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MEASURING HOUSING QUALITY:
THE HEDONIC INDEX TECHNIQUE

A Thesis

by

Myra McCrickard Ragland

September 1982

APPROVED BY:

Larry Ellis
Chairperson, Thesis Committee

Jean-Pierre A Courbois
Member, Thesis Committee

William Rentz
Member, Thesis Committee

Chairperson, Department of Economics

Joyce V. Lawrence
Dean of the Graduate School

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Myra McCrickard Ragland

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ABSTRACT

MEASURING HOUSING QUALITY: THE HEDONIC INDEX TECHNIQUE. (September 1982)

Myra McCrickard Ragland, B.S., Westhampton College

M.A., Appalachian State University

Thesis Chairperson: Larry V. Ellis

The decision to purchase or rent a house involves more than obtaining a structure in which to live. A dwelling unit may be considered to be a bundle of goods. Components of this "housing bundle" vary in characteristics with respect to the number of bedrooms, the size of the living area, or the presence of a fireplace, etc. Due to the large number of characteristics comprising each bundle, housing units are more difficult to compare than single commodities.

The hedonic approach is one method used to make comparisons of quality. Basically, hedonic theory involves the construction of a price index. Regression analysis is performed on a hedonic equation with rent as the dependent variable and housing characteristics as independent variables. The regression coefficients of each housing characteristic are interpreted as implicit prices of that

characteristic. Dwelling units can then be compared on the basis of an index constructed from this equation.

The purpose of this research effort is to use the hedonic technique to construct an index to measure housing quality. This measure is then applied in an analysis of the Existing Housing component of the Section 8 program in rural areas. Section 8 is a federal program designed to provide low-income families with better quality housing at a lower cost through rent subsidies. The analysis uses the hedonic technique to determine if participants in the program actually receive an increase in housing quality. The results of this analysis support the hypothesis that participants in the Section 8 Existing Housing program in rural areas do benefit from the program with better housing conditions.

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to my father

and to my mother

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CHAPTER 1

INTRODUCTION

The housing market plays a crucial role in determining the welfare of every American. For this reason, housing is an issue of concern not only to the individual but to the community as well. The decision to purchase or rent a house involves much more than obtaining a structure in which to live. Housing produces many services encompassing everything connected with the use of the dwelling unit. Basically, housing choices involve decisions concerning structural and neighborhood attributes. Structural characteristics include the physical qualities of the dwelling unit itself, while neighborhood characteristics are those services obtained from the surrounding physical environment and social atmosphere.[1]

Providing adequate housing for those not able to afford it became a major social objective in the early 1960's. This goal was later reflected in the passage of the Housing and Urban Development Act of 1965. Since that time, philosophies concerned with the most effective means to achieve this objective have undergone a gradual evolution.

The most extensively used method of federal housing assistance has been public housing programs in which rental

units are constructed to serve low-income families who receive rent subsidies from the government. Although the federal government had been providing assistance to the nation's poor since the mid-1930's, inadequacies in meeting basic housing needs were still evident in the 60's.[2] In response to those needs, the Housing and Urban Development Act of 1965 provided for the creation of the Department of Housing and Urban Development (HUD) and two major subsidy programs.[3]

However, in the years following implementation of the Act, problems surfaced which indicated the need for improvement in the programs. In addition, the administration began to favor a direct cash supplement program because it would provide households greater freedom in selecting housing and also make more efficient use of the private housing markets.[4]

In order to eliminate some of these problems, the Housing and Community Development Act of 1974 provided for formation of the Section 8 Housing Assistance Payments Program under the direction of the Department of Housing and Urban Development. Its purpose is to provide housing assistance to low income families by lowering housing costs or improving housing standards using two basic approaches. The Existing Housing program is designed to encourage the use of existing dwelling units in the rental housing market. The New Construction, Moderate Rehabilitation, and Substantial Rehabilitation programs are intended to stimulate

production and rehabilitation of housing units by the private sector.

Under the Existing Housing component of the Section 8 program, rent supplements are provided to families renting privately owned housing that pass required quality standards. Implementation of the program represents a novel approach to housing assistance in that tenants are allowed to select the rental unit and negotiate leasing terms.[5] Participants receive rent subsidies which make up any difference between 25% of their income and gross rent.[6]

The Section 8 Existing Housing program is the second largest program in the United States which provides low-income rental assistance to households. Still, the number of households eligible for assistance exceeds the funds available for rent supplements.[7] Given that resources are limited, evaluations of programs such as Section 8 to determine the efficiency with which objectives are being met are important. Programs judged to be efficient are those that meet their objectives using the fewest possible resources. Thus, in beginning an evaluation, it must be first determined that the stated goals of a program are in fact being met.

Analysis in this study was designed to answer this initial question with respect to the Section 8 Existing Housing program. Its overall intent is to determine if the Existing Housing component of Section 8 actually increases housing quality for participants, which is one of its basic

goals. The primary purpose of this research effort is to apply a technique for measuring housing quality change to make this determination. It is significant because it provides a basis on which program evaluation can begin.[8]

Comparisons of single homogeneous commodities are not difficult. However, because housing can be considered as a bundle of many goods, comparisons of housing quality are often more complicated. This research effort involves the construction of a hedonic index to measure housing quality. Comparisons of pre-program and program samples can then be made to determine if better housing conditions are realized by Existing Housing participants. The statistical technique of multivariate regression analysis forms a basis for this approach. Rent payments are regressed on all characteristics believed to be important in determining the level of housing quality. Theoretically, the coefficient estimates on the regressor variables can then be interpreted as the implicit price of each housing characteristic. A measure of housing quality can be obtained for a dwelling unit or the mean dwelling unit by multiplying the quality of each characteristic contained in the dwelling unit by its implicit price.

The rest of the paper is divided into three sections. In Chapter 2, the theoretical basis underlying the use of the hedonic technique is discussed as well as limitations involving its construction and interpretation. In Chapter 3, the empirical results of this study are presented.

Chapter 4 provides an overall summary of the paper and contains suggestions for further research.

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[3]Robert Taggart, Low-Income Housing: A Critique of Federal Aid (Baltimore, Md.: The Johns Hopkins Press, 1970), p. 14.

[4]J. Paul Combs, Jean-Pierre Courbois, and Larry Ellis, "A Proposal to Evaluate Section 8 Assistance Payments Program Operations in Rural Areas Draft Research Design and Analysis Plan," July 1979, p. 2.

[5]Wallace et al., "Participation and Benefits in the Urban Section 8 Program: New Construction and Existing Housing," 2 Cambridge, Massachusetts, 1981: pp. 1-3.

[6]Edgar O. Olsen and William J. Reeder, "Does HUD Pay Too Much for Section 8 Existing Housing?" Land Economics 57 (May 1981): p. 243.

[7]Ibid.

[8]Recently, an evaluation of the Section 8 Existing Housing program in rural areas of the United States was completed at Appalachian State University. This paper originated as an extension of that research. A more complete description of the data base will be given in Chapter 3.

