Place to Place Indexes Of the Price of Housing

SOME NEW ESTIMATES AND A COMPARATIVE ANALYSIS

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PREFACE

The Experimental Housing Allowance Program (EHAP) is a large-scale research effort of the U.S. Department of Housing and Urban Development. It examines the effects of income-conditioned rent subsidies on low-income housing consumers and housing markets, and it does so primarily through large field experiments which have involved about 23,000 households in twelve cities. Some of the effects of housing allowances--particularly longer-run impacts on slowly-adjusting housing stocks and housing markets--are difficult to explore fully in short-term field experiments. Hence, analytical, nonexperimental studies of probable market responses to allowances have also been included in EHAP research to supplement the insights available from field operations.

This paper is one product of these analytical studies. It came into being as an intermediate step in the development of a model of the supply response to housing allowances. Findings of that research activity will be reported in a separate paper.[1] The subject of this paper--indexes of housing values and rents--is, however, of considerable interest to the housing research community. We therefore are pleased to make this paper generally available.

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1. See Ozanne (5).

EXECUTIVE SUMMARY

This is a study of the variation in the cost of comparable housing among thirty-nine large SMSAs. The subject is the measurement of the variation rather than the determinants of it. The principal goal is to provide new constant quality, cross-sectional indexes of the price of housing. These indexes are calculated using Annual Housing Survey (AHS) data collected in 1974 and 1975. They are constructed for both owner-occupied and renter-occupied units.

The results of this study should be useful both to government personnel and to academicians interested in the operation of metropolitan housing markets. Additionally, since the variation of housing costs is a key component of the variation in the overall cost of living, the results are useful to anyone interested in the subject of cross-sectional variation in the cost of living.

Constructing constant quality indexes of the price of housing is a difficult problem because housing is a heterogeneous commodity. Differences in the rents or values of two housing units can result from differences not only in the price of housing, but also from differences in the size and quality of the units. For example, if one house is twice as large as another and sells for twice as much, would we conclude the larger house has a higher price? No, not necessarily. The larger house costs more, but one gets more for the extra money.

The "amount of house" purchased per dollar of expenditures may be the same for both units. It is this notion--the amount of house per dollar of expenditures--that our indexes try to measure.

Our problem is that neither the price per unit of housing services nor the quantity of services are directly observable. They must be inferred from data on the rents and values of housing units. There are two methods which we feel allow inferences to be made about the price per unit of housing services. We apply each of them using the Annual Housing Survey of thirty-nine Standard Metropolitan Statistical Areas (SMSAs).

One technique we use is the method of hedonic indexes. The technique is based upon two key assumptions. The first is that a housing unit is not a single heterogeneous unit but rather a bundle comprised of many dwelling characteristics, for example, number of rooms, type of heating system, etc. Second, each one of these characteristics has its own price which, although not directly observable, can be estimated via multivariate regression analysis. For example, the regression results might indicate that an additional room adds ten percent to monthly rent in a particular SMSA.

Equipped with sets of these characteristic prices for the thirty-nine SMSAs in the sample, construction of indexes of housing rents and values is the same as standard price index construction. A particular type of housing bundle--one for rental units, one for owner-occupied homes--is specified and then priced in each of the thirty-nine SMSAs. The ratio of the predicted rents (or values) between any two SMSAs corresponds to the ratio of the relative price per unit of housing services (or housing stock) between the two SMSAs. In other words, the price per unit of housing services between any two SMSAs is a weighted average of the prices of the individual characteristics in one SMSA relative to those in another SMSA. The schedule of predicted rents (or values) for all thirty-nine SMSAs gives the full hedonic housing price index. This procedure is discussed in more detail and demonstrated in chapter 2.

The second technique is the Bureau of Labor Statistics (BLS) method. This method is quite simple in comparison to the hedonic technique. First, a particular type of housing bundle is specified. For example, a five room rental unit with central heating might be selected. Then, all dwellings within a particular SMSA (or a sample of these units) with such characteristics are selected, and the average rent of the selected units is computed. The procedure is repeated in other SMSAs using the <u>same</u> set of selected housing characteristics. The resulting schedule of average rents constitutes the BLS-type rental price index. An index of house values can be constructed analogously by specifying a particular type of owner-occupied housing and calculating its average value in each SMSA. This procedure is discussed in more detail and demonstrated in chapter 3.

The major findings that result from constructing these two types of indexes with the Annual Housing Survey data are as follows:

1. Significant variation exists under both index procedures in the price of housing across SMSAs. It is not unusual for some SMSAs to be twice as expensive as the less expensive ones. The variance in prices is substantial for both renter and owner-occupied housing.

2. The two indexes generally agree on which SMSAs have more expensive and which have less expensive housing. For example, Paterson and Newark are expensive SMSAs according to both indexes, while Kansas City and Wichita are inexpensive. The overall correlation between the two rent indexes is .61, and between the two house value indexes it is .75. However, the price differences between the most expensive and least expensive SMSAs tend to be smaller using the BLS-type index rather than the hedonic index.

3. Both indexes are sensitive to changes in the reference bundles. This suggests that separate indexes are needed for low and high income families.

4. Additional experimentation with the hedonic index finds it to be relatively insensitive to the following:

- The metropolitan location of the reference bundle. That is, using the average bundle consumed by households in Albany as the reference bundle produces much the same index as is obtained using the Anaheim average bundle.

- Intrametropolitan location of the reference bundle, that is, central city versus suburbs. The cities for which it did make a difference--Detroit and Philadelphia--are not surprises, since they seem to fit the mold of a declining Northeastern central city.

- Inclusion or exclusion of neighborhood characteristics. This could be because the neighborhood variables used in the hedonic are not sufficient measures of the influence of neighborhood on rents and values. More work should be done here.

5. The BLS procedure applied to the Annual Housing Survey yields an index with average rents substantially above those of the official BLS index. The difference does not seem to be due to

differences in dwelling-unit specifications but could result from shortcomings in the updating of the official index over time. In spite of this major difference in levels, the relative rankings of ours and the official index are close.

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CHAPTER I: INTRODUCTION

This is a study of the variation in cost of comparable housing among thirty-nine large SMSAs. The subject is the measurement of the variation rather than the determinants of it. The principal goal is to provide new constant quality cross-sectional indexes of the price of housing. These indexes are calculated using Annual Housing Survey data collected in 1974 and 1975. They are constructed for both owner-occupied and renter-occupied units.

A second aim of this paper is to analyze two tools available to construct constant quality price indexes of housing. They are (a) the method of hedonic indexes, and (b) what we call the BLS method. The latter method is used by the Bureau of Labor Statistics to construct the rent component of its intermetropolitan index of the cost of living Sets of indexes are constructed by both methods. Each set is analyzed separately in order to determine its sensitivity to the type of housing bundle upon which the indexes are based. The indexes are also compared to each other in an effort to uncover any systematic differences produced by the two methods.

The results of the analysis should be useful both to government personnel and to academicians interested in the operation of metropolitan housing markets. Additionally, since the variation of housing costs is a key component of the variation in the overall cost of living, the results are of use to anyone interested in the subject of cross-sectional variation in the cost of living.

Motivation

Why do we need to know about the intermetropolitan variations in the cost of comparable housing? Why construct constant quality indexes of the price per unit of housing services? Our original motivation for this study was to provide measures of the price and quantity of housing services which could be used in an econometric model of metropolitan housing prices.[1] But in constructing these indexes several broader applications suggested themselves. First is the monitoring and understanding of metropolitan housing markets. This requires precise information about the price of housing, and unless such information is available, knowledge and understanding of price movements is nearly impossible.

