of Transportation, UMTA/TSC Project Evaluation Series, Aug. 1977.
3. W. J. Grabske and R. K. Faris. Planning and Implementation of Chestnut Street Transitway. Presented at ASCE Annual Convention, Philadelphia, Sept. 27, 1976.
4. Auto-Restricted Zones in the Delaware Valley Region: An Evaluation of Trenton Commons and Chestnut Street Transitway. Delaware Valley Regional Planning Commission, Philadelphia, Aug. 1977.
5. Downtown Trenton Survey Results. City of Trenton Department of Planning and Development, draft rept., 1976.
6. R. Brambilla and G. Longo. For Pedestrians Only. Whitney Library of Design, New York, 1977.
7. R. Remak and S. Rosenbloom. Peak-Period Traffic Congestion: Option for Current Programs. NCHRP, Rept. 169, 1976.

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Density as a Determinant of Highway Impacts

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The effects of superhighways in established residential areas in 23 standard metropolitan statistical areas in nine states are reported. Comparisons are made between affected and unaffected census tracts for 34 population and housing variables by using information from the U.S. Census for 1960 and 1970 and from state highway departments. The analysis tool is multiple regression, which permits statistical control for tract location and "history." Regressions were run separately for high- and low-density tracts, and housing density was posited as a conditioning factor of highway impact. Results indicate (a) substantial differences between affected and unaffected tracts in high-density tracts but not in the low-density stratum and (b) that despite these differences the highway impact variable accounts for little of the variance in the dependent variable. The latter finding implies that highways are of minor importance in explaining changes in census characteristics compared with general demographic trends and deliberate policies in metropolitan areas.

In recent years, there has been increasing concern that the construction of public works such as airports, dams, office buildings, and highways may have profound effects on natural and social environments. Obviously, each project is designed to produce at least one environmental change, such as damming up water, rerouting a stream, providing a detention center, or facilitating transportation. In addition to such manifest aims, however, there may be secondary effects on the surrounding areas that are neither intended nor beneficial.

For example, a new airport, while improving regional and national transportation networks, may affect land and housing values close to the facility and may create bothersome noise for nearby residents. The potential for such troublesome side effects, especially from very large projects, lies behind the drive for studies to assess the environmental impacts of such construction.

A concrete manifestation of the current interest in impact assessments can be seen in the National Environmental Policy Act of 1969 (NEPA). Section 102 of NEPA requires the relevant federal agency to produce an environmental impact statement (EIS) that discusses the likely consequences of a major federally funded construction project (31). An EIS is seen as a tool to aid policy makers to make better informed decisions on a proposed action and to take steps to eliminate or minimize any harmful impacts likely to result from implementation.

An EIS is, however, an estimation of the likely consequences of a project. These projective statements are rarely, if ever, subjected to postconstruction verification. Each project is treated on an ad hoc basis, and there is a minimum of information as to what might be anticipated on the basis of past experience. What is needed to make such assessments more convincing is some basic research on the empirical effects of large-scale construction.

This research provides a description of selected types of social impacts that have resulted from the construction and operation of multilane, limited-access highways in some urban areas. Thus, it is an effort to fill a gap in our empirical knowledge of such effects. Besides informing the impact assessment process, this paper also explores the factors that contribute to demographic change in urban areas. Despite a number of theories of urban morphology and several research techniques, only rarely have man-made elements of the social environment been treated as independent variables, as causal factors in and of themselves (23). This study views highways as an impacting agent whose effects are reflected in census data for cities.

LITERATURE ON HIGHWAY IMPACT

Highways built through residential areas may have a variety of impacts. One may consider the financial and psychological costs to relocated individuals (4, 6, 11, 15), the pollution-related effects on those living in proximity to the road (5, 7, 12, 20), and of course the benefits to highway users. This research focuses on the "remaining neighborhood," defines and measures the amount and nature of change in the characteristics of population and housing, and isolates that portion of the change attributable to the road.