CHAPTER 2

THEORETICAL ANALYSIS OF THE HEDONIC TECHNIQUE

A dwelling unit may be considered to be a bundle of goods. Components of this "housing bundle" vary in characteristics with respect to the number of bedrooms, the size of the living area, or the presence of a fireplace, etc. Differences in the quantity and quality of these characteristics are reflected in the total price of the housing unit. Due to the large number of characteristics comprising each bundle, housing units are more difficult to compare than single commodities. Yet, such comparisions are valuable to the policymaker in evaluating the effectiveness of programs such as the Section 8 Housing Assistance Payments Program.

The hedonic approach is one method used to make comparisons of quality. Basically, hedonic theory involves the construction of a price index. Regression analysis is performed using an equation with rent as the dependent variable and housing characteristics as independent variables. The regression coefficient of each housing characteristic is interpreted as the implicit price of that characteristic. Dwelling units can then be compared by computing an index which is the sum of the products of the quality of each characteristic and its implicit price.

In order to understand hedonic theory and the justification for its use, this chapter begins with a discussion of the assumptions underlying the hedonic approach. An explanation of the theoretical grounds for the hedonic technique follows. The chapter concludes with a summary of its application in empirical studies as well as limitations on its interpretation.

The first assumption made in the application of hedonic techniques to the analysis of housing quality is that a house is a bundle of goods composed of diverse characteristics rather than a single homogenous commodity. Comparisons of dwelling units are based on the number and type of these characteristics embodied in a particular unit. However, in order to make quality comparisons, the value of each housing characteristic must be known so that appropriate weights may be assigned each feature. Because the price of each feature can not be directly determined, a second assumption must be made for the hedonic approach to be valid. The rent of a dwelling unit must reflect differences in the number and type of features and implicit prices of these features can be assigned on the basis of regression analysis.[1]

A complete theoretical foundation for the hedonic relation has yet to be developed. Models which have been proposed can be classified into three major categories. Probably the most familiar models are those based on

theories of household production, such as the models proposed by Lancaster and Muth.[2]

The theory of utility maximization in the household production models is explained by John Muellbauer. In his analysis, the household derives utility not from the good it purchases, but from the characteristics contained in that good. Muellbauer begins with the following assumptions of utility:

> . . . a household . . . purchases market goods in quantities $x_1, \ldots, x_m$ (which yield no direct utility) whose purpose is to jointly produce the commodities Z_1 and Z_2 which yield
> (1) $U = U(Z_1, Z_2)$
> where $U(\ )$ is assumed to be convex. Let the joint production function be $F(x_1, \ldots, x_m; Z_1, Z_2) = 0$. . . . assume that $F(\ )$ is 'neo-classical,' -- i.e., given $x_1, \ldots, x_m$, the production possibility frontier in Z_1 and Z_2 is concave, adn the isoquants in $x_1, \ldots,$ x_m given Z_1 and Z_2 are convex.
> . . . assume the houshold faces the budget constraint
> (2) $y = \Sigma p_i x_i \qquad i = 1, \ldots, m$

From these assumptions, utility is maximized in two stages:

> Stage 1: Minimize $C = \Sigma p_i x_i$ of producing any given bundle Z_1, Z_2. Let the Lagrangian be [where x is the vector $(x_1, \ldots, x_m)$]
> (3) $L = \Sigma p_i x_i + \pi[F(x; Z_1, Z_2)]$
> Let the solution be given by the cost function $c = c\ (p;\ Z_1, Z_2)$ . . . Define the shadow marginal cost of producing Z_j
>
> (4) $\pi_j = \dfrac{\delta C}{\delta Z_j} \qquad j = 1,2$
>
> Differentiating (3) with respect to Z_j gives
>
> (5) $\pi_j = \dfrac{\delta F}{\delta Z_j} \qquad j = 1,2$
>
> Stage 2: Maximize $U = U(Z_1, Z_2)$ subject to the constraint

(6) $y = C(p; Z_1, Z_2)$
Let the Lagrangian problems be
(7) $\max L_2 = U(Z_1, Z_2) + \lambda [y - C(p; Z_1, Z_2)]$[3]

Lancaster's model is based on this theory of the household production function. In his model:

$Z_1 = \Sigma b_{1i} x_i$
$Z_2 = \Sigma b_{2i} x_i$
Each unit of good i is made up of a fixed amount b_{1i} of Z_1 and b_{2i} of Z_2.[4]

It is assumed that consumers will minimize the cost of a particular bundle. The price of the purchased goods is equal to the sum of their shadow prices multiplied by their fixed amounts.[5]

Muellbauer points out two basic problems with this approach. A linear relationship between the market prices and characteristics is implied which may not always be true. Also, information regarding the exact amount of the characteristic, b, may not always be available.[6]

A second class of theories that form a basis for the hedonic technique include the Houthakker and Rosen models. The basic assumption of these models is that utility is derived directly from the characteristics of a particular bundle of goods and the shadow prices of these goods are supply determined. Utility is maximized given the characteristic prices and the budget constraint.[7]

The third major category of models contains the Fisher-Shell "simple repackaging hypothesis." This model endows each market good with a set of "physical characteristics" which forms its quality index. Similar types of goods

have the same indices, therefore they are "independent of market variables" and can be aggregated by summing quality indices "weighted by the number of units of each good purchased."[8]

None of the models discussed above have completely resolved all the theoretical questions related to the hedonic approach. Some of the underlying assumptions which impose restrictions on their use are more fully discussed by Muellbauer.[9] Nonetheless, the hedonic approach is useful in analyzing many situations in which comparisons involving a bundle of goods must be made. The approach used in this research effort is based on the Lancaster household production model.

Many empirical studies applying the hedonic approach can be found in the literature. Hedonic theory has been used extensively to evaluate several aspects of federal housing subsidy programs. It has been useful in developing comparisons of total program benefits and costs (Wallace et al., 1981) as well as in the evaluation of Fair Market Rents (Malpezzi, Ozanne, and Thibodeau, n.d.).[10] The majority of studies using this approach have concentrated on a single market area; however, there have been four attempts to analyze larger cross-sections. An analysis using Annual Housing Survey data was completed on numerous SMSAs (Follain and Malpezzi), (Follain, Ozanne, and Alburger).[11] In addition, HUD has sponsored research efforts

in urban areas (Wallace, Bloom, et al., 1981) as well as in rural areas (Combs, et al., 1982).

The current analysis is an extension of the latter study. In June of 1982, an "Evaluation of the Section 8 Existing Housing Program in Rural Areas" was completed at Appalachian State University (ASU). The ASU study was the first to concentrate on rural areas. The primary goal of this study is to use the hedonic technique to determine whether any change in housing quality was realized by program participants in rural areas.

Research involving single markets are numerous and difficult to compare, so no attempt will be made to do so here. Problems involved in comparisons of previous empirical studies are discussed by Ball.[12]

Other uses of the hedonic approach in housing market analysis include isolating factors determining costs of construction sites (Nelson, 1972), (Witte, 1975), as well as evaluating inter-city differences in housing prices and accessibility (Richardson, Vipond, and Furbey, 1974), (Ball, 1974), (Rosen, 1978), (Linneman, 1980). Research has also been done to determine the demand for housing amenities (Davies, 1974), (Blomquist and Worley, 1980) and the implicit prices of externalities (Wilkinson, 1973). An evaluation of property tax assessment using hedonic theory has also been analyzed (Smith, 1974). Racial discrimination in the housing market has also been evaluated using hedonic theory (Schnare, 1976).

