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A Quantitative Analysis of the Spatial Distribution of Substandard Housing in Bowling Green, Kentucky

Robert Harding
Western Kentucky University

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Robert Forrest

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A QUANTITATIVE ANALYSIS OF THE SPATIAL DISTRIBUTION OF SUBSTANDARD HOUSING IN BOWLING GREEN, KENTUCKY

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Robert Forrest Harding

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A QUANTITATIVE ANALYSIS OF THE SPATIAL DISTRIBUTION OF SUBSTANDARD HOUSING IN BOWLING GREEN, KENTUCKY

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Directed by: Wayne L. Hoffman, J.L. Davis, and J. Bingham

Department of Geography Western Kentucky University

The purpose of the study was to determine the degree and intensity of the factors affecting the spatial distribution of substandard housing in Bowling Green, Kentucky. A stepwise regression model revealed that straightline distance from the CBD, overcrowded units, average number of rooms per dwelling unit, renter occupancy and non-white occupancy accounted for only 37 percent of total explained variation. A filtering process based on blocks exceeding ten percent Black population was utilized to divide the universe. New analyses on Black and White sectors within the city did not increase the coefficient of determination. They did, however, reveal a great disparity in the overall housing situation between Black and White families in Bowling Green. A residual analysis revealed that locations adjacent to diseconomies may be a significant factor in helping to explain the problem distribution.

A QUANTITATIVE ANALYSIS OF THE SPATIAL
DISTRIBUTION OF SUBSTANDARD HOUSING
IN BOWLING GREEN, KENTUCKY

Recommended 19 April 74
(Date)

Wayne L. Hoffman
Director of Thesis

James L. Davis

James M. Bingham

Approved 4-26-74
(Date)

Elmer Gray
Dean of the Graduate College

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CHAPTER I

FACTORS AFFECTING THE DISTRIBUTION OF SUBSTANDARD HOUSING

Introduction

The distribution of substandard housing in the United States is one of intense and immediate importance. It is related to the economic polarization between cities and suburbs as well as constituting a major social and health problem within our urban areas.

The emergence of polarization is inherent in the system by which lower socioeconomic groups secure their dwellings. It is contended that the needs for additional housing for the poor can be met by the production of an adequate supply of new housing for the upper income groups. This filtering-down process can be described most simply as the passing down of housing to successively lower income groups as adequate supplies of housing for the upper income groups are produced.[1] As new housing is constructed on the fringe of the urban area the demand for housing in the older parts of the central city by middle and upper income persons declines. This decline in demand, in turn, can reduce the returns to owners of buildings in the city. Many have allowed their buildings to deteriorate, thus reinforcing flight to the suburbs.[2] This leaves

those least able to migrate to occupy the central substandard units. Thus the problem of substandard housing is related to the growing differences between the central city and the suburban fringe. The resolution of these differences is an essential prerequisite to the continued social and economic viability of America's metropolitan complex.

Substandard dwelling units also contribute to social problems within the city. Housing constitutes a family's immediate physical environment and the effects of unsafe, deteriorating and overcrowded housing are well documented and understood.[3] As Clark has pointed out housing is an extension of a man's personality.[4] If his home is clean and decent his sense of self is stronger for a house is a concrete symbol of what a person is worth. If one has to identify with a physically deteriorating dwelling then a sense of inferiority, aggrevated by other forms of discrimination, is strongly reinforced.[5]

Because of these social and economic implications of substandard housing a problem solving approach is clearly suggested. It was this that led to a formulation of purpose for this thesis.

Purpose of the Study

The distribution of any urban phenomena such as substandard housing is highly complex. Such phenomena may be related to the human characteristics of the city's occupants such as

race or income, or physical characteristics of the city such as highways, public services and employment opportunities. It is the function of the urban geographer to discern the degree to which these phenomena are interrelated in order to explain how the spatial distribution of one or a group of elements is related to another, both functionally and spatially.

The purpose of this thesis will be to determine the degree and intensity of the factors that affect the spatial distribution of substandard housing in a single urban center. To determine if such relationships exist is not only of immediate importance to the people who are currently living and raising families in substandard dwelling units, but also to the social scientist who seeks an understanding of urban reality.

Review of Literature

City Growth and Substandard Housing

While residential quality is not uniform within cities it does exhibit strong regularities and is highly predictable.[6] Much research has been conducted by academicians to determine the regularity of urban growth and the subsequent development of residential areas, which consumes more land in American cities than any other type; 29.9 percent of all urban land and 39 percent of all developed land being devoted to residential uses.[7]

The mechanism for establishing patterns of urban land

use have been the subject of considerable volumes of literature dating back to the early 1920's. The first academic theory of urban land use, the concentric ring theory, was formulated by the sociologist E.W. Burgess. His concentric zones included the CBD, a wholesaling zone, and adjacent residential zones of blight, middle class and upper class occupancy.[8] Burgess contended that as city growth occurs each inner zone tends to invade the next outer zone following a sequence of "invasion-succession," speeding up the "junking" process in the area of deterioration.[9] As a theoretical explanation of the location of major functional areas of land use the model has had considerable applicability. It is in many respects, however, an oversimplification and fails to take into account irregularities that tend to develop in land use patterns.

While Burgess was mainly interested in the city as a laboratory for studies of social disorganization, the work of Homer Hoyt, conducted during the 1930's, was more directly concerned with housing quality and socioeconomic status.[10] In analyzing the patterns of movement of residential neighborhoods, Hoyt observed that occupants of houses in low rent categories tend to move out in sectors from the center of the city mainly by filtering into houses left behind by high income groups. The main reason advanced for this initiation of filtering was the deterioration of the housing stock of an area due to age.

Houses with increasing age have higher repair bills with the steady process of deterioration hastened by obsolescence. Neighborhood desireability thus becomes correlated with age, with low income groups living in secondhand houses in which the percentage needing repair is relatively high.[11]

Other research has tended to substantiate the basic concepts of these models. In Davis' study of middle class housing in the central city, cities with centrally located CBD's were found to exhibit a concentric zonation of residential types. A pattern of sectoral clustering was observed in cities with eccentrically located centers.[12] In analyzing models of urban residential patterns Johnson found that centrifugal growth of cities produces a strong negative relationship between distance from city center and age.[13] Adams reached similar conclusions in Minneapolis.[14] As suggested by Hoyt, housing is passed down the social scale as it ages. Because many centrally located units are too large to be purchased by a single family they are often subdivided into rooms and apartments. Other research has discerned similar patterns.[15]

Because vacant land is more prevalent and cheapest on the periphery of cities, mass building of housing in one locale occurs. New housing is preferable to old housing because it contains the latest conveniences and is less likely to be deteriorated. Because new housing costs more than old housing, higher income households can afford it while lower income households can only afford the older depreciated housing.

Because the new housing is most common on the fringe of the city a pattern is created where economic status is positively related to distance from the CBD, substantiating Burgess' concepts.[16]

Relative location with respect to the CBD is also a determining factor in the price of urban residential land and subsequently the intensity of its use. Investigations have indicated a simple pattern of intra-urban land values decreasing away from some peak value somewhere within the CBD.[17] Alonzo found that the main determinant of land values were the bids made for nonresidential land, and that land with the highest bid rent must be utilized in the highest intensity.[18] Because the accessibility pattern of most cities is based on communication and transportation networks which are CBD oriented, land in the CBD is the most valuable. This pattern of land use intensity and values would create a residential structure with apartments and multi-family units closest to the city center and single-family units beyond. This would seem to substantiate a residential pattern whereby high income families tend to live on the periphery and low income families near the center of cities.[19]

Socioeconomic Status and Substandard Housing

The literature lends evidence to support that the spatial variation of income relates to several factors. In his analysis of the spatial pattern of urban residential land use in Chicago, Muth found that housing demand increased in

proportion to income, supporting the earlier findings of Reid in that same city.[20] Therefore, higher income households would consume better quality housing commensurate with their incomes. Poorer quality, older housing would correspondingly be more cheaply converted to occupancy by lower income households.[21] Because income per family is the most important determinant in housing demand, Muth concludes that demand for more poor quality housing has resulted in the growth of the number of substandard dwellings in the United States.[22] Income also establishes the upper end of the cost scale, for either purchasing or renting, that a family sets in choosing a dwelling unit.[23] The higher the income the more likely the household will purchase its dwelling.[24] Therefore, lower income groups would be more likely to rent their residence. Meyer found a positive linear relationship between median family income and median rent of renter occupied units.[25] He also found that variation in quality of dwellings was correlated to variations in value and rent of dwellings.[26] In analyzing the relationships between rented housing units and quality of housing, Muth postulated that because landlords do not generally live in the neighborhood in which they rent, they make only limited investments in their property. By limiting investment the result would be a large number of dwellings being below a given level of quality.[27] Duncan and Hauser's survey of housing in Chicago revealed that it is primarily in the rental sector that lower

income families experience difficulty in securing standard housing. About four-fifths of lower income families were found concentrated within Chicago's rental sector; 32 percent of lower income renter families as compared with 13 percent of middle and 6 percent of higher income renter families occupied substandard housing.[28] Other empirical analyses confirm this relationship between median income and the occupancy of substandard dwelling units.[29]