Most of the empirical work on remaining neighborhoods has dealt with the delineation of neighborhood boundaries and not with highway impacts themselves. There are many examples of these various approaches

(8, 9, 13, 14, 16, 21, 22). The most sophisticated effort to use aggregate, descriptive data in combination with perceptual and behavioral indicators to define neighborhoods and develop an index to measure change is that of Burkhardt, Lago, and Rothenberg (1, 2).

But in all these cases empirical evidence of highway-induced change is either lacking entirely or measured without the benefit of adequate controls for sources of change other than highways themselves. In addition, the number of cases involved is typically quite small. I will not attempt to do more here than mention the above studies and indicate my belief that quantitative data on highway impacts continue to be lacking for the types of change this study seeks to measure.

RESEARCH METHODS

The impact of highways on population composition and housing characteristics is explored here by using census tracts as the unit of analysis (27, 28, 29). In all cases, comparisons over time are made between equivalent geographic areas. A total of 1571 tracts from the following 23 standard metropolitan statistical areas (SMSAs) are included: Hartford and New Haven, Connecticut; Wilmington, Delaware; Boston, Fall River, Lawrence-Haverhill, Lowell, New Bedford, Springfield, and Worcester, Massachusetts; Detroit and Lansing, Michigan; Newark and Paterson-Clifton-Passaic, New Jersey; Binghamton, Buffalo, and Utica-Rome, New York; Dayton and Youngstown-Warren, Ohio; Erie, Reading, and Scranton, Pennsylvania; and Providence-Pawtucket-Warwick, Rhode Island. These SMSAs had experienced the start and completion of construction of new, four-lane-minimum, limited-access highways during the 1960s. Of the 1571 tracts, 284 incurred impact (impact is defined here in terms of a tract's 1960 boundaries having been touched or crossed by a highway built during the decade).

In the equations, the dependent variable is the 1970 census value for one of 34 descriptive variables for each tract. It is this 1970 value we are attempting to "predict." The three independent variables are (a) the 1960 counterpart of the 1970 descriptor variables inserted to provide control for initial differences among tracts; (b) a location variable LOC, which indicates the distance of a tract from the center of its SMSA (standardized to control for absolute differences among SMSAs); and (c) a highway impact dummy variable HWYDUM, coded 1 for impacted and 0 for nonimpacted tracts. The coefficients for this last variable will represent the net average difference between impacted and nonimpacted tracts on the dependent variable in question.

Admittedly, the model ignores other factors that contribute to change in tracts and that had their effects during the 1960s. Growth trends and policies that are reflected in the 1960 descriptors continue into the decade of the 1960s. Without an intensive city-by-city study, however, such factors cannot be incorporated into the model. Generalizability is deliberately sought over specificity on the basis that the model above is the best overall, parsimonious one for the impact experience.

It is hypothesized that tract housing density in 1960 is an important conditioner of the magnitude and nature of highway impacts. Information from city and regional planning departments and the National Planning Data Corporation was used to develop 1960 figures for housing units per unit of area. All tracts were then stratified into two groups, and high and low density depended on whether they fell above or below the median figure of 15.06 units/hm^2 (6.025 units/acre). The regressions described above were then run separately for each stratum.

RESULTS

The focus here is on two aspects of the statistical findings: the ability to distinguish between affected and unaffected tracts as indicated by the size and significance of the regression coefficients associated with the impact dummy variable and the amount of variance in the dependent variable "explained" by the impact dummy. Table 1 gives the results of the regressions for high-density tracts; Table 2 gives the results for the low-density stratum.

Looking first at the regression coefficients, one notices that in high-density tracts the unstandardized coefficient exceeds its standard error by a factor of at least two in 19 instances (out of 34) whereas the comparable figure for low-density tracts is 8. Hence, one can conclude that highway impacts are more strongly felt in the high-density stratum. Moreover, these significant coefficients in high-density tracts frequently exceed their standard error by a factor of three or four whereas this excess is rare in low-density tracts. The initial hypothesis of greater impact in higher density tracts is thus borne out.