The scope of the hedonic approach extends beyond analysis of housing markets and has been applied to other areas as well. It has been used in evaluating quality characteristics of durable goods such as automobiles (Sweeney, 1974). Also, studies of inflation (Wilkinson and Archer, 1976) and depreciation (Chinloy, 1978), (Palmguist, 1979) have all used hedonic theory as a basis for their analysis. In short, the literature suggests a wide range of problems in which the application of hedonic theory can be useful.

Although hedonic theory has been used extensively in empirical studies, problems on theoretical grounds and in implementation of the technique remain.

The major theoretical problem is how the estimated coefficients are to be interpreted in terms of supply and demand functions. Rosen argues that "estimated hedonic price-characteristics functions typically identify neither demand nor supply."[13] As Blomquist points out:

> . . . if consumers are identical and producers differ . . . then the hedonic regression yields something resembling the demand function, i.e., willingness to pay for marginal changes in the trait. If producers are identical and consumers differ, then the hedonic regression yields something resembling the supply function. If there are distributions of producers and consumers, then the hedonic regression is simply the market cleaning function which need not resemble either a demand or supply function. Under any of the above conditions we fail to get estimates of the demand or supply functions from the single equation hedonic regression. The hedonic regression yields only estimated marginal trait prices which then can be used to estimate the demand function using appropriate variables.[14]

In addition to the theoretical problem mentioned above, difficulties arise in statistically implementing the hedonic technique. The first concerns the problem of omitted variables resulting in coefficient bias.[15] Also, several functional forms of the hedonic model have been used with varying empirical results. Unfortunately, no one functional form is suggested on theoretical grounds.[16] This point is clearly illustrated when Straszheim states:

> . . . these equations are essentially descriptive. Observed house prices or rents at any point in time reflect what households pay for housing services in the prevailing housing submarket, the payments mirroring demands, supplies, and the market clearing process, including market imperfections. There is no compelling logic to prefer a nonlinear form . . .[17]

A third problem concerns the appropriate geographical sample size to use when estimating hedonic equations. There is no general agreement on the existence of urban sub-markets, and empirical evidence has been cited to support both views.[18] Errors due to aggregation will result if different price structures exist across geographical markets and that data is pooled. There have been attempts to deal with this problem by including neighborhood characteristics such as racial mix, accessibility, crime, etc. in the regression equation. However, if sub-markets actually do exist and are reflected in the structural coefficients, either the data must be stratified or the effected coefficients must be allowed to vary between sub-markets.[19]

To conclude, this chapter has discussed possible theoretical justification for the hedonic approach and the assumptions underlying its use. Its application in research as well as major problems involved with its empirical implementation were also reviewed.

In the following chapter, empirical results obtained in constructing a hedonic index of rural housing characteristics are discussed.

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[3]Ibid., pp. 981-982.

[4]Ibid., pp. 986-987.

[5]Ibid.

[6]Ibid., p. 979.

[7]Ibid., p. 991.

[8]Ibid., p. 988.

[9]Ibid., pp. 977-992.

[10]A definition of Fair Market Rents can be found in Malpezzi, Ozanne and Thibodeau, "Characteristic Prices of Housing in Fifty-nine Metropolitan Areas," on p. 4. Fair Market Rents (FMRs) are used in the Section 8 Housing Program "to represent the metropolitan area rent for dwellings that meet Section 8 quality and space requirements." They are used to determine the maximum amount of subsidy a household can obtain.

[11]J. Paul Combs, et. al., "Evaluation of the Section 8 Existing Housing Program in Rural Areas," June 1982, p. 174.

[12]Michael J. Ball, "Recent Empirical Work on the Determinants of Relative House Prices," Urban Studies 10 (June 1973): pp. 213-233.

[13]Sherwin Rosen, "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition," Journal of Political Economy 82 (January/February 1974): p. 54.

[14]Glenn Blomquist and Lawrence Worley, "Hedonic Prices, Demands for Urban Housing Amenities, and Benefit Estimates," Journal of Urban Economics 9 (March 1981): p. 213.

[15]Michael P. Murray, "Hedonic Prices and Composite Commodities," Journal of Urban Economics 5 (April 1978): p. 189.

[16]In the article, "Choice of Functional Form for Hedonic Price Equations," Journal of Urban Economics 10 (July 1981): p. 38, by Robert Halvorsen and Henry O. Pollakowski, a statistical procedure to select an appropriate functional form is proposed in which the Box-Cox and flexible functional form approaches are used. Functional forms providing the best fit in terms of Liklihood ratio tests are then selected.

[17]Mahlon R. Straszheim, An Econometric Analysis of the Urban Housing Market (New York: Columbia University Press, 1975), p. 37.

[18]Murray, "Hedonic Prices and Composite Commodities," p. 189.

[19]Straszheim, An Econometric Analysis of the Urban Housing Market, p. 72.

CHAPTER 3

APPLICATION OF THE HEDONIC TECHNIQUE IN AN EMPIRICAL ANALYSIS

One important application of the hedonic technique is in the area of rent prediction. Comparisons of rent differentials can be made between different subgroups categorized by differences in location, ethnic background, and other characteristics.

As noted in Chapter 1, a primary goal of the Section 8 Existing Housing program is to provide better quality housing for low-income families through the provision of rent subsidies. Assuming rent is in fact a reflection of the quantity and quality of housing characteristics, the hedonic approach can be used to measure changes in housing quality obtained by participants in a program such as Section 8. This is accomplished in three stages. First, a hedonic equation is estimated using data from a pre-program sample.[1] This hedonic equation is used to predict rent and is constructed by regressing rent payments on housing characteristics believed to be important in determining housing quality. A pre-program hedonic index is then formed using structural and neighborhood characteristics. In the final stage, variables in the index are used to measure rent from a sample of program

participants. Any significant change in rent from pre-program to program households represents a change in housing quality. Therefore, using the hedonic approach in rent prediction provides one way to examine how effective Section 8 is in increasing housing quality.

This chapter begins with a presentation of the basic hedonic model used to evaluate housing quality. A description of the data on which the analysis is based follows. Procedures used in specification of the model are then discussed and the final form of the hedonic equation is presented. Finally, the chapter concludes with a comparison of housing quality between pre-program and participant households in the Section 8 Existing Housing program.