Low income households also tend to consume less space per person. Typically an occupancy density factor of 1.01 persons per room is used as a classification for overcrowding. The Report of the President's Committee on Urban Housing has stated that in addition to those residing in structurally substandard units, those living in overcrowded standard units are also inadequately housed.[30] Thus, as was illustrated by McEntire, the intensity of dwelling unit usage can be correlated with substandard living conditions.[31] Reid found in Chicago that low quality of housing and the overcrowding of rooms and rooms per dwelling unit were positively correlated with low normal income.[32] Overcrowding has also been found to be most prevelant in tenant or renter occupied dwellings.[33]

In analyzing thirty years of changes in the United States' housing inventory, Kristof points to the improved situation of overcrowding which decreased from one-fifth (20.2 percent) to less than one-tenth (8.2 percent) of all households between 1940 and 1970.[34] This situation has not,

however, improved uniformly for all members of society. Other studies relating to overcrowding show that while the intensity of overcrowding decreases with time, it becomes more highly concentrated (and more severe) in areas which experience increases in Black population.[35] Mercer's regression analysis of housing quality correlates revealed that when overcrowding is the dependent variable, then race is the principle explanatory variable.[36] Duncan and Hauser postulate that the person per-room ratio is much higher for nonwhite households because of a relatively high proportion of large families, atypical family groups, and persons sharing their dwelling with relatives.[37] This is often attributed to the fact that ghetto housing, while it is overcrowded and substandard, is also expensive.[38] Some suggest that this increases overcrowding by forcing families to double up and pool income in order to obtain housing.[39] This situation is further aggrevated by segration in the housing market which leads to the spread of overcrowding throughout the ghetto into any part initially not crowded.[40]

Race and Substandard Housing

The President's Committee on Urban Housing concluded that the most visible disadvantage of minority groups is in the area of housing.[41] In quality, space, and value the homes of minority families rank far below the general standard of housing in the United States.[42] The Black population is confronted by a series of dilemmas in the housing market.

According to Rose these revolve around: 1) the absolute availability of shelter, 2) cost, 3) quality of shelter and 4) the provisions of social services within the context of the Black urban housing market.[43]

The problem of availability of shelter arises from the fact that White households are competing in a White housing market and Black households are competing in a Black housing market.[44] Since a disproportionate number of low income individuals are Black they tend to concentrate in the central city. This income segregation is reinforced by the discriminatory practices of racial segregation which makes it difficult for Blacks to purchase homes in outlying suburban areas, reguardless of their ability to pay.[45] Thus restricted to search in the confines of the centrally located ghetto, the housing available to Blacks is poorer in quality and more likely to be substandard, deteriorating and older than is White housing.[46]

Blacks must also spend a larger proportion of their income on housing,[47] further indicating that the Black's poor housing situation cannot be explained solely by his poverty. If this were so, the same quality housing would be available for both Blacks and Whites. It has been conclusively determined, however, that Blacks continue to occupy lower quality housing at every rental cost level than their White counterparts with similar incomes.[48]

The President's Committee reports that for populations residing inside SMSA's, nonwhites have a substandard occupancy percentage four times larger than Whites (28 percent vs. 7 percent).[49] Lower income nonwhites living outside SMSA's account for the highest proportion of substandard occupancy with 77 percent occupying substandard housing.[50] Other studies support this strong spatial relationship between the location of Black residences and substandard housing.[51]

Hypotheses to be Tested

The approach to the study assumes that there are definite factors relating to the spatial distribution of substandard housing. The significant findings of the studies reviewed form a basis from which to postulate research hypotheses that can be used to analyze the patterns of substandard housing within a study area.

The following hypotheses will be tested:

Hypothesis 1.	Substandard housing is a negative function of straightline distance from the CBD.
Hypothesis 2.	Substandard housing is a positive function of renter occupancy.
Hypothesis 3.	Substandard housing is a positive function of percentage of units overcrowded.
Hypothesis 4.	Substandard housing is a negative function of average number of rooms per dwelling unit.

Hypothesis 5. Substandard housing is a positive function of non-white occupancy.

These five hypotheses when taken together form the general hypothesis to be analyzed.

General Hypothesis. The variables selected and set forth in hypotheses one through five will explain a high percentage of the total variance of the distribution of substandard housing.

Summary

This chapter was concerned with establishing the central purpose of the study. To accomplish this goal the problems caused by substandard housing were analyzed. A review of related literature was conducted to provide justification and greater insight into the nature of the problem from geographic, economic and sociological sources. Utilizing the findings of these sources the formulation of hypotheses to be tested was presented. Chapter II will deal with the selection of a methodology and a study area in which to test these hypotheses.

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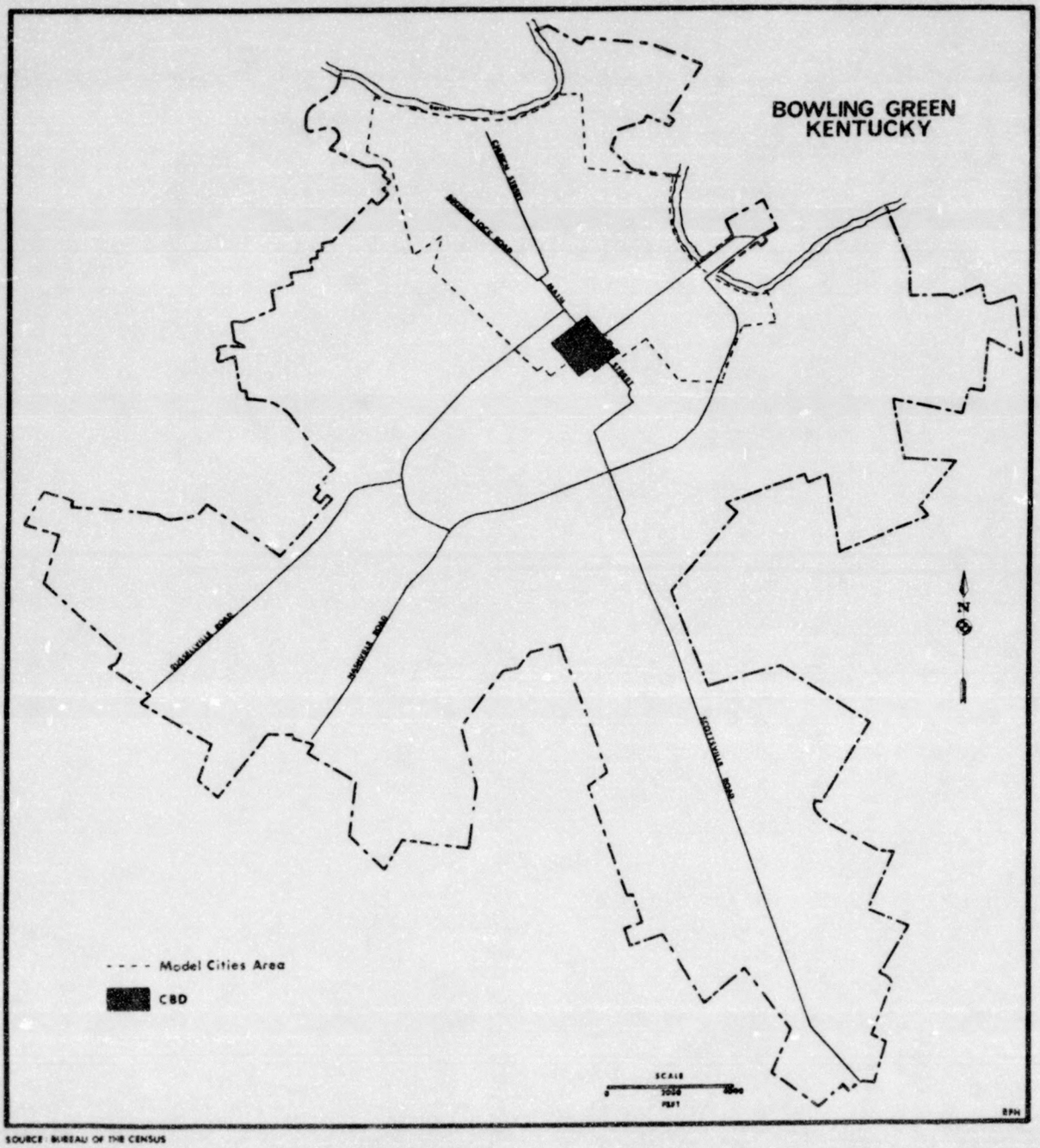
CHAPTER II

SETTING AND RESEARCH DESIGN

Setting

The study will be conducted within the city limits of Bowling Green, Kentucky (Map 1). The county seat of Warren County, Bowling Green is located in south central Kentucky, 114 miles south of Louisville, Kentucky and 63 miles north of Nashville, Tennessee. The 1970 population was 36,253. Bowling Green was chosen for study because of a number of characteristics which render it quite suitable for empirical consideration. The city has experienced considerable growth in the past ten years, its population increasing 28 percent from 1960 to 1970. New housing construction has been continually consuming land on the periphery of the city indicating a pattern of increasing socioeconomic fragmentation.