High-Density Tracts

In the high-density stratum, it is possible to describe the pattern of impact in the following way. The coefficients are generated mainly through a loss of population and housing units in this stratum, and that loss is concentrated in people at the lower end of a socioeconomic continuum. There are significant differences between affected and unaffected tracts for all age categories. Most notably, it appears that families with children are less frequently present in affected tracts in 1970. In addition, it does not appear that these individuals were replaced by more affluent people. Median years of school completed, median family income, number of white-collar workers, number of families with incomes over $25 000, and number of college-educated people are not different for affected compared with unaffected tracts.

Likewise, housing losses occurred in a variety of housing categories. Both single-unit structures and units in structures of five or more units show significant, negative, net average differences between affected and unaffected tracts. Moreover, these units were not replaced since there is no indication of a difference in new construction (units built between 1960 and 1970) between the two groups of high-density tracts. The negative net difference in size of household in affected tracts (measured by median persons per occupied unit) reinforces the evidence on the relative absence of families with children.

The absence of significant differences between the two sets of tracts on variables that describe the better educated, white-collar, affluent population can be explained by various factors. These high-density tracts tended to be located closer to the city center where such people reside less frequently (the relation between status and distance of residence from the city center is far from perfect). Since these people are absent from these areas, they cannot be affected by a new highway. The lack of difference may also stem from the relatively small absolute number of people in the higher socioeconomic categories in 1960. For instance, only about 11 families were earning over $25 000 in 1960 in each high-density tract.

One might argue that highways are routed so as to avoid affluent sections of tracts and that this permits the impacts to fall on a politically less powerful segment of the population. On the basis of available information, this notion can be rejected. Correlations between the highway-impact dummy variable and various measures of socioeconomic status are close to zero whether one considers high-density tracts, low-density tracts, or all tracts together. In addition, although it is possible that highway engineers take population composition into account in planning routes, such social factors are certainly not the only—and most likely not the major—consideration in such decisions. Highways have to yield to topographic features and are generally routed in as straight-line a pattern as possible. Highway costs are figured per unit of distance. Routing a road around high-income areas within tracts could well result in higher costs in the end because of the circuitous path. Besides, the political impotence of inner-city residents is not total. Effective opposition to highway and other projects has been mounted in various types of neighborhoods, and inner-city residents during the 1960s had

Table 1. Highway impacts in high-density tracts.