The basic hedonic model involves the relationship between rent and three principal categories of housing characteristics, including structural features, neighborhood features, and tenure characteristics. Structural features are those attributes of the dwelling unit itself. Neighborhood features include characteristics of the immediate environment such as the density of housing on a block. Both structural and neighborhood features directly influence rent in terms of inherent quality standards. Tenure characteristics, on the other hand, are factors which have an effect on rent, but are not related to housing quality. Characteristics in this category include length of tenure, relationship to landlord,

etc. The general hedonic relationship can be expressed in the following regression equation:

$$R = a + \alpha X + \beta Y + \mu$$

where R = rent

a = intercept term

X = the vector of structural and neighborhood characteristics

Y = the vector of tenure characteristics

α, β = undetermined coefficients

μ = stochastic error term

This relationship, then, involves multivariate regression analysis. The estimated coefficients represent implicit prices which measure the value each structural and neighborhood characteristic contributes to the overall rent.

Once estimates for a, α, and β have been obtained, a hedonic index, I, can be constructed in the following manner:

$I = a + \Sigma \alpha x$, where tenure characteristics are excluded, and predicted rent can be calculated:

$$R = a + \Sigma \alpha x + \Sigma \alpha Y$$

where I, a, α, β, and R are estimates.

The data base used in the "Evaluation of the Section 8 Existing Housing Program in Rural Areas" was designed to address many program-related questions. As such, it represents an extensive data set, containing a wide variety of information that can be used in evaluating the effectiveness of the Section 8 Program.

Information concerning housing quality for participant groups was collected from three primary sources. These included data obtained from the Public Housing Authority (PHA) files, personal interviews, and a Housing Measurement Survey conducted by interviewers trained to evaluate in significant detail the conditions of housing units.[2]

A cross-section sample of the population which included 108 PHAs in 72 counties and approximately 6500 low-income households in the rural U.S. was collected. Table 1 presents the sample sizes and types of information on which the present research effort is based.[3] From this data set this study will rely primarily on rent and housing condition information obtained from household interviews and the Housing Measurement Survey (HMS).

TABLE 1

CROSS-SECTION RESPONDENT SAMPLE SIZE
IN EXISTING HOUSING PROGRAM

	File Data	Interviews	Housing Evaluations
Pre-Program Households	2073	1166	954
Program Households	2071	931	740
PHAs	108	108	---

Specification of the model used in this study involved decisions concerning the functional form of the equation,

the geographical extent of the market on which to construct the index, the variables to be selected for the equation, and the pooling of sample data.

The functional form selected for the equation was a linear one. As the discussion in Chapter 2 suggests, there is no a priori reason for selecting one functional form over another. The linear relationship was used for three reasons. It permitted the use of variables which may be interdependent such as neighborhood attributes and dwelling unit size.[4] Also, estimates of coefficients obtained using the linear form are easily interpreted as the marginal value each characteristic contributes to rent. Finally, it enabled easier comparisons between results of this study and research completed earlier in the ASU study.

As the discussion in Chapter 2 pointed out, problems concerning the selection of an appropriate geographical sample size on which to estimate the hedonic equation may result in errors of aggregation. In order to reduce sub-market variation, variables including neighborhood characteristics such as racial mix and measures of local rent levels were included in the regression equation. Median Regional Income and Fair Market Rents were both considered as measures of local rent levels. Median Income was selected over Fair Market Rent as a better measure for sub-market variation in housing costs. Because many

landlords were told by PHAs to match the local FMR, this variable tended to have a different meaning for pre-program and program sub-groups. Both measures were HUD management tools, the former to determine eligibility of participants, the latter to establish local limits on Section 8 rents.

Another aspect of model specification concerns which variables to include in the equation. Variables were selected according to the following criteria:

(1) ability to maximize explanatory power, as measured by R^2;

(2) statistical significance;

(3) conformance with economic theory regarding the expected sign;

(4) obtaining an adequate representation of structural neighborhood and tenure characteristics comprising the basic model relationship;

(5) minimizing multicollinearity when possible.

The major objective in constructing the hedonic equation was to obtain an equation which was useful in predicting rent. Therefore, even though all of the above criteria were used to select variables, priority was given to the first criterion, thus emphasis was placed on the ability of the equation to maximize explanatory power.

Initial equations included many variables which were later omitted or combined with other variables to produce an equation with better predictive power. These decisions

were made after examining the sample variances and correlation matrices as well as considering the importance of each characteristic on subjective grounds.

One major consideration involved the rent measure. Regressions were run on both the pre-program and program samples. In the final equation, utilities were included in the rent forming the variable UTIRENT. Tenants paying only partial rent were excluded in the rent measure.

Several groups of variables exhibited collinearity. Although some of these variables were redefined based on results from principal component analysis, a major attempt to eliminate multicollinearity problems was not undertaken since the primary focus in this study was to develop a hedonic equation useful in rent prediction, rather than to assign precise market values to individual housing characteristics. Therefore, more care was taken to reduce bias arising from omitted variables rather than solving problems resulting from multicollinearity.[5]

A final issue in model specification concerned whether the pre-program and program samples could be pooled. A Chow test was conducted on several regression sets.[6] None of the pre-program and program data could be pooled at a 1% or 5% level of significance for any of the regression sets, therefore pre-program data was used for construction of the hedonic index.

The hedonic equation was constructed based on the above criteria. Variables included in the final form of the model are summarized in the tables which follow. Table 2 lists the hedonic variables by group characteristics. Table 3 defines each variable. A statistical summary of the hedonic equation is found in Table 4. Appendix A contains a description of the way in which hedonic variables were coded in the computer.[7]

TABLE 2

HEDONIC VARIABLES INCLUDED IN THE EQUATION BY GROUP CHARACTERISTIC

Dwelling Unit Features

Furnished
Parking
Number of rooms
Number of bedrooms
Fire exits
Room layout and excess
Floor area
Mobile home
Apartment
Living room amenities
Structure, surface of living room
Kitchen sink
Kitchen sink condition
Length of counter tops
Length of shelving/cabinets
Kitchen amenities
Condition of kitchen appliances, cabinets, countertops
Structure, surface of kitchen
Presence of bathroom
Presence of tub or tub and shower
Condition of fixtures
Bathroom amenities
Structure, surface of bathroom
Dining room
Basement
Primary heating equipment
Cooling adequacy
Condition of foundation
Exterior wall structure and surface
Grounds quality and site cleanliness
Estimated age of original structure
Overall condition of dwelling unit
Overall quality of dwelling unit
Detracting or dangerous features
Attractive or beneficial features
Shack, tenement, converted barn/garage
Single family detached unit
Heat breakdown
Appliances
Bath 1
Bath 2
Washer/Dryer
Yard/lawn
Area of hall
Electrical hazards

TABLE 2 - CONTINUED

Site and Neighborhood Features
Proportion of white
Odor
Street condition
Walkway condition
Land use mix reflecting undesirable characteristics
Land use mix reflecting business parcels
Total land use mix
Adequate security in building
Neighborhood conditions that are undesirable
Neighborhood services
Vacancy rates
Tenure Characteristics
Length of time head of household lived in unit
Dwelling unit owned or being bought by tenant or relative
Relationship to owner
Owner lives in building
Median regional income
Number in family

