Parkways, Values and Development in the Washington Metropolitan Region

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Parkways in the Washington Metropolitan Region, because of their dual function as commuter roads and as tourist routes, and because of an aesthetic emphasis in their layout and design, are associated with somewhat different land value patterns than non-parkway roads are. This paper presents the land value patterns for selected roadways—parkways and non-parkways—in the Washington area for 1950 and 1961. An analysis of the changes in these patterns through time are presented. The purpose is to identify those patterns and changes that seem peculiar to parkways in this region.

In conclusion, the paper presents a factorial analysis of land value variations to demonstrate the significance of location with respect to a roadway in explaining observed variations.

•THE SIGNIFICANCE of the roadway network to the development of urban regions is appreciated by most students of the urban scene. To say that it is appreciated, however, is not to say that it is completely understood. Questions have been raised concerning specific roadways in particular places. The work (1) on which this paper is based was undertaken within such a frame of reference. In this case the specific roadways are the National Capital Parkways; the particular place is the Washington Metropolitan Region, frequently referred to as the National Capital Region.

The National Capital Region, for the purposes of this paper is the standard metropolitan statistical area (SMSA) of Washington, D.C. It includes the city of Washington, coterminous with the District of Columbia and constituting the central city; Montgomery and Prince Georges Counties, Md.; and Arlington County, Fairfax County, and the City of Alexandria, Va. Numerous smaller entities are also part of the SMSA. This list, however, indicates the major components.

The 1960 census reported a population in excess of 2,000,000 for this region. This is a considerable increase from the 1,461,000 reported in 1950. More than 1,200,000 people live in suburban areas where 660,000 persons were found in 1950. The population of the central city has declined in this time period. The suburban shift of population is similar to other large cities of North America and underscores the pressures placed on regional transportation systems.

Along with the suburban shift in population, Washington has experienced a suburban shift of some employment centers. The Pentagon, the Bureau of the Census, the Atomic Energy Commission, and the Central Intelligence Agency are some of the better known examples of this trend. Decentralization of population and employment centers has created multiple focuses for urban growth. Distinct identities of components of the area are reinforced by the physical and political structure of the region.

The National Capital Region is compartmentalized by nature and by an unnatural political structure. Physiographically, the site of Washington is described as a fall line location—the place where the Potomac River emerges from the steeply rolling piedmont by a series of falls and rapids into the more gently rolling coastal plain. It is not generally appreciated that the major portion of the City of Washington occupies

Paper sponsored by Committee on Indirect Effects of Highway Improvements.

a peninsula between two rivers—the Potomac and the Anacostia. Suburban Virginia is separated from the central city by the Potomac River and gorge. Portions of suburban Maryland are separated from the central city by the Anacostia River. A large portion of west Washington is separated from the rest of the city by Rock Creek Valley. These are some examples of the manner in which the site of Washington is compartmentalized by physical features. The river valleys provide aesthetic possibilities for parkways, however, and such roadways are associated with many of the rivers.

The political structure of the region is unnatural in the sense that no overall authority exists in the region. Not only are the U.S. Congress, two State governments, and four county governments directly involved, but, as well, numerous city and town authorities have their areas of local responsibility. Several quasi-public bodies, such as the Suburban Sanitary Commission, contribute to further compartmentalization of the region.

The roadway network of the National Capital Region displays some of the same natural and unnatural compartmentalization characteristics typical of the region as a whole. River obstacles limit the number of entrance and exit points to the central city; routes must cross these barriers on bridges and viaducts. Federal, State and local highway authorities, though cooperating extensively, face the problems inherent in their being so many.

One segment of the regional roadway authority is represented by the National Capital Region of the National Park Service which administers the National Capital Parkways. By official, albeit paraphrased, definition, "a parkway is an elongated park area which contains as its principal feature a limited access roadway connecting elements of national, scenic, historic and scientific significance. The design criteria for a parkway roadway are based primarily on recreational, interpretative, and preservative factors associated with the area, rather than on traffic demands." It is the phrase, "rather than on traffic demands," which has stimulated considerable controversy in the region, a controversy beyond the scope of this paper and related to the part parkways should play in the regional roadway system.

Growth in the region, since World War II, has engulfed considerable portions of the parkway system. Roads designed with the presentation of features of national signficance (such as Mount Vernon) in mind are burdened with the more prosaic task of channeling a very heavy commuter traffic to and from the central city. This is a use and a role for parkways which their designers were not always able to envisage. As well, the parkways are used for their "official" purpose by many thousands of visitors every year. Estimates place the average daily influx of tourists to Mount Vernon in excess of 20,000. The apparent conflict between parkway use and parkway purpose raises the question whether the dual role played by the National Capital Parkways affects values and developments so that it is possible to distinguish parkways from other kinds of roadway in the region.