Second, cross-sectional price indexes of housing are of potential use in the numerous housing programs operated by the Department of Housing and Urban Development. A prime example is the Section 8 Existing Housing Program. Section 8 is a housing subsidy program for low income renters. The subsidy is tied to both the income of the participant and the Fair Market Rent (FMR) for an area. The FMR schedule is intended largely to measure the amounts for which certain types of apartments rent in different housing markets. The indexes presented in this paper can be used as aids in the development of an efficient and equitable FMR schedule. In fact, in another document we show in some detail how our indexes relate to the FMR schedule.[2] That analysis also suggests some improvements which could be made in the FMR schedule and the process currently used to produce it. Another

1. Ozanne (6).
2. Follain (2).

exercise could be conducted to analyze the differential impact of the nationwide FHA 203(b) mortgage limit upon FHA 203(b) activity in specific SMSAs.

Third, construction of indexes of housing prices also contributes to the development of indexes of the overall cost of living among metropolitan areas. There are many uses to which such cost of living indexes could be applied. Consider the large number of federal transfers and grants which could be adjusted to reflect local cost differences, for example, Revenue Sharing, Community Block Grants, Aid to Families with Dependent Children, and Supplemental Security Income. Currently a great deal of attention is focused on formulas for allocating federal dollars but little information is available about what these dollars can purchase in different cities.

Of course, if differences in housing prices among SMSAs were inconsequential none of the above uses of housing price indexes would be important. But common experience tells us housing price differences among SMSAs are quite consequential. Many people have had the experience of selling a house in one city and paying considerably more (or less) for a comparable house in another city. For example, in early 1975 a typical seven-room house sold for about $29,000 in Spokane and $56,000 in Paterson.[1] At the same time a typical five-room apartment rented for $140.00 in New Orleans and $231.00 in Miami.[2] Since families on average devote more than 25 percent of their budgets

1. Table 15 and chapter 3.
2. Table 14 and chapter 3.

to housing and utilities, such differences in values and rents are indeed consequential.[1]

Not only are differences among SMSAs in house rents and values for similar units substantial in size, they tend to be long lasting. This is because of the immobility and durability of housing. Housing's immobility makes arbitrage--the movement of goods from a relatively cheap market to a relatively expensive one--impractical. Arbitrage is more easily done with mobile goods. For example, if automobile or meat prices were much higher in the West than the South, southern supplies of cars or meat would be shipped to the West. The movement would increase supplies in the West and decrease supplies in the South. This would, in turn reduce prices in the West and increase them in the South. The process would continue until prices in both regions differed by no more than the cost of transportation between them. As arbitrage cannot work with housing, differences in local housing prices tend to persist. Furthermore, housing's durability means that once local conditions alter prices, it can take a very long time before the existing housing stock adjusts to bring prices back toward national levels.

In summary, the motivation for constructing housing price indexes stems from the important cost differences which seem to exist among metropolitan areas and the wide range of potential uses for such indexes.

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1. History of the CPI (13), Bulletin 1517, appendix table 9, p. 97. Shelter and utilities is the largest item in the consumer's budget, and it is almost eight percentage points higher than the fraction spent on food consumed at home.

Problem

Constructing constant quality indexes of the price of housing is a difficult problem because housing is a heterogeneous commodity. Differences in the rents or values of two housing units can result from differences not only in the price of housing, but also from differences in the size and quality of the units. For example, if one house is twice as large as another and sells for twice as much, would we conclude the larger house has a higher price? No, not necessarily. The larger house costs more, but one gets more for the extra money. The "amount of house" purchased per dollar of expenditures may be the same for both units. It is this notion--the amount of house per dollar of expenditures--that our indexes try to measure.

The discussion can be made more precise by introducing the concept of "housing services." Housing services refer to all the physical features of a housing unit and its neighborhood which make it a desirable or undesirable place to live. The bigger and better a house, the more housing services it generates, or, the greater the quantity of housing services the unit produces. A logical companion to the quantity of housing services is the price per unit of housing services, or the amount of house per dollar of expenditures. Using these two terms, we can define the rent or value of a unit as total expenditures on housing where total expenditures equal the product of price and quantity. Our indexes are measures of the price per unit of housing services in different metropolitan markets.

Carefully defining the concepts upon which our indexes are based is important, but it does not produce the measures we seek. The problem is that neither the price per unit of housing services nor the quantity of services are directly observable. They must be inferred from data on the rents and values of housing units. There are two methods which we feel allow inferences to be made about the price per unit of housing services, and they are discussed below.

Before that discussion begins, one further distinction needs to be made which is central to an understanding of the differences between indexes of rent and value presented in this paper. Rent and value indexes do not measure exactly the same thing. The rent indexes are true measures of the price per unit of housing services because a renter partakes in an exchange of rent for the <u>use</u> of a unit for some period of time. The owner, on the other hand, exchanges money for a <u>structure</u> and its neighborhood. One exchange involves a flow of services (renters) and the other involves a stock (owner). Accordingly, the measure of rent we use includes utility expenses because utilities are important contributors to the total flow of housing services. Obviously, the value of an owner-occupied unit does not include payment for utility expenses. These distinctions imply that the rent and owner indexes measure similar but not identical concepts. The rent index is a measure of the price per unit of renter-occupied housing services, inclusive of utilities. The owner index measures the price per unit of housing <u>stock</u> exclusive of utility expenses.

In summary, constructing indexes of the price of housing is difficult because housing is heterogeneous and the price per unit of housing services is unobservable. We observe, instead, expenditures on housing. There are methods which can produce constant quality price indexes from rent and value data. The two which we employ are discussed next.

Our Approaches

One technique we use is the method of hedonic indexes. The technique is based upon two key assumptions. The first is that a housing unit is not a single heterogenous unit, but rather a bundle comprised of many dwelling characteristics, for example, number of rooms, type of heating system, etc. Second, each one of these characteristics has its own price which, although not directly observable, can be estimated via multivariate regression analysis. For example, the regression results might indicate that an additional room adds ten percent to monthly rent.

Equipped with sets of these characteristic prices for the thirty-nine SMSAs in the sample, construction of indexes of housing rents and values is relatively straightforward. A particular type of housing bundle--one for rental units, one for owner-occupied homes--is specified and then priced in each of the thirty-nine SMSAs. The ratio of the predicted rents (or values) between any two SMSAs corresponds to the ratio of the relative price per unit of housing services (or housing stock) between the two SMSAs. In other words, the relative price per unit of housing services between any two SMSAs is a weighted average of the prices of the individual characteristics in one SMSA relative to those in another SMSA. The schedule of predicted rents (or values) for all thirty-nine SMSAs gives the full hedonic housing price index. This procedure is discussed in more detail and demonstrated in chapter 2.

The second technique is the BLS method. This method is quite simple in comparison to the hedonic technique. First, a particular type of housing bundle is specified. For example, a five room rental unit with central heating might be selected. Then, all dwellings within a particular SMSA (or a sample of these units) with such characteristics are selected and the average rent of the selected units is computed. The procedure is repeated in other SMSAs using the <u>same</u> set of selected housing characteristics. The resulting schedule of average rents constitutes the BLS-type rental price index. An index of house values can be constructed analogously by specifying a particular type of owner-occupied housing and calculating its average value in each SMSA. This procedure is discussed in more detail and demonstrated in chapter 3.

Neither the hedonic nor the BLS method is without problems. Foremost, in our minds, is the concern that the measures of the variation of housing prices are sensitive to the specification of the referenced housing bundle. For example, it is possible that Albany is much less expensive than Boston for some types of housing, but more expensive for other types. Since we think this is possible, we construct several indexes by each method. In so doing, insight is achieved as to the quantitative significance of our concern. As will be seen, the concern is real.

<u>Other Existing Indexes</u>

There are two existing measures which are used as intermetropolitan indexes of the price of housing. One is a schedule of median rents and values reported, among other places, in the Annual Housing Survey.

The second is the Family Budgets index produced by the Bureau of Labor Statistics.

The first measure is not designed to be a constant quality index, but it is occasionally used to make inferences normally made by constant quality price indexes. For example, Michael Sumichrast reported in the Washington Star, the median house values for twenty-one SMSAs in the 1975 wave of the Annual Housing Survey. He used the list to make inferences about the most and least expensive SMSAs in the country.[1] Presumably, median rents and values would be acceptable constant quality price indexes if the distribution of the size and quality of housing is relatively constant among SMSAs. Two observations suggest such is not the case.