TABLE 3

HEDONIC VARIABLE DEFINITIONS

Variable	Definition
UTIRENT	Total rent with utilities
HDLIVED	Length of time head of houshold lived in unit
X16	Dwelling unit owned or being bought by you or relative
X41	Furnished or unfurnished
X42	Availability of parking facilities
X50	Relationship of owner
X55	Owner lives in building
X56	Number of rooms
X57	Number of bedrooms
X71	Proportion of white in neighborhood
X73	Presence of fire exits
X74	Room layout and access
X75	Floor area of dwelling unit
MOB	Mobile home units
APT	Apartment
LRA	Living room amenities
STRL 1	Structure and surface of living room ceiling, wall, floor
X95	Presence of kitchen sink
X96	Condition of kitchen sink

TABLE 3 - CONTINUED

Variable	Definition
X99	Length of counter top
X101	Length of shelving/cabinets
KA	Kitchen amenities
KWEAR	Condition of kitchen appliances, cabinets, countertops
STRK 1	Structure and surface of kitchen ceiling, wall, floor
X127	Presence of bathroom
X129	Presence of tub or tub and shower
X131	Condition of fixtures
BA	Bathroom amenities
STRB 1	Structure and surface of bathroom ceiling, wall, floor
DR	Presence of dining room
X155	Presence of basement
X156	Primary heating equipment
X160	Cooling adequacy
ODOR	Odor from sewer, gasses, garbage, trash
X166	Condition of foundation
CEXT	Exterior wall structure and surface
CLEAN	Grounds quality and site cleanliness
X175	Estimated age of original structure
X178	Overall condition of dwelling unit
X179	Overall quality of dwelling unit

TABLE 3 - CONTINUED

Variable	Definition
X181	Detracting or dangerous features
X182	Attractive or beneficial features
SHACK	Shack, tenement, converted barn/garage
DETACH	Single family detached unit
HTBRKDWN	Heating breakdown or need for additional heating
Y33	Median regional income
X183	Street condition (maintenance)
X184	Walkway condition
BAD 1	Land use mix reflecting presence of liquor stores, shacks, vacant lots, abandoned buildings, etc.
BUS	Land use mix reflecting business parcels in neighborhood
TOT	Total land use mix
X10	Number in family
APP	Provision of refrigerator, range/cook-stove by landlord
BATH 1	$1\frac{1}{2}$ bathroom
BATH 2	2 bathrooms or more
WASHDRY	Provision of washer or dryer by landlord
Y10	Adequate security in building
Y11	Presence of yard or lawn
NEIGHBAD	Neighborhood conditions such as noise, traffic, trash, etc.

TABLE 3 - CONTINUED

Variable	Definition
NEIGHDIS	Neighborhood services such as public transportation, schools, police protection, etc.
Y29	Area of hall
HAZ 2	Minor or major electrical hazards
Y32	Vacancy rates

TABLE 4

STATISTICAL SUMMARY OF HEDONIC VARIABLES

Variable	Expected Sign	Coefficient	Standard Error	F
Y32	-	-0.3235574	0.19326	2.803***
HDLIVED	-	-0.1522007	0.05235	8.452*
X16	-	6.230682	41.77106	0.022
X41	+	-8.776921	9.98756	0.772
X42	+	22.40966	9.85763	5.168**
X50	-	-24.58172	40.43065	0.370
X55	-	-32.21530	10.59309	9.249*
X56	+	4.863443	6.19510	0.616
X57	+	0.7323645	8.64262	0.007
X71	+	.1366038	0.09238	2.186
X73	+	-0.3855065	10.68538	0.001
X74	-	16.21063	12.40659	1.707
X75	+	-0.07363738	0.02430	9.180*
MOB	-	7.340854	15.47327	0.225
APT	+	12.57286	10.36033	1.473
LRA	+	3.809429	5.28141	0.520
STRL 1	-	-2.146577	11.55380	0.035
X95	-	4.728315	12.51916	0.143
X96	-	-2.233974	11.06344	0.041
X99	+	0.7849950	1.31086	0.359
X101	+	-0.2568220	0.67911	0.143
KA	+	-0.1514785	3.66646	0.002
KWEAR	-	-16.49812	9.53089	2.996***
STRK 1	-	-0.9421859	9.14172	0.011
X127	-	-22.93121	26.80610	0.732
X129	-	-14.14169	7.92129	3.187***
X131	-	-4.344622	10.46717	0.172
BA	+	9.783053	13.00773	0.566
STRB 1	-	-4.707656	6.23818	0.570
DR	+	-8.196634	10.28966	0.635
X155	-	-44.42043	8.21827	29.215*
X156	-	-10.24325	10.97008	0.872
X160	-	-13.85460	8.15702	2.885***
ODOR	-	34.89650	13.45970	6.722**
X166	-	-22.21894	13.37040	2.762***
CEXT	-	-.02244267	12.23947	0.000
CLEAN	-	16.53764	7.44850	4.930**
X175	-	21.75573	10.32522	4.440**
X178	-	-13.83597	8.78439	2.481
X179	-	-7.918649	10.40234	0.579
X181	-	7.616139	10.04228	0.575
X182	+	0.02564198	13.56012	0.000
SHACK	-	13.93656	19.12731	0.531
DETACH	+	12.66821	10.06732	1.583

TABLE 4 - CONTINUED

Variable	Expected Sign	Coefficient	Standard Error	F
HTBRKDWN	-	0.8387848	9.24550	0.008
Y33	+	0.009844131	0.00229	18.526*
X183	-	-16.48317	8.10474	4.136**
X184	-	8.662663	9.17750	0.891
BAD 1	-	-0.3753275	1.07198	0.123
BUS	(either)	-0.8188241	0.95389	0.737
TOT	(either)	-0.7356761	0.65584	1.258*
X10	+	12.20957	3.01529	16.396*
APP	+	20.65310	9.55550	4.672**
BATH 1	+	72.65519	14.25430	25.980*
BATH 2	+	69.10997	26.32638	6.891*
WASHDRY	-	17.21258	7.88780	4.762**
Y10	+	11.54047	8.36101	1.905
Y11	+	-9.580516	10.31294	0.863
NEIGHBAD	-	0.3027321	2.59765	0.014
NEIGHDIS	-	-1.718889	2.64525	0.422
Y29	+	0.2691703	0.11027	5.958**
HAZ 2	+	-13.20594	10.67103	1.532
(constant)		43.47303		

Multiple R = .84342
R Square = .71136
Adjusted R Square = .65250
Standard Error = 52.75652
F = 12.08439

* Significant at the 1% level
** Significant at the 5% level
*** Significant at the 10% level

Note: The final sample size included 367 cases, which is smaller than the original sample. The smaller sample resulted from using a listwise deletion procedure to account for missing values in addition to selecting only those households who rented housing.

