated that noise from the highway is the single most important source of annoyance from highways in the study areas surveyed. The researchers failed to find any significant annoyance due to dust, dirt or other forms of air pollution. Therefore, the research team used measured NPL as the sole indicator of highway "environmental impact", narrowly defined in the sense of air and noise disturbance. The reader should be cautioned, however, not to infer any broader meaning to the term "environmental impact".

Stepwise multiple regression was the principal statistical tool used to study the relationship between residential property values and several highway variables developed in the study. In addition to the highway variables, many other independent variables were used in an effort to explain variations in property values.

The results of the stepwise multiple regression are given below.

North Springfield, Virginia

Property value was determined by the number of floors, the number of rooms, the number of bathrooms, whether the basement was finished, NPL, and age of the house. The equation was

Value = 1,201 (no. of floors) + 839 (no. of rooms) + 1,578 (no. of baths) + 1,807 (finished basement) - 69 (no. of dBA above ambient) - 569 (age of house in years)

R^2 = 0.67, i.e., 67% of the variation in market value is explained by the independent variables

Bogota, New Jersey

Property value was determined by whether or not the house was on a corner lot, NPL, and age. The equation was

Value = 4,708 (whether the house was on a corner) - 646 (no. of dBA above ambient) - 168 (age of house in years)

R^2 = 0.48, i.e., 48% of the variation in market value is explained by the independent variables.

Rosedale, Maryland

The equation was

Value = 94 (age of head of household) - 853 (lived near highway) + 273 (no. of rooms) + 850 (central air conditioning) + 3,056 (split level house as opposed to other types) + 1,629 (ranch house as opposed to other types) - 60 (no. of dBA above ambient)

$R^2 = 0.78$

Towson, Maryland

The equation was

Value = 4,291 (no. of baths) + 2,338 (central air conditioning) - 141 (no. of dBA above ambient) - 385 (age of house in years)

$R^2 = 0.52$

The above results indicate that noise disturbance significantly affected residential property values in all four study areas. The effect ranged from a high in Bogota of a $646 decrease in value per each 1 unit increase in dBA level above ambient to a low in Rosedale of a $60 decrease for each 1 unit increase in dBA level. This reviewer would be less than objective and candid if he did not comment on the R^2 results in the equations above. In the reviewer's opinion, the research team should not have used stepwise regression analysis. Rather than allowing the computer program to choose the variables affecting property values, it would have lended more rigor to the analysis had the researchers set out to define the non-highway variables which might affect property value on the basis of past research findings. A substantial amount of work has been done in this field which may have been helpful. Furthermore, by the inclusion of more non-highway variables, such as property taxes and public expenditures, the variations in property values likely would have been better explained; that is, R^2 would probably have been higher. The concern of this reviewer is not that the conclusion that property values are reduced by noise disturbance is incorrect, but rather that the estimates of the extent to which they are reduced may have been better if a simple rather than a stepwise regression had been used.

Still, this piece of research is the best reported to date. Estimates of the cost of noise in terms of property value loss can be given on the basis of this work, but in this reviewer's opinion caution should be taken that the estimates be viewed as qualified forecasts rather than hard and fast formulas. The effort is an excellent starting point and certainly leaves research organizations concerned with environmental effects an excellent starting point from which to derive new estimates of environmental effects.

The estimates of the reduction in residential property values due to highway disturbances (as measured by NPL only) are given below.

TABLE 2

ESTIMATED EFFECT OF HIGHWAY DISTURBANCES
ON VALUE OF ABUTTING PROPERTIES
(As Measured by NPL Only)

Study Area	Cost to Abutting Properties		
	Amount	Percent	Average Property Value
Bogota, New Jersey	$-4,522	-15.5	$29,100
North Springfield, Va.	-1,518	-4.5	33,600
Rosedale, Maryland	-1,200	-4.8	25,100
Towson, Maryland	-3,525	-10.7	33,100

TABLE 3

ESTIMATED EFFECTS OF HIGHWAY DISTURBANCE ON
PROPERTY VALUE RELATED TO DISTANCE FROM HIGHWAY
(As Measured by NPL Only)

Study Area	Distance from Highway (Feet)									
	100	200	300	400	500	600	700	800	900	1,000
Bogota, New Jersey	$-5,100	$-2,600	$-1,000	$ -150	$ —	$ —	$ —	$ —	$ —	$ —
North Springfield, Va.	-1,950	-1,450	-1,050	-800	-600	-450	-300	-150	-50	—
Rosedale, Maryland	-1,350	-1,100	-900	-700	-525	-375	-250	-125	-50	—
Towson, Maryland	-3,600	-2,800	-1,900	-1,250	-825	-500	-250	-25	—	—

REGIONAL ACCESSIBILITY EFFECTS

Because the figures in the tables above do not include an estimate of the effect of accessibility on property values of the region, they are estimates of gross costs rather than net costs. To provide a more balanced and realistic view of the net effects of a major highway, the research team had to estimate the influence of improved accessibility on property values. North Springfield was chosen for study.