Within the National Capital Region, as in most urban regions, a variety of roadway types may be found. These range from the neighborhood access street to the controlled-access superhighway. Each type plays a part in the regional transportation system; each is supposed to have an effect, direct or indirect, on regional growth and change. This effect may be related to the design of the roadway and to the role the roadway plays in the regional system. This paper is addressed to only two of the many possible questions that might be raised about parkway effects:

1. How do parkways affect value patterns for adjacent residential properties?
2. What development characteristics differentiate parkways from other kinds of roadways?

To these ends, three roadways are considered:

1. The George Washington Memorial Parkway (Mount Vernon section). This parkway follows the course of the Potomac River southwards from the City of Alexandria. Throughout most of its length, it is developed on the west side only, the river lying close to the east.
2. The Baltimore-Washington Parkway. This parkway connects the cities of Baltimore and Washington. The area studied extends from the central city outwards about 5 miles. Developments occur on both sides of the right-of-way.

3. Shirley Memorial Highway. This controlled-access highway serves as a bypass of the City of Alexandria. Study of this area focuses on interchanges. The function of the non-parkway is to provide some basis of comparison for evaluating the observations of parkway study areas.

A brief comment on the extent of the study areas is desirable before considering the findings. The selection of study areas was limited somewhat by a need to consider roadways in a number of different contexts. Thus, roadways in Maryland, Virginia, and the District of Columbia were selected for the original study. Because of differing dates of construction, ranging from the 1920's to the 1950's, a before-and-after type of comparison was not made. It was felt that conditions in the region were so different for different points in time that a more useful approach would be to consider variables such as value through the decade 1950-61. The study areas were limited to nine properties or 2,100 ft outwards from the right-of-way, whichever occurred first. Interchange areas are those within ½ mi of an interchange. Data were collected and organized about parcel units. Not all parcels within the study areas were considered. Use was made of random sampling procedures in the selection of those parcels for which data were collected. All data were recorded on standard 80-column IBM cards and these cards were the basis of subsequent analytical procedures.

The measure of value used was the assessed value of land and improvements, adjusted to eliminate discrepancies resulting from different assessment practices in different assessment jurisdictions. The method of adjustment was straightforward: the sum of the assessed values for land and improvements, if any, was obtained, and this sum multiplied by the reciprocal of the appropriate assessment ratio. In all cases the adjusted values were expressed in dollars per square foot.

PARKWAY EFFECTS ON VALUES, 1950-61

Inasmuch as the predominant land use type associated with parkways, almost to the exclusion of any others, is single family residential or vacant but intended for this kind of development, subsequent references to value, though including all forms of residential use and vacant land, exclude from consideration any other uses.

The plotting of the value patterns for 1950 and 1961, and of the changes in value in that time interval, is suggestive of the nature of the influence of a roadway on value. In this connection the work of Carroll et al. (2) is of interest.

The first example is the north portion of the study area delimited about the George Washington Memorial Parkway. The distance to the 14th Street bridges and the District of Columbia is somewhat more than 10 miles to the north (Fig. 1).

The orientation of isolines of change is, for the most part, at right angles to the right-of-way. This is suggestive of an influence emanating from the central city and operating outwards along the right-of-way with diminishing effect. The absence of parallelism in the lines of change suggests that no influence operates outwards from the right-of-way. The spacing of the isolines is regular, suggesting regularity in both amount and direction of change.

The southward dip of the (plus) 500 line along the parkway is interesting. This is a southerly extension of a fairly completely developed area to the north. For a distance of about one mile, single family homes flank the right-of-way to a depth of about three properties. Land immediately west of this remains undeveloped. Access to this prong does not appear to be convenient, access points being shown in Figure 1.

The second example is a portion of the study area delimited about the Baltimore-Washington Parkway. The central city is about 3 mi south of this section (Fig. 2). The pattern of value change in this case is quite different from that of the previous example.

Figure 2 shows the second basic pattern of change observed for parkways in the region. The isolines of change parallel the right-of-way and cross it infrequently. This is suggestive of an influence operating latitudinally from the parkway. Greatest positive changes in value are observed at points further removed from the right-of-way. The orientation of these lines does not suggest an influence emanating from the central city and operating with diminishing effect outwards along the right-of-way.