1970 Census Dependent Variable	R^2	HWYDUM β	HWYDUM Variance Explained (%)	LOC β	LOC Variance Explained (%)	1960 Census Descriptor β	1960 Census Descriptor Variance Explained (%)
Total population	0.83	-670.20[a]	0.5	1251.51[a]	3.3	0.79[a]	79.0
		-0.109		0.092		0.894	
Nonwhite population	0.57	-565.46[a]	2.1	6.61	4.0	0.84[a]	51.2
		-0.110		0.001		0.745	
Population under 5 years	0.25	-77.12[b]	1.0	235.73[a]	2.5	0.27[a]	21.5
		-0.097		0.136		0.464	
Population aged 19 and under	0.71	-308.34[a]	1.1	232.66[c]	0.8	0.80[a]	69.0
		-0.122		0.042		0.832	
Population aged 55 and older	0.73	-97.75[b]	0.0	412.10[a]	5.9	0.79[a]	67.2
		-0.061		0.117		0.831	
Females aged 15 to 44	0.72	-114.21[b]	0.3	289.15[a]	2.3	0.87[a]	69.4
		-0.073		0.084		0.836	
Fertility rate	0.02	-6.23	0.0	79.17	0.2	0.07[b]	1.6
		-0.010		0.056		0.128	
Dependency ratio	0.04	5.53	0.2	-13.48	0.2	0.20[a]	3.2
		0.041		-0.045		0.178	
Married couples with own children under age 18	0.41	-77.17[b]	0.9	220.57[a]	6.5	0.64[a]	33.4
		-0.089		0.115		0.594	
Married persons	0.82	-240.47[a]	0.9	637.22[a]	7.0	0.70[a]	74.6
		-0.093		0.113		0.876	
Persons aged 5 and older residing in same house as 5 years previous	0.80	-323.92[a]	0.6	312.47[c]	5.8	0.83[a]	71.6
		-0.102		0.045		0.868	
Households residing at current address for less than 2 years	0.62	-66.57[b]	0.0	206.54[a]	0.2	0.84[a]	61.8
		-0.067		0.094		0.791	
Stability index	0.77	-271.16	1.3	-220.67	1.5	0.84[a]	73.8
		-0.034		-0.013		0.873	
Persons over age 25 with eighth-grade education or less	0.77	-123.33[a]	0.0	337.52[a]	0.7	0.56[a]	75.8
		-0.086		0.107		0.875	
Persons over age 25 who are college graduates	0.86	4.54	0.0	20.28	2.1	1.02[a]	83.7
		0.007		0.015		0.924	
Median years of school completed for persons over age 25	0.80	-0.057	1.1	-0.077	4.1	0.89[a]	74.5
		-0.015		-0.009		0.893	
Families with income under $10 000	0.83	-80.30[a]	0.4	76.51[c]	2.6	0.53[a]	79.7
		-0.083		0.036		0.901	
Families with income over $25 000	0.07	-4.21	0.2	25.73[b]	1.3	0.12[a]	5.1
		-0.042		0.117		0.226	
Median family income	0.60	42.34	0.5	-961.75[b]	2.8	1.36[a]	56.8
		0.008		-0.079		0.797	
Households owning no automobile	0.73	-99.31[a]	0.9	119.95[c]	0.6	0.74[a]	72.5
		-0.081		0.044		0.868	
Percentage of women in labor force	0.39	-0.19	0.00	7.02[a]	5.0	0.65[a]	34.3
		-0.008		0.139		0.592	
White-collar workers	0.83	10.42	0.0	-3.28	4.8	1.02[a]	78.0
		0.013		-0.002		0.911	
Blue-collar workers	0.67	-123.91[a]	0.5	200.85[a]	3.3	0.68[a]	63.3
		-0.112		0.083		0.802	
Total housing units	0.83	-146.45[b]	0.0	364.04[a]	1.7	0.86[a]	80.9
		-0.063		0.071		0.902	
Owner-occupied units	0.89	-33.12[c]	1.4	34.48	3.9	0.96[a]	83.3
		-0.028		0.013		0.935	
Units vacant and available for rent or purchase	0.38	-9.56	0.1	-52.61[b]	6.1	0.43[a]	31.3
		-0.041		-0.102		0.583	
Median persons per unit	0.67	-0.095[b]	3.0	-0.009	1.0	0.83[a]	63.4
		-0.067		-0.003		0.809	
Median rooms per unit	0.89	-0.037	3.5	-0.225[b]	2.5	0.94[a]	82.5
		-0.015		-0.040		0.946	
Median persons per room	0.42	-0.003	0.2	-0.002	0.8	0.63[a]	41.1
		-0.010		-0.004		0.649	
Single-family units	0.83	-59.99[b]	0.9	77.81[c]	0.6	0.76[a]	81.3
		-0.057		0.034		0.904	
Units in structures with five or more units	0.82	-66.84[c]	0.8	201.66[b]	0.3	0.88[a]	81.3
		-0.036		0.050		0.916	
Units built in last 10 years	0.08	-5.01	0.0	72.66	0.9	0.23[a]	7.4
		-0.010		0.069		0.273	
Median contract rent	0.62	2.38	0.1	19.30[a]	3.1	1.22[a]	58.9
		0.033		0.123		0.772	
Median value of owner-occupied units	0.67	411.07	0.0	64.32	4.2	1.32[a]	62.4
		0.025		0.002		0.817	

Note: N = 789; 115 affected.

[a] Coefficient at least four times its standard error. [b] Coefficient at least three times its standard error. [c] Coefficient at least two times its standard error.

their advocates in political decision making in metropolitan areas.

Low-Density Tracts

In the low-density set of tracts, one finds few significant differences between affected and unaffected tracts. Most important, total population and number of housing units show no net effects from highway construction. Obviously, this does not imply that construction required no demolition or displacement of population. But one would assume that losses that did occur were either minor or were balanced by gains over the decade and that this resulted in no net difference between affected and unaffected tracts in 1970. I suggest the following scenario to account for those differences that do appear.