Consider, first, the intermetropolitan variations in three measures of the size of owner-occupied housing: the number of bathrooms, the number of total rooms, and the number of bedrooms. These statistics are all drawn from the sample upon which our price indexes are based which also happens to be the sample upon which Sumichrast's values are based. The average number of bathrooms in the thirty-nine SMSA sample varies from 1.33 to 2.05. The average number of rooms varies from 5.55 to 7.07, and the average number of bedrooms varies from 2.74 to 3.33. The standard deviations of the distribution of the mean estimates are .16 for bathrooms, .36 for rooms and .15 for bedrooms.[2] The amount of variation in the number of bathrooms and total rooms is most striking. They indicate, for example, that median values could

1. The Washington Star (7). In the same article Sumichrast also uses the change in median values of homes 1970-1975 to draw inferences about changes in the price of constant quality homes.

2. Follain and Malpezzi (3), p. 22.

refer to a 7.1 room, 2.05 bath house, or a 5.55 room and 1.33 bath house. Even in a world of perfect equality of the price per unit of housing stock, variation of this degree in the quantity of housing stock could lead to significant variation in median values.

A second reason median value variations do not necessarily reflect price variations involves the pattern of new construction in recent years. The pattern is marked by relatively higher levels in the South and West. Secondly, the average size and quality of new housing have improved (see figure 1). These two facts suggest that median values would be rising more rapidly in the South and West even if the base price per unit of housing stock was constant across the United States.

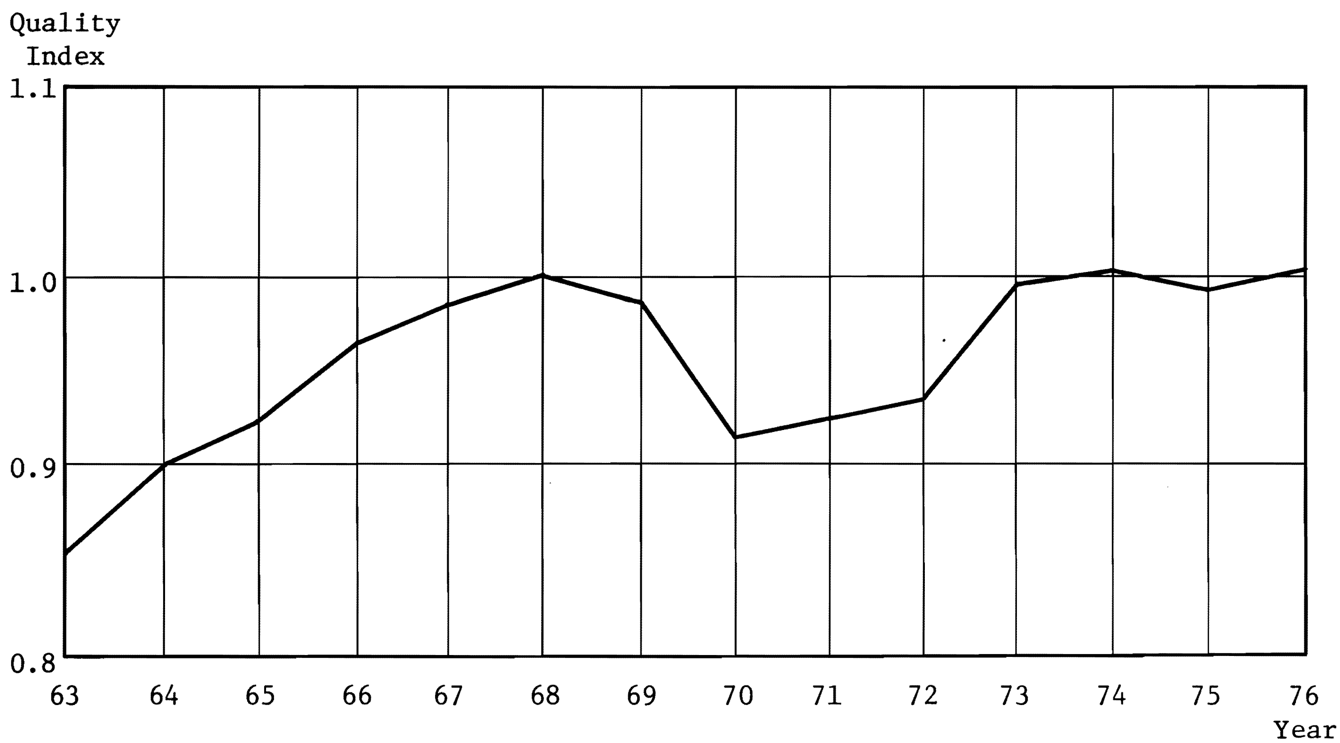
The only constant quality price index of housing comparing a large number of metropolitan areas which existed prior to ours is that published by BLS. It is a component of the Family Budgets Cost-of-Living index.[1] This index measures separately the costs of owner and renter-occupied housing. The accuracy of this index is difficult to assess since it is the only index of its kind. There are, however, several aspects of the BLS index where improvement seems possible.

The first involves quality control for rental housing. An apparent problem is that very few features of an apartment are used to define the type of unit the BLS prices in each market. Their rental unit is essentially a five-room, nondilapidated unit. A sample of all units in an SMSA fulfilling a slightly extended version of this

1. BLS, Autumn 1975 (10). A pioneering study by Gillingham (5) created indexes similar to ours for rental housing, but only for ten cities and no comparable owner-occupant index of house values was constructed.

Figure 1

"QUALITY" OF NEW ONE-FAMILY HOMES



The quality index was derived as follows. Both (a) the price of a new unit of fixed quality and (b) the price of new dwellings of the actual average quality for each year 1963-1976 are given in the Department of Commerce, Price Index of New One-Family Houses Sold (Washington, D.C.: U.S. Government Printing Office, 1976). Since the former is a price index, any difference between the two prices for a given year must be due to quality differences between the base of the constant-quality index and average, actual quality. Hence the ratio (b)/(a) yields an index of housing quality.

This is essentially an updated version of a chart used by Frank deLeeuw, Anne B. Schnare and Raymond Struyk, in "Housing," The Urban Predicament (1), p. 140.

definition are used to compute an average rent for the SMSA. Since the definition used is not very exhaustive, it is unlikely that the index is truly a constant quality price index.

A second potential problem with the existing BLS rent index is that the pricing of the BLS "constant quality" bundle took place in 1969. Since then, the rents in each of the thirty-nine SMSAs in the BLS sample have been updated by the Consumer Price Index (CPI) for all rental housing in that SMSA. If all rental housing prices in an SMSA move uniformly and if the CPI rent index is accurate, then the updated index is accurate. Otherwise, it is out of date.

Similar problems of quality control and index adjustment over time occur for the homeowner side of the Cost-of-Living Index. A major component of homeowner expenses is the purchase price of the house. For this expense, the BLS uses average house values per metropolitan areas as reported in the 1959-60 Comprehensive Housing Unit Survey.[1] Little quality control seems to be exercised to insure that local average values reflect prices for similar quality housing among metropolitan areas. Also, adjustment of the homeowner index over time is hampered by reliance on Federal Housing Administration (FHA) records of homes sold with an FHA insured mortgage. In the 1970s FHA insured homes have reflected a small and unrepresentative sample of all home sales so that their sales values provide a questionable basis for updating marketwide house costs.