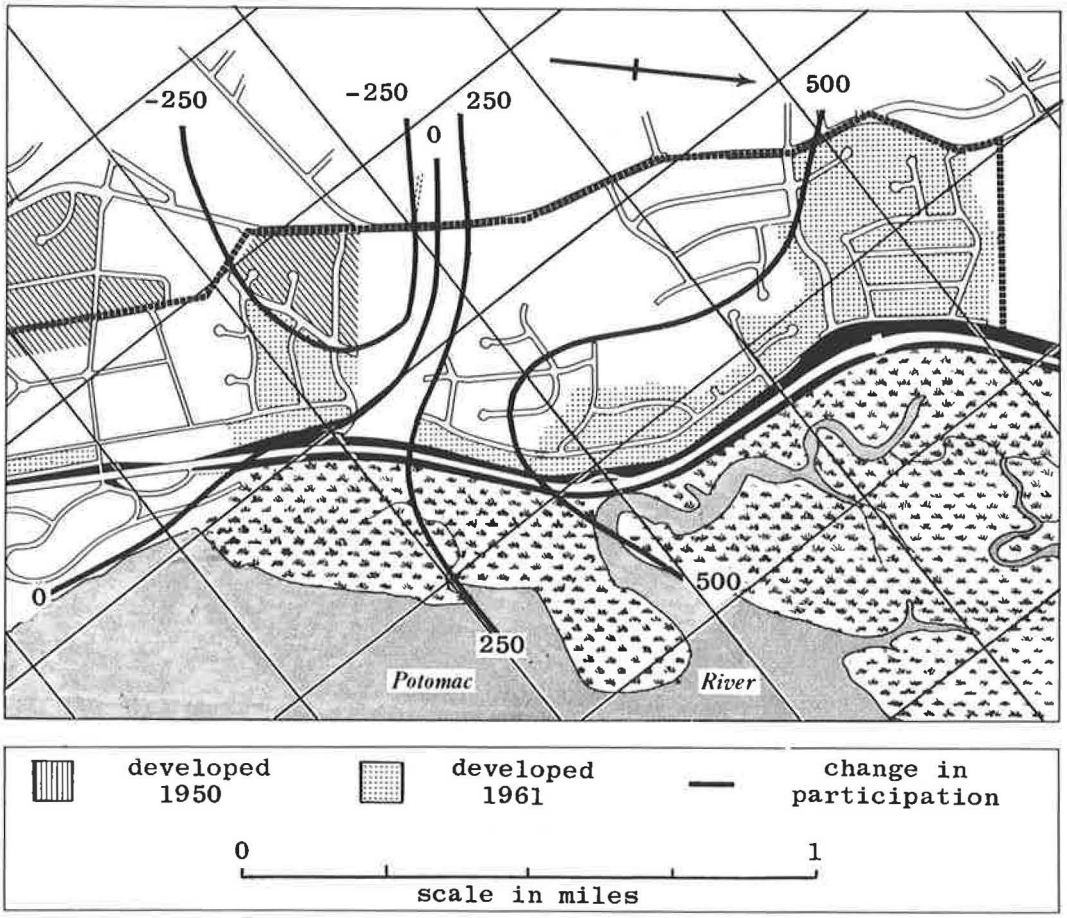

Figure 1. Development and participation changes, George Washington Memorial Parkway, north portion.

A complete explanation of value changes in the vicinity of these major roadways must consider a larger, regional, frame of reference. Regional demands for housing have a major bearing on value determination and change. In the case of these roadways the nature of development in 1950 can be demonstrated to have had an effect on value changes. The tracing of many possible value influencers was beyond the scope of the problem treated here, where the focus is narrow, concentrating on value parcel and roadway. The previous portrayal is preliminary evidence of variations in value about a roadway. As such, it is suggestive but not conclusive.

One might observe that, in general, the result of value changes has been the creation of a more homogeneous pattern in 1961 than existed in 1950. Two basic patterns of change, perpendicular and horizontal, suggest two possible influences on value. The questions may now be raised as to what variations in value may be attributed to the location of a parcel with respect to the roadway and the central city and how value varies as distance from the right-of-way and central city varies.

For the George Washington Memorial Parkway and the Baltimore-Washington Parkway, answers to these questions have been sought through the use of a mathematical model construct. Attribution of variations in value to measures of location is made on the basis of statistical significance at the 5 percent level. The model used is a factorial model that tests the extent to which variations in value may be attributed to distance from the central city in miles, distance from the right-of-way in feet, and distance from