Highway construction increases the value of the land that lies in proximity to the road. This land is afforded

Table 2. Highway impacts in low-density tracts.

		HWYDUM		LOC		1960 Census Descriptor	
1970 Census Dependent Variable	R^2	β	Variance Explained (%)	β	Variance Explained (%)	β	Variance Explained (%)
Total population	0.79	-166.82 -0.022	0.8	1880.14[a] 0.151	15.2	1.00[a] 0.839	63.3
Nonwhite population	0.55	-66.39 -0.026	0.0	-242.55[b] -0.060	2.9	0.95[a] 0.732	52.4
Population under 5 years of age	0.34	42.44 0.057	0.7	278.97[a] 0.231	11.9	0.24[a] 0.479	21.7
Population aged 19 and under	0.78	-106.27[b] -0.035	0.6	624.98[a] 0.127	14.6	0.89[a] 0.839	62.3
Population aged 55 and older	0.70	-5.54 -0.004	0.2	443.73[a] 0.193	9.3	0.93[a] 0.790	60.9
Females aged 15 to 44	0.77	-17.74 -0.010	1.1	415.11[a] 0.150	15.0	0.99[a] 0.823	60.7
Fertility rate	0.01	15.66 0.032	0.1	-55.61 -0.070	0.3	0.04[b] 0.103	1.0
Dependency ratio	0.06	-6.01[b] -0.077	0.7	-9.13 -0.072	0.8	0.16[a] 0.211	4.4
Married couples with own children under age 18	0.77	-27.02 -0.024	0.9	254.38[a] 0.137	17.6	0.88[a] 0.825	58.6
Married persons	0.80	-70.11 -0.020	0.8	901.79[a] 0.157	17.4	0.93[a] 0.838	62.1
Persons aged 5 and older residing in same house as 5 years previous	0.76	2.43 0.001	0.4	1552.13[a] 0.244	17.8	0.92[a] 0.785	58.0
Households residing at current address for less than 2 years	0.55	6.79 0.010	1.2	130.87[a] 0.118	5.9	0.98[a] 0.712	48.2
Stability index	0.13	-426.30 -0.053	0.2	4094.89[a] 0.312	10.4	0.02[a] 0.155	2.4
Persons over age 25 with eighth-grade education or less	0.78	-24.28 -0.024	1.1	201.37[a] 0.121	1.3	0.69[a] 0.877	75.2
Persons over age 25 who are college graduates	0.83	10.28 0.011	0.0	101.42[a] 0.069	10.3	1.18[a] 0.888	72.5
Median years of school completed for persons over age 25	0.81	0.064 0.019	0.0	0.215[b] 0.039	12.3	0.793[a] 0.884	68.4
Families with income under $10 000	0.76	-29.55[b] -0.041	0.8	82.02[c] 0.070	7.6	0.47[a] 0.859	67.7
Families with income over $25 000	0.36	6.03 0.019	0.0	121.81[a] 0.242	6.6	0.76[a] 0.542	29.2
Median family income	0.81	215.16 0.027	0.0	904.61[a] 0.071	7.2	1.43[a] 0.882	73.8
Households owning no automobile	0.70	-37.93[c] -0.080	0.2	-7.23 -0.009	2.4	0.75[a] 0.840	67.0
Percentage of women in labor force	0.37	1.31[b] 0.066	0.5	4.75[a] 0.149	0.2	0.67[a] 0.615	36.6
White-collar workers	0.74	28.13 0.027	0.3	259.06[a] 0.152	16.8	1.01[a] 0.800	57.5
Blue-collar workers	0.80	-12.35 -0.010	1.6	238.39[a] 0.117	7.6	0.98[a] 0.868	71.0
Total housing units	0.82	-55.40 -0.024	1.0	598.79[a] 0.162	12.8	1.07[a] 0.858	68.3
Owner-occupied units	0.89	-49.08[b] 0.026	0.3	265.25[a] 0.087	14.7	1.07[a] 0.913	73.8
Units vacant and available for rent or purchase	0.22	0.74 0.010	0.6	-7.50 -0.060	1.5	0.39[a] 0.454	19.8
Median persons per unit	0.75	-0.009 -0.008	0.0	0.096[b] 0.050	15.7	0.769[a] 0.846	59.6
Median rooms per unit	0.83	-0.018 -0.008	0.5	0.082 0.024	8.9	0.894[a] 0.903	73.6
Median persons per room	0.58	0.004 0.016	0.6	0.011 0.029	0.7	0.637[a] 0.760	57.1
Single-family units	0.87	-63.61[b] -0.032	0.2	288.54[a] 0.090	14.3	1.07[a] 0.904	72.6
Units in structures with five or more units	0.52	45.07[b] 0.066	0.8	175.66[a] 0.158	0.1	0.944[a] 0.726	51.0
Units built in last 10 years	0.27	6.76 0.007	0.2	323.54[a] 0.204	12.1	0.331[a] 0.406	14.3
Median contract rent	0.67	2.03 0.023	0.0	15.14[c] 0.104	6.6	1.47[a] 0.789	59.9
Median value of owner-occupied units	0.83	19.23 0.001	0.0	2018.30[a] 0.070	10.6	1.48[a] 0.889	72.5