Given these areas where improvement seems necessary, one might think a paper like ours would have been done long ago. In fact, a

1. BLS (12), pp. 42-43.

1975 study by Robert Gillingham of BLS used essentially the same methodology as is employed in this paper.[1] Furthermore, the Bureau has maintained an active research program to improve its indexes. But the Gillingham study was confined to rental housing in only ten cities, a data shortcoming which apparently also hampers other BLS efforts to improve its Family Budgets Cost-of-Living index. This study, on the other hand, makes use of the newly available Annual Housing Survey. The survey combines detailed descriptions of individual dwellings with broad coverage of U.S. metropolitan markets which permits improved index construction for most major metropolitan areas[2]. Thus, the availability and quality of this new data source are the main reasons why our study is now possible. The Annual Housing Survey is briefly discussed in chapter 2.[3]

Overview of the Results

In chapter 2, indexes based upon the hedonic technique are presented. A description of the data we use and a detailed description of the technique are also provided. In addition to presenting indexes based upon a "typical bundle," we also present indexes for a wide variety of dwelling types and dwelling locations. We find evidence of extensive variation in the price per unit of housing services and stock. Furthermore, there is evidence that indexes are sometimes quite sensitive to the type of bundle being priced.

1. Gillingham (5).

2. The full survey covers fifty-nine SMSAs in three yearly waves. The present study is based on the first two waves which includes thirty-nine SMSAs.

3. For a more complete description, consult any of the printed reports based upon the survey (8).

The third chapter contains analysis of the BLS method similar to that done in chapter 2. We find the BLS method is also sensitive to the type of bundle specified. In chapter 3, we also compare our BLS Indexes with the official BLS rent indexes. The comparison shows the official index is less than our BLS index in seventeen of the eighteen SMSAs in which a comparison is possible. This is consistent with the claim that the updating procedures used by the BLS contain some significant inaccuracies.

As mentioned earlier, one of the goals of this paper is to analyze the two methods used to produce the price indexes. In chapter 4, we compare the hedonic indexes with BLS indexes. Some significant differences are uncovered which suggest there are real differences in the methods since the data used to construct the indexes are identical. In particular, we find the BLS indexes show much less intermetropolitan variation in the price per unit of housing than the hedonic based indexes. Several hypotheses are offered for the differences and tested.

CHAPTER II: PRICE INDEXES BASED UPON THE METHOD OF HEDONIC INDEXES

In this chapter, we present indexes of the price per unit of housing services for renters and per unit of housing stock for owners. The indexes are based upon the hedonic method. In addition to simply presenting the indexes, we analyze the sensitivity of the indexes to the type of housing bundle used to construct it. In particular, we examine the sensitivity of the index to (a) quality of housing being priced, (b) differences in housing consumption patterns among SMSAs, (c) central city and suburban price differences, and (d) inclusion of neighborhood quality as a component of housing. The sensitivity of a housing price index to these factors is important for knowing if the same index is applicable to rich and poor households, to frostbelt and sunbelt cities, to central cities and suburbs, and so on.

The remainder of the chapter is divided into four sections. The method used to construct the indexes is discussed in the next section. The following section contains a discussion of the data employed. Then our hedonic indexes are presented and discussed. The chapter ends with a summary of findings.

Method Used to Develop the Hedonic Price Indexes

The typical price index for a group of commodities is a weighted average of the observed prices of commodities within the group. The weights are some function of the quantities of the commodities consumed by a referenced household. If the housing unit is viewed not as a commodity but rather as a commodity group, then the procedure used in this chapter to develop price indexes is almost identical to the standard procedure. The key difference is that the prices of the commodities or characteristics in the housing bundle are not observable and must be estimated.

The prices of the characteristics of the housing bundle are estimated via the hedonic regression model. In this model, the rent (or value) of a dwelling is a function of the structural characteristics of the dwelling and the characteristics of the neighborhood in which the dwelling is located. That is, $R = F(X^s, X^n, X^t)$ where R is the gross rent (contract rent plus utilities) of the dwelling, X^s is the vector of the dwelling's structural characteristics, X^n is the vector of the characteristics of the neighborhood in which the dwelling is located, and X^t is a vector of selected tenant characteristics which affect the price per unit of housing services, for example, race. The value of a unit is used as the dependent variable for owner regressions.

The particular specification of the regression equation we use is the semilog form:

$$\ln R = \ell_o + \ell^s X^s + \ell^n X^n + \ell^t X^t$$

where ℓ^s, ℓ^n, and ℓ^t are the vectors of the prices of the structural, neighborhood, and tenant characteristics respectively. A description of all the characteristics used in the regressions is in appendix A. Two sets of characteristics are used in the regressions, one for owners and one for renters. The two sets are, however, quite similar. The set for each tenure group is designed so that it can be estimated identically in all SMSAs in our sample. With a few very minor exceptions, this is in fact, what is done.[1]

The regression model is estimated in each of the thirty-nine SMSAs examined in this paper. The product of each regression is a set of $\ell_i = (\ell_i^s, \ell_i^n, \ell_i^t)$ i = 1,39. Each ℓ_i is a vector of hedonic prices. One set of ℓ_i is calculated for owners and one for renters. Until it becomes necessary to distinguish, the following discussions relate to the set of prices for renters.

Given a set of thirty-nine hedonic price vectors, construction of a price index is relatively straightforward. First, a particular bundle is selected, say a five-room, two-bedroom, one-bath, ten-year old apartment in a "good" neighborhood. This bundle is priced in each city by multiplying the estimated prices of the specified characteristics by the quantities of those characteristics and summing the products. The antilog of the sum of the products in city i[2] is the predicted amount for which the selected bundle would rent in city i. The ratio of the predicted rent of the bundle in city i to the predicted rent of the selected bundle in city 1, is the price of housing in city i

1. The hedonic regressions performed reasonably well. The R^2 statistics averaged about .62 and the standard errors of the regression equations varied between twenty and thirty percent of either mean rent or value. A full discussion of the development of the hedonic equation estimation problems and other pertinent information about the estimated hedonic equations is contained in Follain and Malpezzi (3).

2. Pricing the bundle with the regression estimated prices gives the expected value of the logarithm of rent for dwellings with such characteristics. The antilog of that figure give the predicted rent for a dwelling with such characteristics but it is not the expected value of rent.

relative to city 1. More precisely,

$$P_{i1} = \text{EXP} \left(\sum_{k=0}^{n} \hat{\ell}_{ki} \bar{X}_K \right) / \text{EXP} \left(\sum_{k=0}^{n} \hat{\ell}_{k1} \bar{X}_k \right)$$

where P_{i1} is the price of housing in city i relative to city 1 and n is the number of characteristics in the selected bundle. The "^" symbol indicates the estimated value of ℓ. Albany is used as the base SMSA for all the price indexes. This is an arbitrary choice, any other SMSA would serve the same purpose.

Data Used to Construct Indexes

The data sets used to estimate the hedonic regression equations are the 1974 and 1975 Annual Housing Surveys for Selected Metropolitan Areas (7). Separate surveys are available for 39 SMSAs. In most surveys, 5,000 housing units are surveyed, but in the 8 largest SMSAs, 15,000 are surveyed.

In addition to the criteria used by the Census to select the total sample, we add several others for our subsample. One of our restrictions is that units must have been occupied by the current resident for both the last 90 days and the previous winter. This restriction is employed because it is only for these units that answers are provided to all questions about housing and neighborhood characteristics in the AHS. A second restriction is that public housing units and units occupied by households receiving government housing subsidies are excluded. This is done because the rents of these dwellings are influenced more by non-market forces than the strictly private units. A third set of restrictions is that only specified owner-occupied and specified renter-occupied houses, apartments and flats are used. This is because rents and values are always available for these units.[1] These three sets of restrictions result in a 5 to 15 percent reduction in the size of the samples, but in all cases, the sample size exceeds 700 units for each tenure type. Most samples are between one and two thousand units. There are some other minor restrictions we employ. For a fuller discussion of the data sets, see Follain and Malpezzi (4).