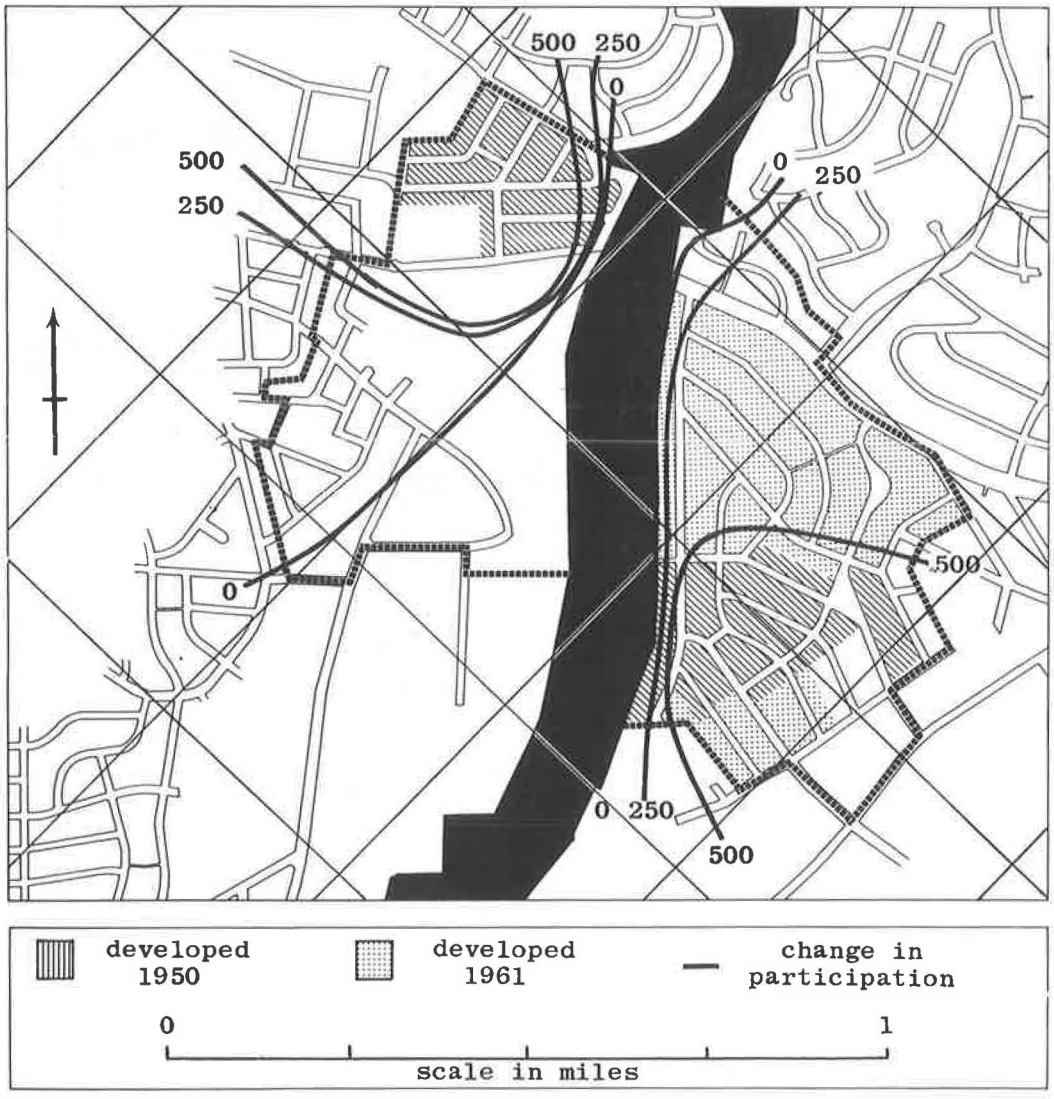

Figure 2. Development and participation changes, Baltimore-Washington Parkway, urban area.

the right-of-way in properties. Value, again, is the adjusted value of land plus improvements for 1961.

The simplified form of the model is

$$Y_{ijk} = m + D_i + N_j + (DN)_{ij} + d_{jk} + (Dd)_{ijk} + e \qquad (1)$$

in which

Y = adjusted value of land and improvements (parcel);
D = distance from central city;
N = number of properties distant from right-of-way;
d = number of feet distant from right-of-way;
m = mean effect; and
e = error term.

This is a model for a factorial experiment. A significance among the D_i implies that values differ for varying distances from the central city. Significance among the N_j implies that values differ as the number of properties from the right-of-way changes. A significance among the d_{jk} implies that values differ for varying distances in feet from the right-of-way. The combined terms of the model, $(DN)_{ij}$ and $(Dd)_{ijk}$, indicate interactions. It is recognized that some part of the variation in value is attributable to a combination effect of the variables. A significance among the interaction terms will indicate this.

The application of this model to data from the two parkways provided the results in Tables 1 and 2. Briefly, distance from the central city is a significant source of variation in value for both parkways. Recalling the patterns of change (Figs. 1 and 2), one might have expected this result for the George Washington Memorial Parkway, but there was no clear indication of it in the case of the Baltimore-Washington Parkway.

The number of properties from the right-of-way is a significant source of variation in value in the case of the Baltimore-Washington Parkway, as the maps of change suggest. Here one may conclude that values do differ as the number of properties from

TABLE 1

SIGNIFICANCE OF VARIABLES ON VARIATIONS IN VALUE, GEORGE WASHINGTON MEMORIAL PARKWAY

Source[1] Due to	Degrees of Freedom	Sum of Squares	Mean Sum of Squares	Significant at 0.05
D_i	3	15.50	5.17	Yes
N_j	3	0.18	0.06	No
$(DN)_{ij}$	9	8.47	0.94	Yes
d in N_1	1	0.03	0.03	No
d in N_2	2	0.10	0.05	No
d in N_3	1	0.05	0.05	No
d in N_4	1	0.09	0.09	No
$(Dd)_{ijk}$	15	2.11	0.14	No
Error	196	97.60	0.28	

[1] In which i = 1, 2, 3, 4; j = 1, 2, 3, 4; k= 1, 2, 3, 4, 5, 6; D_1 = 1.9 to 2.4 mi from central city (straight line); D_2 = 2.5 to 3.0 mi from central city; D_3 = 3.1 to 3.8 mi from central city; D_4 = 3.9 to 5.0 mi from central city; N_1 = 1 property from right-of-way; N_2 = 2 and 3 properties from right-of-way; N_3 = 4 and 5 properties from right-of-way; and N_4 = 6, 7, 8 and 9 properties from right-of-way.