Bowling Green, as the largest urban center in south central Kentucky, is quite diversified in terms of economic activities. It is also old enough to contain a diversified housing market with respect to age and type of structures. Its population structure is well distributed from highest to lowest socioeconomic status. The city reports that 17.9 percent of all households are below poverty status and 10.6



SOURCE: BUREAU OF THE CENSUS

MAP 1

percent of all housing stock is classified as substandard.[1] At present there are no federal subsidies available for low income housing. The city should therefore have a housing quality continuum established by socioeconomic determinants. The city should also have few structural abnormalities in terms of its population characteristics and housing market.

Prior to the most recent census there was no aggregate data base for evaluating the city's housing stock. With the publication of block statistics for Bowling Green in the 1970 Census of Housing,[2] and a "Housing Element Report" prepared by the City Planning Commission in 1973,[3] new sources were made available for detailed geographic analysis. These facts combined to make Bowling Green particularly appealing for study and consequently it was selected for consideration in this thesis.

Research Design

Collection of Data

The data for analysis are provided by two sources. The limitations and advantages of using each merit brief consideration. In conducting research one must search and select data and a rationale that may be used in conjunction with the kinds of aggregate spatial data that are readily available. By far the most available and most detailed information on housing is provided by the U.S. Census of Housing, Block Statistics. From 1940 to 1960 this census included data on the quality of

housing. This quality data was discontinued in 1970, however, after an evaluation of their reliability and accuracy. As set forth in Working Papers #25 prepared by the Bureau of the Census, the 1960 statistics on housing condition were deemed unreliable due to the estimates of the enumerators.[4] The working papers concluded that if a totally different group of enumerators were sent back to rate the housing units of the United States only about one-third of the units rated as substandard by either group of enumerators would have been so rated by the same group of examiners.[5] This would make the comparison of the relative quality of structural condition of housing between cities subject to considerable error. On the other hand they also concluded that enumerators within a city:

> ...have a common outlook and are dealing with a common environment. For this reason intracity comparisons of structural condition may be adequately based while intercity comparisons may not be.[6]

Conducting an analysis of housing quality data for the American Society of Planning Officials (ASPO), Siegelman determined that the Census Bureau's enumerators could not be expected to substitute for local housing inspectors.[7] ASPO asserted that supplementing the census material with local data could help to broaden housing deficiency concepts, a broadening necessary to increase awareness that housing programs are best administered when seen in relationship to the realities of poverty, race and services within the municipality.[8]

For this study the housing condition data for Bowling Green was obtained from the City-County Planning Commission. As a portion of their "Housing Element Report" the commission staff, under the supervision of the city planner, canvassed the entire city to record the number and condition of all residential units within the corporate limits. This survey was conducted during the Spring of 1973. It was completed by walking the congested districts and riding the more sparsely settled areas. Subjective determinations were made of the condition and number of units in each structure and then recorded on a map. The criteria used for classifying structures were based on the U.S. Census standards used in 1960 (Appendix A).

Preparation of Data

This study utilized the planning commission field maps to determine the number of substandard units for each of the city's 445 census blocks. This was done to achieve greater statisticla accuracy and to discern a higher degree of spatial variation.

The 1970 Census of Housing, Block Statistics for Bowling Green provided all other data. The variables chosen for analysis were converted to averages, distances or ratios. The distance from each block to the CBD was computed using a straightline measurement and a U.S. Department of Commerce, Bureau of the Census block map of the city (one inch equal to 2000 feet).

Method of Analysis

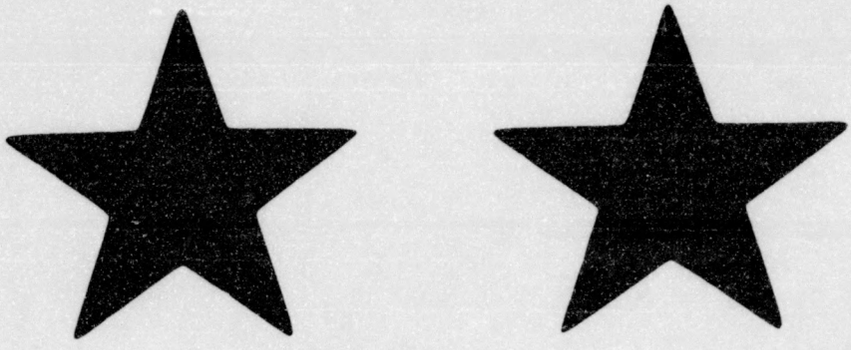
An explanation of the spatial distribution of substandard housing is extremely complex, suggesting the need for some type of statistical methodology. While simple correlation analysis might provide some evidence to support the hypothesized relationships, such analysis by itself is not completely satisfactory. Simple coefficients of correlation must be interpreted with the assumption that all other relevant factors are equal. Since it is highly unlikely that such is the case, a multivariate analysis will be conducted to provide a more complete test of the hypotheses. Pertinent data will be applied to a stepwise regression model and appropriate statistical tests made.

To further aid in summarizing and interpreting data such traditional geographical techniques as mapping will be used. Cartographic representations of the dependent variable, the most significant independent variables and residuals of the regression will be constructed and analyzed.

Summary

Chapter II has dealt with the selection of the study area and research design for testing the designated hypotheses. The limitations and advantages of each were discussed. The following chapter will deal with applying the selected statistical and cartographic methodologies in Bowling Green.

CORRECTION



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CHAPTER III

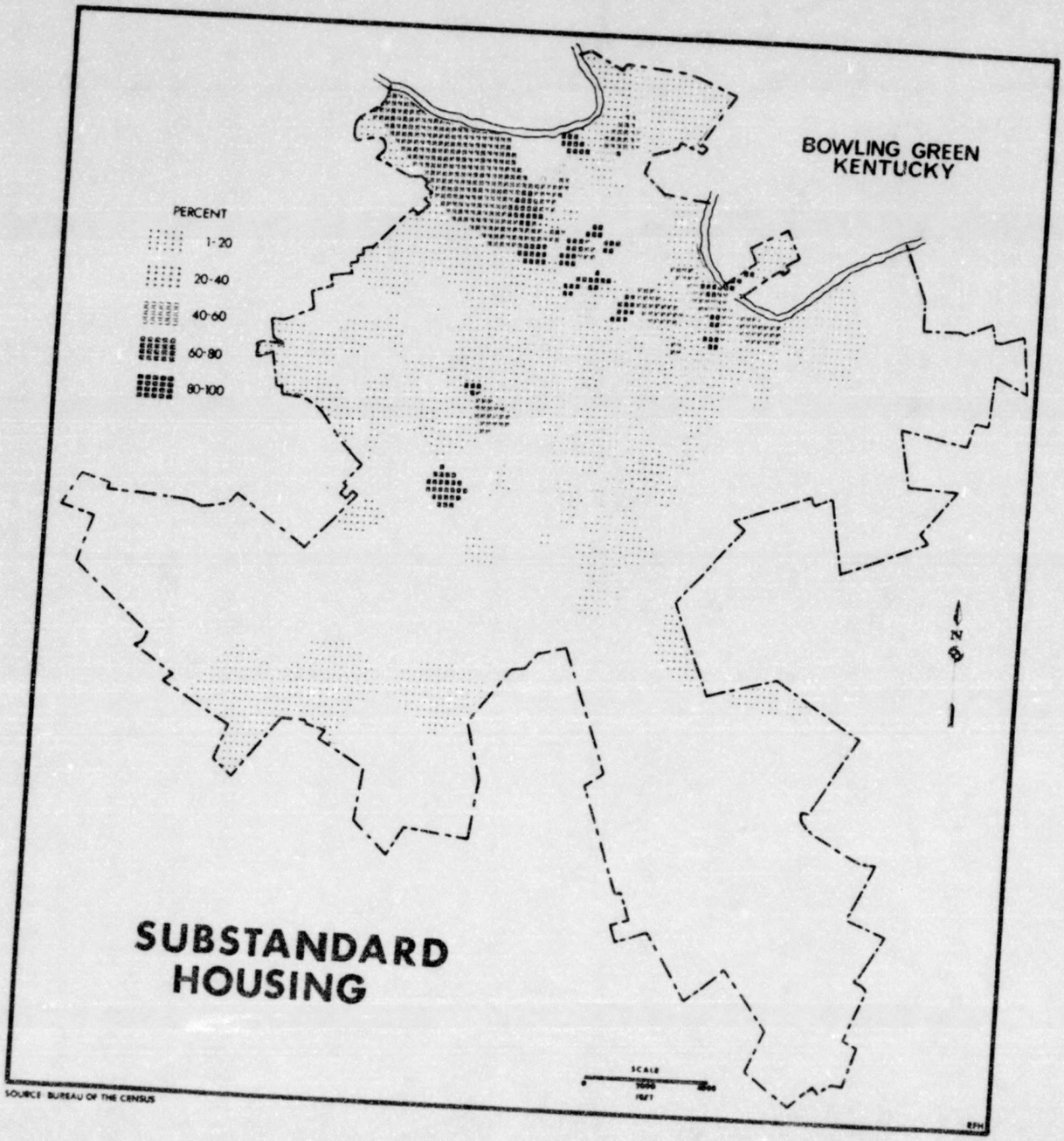
THE STATISTICAL AND CARTOGRAPHIC ANALYSIS OF THE MODEL

Analysis of the Hypotheses

Substandard housing is a positive function of percentage of units overcrowded.