Note: N = 782; 169 affected.

[a] Coefficient at least four times its standard error. [b] Coefficient at least two times its standard error. [c] Coefficient at least three times its standard error.

better accessibility to other parts of the metropolitan area—an important consideration given the generally more distant location of low-density tracts from the city center. The increased value of land requires that it be used more intensively or encourages such use. Note that affected tracts in this stratum show significantly fewer owner-occupied units, significantly fewer single-family units, and significantly more units in structures of five or more units. These three coefficients suggest the replacement of less intensive land users (single-family units) with more intensive land users (multifamily units). Between 1960 and 1970, 46.5 percent of all housing units built in metropolitan areas outside the central city were in structures of at least two units [the remainder being single-family units or mobile homes (30)].

Besides encouraging different land uses, highways also contribute to increases in the prices for land within a category of use. Thus, we find fewer low-income families or households without automobiles in the affected tracts. Admittedly, this is scanty evidence for such a conclusion, but it is suggestive.

DISCUSSION OF RESULTS

How does one account for the different patterns and magnitude of impacts between high- and low-density strata? I believe that the explanation lies in the distinction between the highway as a physical entity and the highway as a transportation facility. The former refers to the road as a physical intruder that necessitates demolition of housing and relocation of population, creates barriers to movement within neighborhoods, increases traffic around access and egress points, and generally pollutes the physical environment. The highway as a facility is a carrier of goods and population that provides access between different zones of the metropolitan area.

In the high-density tracts, which are typically located nearer the city center, the physical aspect of the highway predominates. In areas where there is a greater dependence on pedestrian movement, as hypothesized by Kriken, Bottiny, and Thiel (16), and where the highway is more visually intrusive, sensitivity to the road as a physical object would be greater. More people are likely to reside within any given distance of the road than would be the case in low-density tracts. Lower income and greater pedestrian dependency, more children walking to school, and more use of local neighborhood shopping facilities all contribute to the likelihood that a new highway will disrupt normal transportation routes, force people to take detours, and otherwise disrupt movement. In short, the more densely populated an area is, the greater the physical intrusiveness of any major construction project can be expected to be.

In high-density tracts, population differences between affected and unaffected tracts were high among those age and marital categories that reflect families with young children. Families whose children are approaching school age have a tendency to seek suburban, single-family housing and open space. Highways interrupt access routes within neighborhoods, preempt relatively scarce open space that might have been used for parks or playgrounds, and generally increase the "urbanness" of an area (a condition typified by congestion, noise, traffic, and the relative absence of open space and greenery).

All of these factors would generally be negatively evaluated by a family with children of school age who must walk to school and whose play patterns require more room than those of toddlers or infants. The impetus to seek suburban, single-family housing is strong for families whose children are moving out of infancy. A highway constructed through a densely populated neighborhood contributes significantly to the decreased desirability of that area for such families. This pattern is reflected throughout the regression equations generated for high-density tracts. Once the children begin to venture out alone, the quality of the neighborhood becomes more important to the parents.