TABLE 2

SIGNIFICANCE OF VARIABLES ON VARIATIONS IN VALUES, BALTIMORE-WASHINGTON PARKWAY

Source[1] Due to	Degrees of Freedom	Sum of Squares	Mean Sum of Squares	Significant at 0.05
D_i	2	0.24	0.12	Yes
N_j	3	0.58	0.19	Yes
$(DN)_{ij}$	6	0.23	0.04	No
d in N_1	3	0.05	0.02	No
d in N_2	1	0.05	0.05	No
d in N_3	2	1.10	0.55	Yes
d in N_4	1	0.02	0.02	No
Error	493	0.27	0.035	

[1] In which i = 1, 2, 3; j = 1, 2, 3, 4; k = 1, 2, 3, 4, 5, 6; D_1 = 1.6 to 2.9 mi from central city (straight line); D_2 = 3.0 to 3.9 mi from central city; D_3 = 4.0 to 5.7 mi from central city; N_1 = 1, 2, and 3 properties from right-of-way; N_2 = 4 and 5 properties from right-of-way; N_3 = 6, 7, and 8 properties from right-of-way; and N_4 = 9 properties from right-of-way.

the right-of-way varies. Although the number of properties is not of itself a source of variation in value along the George Washington Memorial Parkway, there is a significant interaction effect of this variable, with distance from the central city.

Distance in feet from the right-of-way was not indicated in either case as a significant source of variation in value. (There is one exception to this generalization in the 6th, 7th, and 8th property tiers of the Baltimore Parkway.)

An advantage of the application of the factorial model to spatially distributed data is that one may plot graphically the variations in value against the significant factors. The patterns so plotted for the George Washington Memorial Parkway are shown in Figure 3.

Considering first the variations in value outwards from the central city (D-factor) at different property tiers from the right-of-way, one may observe that a regular decrease in value outwards from the central city exists. As distance from the central city increases, value decreases in a regular manner in properties adjacent to the right-of-way. The actual value decrease was from a high slightly under $2.50 per sq ft to

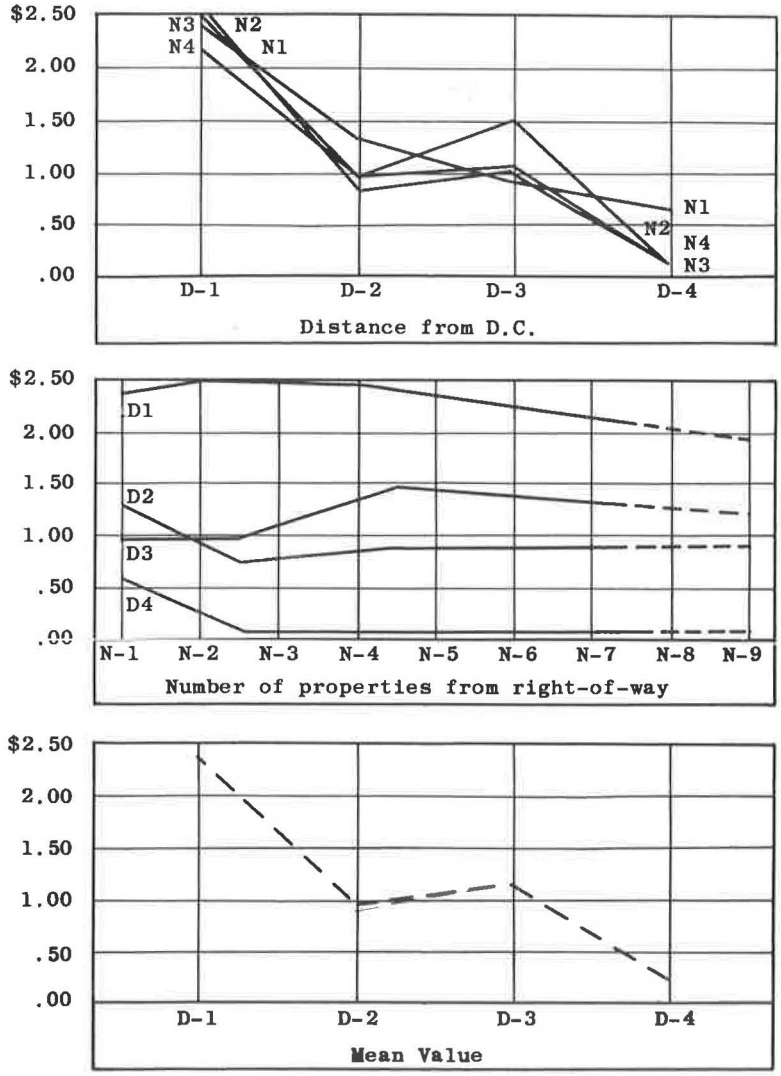

Figure 3. Variations in value, George Washington Memorial Parkway.

a low of about $0.60 per sq ft. The high is not so high nor the low so low as in properties farther removed from the right-of-way.