The coefficients listed in Table 1 indicate the simple relationship between each variable and every other variable included in the analysis. Percent of units overcrowded had the highest simple correlation with substandard housing with a value of .49 which proved to be statistically highly significant (Table 1).

The association between overcrowding and substandard housing is one that deserves additional consideration. Prior to the exclusion of substandard data on the 1970 census, overcrowding was used as an indication of substandard living beyond the habitation of physically deteriorating dwellings. This was not the case with Bowling Green's "Housing Element Report". If, as in the past, overcrowding were included with physical deterioration as a measure of substandardness, the city's total number of substandard housing might increase considerably.


BOWLING GREEN
KENTUCKY
PERCENT
1-20
20-40
40-60
60-80
80-100
SUBSTANDARD
HOUSING
SCALE
SOURCE BUREAU OF THE CENSUS

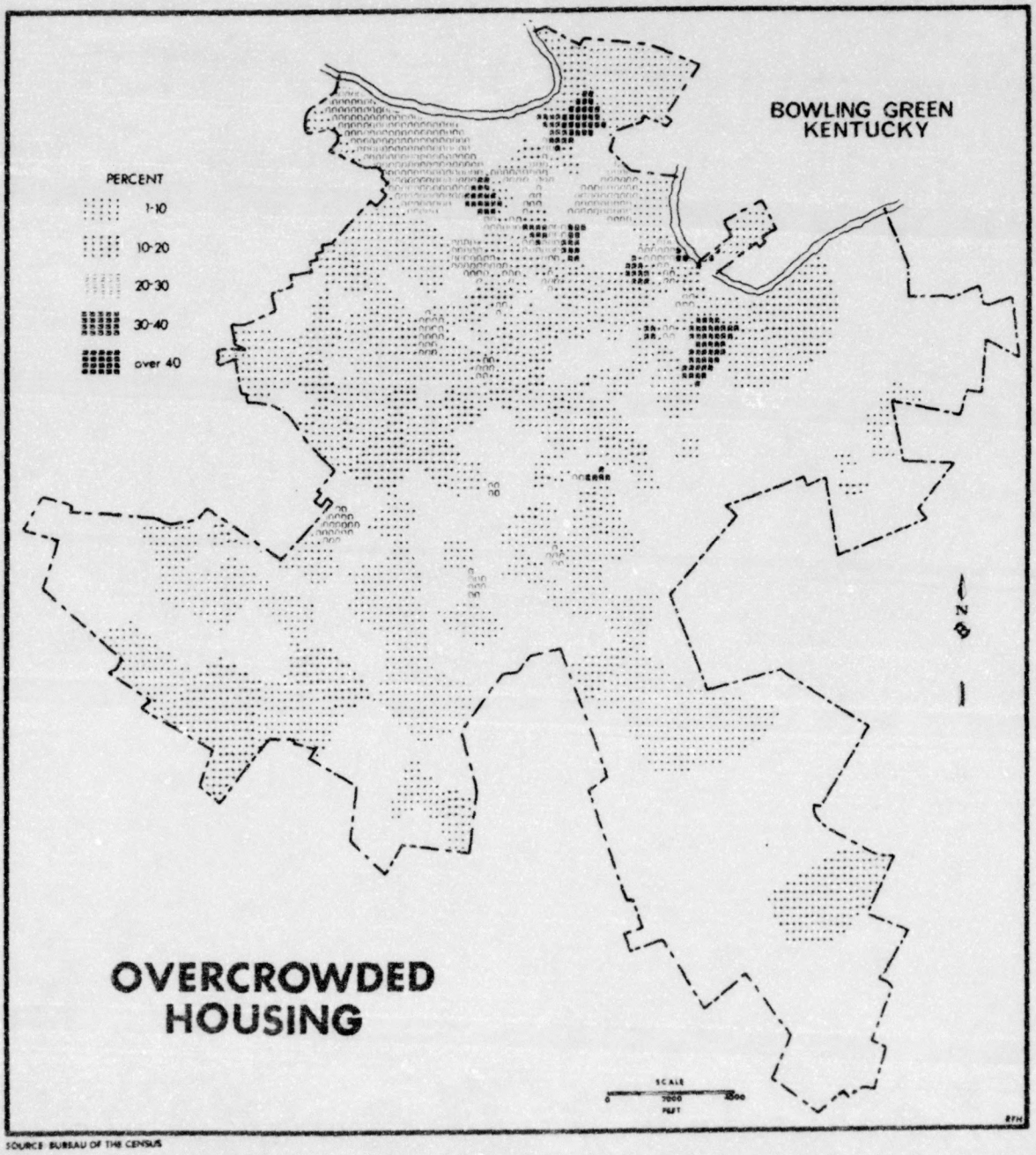
MAP 11

TABLE 1

ZERO ORDER CORRELATION MATRIX **

	Y	X_1	X_2	X_3	X_4	X_5
Percent Substandard (Y)	1.000	.419	-.267	-.285	.303	.493
Percent Black (X_1)		1.000	-.136	-.244	.177	.299
Average Number of Rooms (X_2)			1.000	.166	-.144	-.144*
Distance from CBD (X_3)				1.000	-.580	-.188
Percent Renter Occupied (X_4)					1.000	.413
Percent Overcrowded (X_5)						1.000
$\bar{X}$	13.54	10.59	4.39	3.13	33.35	6.66
S.D.	24.12	24.97	2.45	1.98	26.59	9.18

**All simple correlations were significant at the .01 level except where noted.
*Significant at the .05 level.
Source: Calculated by author.



SOURCE: BUREAU OF THE CENSUS

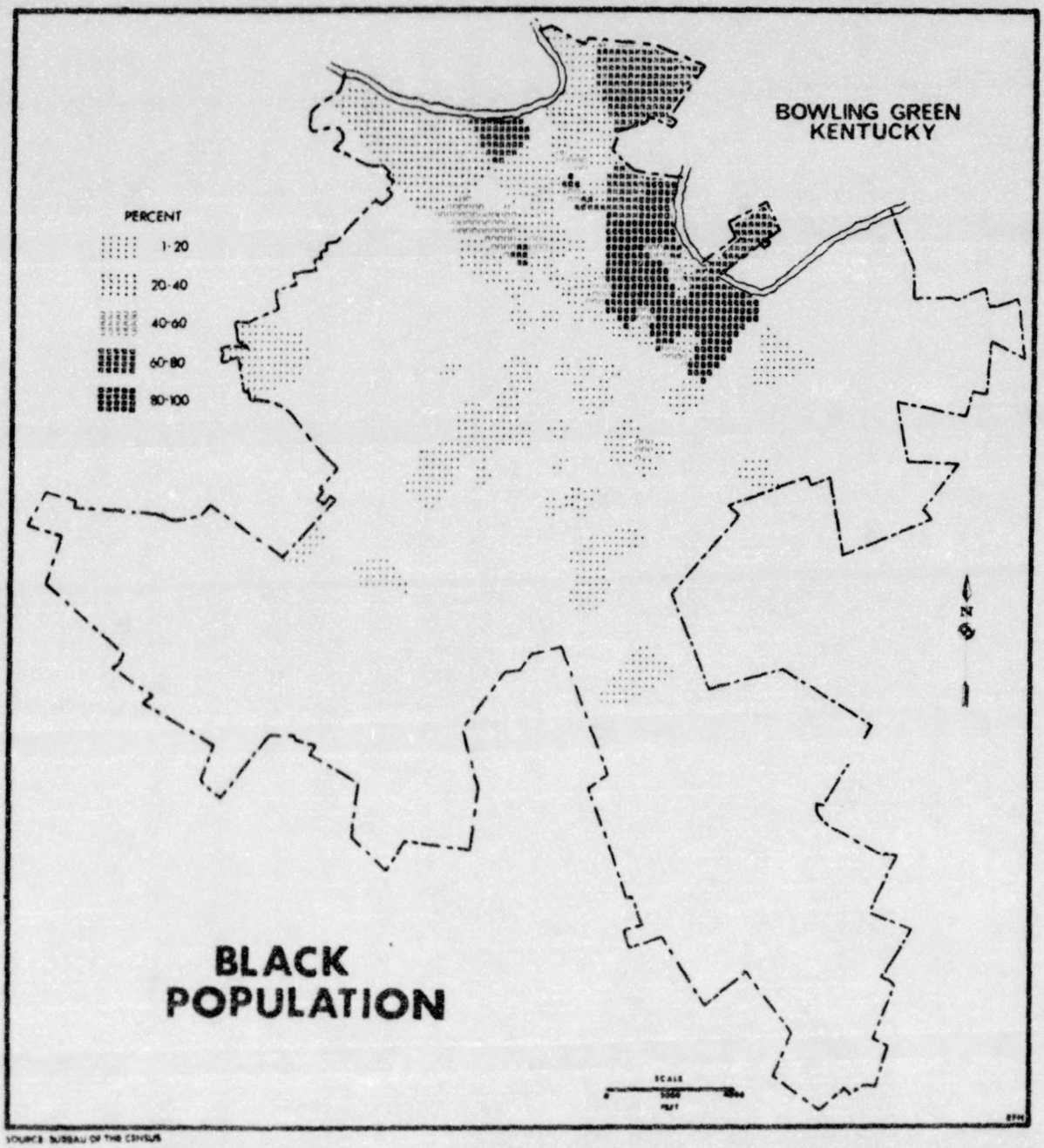
MAP III

The mapping of this variable shows a concentration in the north central section of the city, falling within Bowling Green's Model City Area (Map III). A comparison with the map of substandard housing (Map II) reflects the high simple correlation (r=.49). This portion of the city has experienced little new construction and consists primarily of older housing. In light of these empirical observations and the strength of the simple correlation the hypothesis is accepted.