The data presented in Table 4 can be used to determine whether the basic hedonic equation is meaningful. Two important criteria used in making this determination involve an examination of the statistical significance of the coefficient estimates along with their signs and the total explanatory power of the estimated equation.[8]

The statistical summary lists each variable with its expected sign, coefficient, standard error, and F-value. The expected sign represents the positive or negative relationship an independent variable is expected to have with the dependent variable, UTIRENT, based on economic theory. The coefficient of each variable in the hedonic equation is interpreted as the implicit price of that housing characteristic. It is an indication of marginal value in that it represents how much rent would change with a small unit change in the quantity of that particular characteristic. The standard error is the standard deviation of the estimation errors based on a sampling distribution.[9] The final column in the statistical summary is the F-value. This statistic represents a test of the significance of each variable in the equation. If a variable is considered to be significant, it may be concluded that its coefficient does not differ from zero due to chance.[10]

As an example, the variable, KWEAR, in the hedonic equation has an expected negative sign. This variable was set up as a dummy variable.[11] If the condition of

kitchen appliances, cabinets, and countertops was good, KWEAR was assigned a value of zero. If the condition was poor, KWEAR was assigned a value of one. Therefore, one would expect poor kitchen quality of appliances, cabinets, and countertops, to result in a lower rent. Thus the higher coefficients of the variable KWEAR result in lower values of rent, producing a negative relationship.

The coefficient of the variable, KWEAR is -16.50. This value can be interpreted to mean that a kitchen with appliances, cabinets, and countertops in poor rather than good condition results in a $16.50 decrease in rent. Because the F-value of KWEAR exceeds 2.75, its effect on the value of rent is considered significant at the 10% level.

Sixty-two variables are included in the hedonic equation. Of these, 21 have significant coefficients at the 10%, 5% or 1% levels. In the majority of cases, the significant coefficients remained consistent in sign as regressions were run on various hypothesized models. In the final form of the equation, only five of the significant variables have the wrong sign.

Variables exhibiting the wrong sign are primarily those that reflect structural and size characteristics. The remaining two are neighborhood characteristics reflecting site cleanliness. These anomalies may be attributed to multicollinearity or misspecification either of which may result in unexpected signs on the variable coefficients.

The coefficient of multiple determination is one measure of the explanatory power of the model. The coefficient of multiple determination (R^2) for the final form of the model is .71, indicating 71% of the variation in UTIRENT can be explained by the independent variables in the equation. Therefore, in view of these criteria, the hedonic equation is useful in predicting rent.

The final stages of the empirical analysis involved constructing an index from the hedonic equation and using it to compare housing quality between pre-program and participant households. Any difference in the value obtained is interpreted as the change in housing quality realized by program participants.

Two methods may be used to construct the index. In the first method, the pre-program value of housing is calculated by multiplying applicant prices by applicant quantities. This index is then compared to an index constructed for participants calculated by multiplying applicant prices and recipient quantities.

The second method uses participant prices as weights. The pre-program values are calculated by multiplying recipient prices and applicant quantities. This value is then compared with the value obtained for the participant index which involves multiplying recipient prices and recipient quantities.

Indices using both methods were calculated in this study. In addition, two measures of housing quality were

obtained. Predicted rent is a measure which includes tenure characteristics. The housing quality index omits these variables.

Values obtained from the hedonic indices for pre-program and participant households are summarized in Table 5. Both measures result in an increase in housing quality for participants in the program, regardless of the method used to construct the index. Comparisons of pre-program and participant households were made in the following manner:

Predicted Rent

(1) $\Sigma P_A Q_A = \$196 < \Sigma P_A Q_R = \$205$

(2) $\Sigma P_R Q_A = \$204 < \Sigma P_R Q_R = \$215$

Housing Quality Index

(1) $\Sigma P_A Q_A = \$\ 6 < \Sigma P_A Q_R = \$23$

(2) $\Sigma P_R Q_A = \$79 < \Sigma P_R Q_R = \$97$

As indicated, when predicted rents are considered, participants realize an increase of $9 or $11, depending on whether applicant or recipient prices are used as weights. On the other hand, when housing quality is compared, participants receive an increase of $17 or $18, depending on the method used to construct the index.

TABLE 5

GROSS AND NET HOUSING VALUES:
PROGRAM AND PRE-PROGRAM

	Gross Housing Value	Net Housing Value*
$\Sigma P_A Q_A$ [1]	$196	$ 6
$\Sigma P_R Q_R$ [2]	215	97
$\Sigma P_A Q_R$ [3]	205	23
$\Sigma P_R Q_A$ [4]	204	79

[1] $\Sigma P_A Q_A$ = Pre-program value using pre-program prices and quantities.

[2] $\Sigma P_R Q_R$ = Program value using program prices and quantities.

[3] $\Sigma P_A Q_R$ = Program quantities valued using pre-program prices.

[4] $\Sigma P_R Q_A$ = Pre-program quantities valued using program prices.

* Net Housing Value omits tenure

Although these results indicate participants in the Section 8 Existing Housing program did realize increased housing quality, this conclusion should be interpreted with some caution. As mentioned earlier, the variable coefficients reflect supply and demand conditions in various sub-markets. The effects of market conditions on the implicit price of each characteristic is unknown. Also, a biased comparison between samples may result from using pre-program data to construct the original hedonic equation. An unbiased comparison would be possible only if pre-program and program households placed the same relative values on housing characteristics.[12]

In this chapter, the empirical analysis examined whether participants in the Section 8 Existing Housing program realized gains in housing quality. The final chapter begins with a summary of the analysis. Suggestions for future research are discussed in the chapter conclusion.

REFERENCES

[1]The pre-program sample includes households who had applied to the program but had not been accepted.

[2]A definition of the public housing authority can be found in "Evaluation of the Section 8 Existing Housing Program in Rural Areas," by J. Paul Combs, et al., June 1982, p. 12. There it states: "The vehicle for administering the Section 8 Existing Housing Program is the public housing authority (PHA). A PHA is defined as a state, county, municipality, or other government entity or public body (or agency or instrumentality thereof) which is authorized to engage or assist in the development or operations of housing for low-income families."

[3]The final sample included 72 counties, 108 PHAs, and 6500 households. For a detailed discussion of data collection, the way in which the rural population was defined, and information regarding stratification in this study, See Combs, et al., "Evaluation of the Section 8 Existing Housing Program in Rural Areas," pp. S-2-7. Also see J. Paul Combs, Jean-Pierre Courbois, and Larry Ellis, "HUD Section 8 Evaluation in Rural Areas - Rural Section 8 Data Base Dictionary," Vol. I.

[4]James E. Wallace, et al., "Participation and Benefits in the Urban Section 8 Program: New Construction and Existing Housing," 2 vols. Cambridge, Massachusetts, 1981, 2:1-3.

[5]Another concern arose from the missing values. Variables were coded in two ways. On original runs, if values were placed in the "out of universe" category, they were coded as increasing the measure of rent. For example, respondents who answered "out of universe" to the question regarding heat breakdowns were coded as having no breakdowns. This was done to preserve as many observations for each variable as possible. On subsequent runs, all variables were recoded so that "out of universe" responses would be included as missing values. This produced a decrease in the number of cases with almost no change in explanatory power, therefore "out of universe" responses were coded in the original manner in the final analysis.