Two types of measures of accessibility were considered: (1) Distance from property to central Washington, D. C. by the nearest major highway, and (2) a measure of accessibility to jobs prepared by the Washington, D. C. Council of Governments. The Council of Governments index represents the percentage of employment in the Washington, D. C. area which can be reached from the location in question within a travel time of 45 minutes.

A standard linear regression model of the form

$$Y_i = b_j x_{ij} + e_i$$

was used to estimate accessibility effects. This model states that property values (Y_i) are determined by a group of independent variables (x_{ij}) plus some random factor (e_i) not accounted for by the included independent variables. The notation (b_j) represents the extent to which each independent variable affects property values.

The results of two regressions, one of which uses the distance to downtown D. C. as a measure of accessibility, the other the interpolated Council of Governments index, are presented below.

Equation 1: This equation predicts the 1970 sales prices for residential properties located at various points in Fairfax County in terms of distance to downtown D. C., distance to I-495, house type, and age of the house. The results show that 66% of the variation in sale price was accounted for by the four variables. For each 4,000 feet closer to downtown Washington, property value increased $35.00. As distance from I-495 increased, property values decreased approximately $120 per 4,000 feet.

Equation 2: This equation shows that a one-year difference in age accounts for a difference in price of $448. A one-unit increase (0.01) in the Council of Governments index of accessibility increases property value by $197. That is, an increase from 0.75 to 0.76 in the percentage of employment within 45 minutes drive will increase the sale price by almost $200.

For purposes of estimating the net effects of I-495 on property values in North Springfield, equation 2 is the most appropriate, because the Council of Governments has published estimates of the degree to which accessibility has changed through the years. From 1960 to 1968 the accessibility index

for North Springfield increased approximately 0.15 (from 0.60 to 0.75). By multiplying this figure, 0.15, by $197, the regression coefficient noted above, one obtains an estimate of the average increase in property value due to accessibility.

Tables 4 and 5 show the estimated net effects of I-495 on property values in North Springfield, Virginia.

TABLE 4

NET EFFECT OF I-495 ON ABUTTING PROPERTY VALUES — NORTH SPRINGFIELD, VIRGINIA

	Abutters	Nonabutters
Basic Values	$30,690	$30,690
Effect of Regional Access	+2,950	+2,950
Effect of Highway Pollutants	-1,518	0
Net Value (Selling Price)	32,122	33,640
Net Effect of Highway	+1,432	+2,950

CONCLUDING REMARKS

The findings show that for residential properties not within a narrowly defined interchange zone the adverse environmental effects of a major limited access highway lower the value of properties near the highway as compared to properties more distant from the highway. The study also showed that noise is the single most disturbing effect from highways. Furthermore, the noise levels above ambient are the ones with which controls should be concerned, rather than the absolute noise levels.

The reviewer does not quarrel with the findings just mentioned, however, some words of caution are in order regarding the estimates of net effects presented in Tables 4 and 5. In the equations used to estimate the value of regional accessibility, only four variables were used as independent regressors. The result was that only 66% of the variation in property values was explained. More credence could be attributed to the estimated value of accessibility had more variables that affect property values been included. The use of only a minimal number of variables, one of which (house type) is a qualitative variable, invites estimates to be biased even though the estimated coefficient is statistically significant.

TABLE 5

NET TOTAL EFFECTS OF HIGHWAY ON PROPERTY VALUES — NORTH SPRINGFIELD, VIRGINIA[2/]

Distance From Highway (Feet)	Number of Properties	Loss in Value From Highway Effect Per Property	Gain in Accessibility Value Per Property	Total Loss in Value, Highway Effects	Total Gain in Value, Accessibility	Net Effect of Highway on Property Values
<150	5	$-2,100	$2,955	$ -10,500	$ 14,775	$ 4,275
150-300	87	-1,350	"	-117,450	257,085	139,635
300-450	87	-825	"	-71,775	257,085	185,310
450-600	109	-550	"	-59,950	322,095	262,145
600-750	96	-300	"	-28,800	283,680	254,880
750-900	96	-125	"	-12,000	283,680	271,680
900-1,050	88	-25	"	-2,000	260,040	257,840
>1,050	1,126	—	"	—	3,327,330	3,327,330
Total	1,694			$-302,675	$5,005,770	$4,703,095

[2/] Gamble, et al., p. 18.

A second point that should be addressed concerns the estimated value of changes in accessibility through time. Even if one assumes that the estimated value of accessibility differentials between localities in Fairfax County is correct, it does not follow that this estimate ($197) can be used to calculate the value of changes in accessibility on property values through time for a single community (North Springfield). In 1960 accessibility premiums were likely smaller than $197 for each 0.01 change in the index, and, if so, the calculated effects of accessibility would be larger than they actually are.

In view of these observations, one can make an educated judgment that the estimated net effects due to pollutants and increased accessibility are overstated; that is, the total benefits attributable to I-495, although positive, are not as large as indicated in Table 5.