Simple intercorrelations with overcrowding reveal positive associations with percent Black (r=.30) and renter occupancy (r=.41), and negative associations with average number of rooms (r=-.11) and distance from CBD (r=-.19). The low correlation with average number of rooms might indicate that overcrowding need not be totally attributed to a low number of rooms per dwelling unit, but it does seem that renters are more likely to live in overcrowded housing.

Substandard housing is a positive function of nonwhite occupancy.

Percent Black has the second highest correlation (r=.42) with substandard housing. A cartographic representation of this variable demonstrates an extreme pattern of racial segregation in Bowling Green with Blacks confined almost exclusively to the north and northeastern sections of the city (Map IV). A visual comparison with the map of substandard housing (Map II) reflects, however, the less than



SOURCE: BUREAU OF THE CENSUS

MAP IV

perfect correlation between these two variables. This likely indicates that not only do Blacks live in substandard housing, but a sizable group of low income White families also occupy such dwelling units. Field observations tended to support this conclusion. In particular, extensive substandard housing adjacent to West Church Street and along Browns Lock Road were observed to include a large White population.

Even though Black households are segregated north of Main Street, an area of minimal new construction, they apparently do not occupy a disproportionate percentage of substandard units. Perhaps the efforts of the Model City Agency in establishing neighborhood organizations have had some measure of success. People who have and maintain a sense of community pride are less likely to allow their property to become physically deteriorated, even under the most difficult circumstances. The hypothesis is subsequently rejected.

Substandard housing is a negative function of average number of rooms per dwelling unit.

This variable had a simple correlation of -.27 with substandard housing. From the statistical results it might be inferred that substandard units are not necessarily small. Such dwelling units may be comprised of five or more rooms and still be in a state of physical deterioration or dilapidation. Similarly many standard units may be of the "economy" or "bachelor" type apartment often consisting of only one or two rooms. This is especially true in a

university town where many apartments are occupied by students. Because such small units are included in the inventory this variable is not a good "explainer" of the problem distribution. In light of these findings the hypothesis is formally rejected.

Substandard housing is a negative function of straightline distance from the CBD.

In spite of the large volume of literature to support this hypothesized relationship, straightline distance from the CBD had a weak association with the substandard variable (r=-.28). In Davis' analysis of middle class housing it was found that cities with centrally located CBD's tend to grow concentrically, while those which have CBD's that are not centrally located exhibit sectoral growth.[1] If the hypothesized relationship is to exist, than concentric growth should be present. While the historical growth of Bowling Green has been concentric, physical barriers have altered the direction of new development. To the north and northeast no growth has taken place past the Barren River while new housing construction has developed to the south along the Scottsville, Nashville and Russelville Roads (Map I). New growth in Bowling Green, therefore, has developed sectorally, possibly accounting for weak associations between distance from CBD and substandard housing. As a result of these observations the hypothesis is formally rejected.

Simple intercorrelations between distance and the other independent variables demonstrate a rather strong significant relationship between distance from city center and the percent of renter occupancy (r=.58). Thus, as one travels further away from the CBD the less likely a home will be rented by its occupants. The strength of this relationship can probably be explained by the fact that new subdivisions, constructed on the periphery of the city, are almost exclusively owner occupied.

Substandard housing is a positive function of renter occupancy.

A simple correlation of r=.30 exists between renter occupancy and the dependent variable. This would seem to indicate that in Bowling Green home ownership does in some measure indicate that ones home will be maintained at a given level of quality. Because of the relatively weak association, and a lack of empirical evidence to support this relationship, the hypothesis is formally rejected.

Analysis of the General Hypothesis

When all the variables were considered simultaneously for Bowling Green in a stepwise regression model, a multiple correlation of (R) 0.61 and a coefficient of determination of (R^2) 0.37 was obtained (Table 2). Thus, 37 percent of the explained variation of the spatial distribution of substandard housing was accounted for. While consideration

TABLE 2

COEFFICIENTS OF MULTIPLE CORRELATION AND

MULTIPLE DETERMINATION : STEPWISE REGRESSION MODEL

Variable		R	R^2
X_5	Percent Overcrowded	.49	24%
X_1	Percent Black	.57	32%
X_2	Average Number of Rooms	.60	36%
X_3	Distance from CBD	.61	37%
X_4	Percent Renter	.61*	37%

*Significant at .01 level
Source: Calculated by author

will be made of the "unexplained" variation, it is first advantageous to examine the relative strength of each independent variable as it relates to the problem distribution (Map 11).

The multiple regression model takes the following form:

$$Y = 15.96 + .24X_1 - 1.66X_2 - 1.45X_3 + .01X_4 + .97X_5$$

where: X_1 = Percent Black

X_2 = Average Number of Rooms

X_3 = Distance from CBD

X_4 = Percent Renter Occupied

X_5 = Percent Overcrowded

The first variable entered into the stepwise regression model is determined by the relative strength of the simple

correlations. The overcrowding variable (X_5) as the first variable entered into the model accounted for 24 percent of total explained variance (Table 2).

Percent Black was the second variable to enter into the multiple regression equation. It accounted for eight percent of explained variation and combined with percent overcrowded to explain 32 percent of total variance (Table 2). In view of the large volume of literature to support the hypothesized relationship between Black occupancy and substandard conditions, it is somewhat suprising that this variable does not account for a higher percentage of total variation. The remaining variables; distance from CBD, percent renter occupancy and percent overcrowded accounted for less than five percent of total variance (Table 2).

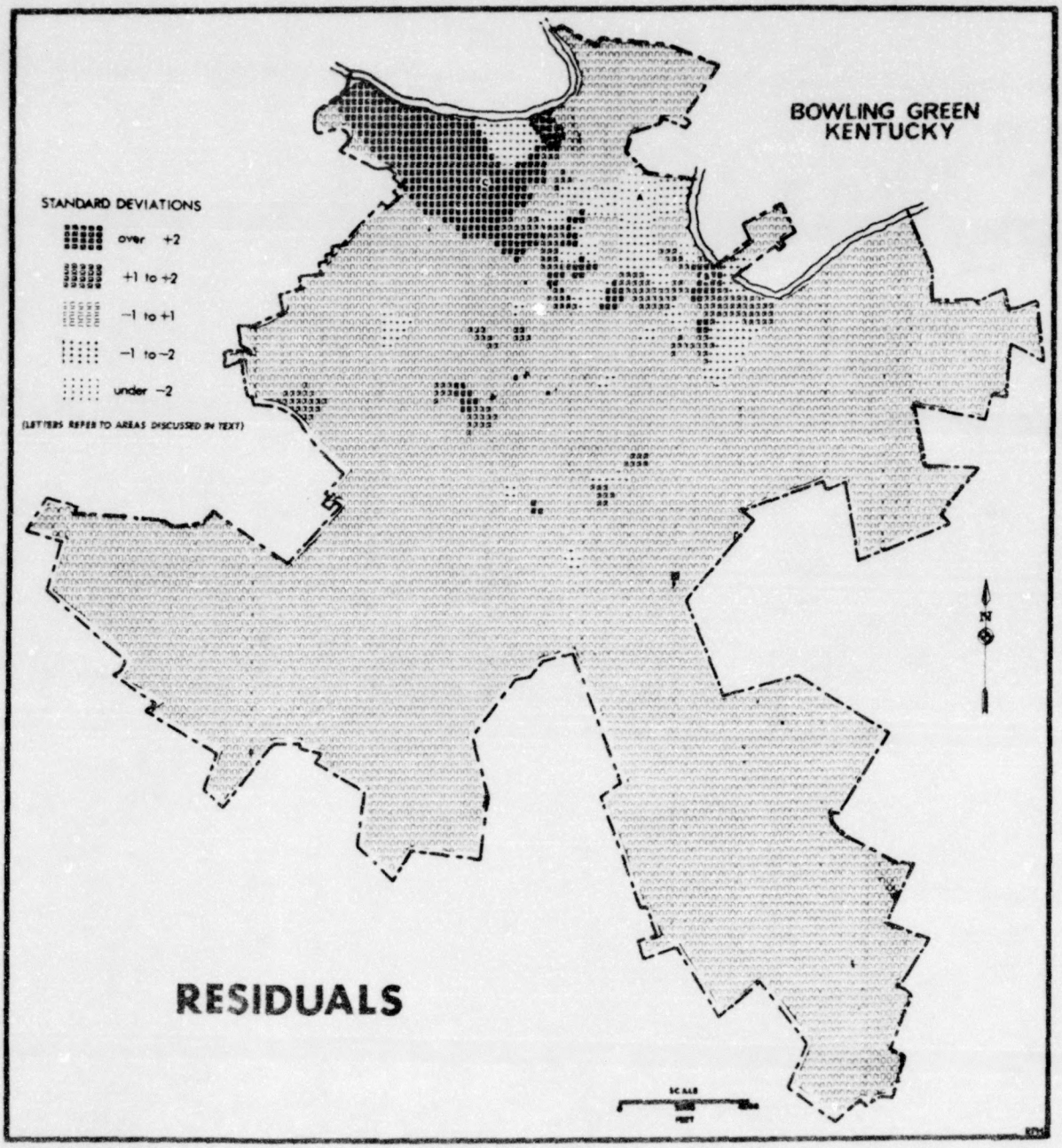
The results of the multiple correlation were found to be statistically significant which guarantees some relative assurance that the results did not occur by chance. In light of this, and because over 60 percent of the problem distribution remains unaccounted for, the general hypothesis is formally rejected. Some insight concerning the variation that was unaccounted for by the five independent variables may be gained by an examination of the gross estimation errors made by the regression equation. Consequently an analysis of the residuals will be conducted.