[6]The Chow test is used to test whether coefficient of the same model based on different data sets are equal. In this application, the hypothesis of the basic model is that dwelling unit and neighborhood characteristics are significant factors in explaining the level of rent. If the two data sets cannot be pooled, theoretically, it can be concluded that the coefficients of the models are different and that the effects of dwelling unit and neighborhood characteristics on rent are different for pre-program and program households. To perform the Chow test, regression results from pre-program, program, and pooled samples are used. The null hypothesis, HO: $\Gamma_I = \Gamma_{II}$, representing the residual sums of squares difference between 2 data sets is rejected if the F-statistic is less than the calculated F-value. Computation of the F-value involves the following formula:

$$F(k, \Gamma_I + \Gamma_{II} - 2k) = \frac{\frac{(Q-Q_1)}{k}}{\frac{Q_1}{(\Gamma_I+\Gamma_{II}-2k)}}$$

where Q = residual sum of square for the pooled data
Q_1 = the sum of the residual sum of square from each of the 2 samples.
For a more complete discussion of the theory and use of the Chow test, see James L. Murphy, Introductory Econometrics (Homewood, Illinois: Richard D. Irwin, Inc., 1973), p. 237.

[7]In addition to Appendix A, specific information about the questionnaire and responses can be obtained in "HUD Section 8 Evaluation in Rural Areas - Rural Section 8 Data Base Dictionary," Vol. I, by Combs, Courbois, and Ellis.

[8]A test to determine the significance of the constant term can be conducted to obtain a measure of bias in the equation. However, the significance test on the constant term was not performed in this analysis because the computer program used, SPSS (Statistical Package for Social Sciences), does not provide the information necessary to perform this test.

[9]A discussion of the theoretical concept and calculation of the standard error can be found in Business Statistics by Wayne W. Daniel and James C. Terrell (Boston: Houghton Mifflin Company, 1979), p. 129.

[10]The theory forming a basis for interpretation of the F-value can be found in Introductory Econometrics by Murphy. pp. 212-216. In this case, if the F-value is greater than 1.0, it is considered significant at a 1% level.

[11]Variables in this equation were represented as dummy variables when possible. Dummy variables are used when the variables are not continuous, but divided into discrete categories. See Introductory Econometrics by Murphy, p. 253.

[12]Combs, et al., "Evaluation of the Section 8 Existing Housing Program in Rural Areas," p. 196.

CHAPTER 4

CONCLUSIONS

In summary, this research effort involved the construction of a hedonic index. The index was then used in an empirical analysis to compare the level of housing quality between pre-program and participant households in the Section 8 Existing Housing program in rural areas. The comparison of the two samples indicated that participants in the program did realize some increase in housing quality.

The essential steps in the analysis began with the construction of a hedonic equation based on pre-program data. Methods of model specification were chosen which contributed to the ability of the final model to predict rent. The final form of the hedonic equation was then used to build an index. In the final stage of analysis, a comparison of housing quality was made between pre-program and participant households based on the hedonic index. Any change in housing quality was attributed to benefits realized from the Section 8 program.

The purpose of this study has been to examine the hedonic technique in a theoretical perspective and then to apply the theory empirically. An analysis of this nature is beneficial in increasing understanding of the

technical statistical problems associated with empirical applications of the hedonic technique. In addition, it provides the first step on which an evaluation of the effectiveness of the Section 8 Existing Housing program can begin.

Future research initiated from this study might proceed in several directions. Benefits received by participants in the Section 8 program include not only housing quality benefits but income benefits as well. The income benefit is the additional real income that households receive by obtaining rent subsidies. A future analysis might evaluate the total benefits received by a household, thus including measures of income and housing quality.

The hedonic technique might also be applied to determine whether HUD is paying too much for housing quality measured by the hedonic technique.

In concluding this study, the hedonic technique provides one method to make comparisons of hetergeneous commodities. It is useful to both the public in reaching socio-economic policy decisions and to the economist in analyzing market conditions.

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APPENDIX A

APPENDIX A

COMPUTER CODING OF HEDONIC VARIABLES

Variable	Code	Type of Variable
UTIRENT	Total monthly rent paid for unit plus utilities where utilities include electricity, gas, water, oil, coal and garbage collection	Continuous
HDLIVED	Length of time in months head of household lived in unit	Continuous
X16	Dwelling unit owned or being bought by you or relative No = 0 Yes = 1	Discrete
X41	Furnished or unfurnished Unfurnished = 0 Furnished = 1	Discrete
X42	Availability of parking facilities No = 0 Yes = 1	Discrete
X50	Relationship of owner No, not related = 0 Yes, related = 1	Discrete
X55	Owner lives in building No = 0 Yes = 1	Discrete
X56	Number of rooms in unit	Continuous
X57	Number of bedrooms in unit	Continuous
X71	Proportion of white in neighborhood. If the neighborhood is not racially integrated and the household's minority status is white then X71 = 100	Continuous
X73	Presence of fire exits Not adequate = 0 Adequate, don't know, out of universe = 1	Discrete

APPENDIX A - CONTINUED

Variable	Code	Type of Variable
X74	Room layout and access Walk through living, dining room, kitchen only to access other rooms or all rooms accessible off corridors or out of universe = 0 Walk through 1,2,3, or 4 bedrooms to access other rooms = 1	Discrete
X75	Floor area of dwelling unit	Continuous
MOB	Mobile home units MOB = o If mobile home is rented or owned, or if dwelling unit type is a mobile home then MOB = 1	Discrete
APT	Apartment. Apt = 0 If dwelling unit type is a multi-family 4-story or less, or a high rise with more than 4 stories, then Apt = 1	Discrete
LRA	Living room amenities Where living room amenities include high quality walls/wall coverings, ceilings, floors or floor coverings, working fireplace or stove, balcony/patio/deck/porch, special windows and doors, special built-in lighting, built-in shelves/bookcases/cabinets, exceptional size (15'x20' or over), and other living room amenities	Continuous
STRL 1	Structure and surface of living room ceiling, wall, floor Where STRL 1 includes the structures and surfaces which require immediate replacement or requires replacement	Continuous
X95	Presence of kitchen sink Present or out of universe = 0 Not present, not connected, or badly connected = 1	Discrete

APPENDIX A - CONTINUED

Variable	Code	Type of Variable
X96	Condition of kitchen sink Kitchen sink shows moderate wear or is in good condition or not applicable or out of universe = 0 Kitchen sink shows severe wear = 1	Discrete
X99	Length of counter top	Continuous
X101	Length of shelving/cabinets If cabinets are not present then X101 = 0	Continuous
KA	Kitchen amenities Where kitchen amenities include eating counter/breakfast nook, pantry, full backsplash at counter, range hood, double oven/ self-cleaning oven/microwave, double sink, high quality walls or wall coverings, floors or floor coverings, high quality kitchen cabinets, working fireplace/franklin stove, balcony/patio/ deck/porch, special windows and doors, special built-in lighting, special storage areas, and an exceptionally large kitchen	Continuous
KWEAR	Condition of kitchen appliances, cabinets, countertops KWEAR = 0; If appliances or cabinets/ countertops show severe wear, then KWEAR = 1	Discrete
STRK1	Structure and surface of kitchen ceiling, wall, floor Where STRK 1 includes the structures and surfaces which require immediate replacement or requires replacement	Continuous
X127	Presence of bathroom Bathroom present or scattered facilities or out of universe = 0 Bathroom not present or out-facilities = 1	Discrete
X129	Presence of tub or tub and shower Built-in tub and shower = 0 Else = 1	Discrete