The behavior of values in the first property tier is markedly different from that of values in more remote tiers. For these the pattern of variation is essentially the same no matter how far away they may be. A steep decrease is followed by a leveling or slight rise, followed by a further decrease to a common low value. If the pattern of the first property tier is attributed to proximity to the parkway, as seems reasonable, this effect is highly localized and not evident in other property tiers.

Turning next to variations in value outwards from the right-of-way, one observes that at any given distance from the central city little variation outwards occurs. The combination effect of this variable (N) with distance from the central city (D) is indicated by the crossing of the lines. Slight appreciations in value, as well as even slighter depreciation in one case, are not significant variations in the statistical sense.

Considering next the behavior of values in the Baltimore-Washington Parkway study area, some differences and some similarities may be observed. The patterns for this area are shown in Figure 4.

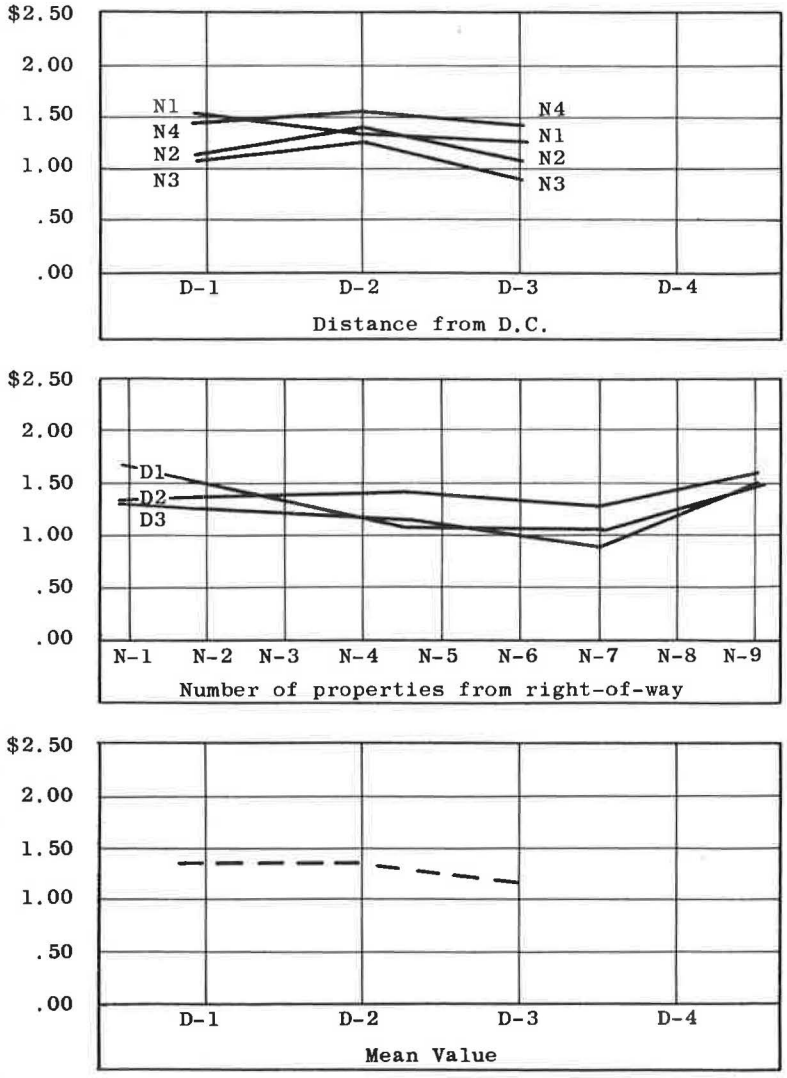

Figure 4. Variations in value, Baltimore-Washington Parkway.

As for variations in value as distance from the central city increases, properties adjacent to the right-of-way behave differently from those farther away. In those properties adjacent to the right-of-way, values decrease regularly as distance from the central city increases. In this instance, the highest values are adjacent to the right-of-way and closest to the central city. In other property tiers, values increase slightly, then fall slightly. The experience for all is similar, although the level may differ. Again, if the pattern of variation in the first property tier is ascribed to the parkway, it is a highly localized influence.

As for variations in value as the number of properties from the right-of-way is increased, one may observe an appreciation of value adjacent to the right-of-way in two out of three cases. The different case (D_2) might plead extenuating circumstances. This slight depreciation has been identified with a large tract of land that was vacant at the time the data for this experiment were collected. This tract is now being built up with apartment units and the effect of this will be to make an appreciation adjacent to the right-of-way for D_2 as well.

For all the profiles, values decrease to minimal points in the 7th, 8th, and 9th property tiers. At this point, it is suggested that properties are falling into the zone of influence of another roadway, and there may be some justification for terminating the influence area of the Baltimore-Washington Parkway in the 7th property tier.