Analysis of Residuals

The multiple regression equation makes it possible to estimate the value of the dependent variable from the known values of the independent variables. In areas where there are large deviations of estimate the relationships expressed by the regression equation are not as accurate. These deviations are due to the fact that for any given block the selected independent variables do not fully account for the average value of the dependent variable. Consequently, a careful examination of the residuals of the regression may indicate factors that could help to provide a more complete understanding of the problem distribution. To facilitate further analysis a map of the residuals from the regression equation was made (Map V).

As suggested by Thomas, maps of residuals are useful to geographers to formulate new hypotheses and to identify new variables for inclusion in an investigation; to establish or modify regional boundaries; or to aid in the selection of specific unit areas in which to conduct field investigations.[2] While each will be ultimately utilized, it was the second offering that initially seemed to indicate a possible solution to the problem.

Comparing the "highs" and "lows" on the residual map (Map V) with the "highs" and "lows" and gradients of other data available for analysis offered no insight into any new variables which might be included in a new model. It was


BOWLING GREEN
KENTUCKY
STANDARD DEVIATIONS
over +2
+1 to +2
−1 to +1
−1 to −2
under −2
(LETTERS REFER TO AREAS DISCUSSED IN TEXT)
N
RESIDUALS
SCALE

MAP V

observed, however, that the extreme values of the residuals were concentrated almost exclusively to the Black residential area of the city (Map V). This suggested the possibility that there were different factors at work here than in the rest of the city, a fact which might help to explain why the hypothesized variables accounted for only 37 percent of total variance.

Utilizing the method employed by Yeates in Chicago,[3] and Brunn and Hoffman in Flint, Michigan,[4] it was decided to divide the study area into "Black" and "White" sectors. A new analysis could then be conducted on each utilizing the original five independent variables.

Summary

The analysis of the spatial distribution of substandard housing in Bowling Green utilizing a stepwise regression model proved unsatisfactory, accounting for only 37 percent of total variation. The general hypothesis that the five independent variables would explain a high percentage of the variance was formally rejected. An analysis of residuals indicated that a separate regression analysis, utilizing the same variables, for "White" and "Black" blocks might produce more meaningful results. Such is the intention of the next chapter.

NOTES

[1]J.Tait Davis, "Middle Class Housing in the Central City," Economic Geography IXL (July,1965), pp.238-251.

[2]Edwin N. Thomas, "Maps of Residuals from Regression," in Spatial Analysis: A Reader in Statistical Geography Edited by Brian J.L. Berry and Duane F. Marble (Englewood Cliffs, N.J.: Prentice Hall Inc., 1968), p.334.

[3]Maurice Henry Yeates, "The Spatial Distribution of Chicago Land Values 1910-1960," (unpublished doctoral dissertation, Northwestern University, 1963).

[4]Stanley D. Brunn and Wayne L. Hoffman, "Spatial Response of Negroes and Whites Toward Open Housing: The Flint Referendum," Annals Association of American Geographers LX (March, 1970),pp.18-36.

CHAPTER IV

THE MODEL REDEFINED

The Filtering Process

As suggested by the residual analysis the city's 445 blocks were subjected to a separation or "filtering" process. The division of the blocks into the Black or White group was based on the percentage of Blacks residing on a particular block according to the 1970 census. Any unit with ten percent or more Black population, in this case 84 blocks, was included in the Black analysis while those with fewer than ten percent were included in the White group (361 blocks). Map VI represents those blocks which fell into the Black sector. The decision to use ten percent as a basis for dividing the two groups was based on similar useage by Brunn and Hoffman, Morrill, and Smith as indicating meaningful threshold levels for Black expansion.[1] Once a unit reaches the ten percent level it seems to indicate a swing towards eventual Black dominance.

Analysis of the General Hypothesis for Black Blocks

The results of the multiple correlation for Black blocks (N=84) are represented in Table 4 which shows a multiple

TABLE 3

ZERO ORDER CORRELATION MATRIX FOR BLACK MODEL

	Y	X_1	X_2	X_3	X_4	X_5
Percent Substandard (Y)	1.000	.069	.195	-.108	.369**	.422**
Percent Black (X_1)		1.000	.262*	-.277*	-.103	.029
Average Number of Rooms (X_2)			1.000	-.032	-.033	.057
Distance from CBD (X_3)				1.000	-.453**	.126
Percent Renter Occupancy (X_4)					1.000	.382**
Percent Overcrowded (X_5)						1.000
$\overline{X}$	37.02	53.70	3.28	2.12	45.92	13.13
S.D.	31.30	31.69	2.52	.89	26.53	11.23

**Significant at .01 level.
*Significant at .05 level.
Source: Calculated by author.

TABLE 4

COEFFICIENTS OF MULTIPLE CORRELATION AND MULTIPLE DETERMINATION : STEPWISE REGRESSION MODEL FOR THE BLACK SECTOR

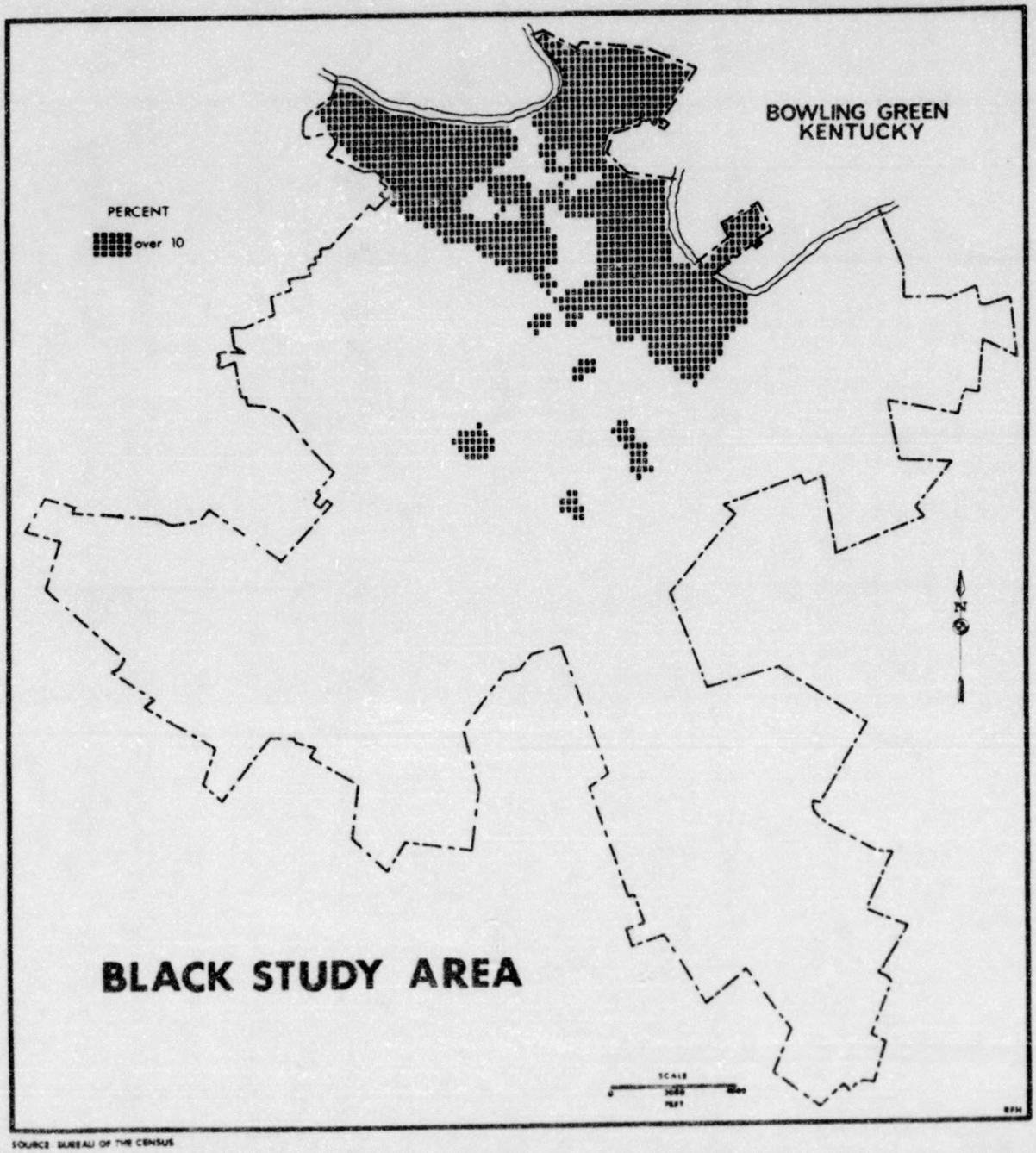
Variable		R	R^2
X_5	Percent Overcrowded	.42	18%
X_4	Percent Renter	.48	23%
X_2	Average Number of Rooms	.51	26%
X_1	Percent Black	.51	26%
X_3	Distance from CBD	.52*	27%