APPENDIX A - CONTINUED

Variable	Code	Type of Variable
X131	Condition of fixtures Shows moderate wear or good condition or out of universe = 0 Shows severe wear = 1	Discrete
BA	Bathroom amenities Where bathroom amenities include a bidet, jacuzzi/whirlpool bath, special feature shower, built-in heat lamp with timer, built-in auxiliary heat source, large mirrors, glass door on tub/shower, separate dressing area, built-in vanity table, double sink, two sinks or other special lavatories, or an exceptionally large bathroom	Continuous
STRBL	Structure and surface of bathroom ceiling, wall, floor, where STRB 1 includes the structures and surfaces which require immediate replacement or requires replacement	Continuous
DR	Presence of dining room If room code is dining room, then DR = 0; DR = 1	Discrete
S155	Presence of basement Not accessible for evaluation or full height - mechanical and/or storage and/or laundry/workshop or full-height - unfinished basement (below and above grade) or out of universe = 0; No basement or basement not accessible = 1	Discrete
X156	Primary heating equipment Vented fuel burning space heaters or floor, wall or pipeless furnace or central heating system or solar or out of universe = 0 No heating source or unvented fuel burning space heaters or fireplace or stove or portable electric heaters= 1	Discrete

APPENDIX A - CONTINUED

Varible	Code	Type of Variable
X160	Cooling adequacy Sufficient or not determinable or out of universe = 0 Insufficient = 1	Discrete
ODOR	Odor from sewer, gasses, garbage, trash. Odor = 0. If sewer or septic tank back-up or leaking gasses or uncovered garbage or accumulated trash is present, odor = 1	Discrete
X166	Condition of foundation Apparently sound or condition not observable or out of universe = 0 Unsound or potentially unsound = 1	Discrete
CEXT	Exterior wall structure and surface CEXT = 0. If exterior wall structure needs immediate replacement or is potentially hazardous or exterior wall surface needs replacement or has numerous areas needing repair, CEXT = 1	Discrete
CLEAN	Grounds quality and site cleanliness CLEAN = 0. If grounds quality is muddy/dirty/unimproved space or has poor upkeep or if site has major or moderate accumulations of litter/ trash, then CLEAN = 1	Discrete
X175	Estimated age of original structure 1960's to 1970's or new, less than one year old or out of universe = 0 1919 or prior or 1920's/1930's to 1945 or post World War II to 1959 = 1	Discrete
X178	Overall condition of dwelling unit Good or new condition or out of universe = 0. Immediately or potentially hazardous or sound, but requiring some structural or surface repair = 1	Discrete

Variable	Code	Type of Variable
X179	Overall quality of dwelling unit Moderate, high, superior quality or out of universe = 0. Uninhabitable, barely inhabitable or low quality = 1	Discrete
X181	Detracting or dangerous features Not present = 0. Present = 1	Discrete
X182	Attractive or beneficial features Not present or out of universe = 0 Present = 1	Discrete
SHACK	Shack, tenement, converted barn/ garage. Shack = 0. If dwelling unit type is a shack or tenement or converted barn/garage then shack = 1	Discrete
DETACH	Single family detached unit Detach = 0. If dwelling unit type is single family detached then Detach = 1	Discrete
HTBRKDWN	Heating breakdown or need for additional heating. HTBRKDWN = 0 If addition heating equipment was used during past winter or if there were breakdowns in heating equipment lasting 6 hours or more during past winter then HTBRKDWN = 1	Discrete
Y33	Median regional income	Continuous
X183	Street conditions (maintenance) Well paved, well-maintained street or out of universe = 0 Unpaved street or paved street needing repair or paved street needing maintenance = 1	Discrete
X184	Walkway condition Pedestrian walkways show moderate or excellent maintenance or there are no walkways present or out of universe = 0. Walkways appropriate but not present or walkways deteriorated severely = 1	Discrete

APPENDIX A - CONTINUED

Variable	Code	Type of Variable
BAD1	Land use mix Where BAD 1 includes massage/ adult/books/movie theatre (x rated) or liquor stores, mobile homes or converted residences or shacks, vacant land parcel (parcel trashed), abandoned buildings, transient hotels and restaurants/bars	Continuous
BUS	Land use mix Where BUS includes the number of commercial parcels, industrial parcels, mixed use parcels (retail/dwelling unit), vacant land parcels (parcel trashed), abandoned buildings, public buildings, hotels/motels/transient hotels and restaurants/bars	Continuous
TOT	Total land use mix Where TOT includes the number of commercial parcels, industrial parcels, single residential units multi-residential units, mixed use parcels (retail/dwelling unit), vacant land parcels (parcel trashed and clean), abandoned buildings, public buildings, hotels/motels, transient hotels and restaurants/bars	Continuous
X10	Number in family	Continuous
APP	Appliances. APP = 0. If landlord provides refrigerator or range/ cookstove or both, then APP = 1	Discrete
BATH 1	1½ bathroom. BATH 1 = 0 If 1½ bathrooms are present either with or without a flush toilet, then BATH 1 = 1	Discrete
BATH 2	2 bathrooms or more. BATH 2 = 0 If 2 or more complete bathrooms are present, then BATH 2 = 1	Discrete

APPENDIX A - CONTINUED

Variable	Code	Type of Variable
WASHDRY	Washer or dryer. WASHDRY = 0 If household provides washer or dryer then WASHDRY = 1	Discrete
Y10	Adequate security in building No = 0. Yes or don't know or out of universe = 1	Discrete
Y11	Presence of yard or lawn No = 0. Yes or don't know or out of universe = 1	Discrete
NEIGHBAD	Neighborhood conditions Where NEIGHBAD includes street or highway noise, heavy traffic, trash or litter, abandoned structures, rundown houses, industrial or business activities, odors or smoke or gas, and airplane noise	Continuous
NEIGHSID	Neighborhood services Where NEIGHBIS include satisfactory public transportation, schools, shopping, police protection, fire protection, health clinics and rescue squad	Continuous
Y29	Area of hall	Continuous
HAZ2	Electrical hazards If major or minor electrical hazards are present, then HAZ2=0 HAZ2 = 1	Discrete
Y32	Vacancy rate of rental units renting within fair market rents	Continuous

VITA

Myra McCrickard Ragland was born in Roanoke, Virginia on June 26, 1953. After graduating from Martinsville High School, Martinsville, Virginia in 1971, she entered Westhampton College of the University of Richmond. There, she received a Bachelor of Science degree in Biology in May 1975. In 1978 she entered Appalachian State University to begin work on a Master's degree. After completing one year in the program, she accepted a position at Wilkes Community College. There, her responsibilities included teaching and counseling students. In 1981 she reentered Appalachian State University to complete work on a Master's degree in the field of Economics.

Ms. Ragland plans to pursue a Ph.D. degree in the field of Economics.