There have been several major studies of the characteristics of mobile families and the characteristics that make individual housing units and neighborhoods attractive or unattractive. This body of research points out the importance of quiet, traffic-free streets and general environmental qualities in conditioning feelings about a neighborhood. Obviously, the desire for certain characteristics in housing units and neighborhoods is not a function of highway impact alone. We argue, however, that for families with young children the presence of a highway significantly increases the desire to move. In inner-city neighborhoods, which are typically renter dominated, there is a continuous out-migration of families to single-family units. In controlling for differences among these neighborhoods (tracts), the tendencies were even greater in those that experienced highway impact (3, 10, 17, 18, 25, 26).

In low-density areas, primarily in the suburbs, the physical impact of the highway is mitigated by the dispersion of the residents. Fewer people live close to the road. Construction requires the demolition of fewer housing units and the relocation of fewer people. Yet it is the accessibility of other parts of the metropolitan region, particularly the downtown area, that marks the influence of a highway in such tracts. Neighborhoods that already lie close to the downtown area benefit to a lesser extent from improved accessibility; they are already at or near the focal destination and their marginal gain is smaller. The ability to commute to other parts of the SMSA increases the attractiveness of low-density, suburban tracts, and their suburban qualities are less disrupted by the presence of a highway.

In short, the physical impact of a highway in such low-density areas is minimal. Pollution, for instance, simply does not affect that many people. To the extent that suburban areas are generally more automobile oriented, the highway serves a positive function. Employment and shopping are typically separated from residence in their location, and children are more often driven or take a bus to school. A new highway complements these patterns through improved accessibility.

CONCLUSIONS

In both Tables 1 and 2, the amount of variance in the dependent variable "explained" by the impact variable is extremely low, never exceeding 3.5 percent and more typically under 1 percent. This characteristic of the tables implies that, although affected and unaffected tracts can be distinguished for a number of variables, highways have only a marginal effect on population composition and housing stock.

Generally, the past is the best predictor of the future, indicating that demographic change occurs slowly. The highway occasionally makes a contribution to the shape of tract characteristics but plays a minor role. Certainly highway construction and widespread automobile ownership have played important roles in opening up peripheral areas of our cities. This study, however, involved areas that were for the most part developed before highway construction. I do not mean to deny the historical importance of highways in urban growth. But, within already-developed parts of our SMSAs, general demographic trends far outweigh the effects of highways.