Distance in feet from the right-of-way did not prove a significant source of variation in value except in the 7th, 8th, 9th property tiers. Because this is believed to be a zone where another roadway influence is being felt, this source of variation is not considered sufficient evidence to conclude that distance in feet from the right-of-way has an effect on value.

To summarize the findings in the case of these two parkways, the following generalizations seem possible:

1. The behavior of values in properties adjacent to the parkway is markedly different from that in other property tiers, changing more regularly and displaying narrower ranges between high and low.
2. Generally, values decrease outwards from the parkway, but the changes are not always significant.
3. Distance in feet from the parkway did not prove a significant source of variation very often, which suggests that the number of properties from the right-of-way is a more useful measure than straightline distance.

Comparison of these parkway effects with a highway of similar design and carrying capacity (Shirley Highway) has only been made with respect to the effect of increasing distance from the central city. Developments along Shirley Highway favor large tracts of land and apartments and precluded comparable treatment of the distance in property and distance in feet factors. Insofar as distance from the central city is concerned the observed pattern of change was different from that for the two parkways.

In the case of Shirley Highway, values close to the central city may be likened to a plateau, dropping precipitously to a plain of low values. The change is abrupt and is related to the abrupt termination of development on the north side of the Route 7 interchange. Thus, though values may be said to decrease outwards from the central city, they do so in one brief interval of space, quite unlike the pattern observed along the parkways.

Having viewed in some detail the value variations about two parkways, overall changes in the region as they relate to these merit some consideration. The different degrees to which parkways and a non-parkway share or participate in total area development constitute a major differentiating feature.

PARTICIPATION IN REGIONAL DEVELOPMENT

Average values per square foot for the Washington region, its major components, and three roadway study areas are given in Table 3. For the entire area, average adjusted value has increased from $0.11 to $0.25 per sq ft between 1950 and 1961. In this time period, both the lowest average values (representative of undeveloped land) and the highest have advanced. The lowest value per square foot in 1950 was $0.01; in 1961, it was $0.10. The highest values (average) per square foot were $1.96 in

TABLE 3

AVERAGE ADJUSTED VALUES PER SQUARE FOOT IN WASHINGTON METROPOLITAN REGION[1]

Political Unit	Average Value ($)	
	1950	1961
Washington SMSA	0.11	0.25
City of Alexandria	0.89	1.20
Arlington County	0.44	1.39
District of Columbia	1.96	2.43
Fairfax County	0.01	0.14
Montgomery County	0.04	0.15
Prince Georges County	0.02	0.10

[1] Source: Assessment figures for all political jurisdictions and assessment ratios obtained by direct contact with respective assessment jurisdictions.

1950 and $2.43 in 1961, both cases in the District of Columbia. It is against this overall pattern of change that study areas associated with the different roadways are viewed.

To facilitate comparisons among the different roadways and to relate these to changes in the region as a whole, values have been expressed in terms of indexes of participation (3). The index is a simple ratio which measures the extent to which a given value exceeds or fails to exceed the regional average. It is the regional average value per square foot divided into the average value per square foot observed in a study area. A value of 1.00 indicates a value equal to the regional average—an average participation in regional development. A value of 2.00 indicates participation twice the average; a value of 3.00 indicates three times the average participation; 0.50 indicates participation one-half the average. These index values for various areas and their absolute and percentage change from 1950 to 1961 are given in Table 4.

TABLE 4

PARTICIPATION OF SELECTED PORTIONS OF WASHINGTON METROPOLITAN REGION IN REGIONAL DEVELOPMENT, 1950 AND 1961

Unit	Index		Absolute Change	Percent Change
	1950	1961		
Average index	1.00	1.00	-	-
City of Alexandria, Va.	8.10	4.80	-3.30	- 40
Arlington County, Va.	4.00	5.56	+1.56	+ 39
District of Columbia	17.82	9.72	-7.10	- 40
Fairfax County, Va.	0.09	0.56	+0.47	+522
Montgomery County, Md.	0.36	0.60	+0.24	+ 66
Prince Georges County, Md.	0.18	0.40	+0.22	+122
George Washington Mem. Pkwy.	1.67	3.27	+1.60	+ 95
Baltimore-Washington Pkwy.	3.60	5.50	+1.90	+ 53
Shirley Memorial Highway	3.73	2.97	-0.76	- 20

Some preliminary conclusions from the overall relationships between the roadway study areas and the portion of the region in which they are situated are possible:

1. The participation of each of the roadway study areas exceeds the regional average. The roadways have attracted larger than average shares of regional development.
2. The relative share of regional development, as measured by value of land and improvements, has increased in the case of two parkways, but it has decreased in the case of the non-parkway.
3. All three roadways are associated with study areas whose participation in regional development exceeds that of the portion of the region through which they pass. Thus, for example, the Baltimore-Washington Parkway study area had an index of 5.50 in 1961, as compared to an index of 0.40 for Prince Georges County through which it passes.