*Significant at .01 level.
Source: Calculated by author.

correlation of (R) 0.52 and a coefficient of determination of (R^2) 0.27. Thus for the Black universe 27 percent of the explained variation is accounted for, a statistically significant figure.

The overcrowded variable was most highly correlated with the substandard variable (r=.42) and was entered into the multiple regression model first with an R^2 of 18 percent (Table 4). Simple correlations again reflect a significant association between overcrowding and renter occupancy (r=.38) (Table 3).

Percent renter, accounting for five percent of explained variation, correlated significantly with the dependent variable (r=.37). Average number of rooms accounted for three



SOURCE: BUREAU OF THE CENSUS

MAP VI

TABLE 5

ZERO ORDER CORRELATION MATRIX FOR WHITE MODEL **

	Y	X_1	X_2	X_3	X_4	X_5
Percent Substandard (Y)	1.000	.140	-.349	-.248	.204	.329
Percent Black (X_1)		1.000	-.140	-.193	.290	.149
Average Number of Rooms (X_2)			1.000	.130*	-.127	-.070[a]
Distance from CBD (X_3)				1.000	-.592	-.161
Percent Renter Occupied (X_4)					1.000	.358
Percent Overcrowded (X_5)						1.000
$\bar{X}$	8.07	.57	4.67	3.38	30.66	5.15
S.D.	18.24	1.63	2.39	2.07	25.87	7.92

**All simple correlations are significant at the .01 level except where noted.
*Significant at .05 level.
[a]Not significant.

percent of total variance with percent Black and distance from the CBD combining for slightly over one percent. None of these three variables correlated significantly with the substandard variable (Table 3).

Analysis of the General Hypothesis for White Blocks

The stepwise regression model for the White universe (N=361) reveals that a total of 29 percent of explained variation (R^2) is accounted for by the hypothesized variables (Table 6). Percent overcrowded was again the independent

TABLE 6

COEFFICIENTS OF MULTIPLE CORRELATION AND MULTIPLE DETERMINATION : STEPWISE REGRESSION MODEL FOR THE WHITE SECTOR

Variable		R	R^2
X_5	Percent Overcrowded	.39	15%
X_2	Average Number of Rooms	.51	26%
X_3	Distance from CBD	.53	28%
X_4	Percent Renter	.53	28%
X_1	Percent Black	.53*	29%

*Significant at .01 level.
Source: Calculated by author.

variable most highly correlated with percent substandard (r=.39) and accounted for the largest amount of explained variance

(R^2= 15 percent). Average number of rooms, accounting for 11 percent of total variation, combined with percent overcrowding to reach a coefficient of determination of (R^2) 0.26 (Table 6). This variable had the hypothesized negative relationship with the dependent substandard variable (r=-.35), a highly significant correlation. The remaining three independent variables, while accounting for approximately three percent of total variation, were weakly correlated with percent substandard (Table 5). Of noteworthy interest, however, was the simple correlation between the distance variable (X_3) and percent renter occupied (r=-.59). This significantly strong relationship might indicate that White households are much more likely to purchase their dwelling as the distance from the CBD increases, a phenomena generally associated with socioeconomic well being.

A Comparative Analysis of the Black and White Models

An examination of Table 7 reveals that the filtering process did not, as speculated, increase the percentage of explained variation for the general hypothesis. It decreased eight percent (37 to 29 percent) for White blocks and ten percent (37 to 27 percent) for Black. It is noteworthy, however, that the independent variables changed in relative importance for each model. The filtering process also revealed some disparity in the overall housing situation between Black and White families in Bowling Green. This

TABLE 7

COEFFICIENTS OF MULTIPLE CORRELATION AND MULTIPLE DETERMINATION : STEPWISE REGRESSION MODEL FOR BLACK AND WHITE SECTORS

Variable		Explained Variation (R^2) White Sector	Black Sector	City
X_5	Percent Overcrowded	15%	18%	24%
X_1	Percent Black	1%	1%	8%
X_2	Average Number of Rooms	11%	3%	4%
X_3	Distance from CBD	2%	1%	1%
X_4	Percent Renter	1%	5%	1%
	TOTAL	29%	27%	37%

Source: Calculated by author.

disparity is reflected in the mean value ($\bar{X}$) for each of the variables utilized in the study (Table 8). Each variable will be analyzed individually.

Units Overcrowded

Percent overcrowded was the most important variable in attempting to account for the distribution of substandard housing in Bowling Green. For the city a coefficient of determination (R^2) of 0.24 was observed. The value was 0.15 for the White universe and 0.18 for the Black (Table 7). The correlation coefficient (r) between this and the

TABLE 8

MEAN VALUE OF SELECT VARIABLES FOR BLACK AND WHITE SECTORS

Variable		Sector		
		White	Black	City
Y	Percent Substandard	8.0	37.0	13.5
X_2	Average Number of Rooms	4.7	3.3	4.4
X_4	Percent Renter	30.7	45.9	33.4
X_5	Percent Overcrowded	5.2	13.1	6.7

Source: Calculated by author.

dependent variable was .49 for the city, .39 for White blocks and .42 for Black blocks. These figures would seem to indicate that there is relatively little difference between overcrowding as an "explainer" of substandard housing in Black and White sectors. Table 8 indicates, however, that there is a difference of almost eight percent between the mean for the Black ($\bar{X}$= 13.1 percent) and White ($\bar{X}$= 5.2 percent) sectors. These figures could suggest one of two possibilities. Either a few Black blocks are extremely overcrowded or the "average" Black unit is more overcrowded than the "average" White unit. In either case it would seem to indicate that eventhough the average Black block is more overcrowded, it is not necessarily more likely to become substandard.

Average Number of Rooms

While average number of rooms accounted for four percent of explained variation (R^2) for the city and three percent for the Black sector, it attributed to 11 percent of total variance for White blocks (Table 7). Simple correlations (r) between this variable and percent substandard are -.27 for the city, .19 for Blacks and -.35 for the White model. This would indicate that for Whites the tendency to occupy substandard housing is greatly increased as the average number of rooms decreases. The mean value ($\bar{X}$) of average number of rooms is 4.7 for White blocks and 3.3 for Black. White areas, therefore, probably exhibit high and low extremes on this variable. These extremes may be related to the distance factor, the next to be analyzed.

Distance from CBD

For the White sector this variable accounted for two percent of the variance in the multiple regression while indicating one or less percent for the Black sector and city (Table 7). The simple correlation (r) for distance and percent substandard was -.25 for White and -.11 for Black blocks. This would seem to suggest a stronger tendency for substandardness to decrease in White blocks as one travels from the CBD. Blacks are thus restricted to search for housing in areas that are more likely to contain substandard housing. Due to the strongly established segregation patterns in Bowling

Green's housing market, this situation seems unlikely to improve in the near future.

Percent Renter

While determining less than one percent of the variation within the city and White universe this factor accounted for five percent of the distribution of substandard housing in the Black sector (Table 7). This disparity is further reflected in the simple correlation coefficients, r=.20 for White, r=.30 for the city and r=.37 for Black blocks. Black households who must rent their dwelling are more likely, therefore, to live in substandard housing. This situation is further complicated by the fact that almost 46 percent of Blacks as opposed to 31 percent of Whites occupy rented housing (Table 8).