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REFERENCES

1. J. E. Burkhardt, A. Lago, and J. Rothenberg. Highway Impact as a Factor in Neighborhood Change: Volume 1—Physical and Economic Measures of Neighborhood Change. Resource Management Corp., Bethesda, MD, 1971.
2. J. E. Burkhardt, A. Lago, and J. Rothenberg. Highway Impact as a Factor in Neighborhood Change: Volume 2—Changes in Neighborhood Social Interaction. Resource Management Corp., Bethesda, MD, 1971.
3. E. Butler, F. S. Chapin, Jr., G. Hemmens, E. Kaiser, M. Stegman, and S. Weiss. Moving Behavior and Residential Choice: A National Survey. NCHRP, Rept. 81, 1969.
4. A. G. Christensen and A. M. Jackson. Problems of Relocation in a Major City: Activities and Achievements in Baltimore, Maryland. HRB, Highway Research Record 277, 1969, pp. 1-8.
5. D. Colony. Estimating Traffic Noise Levels and Acceptability for Freeway Design. HRB, Highway Research Record 365, 1970, pp. 80-87.
6. D. Colony. Study of the Impact on Households of Relocation From a Highway Right-of-Way. HRB, Highway Research Record 399, 1972, pp. 12-26.
7. L. J. Duhl. Planning the Physical Environment. HRB, Bulletin 190, 1958.
8. R. Ellis. Toward Measurement of Community Consequences of Urban Freeways. HRB, Highway Research Record 229, 1968, pp. 38-52.
9. R. Ellis and R. D. Worrall. Toward Measurement of Community Impact: The Utilization of Longitudinal Travel Data to Define Residential Linkages. HRB, Highway Research Record 277, 1969, pp. 25-39.
10. F. Ermuth. Residential Satisfaction and Urban Environmental Preferences. Department of Geography, Atkinson College, York Univ., Downsview, Ontario, 1974.
11. M. Fried. Grieving for a Lost Home. In The Urban Condition (Leonard Duhl, ed.), Basic Books, New York, 1963.
12. W. Galloway, W. Clark, and J. Kerrick. Highway Noise: Measurement, Simulation, and Mixed Reactions. NCHRP, Rept. 78, 1969.
13. S. L. Hill. The Effect of Freeways on Neighborhood: An Analysis of the Relationship of Mobility to Community Values. Right of Way Research and Development, California Department of Transportation, Sacramento, 1967.
14. S. L. Hill and B. Frankland. Mobility as a Measure of Neighborhood. HRB, Highway Research Record 187, 1967, pp. 33-42.
15. B. Kemp. Social Impact of a Highway on an Urban Community. HRB, Highway Research Record 75, 1965, pp. 92-102.
16. A. Kriken, W. H. Botting, and F. Thiel. Estimating Community Effects of Highways. TRB, Transportation Research Record 528, 1974, pp. 9-14.
17. J. B. Lansing and N. Barth. Residential Location and Urban Mobility: A Multivariate Analysis. Survey Research Center, Institute of Social Research, Univ. of Michigan, Ann Arbor, 1964.
18. J. Lansing, E. Mueller, and N. Barth. Residential Location and Urban Mobility. Survey Research Center, Institute for Social Research, Univ. of Michigan, Ann Arbor, 1964.
19. D. M. McGough. Social Factor Analysis: A Study Relating Selected Attitudes and Behavior Patterns of Residents to Selected Census Tract Characteristics. City of Philadelphia Community Renewal Program, Technical Rept. 11, 1964.
20. A. C. McKennel. Noise Complaints and Community Action. In Transportation Noise: A Symposium on Acceptability Criteria (J. Chalupnick, ed.), Univ. of Washington Press, Seattle, 1970, pp. 228-244.
21. E. L. McLean, W. G. Adkins, H. W. Ladewig, P. B. Guseman, and W. Rodriquez. Further Investigation of the Mobility Index for Use in Predicting Freeway Effects on Neighborhood Stability. Texas Transportation Institute and Department of Agriculture, Economics, and Sociology, Texas A&M Univ., College Station, 1970.
22. E. L. McLean and W. G. Adkins. Freeway Effects on Residential Mobility in Metropolitan Neighborhoods. HRB, Highway Research Record 356, 1971, pp. 95-104.
23. W. M. Michelson. Man and His Urban Environment. Addison-Wesley, Reading, MA, 1970.
24. N. Nie, C. H. Hall, J. Jenkins, K. Steinbrunner, and D. Brent. SPSS: Statistical Package for the Social Sciences. McGraw-Hill, New York, 2nd Ed., 1975.
25. P. H. Rossi. Why Families Move: A Study in the Social Psychology of Urban Residential Mobility. Free Press, Glencoe, IL, 1955.
26. A. Speare, Jr., S. Goldstein, and W. Frey. Residential Mobility, Migration, and Metropolitan Change. Ballinger Publishing Co., Cambridge, MA, 1974.
27. U.S. Census of Population and Housing, 1960—Census Tracts. U.S. Government Printing Office, Final Rept. PHC(1), 1960.
28. U.S. Census of Population and Housing, 1970—Census Tracts. U.S. Government Printing Office, Final Rept. PHC(1), 1970.
29. U.S. Census of Housing, 1970—Block Statistics and Maps. U.S. Government Printing Office, Final Rept. HC(3), 1970.
30. U.S. Census of Population and Housing, 1970—General Demographic Trends for Metropolitan Areas, 1960-1970. U.S. Government Printing Office, U.S. Summary, Final Rept. PHC(2)-1, 1971.
31. United States Statutes at Large. U.S. Government Printing Office, Vol. 83, 1969, pp. 852-856.

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