An important feature of the Annual Housing Survey data we use is that it was collected over a two-year time period. Wave I data were collected from April 1974 to March 1975. Wave II data were collected from April 1975 to March 1976. During this period, the housing component of the national CPI increased at annual rates in excess of ten percent. This means that the differences in the values or rents of two identical units could be substantial if the units are surveyed at two significantly different points in time. Furthermore, it is not appropriate to adjust all housing rents and values for a national CPI since inflation rates seem to differ across housing markets. Those cities for which the CPI is available show rent inflation rates ranging from 4.5 in Detroit to 2.4 in Kansas City for the year 1973 to 1974.[2] To solve this problem inflation rates are estimated for each market by tenure as part of our hedonic regressions. The inflation rates are then used to adjust the value (or the rent) of a particular bundle so that all prices refer to the same period -- March 1975.[3]

1. Specified Renter Occupied is the set of all renter-occupied units except those single family homes on ten or more acres. Specified Owner Occupied is the set of all single family units on less than ten acres with no commercial, medical, or dental offices on the property.

2. CPI Detailed Report for December 1974, table 5-A (11).

3. The procedures used to estimate the inflation rates and a discussion of the estimates are fully described in Follain and Malpezzi (3), pp. 105-20.

The Hedonic Indexes

In this section, we present a large number of intermetropolitan indexes of the price per unit of housing services and housing stock. The first part demonstrates how an hedonic index is actually constructed. It also indicates the enormous variations in housing prices and rents which exist among metropolitan areas. The latter parts examine variations in the index with respect to four types of variation in the reference bundles. The four types are as follows:

1. Variations with respect to major differences in housing quality or household income
2. Variations with respect to the intermetropolitan location of the "typical" dwelling
3. Variations with respect to the intrametropolitan location of the "typical" dwelling
4. Variations with respect to the definition of housing services

Price Indexes for a Typical Dwelling

Two price indexes are presented in this subsection, one for renters and one for owners (table 3). The indexes refer to the amounts for which the typical bundles would rent or sell in the thirty-nine SMSAs of this study.

In order to construct the index, two things are needed. First, the specification of the components of a housing unit; second, a set of prices for each of the components specified. The specifications of the rented unit and the owner-occupied unit which we call our "typical" units, are in tables 1 and 2. Each element of the "typical" bundle is the mean value of the means of the components in our samples. For example, the typical renter dwelling has 1.1

Table 1

Bundle Specifications Used to Compute Hedonic Price Indexes for Renters

<u>Characteristics</u>

Description	Variable*	1 Typical Dwelling (TD)	2 Poor Dwelling (PD)	3 Fair Dwelling (FD)	4 Good Dwelling (GD)	5 Excellent Dwelling (ED)
Baths	V074	1.11	1.00	1.00	1.50	2.00
Age	V005LN	2.87	3.91	3.22	1.61	.00
Rooms	V056	4.10	3.00	5.00	6.50	10.00
Bedrooms	V059	1.81	1.00	1.00	3.00	4.00
House Rating	V277	2.15	4.00	3.00	2.00	1.00
Central Heat	V086CH	.39	.00	.00	1.00	1.00
Add Heat	V088	.10	.00	.00	.00	.00
Central Air	V099	.18	.00	.00	1.00	1.00
Privacy	V6162	.13	1.00	.00	.00	.00
Rats	V114	.10	1.00	.00	.00	.00
Fuses	V102FB	.11	.00	.00	.00	.00
Rooms Without Heat	V090B	.13	1.00	.00	.00	.00
Number Units	V050G5	.39	.00	.00	.00	.00
Cooking Fuel	V066E	.40	.00	.00	.00	1.00
Heating Fuel	V084E	.16	.00	.00	.00	1.00
Hallway	V028012	.11	1.00	.00	.00	.00
Cracks	V110	.10	3.00	1.00	.00	.00
Rent and Furnishings	V156	.13	.00	.00	.00	.00
Broken Plaster	V112	.18	1.00	.00	.00	.00
Single Family	V050SF	.23	.00	.00	.00	1.00
Breakdowns	BRKDWS	.57	8.00	2.00	.00	.00
Utilities and Rent	EXTRAS	1.61	.00	.00	.00	.00
Street Rating	V276	2.06	4.00	3.00	2.00	1.00
Bad Housing	V278	.09	1.00	.00	.00	.00
Airplane Noise	AIR	.00†	.00	.00	.00	.00
Schools Inadequate	SCHOOL	.00†	.00	.00	.00	.00
Shopping Inadequate	SHOPS	.00†	.00	.00	.00	.00
Street Crime	CRIME	.00†	.00	.00	.00	.00
Street Noise	NOISE	.00†	.00	.00	.00	.00
Street Traffic	TRAFFIC	.00†	.00	.00	.00	.00
Crowding	V347	.59	1.33	.80	.62	.40
Race	V031B	.15	.00	.00	.00	.00
Length of Tenure	V040YRS	4.91	.00	.00	.00	.00

* Variable specifications appear in appendix A.
† Values set to zero because of instability in estimated coefficients.

Table 2

Bundle Specifications Used to Compute
Hedonic Price Indexes for Owners

Characteristics Description*	Variable*	1 Typical Dwelling (TD)	2 Poor Dwelling (PD)	3 Fair Dwelling (FD)	4 Good Dwelling (GD)	5 Excellent Dwelling (ED)
Baths	V074	1.58	1.00	1.00	1.50	2.00
Age	V005LN	2.86	3.91	3.22	1.61	.00
Rooms	V056	6.16	4.00	5.00	6.50	10.00
Bedrooms	V059	3.00	2.00	2.00	3.00	4.00
House Rating	V277	1.59	4.00	3.00	2.00	1.00
Central Heat	V086CH	.66	.00	.00	1.00	1.00
Add Heat	V088	.06	.00	.00	.00	.00
Central Air	V099	.25	.00	.00	1.00	1.00
Privacy	V6162	.06	.00	.00	.00	.00
Rats	V114	.07	1.00	.00	.00	.00
Fuses	V102FB	.13	.00	.00	.00	.00
Rooms Without Heat	V090B	.12	.00	.00	.00	.00
Garbage Collection	V104	.07	.00	.00	.00	.00
Garage	V125	.81	.00	.00	.00	1.00
Basement	V107	.54	.00	.00	.00	1.00
Cooking Fuel	V066E	.56	.00	.00	.00	.00
Heating Fuel	V084E	.08	.00	.00	.00	.00
Cracks	V110	.03	1.00	.00	.00	.00
Broken Plaster	V112	.07	1.00	.00	.00	.00
Breakdowns	BRKDWS	.34	8.00	2.00	.00	.00
Tax Rate	TAXRTLN	-4.27	-4.02	-4.02	-4.02	-4.02
Street Rating	V276	1.66	4.00	3.00	2.00	1.00
Bad Housing	V278	.04	1.00	.00	.00	.00
Airplane Noise	AIR	.37	.00	.00	.00	.00
Schools Inadequate	SCHOOL	.07	.00	.00	.00	.00
Shopping Inadequate	SHOPS	.00†	.00	.00	.00	.00
Street Crime	CRIME	.00†	.00	.00	.00	.00
Street Noise	NOISE	.00†	.00	.00	.00	.00
Street Traffic	TRAFFIC	.00†	.00	.00	.00	.00
Race	V031B	.55	1.00	.80	.62	.40
Crowding	V347	.07	.00	.00	.00	.00
Length of Tenure	V040YRS	12.08	.00	.00	.00	.00

* Variable specifications appear in appendix A.
† Values set to zero because of instability in estimated coefficients.

bathrooms. This is the average of the mean values for bathrooms for each SMSA in the sample. The mean for a particular SMSA, say Chicago, is the mean number of bathrooms for the housing units in our Chicago renter sample.

An idea of what the typical dwelling unit is like can be determined by examining the values of the first five elements of the bundle (columns 1 of tables 1 and 2). For example, the typical renter occupied dwelling has 1.1 bathrooms, 4.1 rooms, 1.81 bedrooms, is 17.65 years, old and is rated 2.15 by the occupant on a scale of 1 to 4 (1 = excellent). The typical owner-occupied dwelling is about the same age (17.44 years old) but is larger (1.58 bathrooms, 6.16 rooms, 3.00 bedrooms) and judged by the occupant to be of higher quality (1.59). Both units are located in the central city.