Evaluation of the Comparative Models

When all the hypothesized variables were considered simultaneously for Bowling Green's Black blocks (N=84) a multiple correlation of (R) 0.52 and a coefficient of determination of (R^2) 0.27 was obtained (Table 4). This compared with a multiple correlation of (R) 0.53 and a coefficient of determination of (R^2) 0.29 for the White universe (N=361). Thus 27 percent of the explained variation of the spatial distribution of substandard housing among Black blocks, and 29 percent for White was accounted for. The results of both

multiple correlations were found to be statistically highly significant. Because, in each model, over 70 percent of the problem distribution remains unaccounted for, the general hypothesis for each is formally rejected.

The comparative analysis did, however, point to several disparities between the city's Black and White housing situation. Thirty-seven percent of the housing on Black blocks, as compared to eight percent on White blocks, is classified as structurally substandard. Black households average fewer rooms per dwelling unit and are more likely to overcrowded and rent their housing (Table 8). While percent overcrowding was the most important explanatory variable in both models, it was percent renter that was second most in importance for the Black area and average number of rooms for the White area (Table 7). It would appear, therefore, that there are different factors affecting the spatial distribution of Black and White substandard housing in Bowling Green, over 70 percent of which remains unexplained by the variables selected for the second stage of this analysis.

The map of residuals (Map V) did, however, lend evidence to indicate that the unexplained factors were spatially located in the area of Black filtered blocks (Map VI). A re-evaluation of residuals will subsequently be conducted.

Re-Analysis of Residuals

The third suggestion of Thomas with regard to residual maps, the selection of areas in which to conduct field investigation, was utilized in a final attempt to account for the unexplained variation.[2] Reference to Map V indicates that in some areas of the city the regression equation has overestimated the actual incidence of substandard housing while in other areas it has underestimated the amount. After conducting field work in these areas several factors were indicated to be mainly responsible for this lack of exactness in prediction.

Several blocks of underestimation were found in new low income housing projects, most noticeably in the area between Webb and Thomas Streets in the northern part of the city (point A, Map V). This area was the scene of urban renewal and is the only new housing north of Main Street. In the hypothesis it was assumed that the oldest and most substandard houses were near the city's center, with the amount of substandard housing a negative function of distance from the CBD. Thus a linear function was assumed, when actually, at a few points around the center, renewal has taken place. Renewal may well be a relevant factor in helping to explain the distribution of substandard housing, especially within the Black sector.

Two distinct areas of overestimation were discerned, along First Street between State and Center Streets

(point B, Map V) and between Richardsville Road and Browns Lock Road north of Potter Street (point C, Map V). These blocks were found to contain many commercial and industrial enterprises which may influence standard housing to the extent that it becomes deteriorated. Heavy traffic, waste disposal and parking problems could all tend to depreciate the appearance of adjacent homes. Area B was found to contain commercial establishments that consumed large amounts of space with heavy truck traffic. Most notable was the presence of several tobacco warehouses, used car lots and trucking terminals. Area C was an industrial area including several large lumber mills, oil and gas storage tanks, and railroad terminals with tracks dividing many blocks. It is quite probable that these factors, which were not accounted for in the statistical models, could help to explain the distribution of substandard housing in these areas.

Summary

Chapter IV dealt with a redefinition of the original model. Separate regressions were run for the city's Black and White sectors. While this re-analysis did not increase the amount of explained variation it did indicate that Bowling Green's Black population occupy a lower quality of housing. A second analysis of residuals revealed that low income housing projects and the location of diseconomies might help to explain some of the distribution of substandard

housing in Bowling Green. These findings indicate possibilities for further research as outlined in the next and final chapter.

NOTES

[1]Stanley D. Brunn and Wayne L. Hoffman, "The Spatial Response of Negroes and Whites Toward Open Housing: The Flint Referendum," Annals Association of American Geographers LX (March, 1970), pp.18-36; Richard C. Morrill, "The Negro Ghetto, Problems and Alternatives," Geographic Review LV (September,1965), pp.339-361; B. Smith Jr., "The Differential Residential Segregation of Working-Class Negroes in New Haven," American Sociological Review XXIV (December, 1959), pp.529-533.

[2]Edwin N. Thomas, "Maps of Residuals from Regression," in Spatial Analysis: A Reader in Statistical Geography Edited by Brian J.L. Berry and Duane F. Marble (Englewood Cliffs, N.J.: Prentice Hall Inc.,1968), p.334.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to determine the degree and intensity of the factors that affect the spatial distribution of substandard housing in Bowling Green, Kentucky. A review of the literature relating to the distribution of substandard housing in other cities was conducted towards the purpose of formulating research hypotheses to be tested in Bowling Green.

The dependent variable was expressed in terms of percent of substandard dwelling units per-block while quantification of the five independent variables was based on either distances or percentage values. The 1970 Census of Housing for Bowling Green and a "1973 Housing Element Report" published by the Bowling Green, Warren County Planning Commission were utilized as data sources. The universe consisted of 445 blocks within the 1970 corporate limits of Bowling Green.

Five hypotheses were formulated, which, when combined, formed the general hypothesis:

Hypothesis 1. Substandard housing is a negative function of straightline distance from the CBD.

Hypothesis 2.	Substandard housing is a positive function of renter occupancy.
Hypothesis 3.	Substandard housing is a positive function of percentage of units overcrowded.
Hypothesis 4.	Substandard housing is a negative function of average number of rooms per dwelling unit.
Hypothesis 5.	Substandard housing is a positive function of non-white occupancy.
General Hypothesis:	The variables selected and set forth in hypotheses one through five will explain a high proportion of the total variance of the distribution of substandard housing.

The techniques utilized for testing the hypotheses included simple correlation, stepwise regression and cartographic analysis. When all the variables were considered simultaneously in a stepwise regression model a multiple correlation of (R) 0.61 and a coefficient of determination of (R^2) 0.37 was obtained. Because over 60 percent of the problem distribution was unaccounted for the general hypothesis was rejected. Hypotheses three, which accounted for 24 percent of explained variation was accepted. All other hypotheses were formally rejected.

As a result of an initial residual analysis the city was divided into Black and White Sectors with all blocks containing ten percent or more Black residents catagorized in

the prior sector. A new analysis was conducted for each. The explained variance for each sector showed a decline from the city wide model to 27 percent for Black blocks and 29 percent for White blocks. The filtering process revealed, however, that the hypothesized variables affect the spatial distribution of substandard housing in varying degrees for Black and White blocks. It also showed that the average housing quality for Bowling Green's Black population is below that of their White counterparts.

A reexamination of the residuals was conducted in an attempt to determine other variables that could effect the problem distribution. Field investigations revealed that urban renewal and the location of housing with respect to diseconomies might help to account for some of the variation left unexplained by the general hypothesis.

Weaknesses of the Study

The results of the statistical tests conducted indicate that generally accepted concepts concerning substandard housing in larger urban areas are not applicable to cities the size of Bowling Green. The hypotheses formulated in this study were selected in light of the literature reviewed. The research which this review incorporated was conducted primarily in northern cities with populations exceeding 500,000. In light of the small percentage of explained variation that was ultimately accounted for, it could be speculated that

different social and economic forces affect the housing market in smaller urban centers.

A second difficulty arises from the fact that smaller cities often lack an adequate data base for detailed analysis. Utilizing the only available variables for formulating the basic research model may have resulted in an oversimplified model. While block statistics offer detailed figures on housing, they do not provide sufficient socio-economic data. Because of this the choice of variables which might possibly affect the distribution of substandard housing was extremely limited.

Areas of Further Research

As suggested by the residual analyses there remains several possibilities for further analysis into the factors affecting the distribution of substandard housing in Bowling Green, Kentucky. The most significant of these could be the effect of various diseconomies (industrial and commercial useage, railroads, etc.) upon residential areas. A second might include a detailed analysis of factors effecting the disparity in the housing situation between Bowling Green's Black and White residents.

The job of providing adequate housing for all members of society must ultimately fall upon state and municipal agencies. At the present time there is no federal program to assist low income families to participate in the purchasing of new

housing. They must, therefore, be economically segregated in the lower quality areas of the city. It is hoped that making some statistical inferences concerning spatially related phenomena might assist in formulating programs designed to strike at the cause, rather than having to deal with the results, of substandard housing.

APPENDIX A- DEFINITIONS

Census Block: A well definied rectangular piece of land bounded by streets and roads. However, it may be irregular in shape or bounded by railroad tracks, streams or other features.

Housing Conditions:

Standard- Dwelling unit provides safe, sanitary and altogether adequate shelter for its residents. It is in need of no repairs and shows evidence of regular maintenance.

Substandard- Dwelling unit may be structurally sound, but repairs are required, such as painting, roofing and carpentry work to meet the definition of standard conditions. Units in this catagory show signs of neglect and lack of regular maintenance. Major repairs such as partial replacement of roof, foundation, windows, and porches are often needed. Such units would be classified as deteriorating.

or: Dwelling unit is completely unsound structurally and is totally unfit for human habitation. Units in this condition contain either one or all of the following deficiencies; crumbling or no foundation, rotting floors, littered yard and rotting outbuildings. It is not feasible to make necessary repairs on these structures except in unique circumstances. Such units would be classified as dilapidated.

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