Considering the absolute change in the index of participation, one may observe that the two parkways have increased their relative shares, whereas the non-parkway has experienced a decrease in its share of total development. The non-parkway has a smaller slice of a larger pie. As the measure of value embraces improvements as well as land, one must conclude that development has proceeded more rapidly along the parkways than along the non-parkway. Parkway developments are associated with single family residential units; non-parkway, in this case, with apartment units. It seems reasonable to suppose that the relative market demands for these two kinds of housing have operated in the 1950-61 period to favor the development of parkway areas.

The final column in Table 4 expresses the absolute changes in the index of participation as percentages of the participation in 1950. Plus and minus signs indicate the direction of change. The rate of change in the index, as well as its direction, adds a further dimension to the comparisons. Thus, though the absolute change for the District of Columbia is quite different from that of the City of Alexandria, in terms of percentage change they are the same. The rate of change along Shirley Highway is less than that along the parkways, but in the opposite direction. A greater rate of change characterizes Fairfax County than the George Washington Parkway study area. This is a reflection of the degree of development in the two areas. The parkway study area is more completely developed than the county through which it passes. This raises the question of what the level of participation might be for these two areas when both are completely developed. Comparisons have been made with non-parkway portions of the region. These suggest that, assuming relatively complete development, the level of participation about parkways will be significantly higher than that of the region through which they pass.

By way of conclusion to this paper, some tentative statements may be made. In such a study as this, of necessity partial and restricted in scope, numerous questions arise that could not be answered satisfactorily. These, too, merit mention, however brief.

CONCLUSIONS

It is believed that the study just reported substantiates the hypothesis that parkways have effects on values and development that differentiate them from other kinds of roadways. It was not possible to specify what it was about a parkway that contributes to this differentiation. The question of what specific attributes of a certain kind of roadway create these effects remains unanswered in this case.

It would seem implicit in a hypothesis that different roadways have different effects that the areas about the different roadways would be demonstrably different. Ought not different effects produce different areas? In the present case an attempt was made to characterize the study areas in terms other than use and value. Such measures as lot size, family size, income, and condition of structure were tested by standard analysis of variation procedures and, where appropriate, an attempt was made to develop discrimination models. That the attempt failed suggests that the variables selected may be inappropriate—nondiscriminating, or that the areas used were too gross. The possibilities of this approach seem promising but only a glimpse of the prospect was gained in the study of parkway effects in the Washington Region.

With respect to the methodology used to identify and describe roadway effects, the

experience of others with variations of the participation ratio is confirmed here in the light this measure sheds on the problem. The factorial model functioned satisfactorily for the purposes of the present study. Through it, significant sources of variation have been identified. That not all were considered is indicated by the size of the error terms obtained. Other significant sources of variation exist, although the experience here suggests that distance in feet from the right-of-way is not significant. The identification of these other sources of variation might be attempted through further applications of this technique. It has proved its value for this purpose in studies in other fields. Hopefully, a useful predictive model might be derived more easily when significant variables are identified and their behavior known.

ACKNOWLEDGMENTS

This paper is based on work carried out by the George Washington University under the terms of a contract with the National Capital Region, National Park Service, Department of the Interior, with the support and cooperation of the Bureau of Public Roads, Department of Commerce, and the highway departments of the District of Columbia, the State of Maryland, and the Commonwealth of Virginia.

REFERENCES

1. Davis, J. T., and Ames, D. L., "Parkway Impact Study: An Investigation of the Effects of Parkways in the National Capital Region." (1962).
2. Carroll, Borchert, Schwinden, and Raup, "The Economic Impact of Highway Development upon Land Use and Value." University of Minnesota (1958).
3. Sternberg, H. O., "The Distribution of Water Power Resources in Brazil with Reference to the Participation Ratio Concept." Annals, Assoc. Amer. Geographers, 38:133-144 (1948).
4. "Guide for Highway Impact Studies." Bureau of Public Roads (Dec. 1959).
5. Garrison et al., "Studies of Highway Development and Geographic Change." University of Washington Press (1959).
6. Garrison, W. L., "Statistical Analysis of a Road Improvement Impact Problem." HRB Special Report 28, 84-86 (1957).
7. Garrison, W. L., "Obtaining Data for a Highway Impact Study." HRB Special Report 28, 86-89 (1957).
8. Heller, I., "The Military Region: A Mathematical Model." George Washington University, Historical Records Project, Final Report, Sec. 6 (Sept. 1957).
9. Lively, C. E., and Almack, R. B., "A Method of Determining Rural Social Sub-Areas with Application to Ohio." Ohio State University, Dept. of Rural Economics Mimeograph Bull. 106 (Jan. 1938).
10. "Manual, Schedules, Coding Instructions, Data Card Descriptions Pertaining to Work Done in the York Study Area." Pennsylvania State University, Project WAMBY Research Group (1960).
11. "Coding Procedure for Highway Impact Studies, Revised." Oklahoma State Highway Department.