The second set of data needed to construct an index is a set of prices. A set of prices consists of thirty-nine vectors of characteristic prices. Each element of a vector is the estimated price of a particular characteristic in the typical bundle. For example, the price of a bathroom in Chicago (expressed as the percentage contribution of one more bathroom to gross rent) is 26 percent. The full set of prices is reported elsewhere.[1]

The price indexes are constructed from these two sets of data. First, the amounts for which the selected bundle would rent in the various SMSAs are calculated. This is done by multiplying the quantities of the selected characteristics by their estimated prices and summing the products. The results of these calculations are

1. Follain and Malpezzi (4).

presented in columns one (renters) and four (owners) of table 3. For example, the typical renter-occupied unit rents for $196 in Albany.

Second, the rent and value indexes are constructed by dividing the predicted rents and values for each city by the average rent or value for all cities. The index values are in columns 2 (renters) and 5 (owners) of table 3.

Finally, the ranks of the different SMSAs are determined. These are in table 3, columns 3 and 6. The higher the rank, the more expensive the SMSA. The three most expensive cities for renters are Anaheim, Albany, and Boston. The three least expensive are San Antonio, Kansas City, and Fort Worth.

The principal message of the data in table 3 is that significant variation exists in the price of renter-occupied and owner-occupied dwellings. The range for rents is $141 and the range of the index values of rent is 1.06. As may be seen from the table, the wide range is not the result of a few outliers.

For owners, the variation in housing prices is also striking. The range of values is $24,000 ($45,140 in Paterson to $21,026 in Kansas City). The range of the index values is .79 (1.48 to .69). In other words, our typical dwelling sells for over twice as much in Paterson as it does in Kansas City. The wide range for owners is not the result of a few outliers either.

A second important point is that the indexes of owner-occupied dwellings differ from those of renter-occupied dwellings. The top five cities for owner-occupied units are Paterson, San Francisco, Los

Table 3

Rents, Values, Index Values, and Rankings Based Upon the Typical Bundles and the Hedonic Approach

	Renters			Owners		
SMSA	Rents	Index	Rank*	Value	Index	Rank**
Albany	196	1.35	38	$ 30935	1.01	24
Anaheim	236	1.63	39	38143	1.25	32
Atlanta	128	.88	10	29656	.97	23
Boston	195	1.34	37	36071	1.18	30
Chicago	156	1.08	28	35136	1.15	29
Cincinnati	106	.73	5	24339	.80	6
Colorado Springs	138	.95	18	26394	.86	16
Columbus	106	.73	6	24709	.81	8
Dallas	130	.90	13	24598	.81	7
Detroit	130	.90	11	26485	.87	17
Fort Worth	97	.67	3	24129	.79	5
Hartford	179	1.23	33	37897	1.24	31
Kansas City	95	.66	2	21026	.69	1
Los Angeles	155	1.07	27	42361	1.39	37
Madison	127	.88	8	32998	1.08	27
Memphis	132	.91	14	27143	.89	19
Miami	145	1.00	23	39745	1.30	34
Milwaukee	138	.95	19	33803	1.11	28
Minneapolis	177	1.22	32	28789	.94	22
Newark	189	1.30	36	39730	1.30	33
New Orleans	127	.88	9	31224	1.02	25
Newport News	151	1.04	24	28095	.92	20
Orlando	185	1.28	35	26333	.86	15
Paterson	180	1.24	34	45140	1.48	39
Philadelphia	133	.92	15	23975	.79	4
Phoenix	141	.97	21	25520	.84	10
Pittsburgh	154	1.06	26	25627	.84	12
Portland	130	.90	12	25895	.85	13
Rochester	135	.93	16	24896	.82	9
Salt Lake City	120	.83	7	27133	.89	18
San Antonio	82	.57	1	26002	.85	14
San Bernardino	157	1.08	29	28654	.94	21
San Diego	144	.99	22	41756	1.37	36
San Francisco	170	1.17	30	43285	1.42	38
Spokane	140	.97	20	21884	.72	2
Springfield	151	1.04	25	32512	1.06	26
Tacoma	137	.95	17	25620	.84	11
Washington, D.C.	173	1.19	31	40188	1.32	35
Wichita	100	.69	4	22789	.75	3
Average	145			30529		

* The larger the rank, the higher the price of housing.
** Ranks are based on actual values before the rounding of the numbers in the rent and value columns.

Angeles, San Diego, and Washington, D.C. The top five for renters are Anaheim, Albany, Boston, Newark, and Orlando. There is not one SMSA which is in the top five for both owners and renters. This suggests that the rankings of SMSAs are different for owners than renters. In fact, the simple correlation between the two indexes is .61.

Another indicator of the difference is the ratio of the mean rent or value to its standard deviation. For renters, the ratio is 4.59 and for owners it is 4.57. This suggests the variation in rents is quantitatively similar to the variation for values even if the rankings are different. Succinctly stated, both rents and values vary a great deal across SMSAs and the rankings of the SMSAs are not identical.

Variation in the Index with Respect to Family Income or Major Quality Changes

The indexes in the last subsection are constructed for a somewhat arbitrary bundle. It is reasonable to ask how sensitive are the indexes to the specification of the reference bundle. We now begin to answer this question. The first variation considered is with respect to major changes in the quality and size of the referenced housing unit. This variation in housing could result from major differences in the income of the occupants. Thus, this analysis permits a statement to be made about the intermetropolitan variation in the price of housing for households of different income levels.

Four bundles are considered for each tenure type and the details of the dwellings are in table 1. A broad description of the renter dwellings is given here. The first is a Poor Dwelling (PD). This unit is fifty years old, has one bathroom, three rooms, one bedroom and is rated poor by the occupant. The street is also rated poor.

The other three dwellings are progressively larger and receive higher housing quality and neighborhood quality ratings by the occupant. FD (Fair Dwelling) is a five-room unit with a rating of fair for its housing and neighborhood. GD (Good Dwelling) is a 6.5 room unit with good ratings and ED (Excellent Dwelling) is a ten-room unit with excellent ratings. All units are located in the central city of the SMSA.

In order to determine the sensitivity of the index to the specification of the overall size and quality of the reference bundle, the ranges of the index values and the rankings are examined. In addition, the correlations among the indexes and the rankings are calculated. The results are in table 4 (renters) and table 5 (owners).

The overwhelming conclusion is that this type of change in the reference bundle does matter. Consider, first, the wide range of index values for renters obtained for a particular SMSA. Pittsburgh is an especially striking example of this. For a Poor Dwelling, Pittsburgh is slightly less expensive than average (index of .99). For an Excellent Dwelling, however, Pittsburgh is 1.42 times more expensive than average and only three areas are more expensive. The range is .43. The ranges of index values for the other SMSAs are not always so striking but fourteen exceed .25 and only nine are less than .10. Thirteen cities actually straddle unity which means that for some bundles the city is more expensive than average and for others, it is less expensive. The other twenty-six cities are always either more expensive or less expensive than average.

The standard deviation of the rankings for a particular SMSA is typically between two and four. Eight SMSAs have standard deviations

Table 4

Rents, Index Values, and Ranks Based Upon
Four Special Bundles and the Hedonic Approach

	1	2	3	4	5	6	7	8	9	10	11	12
	Rent				Index				Rank			
SMSA	PD	FD	GD	ED	PD	FD	GD	ED	PD	FD	GD	ED
Albany	97	159	298	620	1.11	1.28	1.27	1.37	29	33	33	33
Anaheim	181	198	352	615	2.08	1.60	1.50	1.36	39	39	38	32
Atlanta	83	130	249	456	.95	1.05	1.06	1.01	21	24	28	25
Boston	115	167	282	579	1.32	1.35	1.20	1.28	35	36	30	29
Chicago	92	117	220	420	1.06	.94	.94	.93	26	21	19	22
Cincinnati	63	85	174	351	.72	.69	.74	.78	4	3	5	12
Colorado Springs	83	111	215	371	.95	.90	.91	.82	20	15	16	14
Columbus	68	93	166	280	.78	.75	.71	.62	7	6	2	2
Dallas	94	110	222	374	1.08	.89	.94	.83	27	14	22	15
Detroit	85	97	186	402	.98	.78	.79	.89	23	8	9	20
Fort Worth	72	92	179	333	.83	.74	.76	.74	10	5	7	8
Hartford	120	166	343	654	1.38	1.34	1.46	1.45	37	34	37	37
Kansas City	73	91	170	306	.84	.73	.72	.68	12	4	3	5
Los Angeles	72	109	239	493	.83	.88	1.02	1.09	11	13	25	27
Madison	71	95	229	566	.82	.77	.97	1.25	9	7	24	28
Memphis	88	103	205	375	1.01	.83	.87	.83	24	11	14	16
Miami	95	123	213	389	1.09	.99	.91	.86	28	22	15	18
Milwaukee	68	112	222	427	.78	.90	.94	.94	6	16	21	23
Minneapolis	109	148	295	623	.01	1.19	1.26	1.38	34	30	32	34
Newark	119	170	364	797	1.37	1.37	1.55	1.76	36	37	39	39
New Orleans	78	112	197	396	.90	.90	.84	.88	16	17	11	19
Newport News	76	128	221	345	.87	1.03	.94	.76	13	23	20	11
Orlando	121	180	302	447	1.39	1.45	1.29	.99	38	38	34	24
Paterson	105	167	323	716	1.21	1.35	1.37	1.58	32	35	36	38
Philadelphia	76	130	199	305	.87	1.05	.85	.67	15	25	12	4
Phoenix	99	139	246	376	1.14	1.12	1.05	.83	31	28	26	17
Pittsburgh	80	144	294	643	.92	1.16	1.25	1.42	18	29	31	36
Portland	69	102	182	312	.79	.82	.77	.69	8	10	8	6
Rochester	88	117	201	342	1.01	.94	.86	.76	25	20	13	9
Salt Lake City	60	100	218	407	.69	.81	.93	.90	3	9	17	21
San Antonio	46	65	146	260	.53	.52	.62	.58	2	1	1	1
San Bernardino	76	115	220	359	.87	.93	.94	.79	14	18	18	13
San Diego	80	116	193	345	.92	.94	.82	.76	17	19	10	10
San Francisco	98	156	267	598	1.13	1.26	1.14	1.32	30	32	29	31
Spokane	67	108	226	476	.77	.87	.96	1.05	5	12	23	26
Springfield	105	131	249	636	1.21	1.06	1.06	1.41	33	26	27	35
Tacoma	85	138	173	330	.98	1.11	.74	.73	22	27	4	7
Washington, D.C.	82	149	318	595	.94	1.20	1.35	1.32	19	31	35	30
Wichita	42	74	174	300	.48	.60	.74	.66	1	2	6	3
Average	87	124	235	452								

NOTE: PD = Poor Dwelling; FD = Fair Dwelling; GD = Good Dwelling, ED = Excellent Dwelling.
For definition, see table 1.

Table 5

House Values, Index Values, and Ranks Based Upon Four Special Bundles (Owners) and the Hedonic Approach

	House Values				Index				Rank			
SMSA	PD	FD	GD	ED	PD	FD	GD	ED	PD	FD	GD	ED
Albany	5887	13338	28322	61813	.50	.80	.96	1.04	6	16	23	26
Anaheim	21016	26560	34364	58445	1.78	1.58	1.17	.98	35	36	29	16
Atlanta	11741	15936	28717	54943	1.00	.95	.97	.92	23	23	24	13
Boston	12772	19636	36824	77291	1.08	1.17	1.25	1.30	25	30	35	39
Chicago	10581	18679	35916	70542	.90	1.11	1.22	1.18	20	29	31	33
Cincinnati	8083	12605	23000	49044	.69	.75	.78	.82	13	13	5	7
Colorado Springs	19527	16994	26028	43026	1.66	1.01	.88	.72	34	26	14	1
Columbus	5816	11600	23723	46744	.49	.69	.81	.78	5	6	7	4
Dallas	8846	11904	23553	51860	.75	.71	.80	.87	18	8	6	10
Detroit	6713	12186	27697	60518	.57	.73	.94	1.01	9	9	20	24
Fort Worth	8346	11104	22140	58313	.71	.66	.75	.98	14	3	3	15
Hartford	17673	23298	36394	73783	1.50	1.39	1.24	1.24	33	31	33	36
Kansas City	5479	9595	22010	47778	.47	.57	.75	.80	3	1	2	5
Los Angeles	14678	23509	38511	68305	1.25	1.40	1.31	1.14	29	32	38	32
Madison	9043	15266	31176	62478	.77	.91	1.06	1.05	19	19	26	27
Memphis	5617	13042	27056	58972	.48	.78	.92	.99	4	14	16	19
Miami	24687	26611	37624	63659	2.10	1.59	1.28	1.07	38	37	36	28
Milwaukee	8813	16093	33559	71742	.75	.96	1.14	1.20	17	24	28	34
Minneapolis	10663	15207	27982	60172	.91	.91	.95	1.01	21	18	22	23
Newark	16792	24229	37944	72683	1.43	1.45	1.29	1.22	31	33	37	35
New Orleans	15281	18608	30952	65994	1.30	1.11	1.05	1.11	30	28	25	30
Newport News	8734	15446	25422	44894	.74	.92	.86	.75	16	21	13	2
Orlando	13483	15374	24675	55958	1.14	.92	.84	.94	28	20	10	14
Paterson	21103	30006	45938	77264	1.79	1.79	1.56	1.29	36	39	39	38
Philadelphia	6672	12565	21708	45490	.57	.75	.74	.76	8	11	1	3
Phoenix	7710	13337	27091	58979	.65	.80	.92	.99	11	15	17	20
Pittsburgh	4612	10049	27440	76764	.39	.60	.93	1.29	1	2	19	37
Portland	10852	14349	24873	50384	.92	.86	.84	.84	22	17	11	8
Rochester	5316	11749	24579	48175	.45	.70	.83	.81	2	7	9	6
Salt Lake City	12965	15447	26686	54254	1.10	.92	.91	.91	26	22	15	11
San Antonio	7229	12585	22737	58949	.61	.75	.77	.99	10	12	4	18
San Bernardino	13147	16145	25165	59198	1.12	.96	.85	.99	27	25	12	21
San Diego	25545	25401	34896	58821	2.17	1.52	1.18	.99	39	35	30	17
San Francisco	21657	27278	36351	61741	1.84	1.63	1.23	1.03	37	38	32	25
Spokane	6164	11260	27831	64472	.52	.67	.94	1.08	7	4	21	29
Springfield	12502	17943	31948	67836	1.06	1.07	1.08	1.14	24	27	27	31
Tacoma	8396	12314	27320	59902	.71	.73	.93	1.00	15	10	18	22
Washington, D.C.	17351	25031	36726	54496	1.47	1.49	1.25	.91	32	34	34	12
Wichita	7820	11593	23936	51564	.66	.69	.81	.86	12	5	8	9
Average	11777	16766	29457	59673								

NOTE: PD = Poor Dwelling; FD = Fair Dwelling; GD = Good Dwelling, ED = Excellent Dwelling. For definition, see table 2.

greater than six and six have standard deviations less than two. This means that examples can be found of very inconsistent rankings and of very consistent rankings. For example, Tacoma is ranked twenty-seventh for Fair Dwelling and fourth for Good Dwelling. San Antonio, on the other hand, is always ranked first or second.

A better idea of the similarity of the index values and rankings is achieved by examining the correlations among these values. Table 6 presents the simple correlations (r) among the index values based upon the four special bundles. Most of the numbers in table 6 are consistent with the hypothesis that the index values based upon the different bundles are correlated. For example, the correlation between the index values based upon Poor Dwelling and Fair Dwelling is .87 for renters and .91 for owners.

Note, however, that the correlations decline as the differences between the reference bundles increase. For example, the correlation between indexes based upon Poor Dwelling and Fair Dwelling is greater than that between Poor Dwelling and Excellent Dwelling. In fact, for owners, the simple correlations between the indexes based upon Poor Dwelling and Excellent Dwelling and Fair Dwelling and Excellent Dwelling are quite small--24 and .44, respectively. Much the same picture is obtained by examining Spearman-Rank correlation between the various rankings (table 7).

The above comparisons suggest that separate indexes should be used to compare cross-SMSA rents (or values) for dwellings that differ substantially in their make up. In particular, indexes for high-quality dwellings are inappropriate for measuring rent (or value) differences among low quality dwellings, and the reverse holds as well. This lack of similarity between indexes for substantially different dwelling types could arise because of market segmentation within metropolitan areas, for example from strong neighborhood, racial or class identifications that effectively separate different housing qualities. Alternatively, dissimilarity in the indexes could arise because different quality dwellings provide dissimilar types of housing services. Thus, even if the same person might consider renting or buying either type of dwelling, he would not demand similar prices per unit of service because the services provided are so different. Probably both of these factors contribute the dissimilarity among the indexes uncovered here.

Table 6

Correlations Among Indexes for Four Special Bundles

Renters*					Owners**				
	PD*	FD	GD	ED		PD	FD	GD	ED
PD	1.00	.87	.76	.61	PD	1.00	.91	.70	.24
FD	-	1.00	.89	.73	FD	-	1.00	.89	.44
GD	-	-	1.00	.90	GD	-	-	1.00	.72
ED	-	-	-	1.00	ED	-	-	-	1.00

* For definitions of these dwellings, see table 1.
** For definitions of these dwellings, see table 2.

Table 7

Spearman-Rank Correlations Among Rankings
Based Upon Four Special Bundles

Renters*					Owners**				
	PD	FD	GD	ED		PD	FD	GD	ED
PD	1.00	.84	.69	.61	PD	1.00	.90	.65	.26
FD	-	1.00	.82	.68	FD	-	1.00	.81	.41
GD	-	-	1.00	.91	GD	-	-	1.00	.75
ED	-	-	-	1.00	ED	-	-	-	1.00

* For definitions of these dwellings, see table 1.
** For definitions of these dwellings, see table 2.

Variations in the Indexes with Respect to the Metropolitan Location of the Typical Dwelling

The typical bundles used to construct our first two indexes refer to those bundles consumed by a typical household in a typical metropolitan area. But what if the bundle consumed by the typical household depends upon the metropolitan location of the unit? Then it is interesting to consider the sensitivity of the index to the choice of the metropolitan area. A clear example of how the bundle might vary with respect to metropolitan area concerns selection of heating and air conditioning systems. That is, heating systems are less crucial to a household in Miami than one in Minneapolis and just the opposite is true of air conditioning. The example demonstrates the potential importance of the metropolitan location of the reference bundle, a subject which we investigate in this subsection.

The first task is to define a "typical" bundle for each SMSA. For this, we use the vectors of mean values of the characteristics used in the SMSA regressions.[1] For example, the typical bundle for Miami is the vector of the means of characteristics in the Miami regression. The second task is to price each of the thirty-nine typical bundles in all SMSAs. The result is a thirty-nine by thirty-nine matrix of predicted rents or values. The matrix can be used to construct thirty-nine different indexes of the price of housing. Each index is based upon the typical bundle for one of the SMSAs in the study. There are two of these thirty-nine by thirty-nine matrices,

1. The only exceptions to use of SMSA mean values are noted in tables 1 and 2. These exceptions were made because of instability in the estimated prices of these characteristics in many SMSAs.

one for owners and one for renters. Note, too, that each matrix also yields a matrix of rankings.

Instead of presenting the full matrix of indexes or rankings, summary information about the rankings is in table 8. Four columns are presented for each tenure type. The first is the maximum rank a city obtains and the second is the minimum rank. The third is the average rank and the fourth is the standard deviation of the thirty-nine different ranks. So, for example, Dallas is ranked nineteenth using the typical renter's bundle of city i but only ninth using the typical renter's bundle of city j. Of the thirty-nine different renter rankings of Dallas the average rank is fourteen and the standard deviation is 2.5.

The numbers in table 8 suggest that the construction of a price index for renters is not very sensitive to the metropolitan location of the reference bundle.[1] In other words, the rankings obtained using Miami's typical bundle as a base are not much different than those obtained using Minneapolis' typical bundle. The ranges of the rankings are generally less than or equal to ten which suggests an SMSA can be placed in the proper quartile regardless of the metropolitan location of the reference bundle.

The stability of the renter indexes with respect to changes in the metropolitan location of the typical bundle is also suggested by the high correlations between index values based upon different metropolitan areas. Not one correlation coefficient is less than .94. A

1. Gillingham (5), p. 166, reached the opposite conclusion for his sample of only ten cities; that is, he found the rankings of cities changed considerably when metropolitan locations of the reference bundle changed.

Table 8

Rankings Based on the Intermetropolitan Location of an Average Household

	Renters				Owners			
SMSA	Maximum	Minimum	Average	Standard Deviation	Maximum	Minimum	Average	Standard Deviation
Albany	38	34	37	.9	27	17	23	2.4
Anaheim	39	39	39	.0	37	24	32	2.6
Atlanta	15	7	11	2.0	27	19	23	1.6
Boston	38	34	37	.8	38	26	30	2.4
Chicago	29	25	27	1.3	31	28	29	.7
Cincinnati	6	4	5	.5	15	2	8	2.9
Colorado Springs	23	15	18	2.3	37	3	14	7.9
Columbus	6	4	6	.5	13	4	9	2.5
Dallas	19	9	14	2.5	15	4	8	2.9
Detroit	20	8	12	3.0	22	7	14	3.9
Fort Worth	4	2	3	.5	14	1	7	3.6
Hartford	36	30	33	1.7	32	29	31	.8
Kansas City	3	2	2	.4	18	1	2	2.8
Los Angeles	28	25	27	1.0	38	23	36	2.3
Madison	22	8	11	3.6	34	19	26	2.3
Memphis	22	10	14	3.3	22	11	18	2.5
Miami	28	18	22	2.1	37	20	33	2.6
Milwaukee	21	14	18	1.5	36	21	27	2.8
Minneapolis	35	31	33	1.1	25	5	20	3.3
Newark	37	32	35	1.0	38	31	34	2.0
New Orleans	17	8	11	2.0	30	3	25	4.9
Newport News	28	23	25	1.4	28	16	20	2.4
Orlando	38	31	35	2.2	27	1	14	6.7
Paterson	35	30	33	1.7	39	31	38	1.8
Philadelphia	21	8	13	4.2	33	2	7	5.9
Phoenix	20	13	17	1.7	16	4	11	3.6
Pittsburgh	29	22	25	2.3	30	3	12	6.8
Portland	15	8	11	2.1	20	8	15	2.2
Rochester	22	11	16	2.5	16	5	10	2.3
Salt Lake City	8	7	7	.2	20	12	17	1.9
San Antonio	1	1	1	0	20	2	13	5.3
San Bernardino	29	24	27	1.7	28	6	21	4.4
San Diego	26	17	22	1.9	39	21	36	2.9
San Francisco	36	30	31	1.7	39	26	37	2.3
Spokane	24	13	20	2.3	6	1	3	1.5
Springfield	29	21	26	2.6	39	23	27	2.4
Tacoma	25	8	18	4.7	17	5	12	2.7
Washington, D.C.	34	30	31	1.3	36	27	34	1.7
Wichita	5	3	4	.4	10	2	4	1.7

strong correlation among the rankings is also suggested by the Spearman rank correlations.

The indexes for owner-occupied units display more variance than the renter-occupied dwellings. In this regard, however, two points are relevant. One, the ranges of the rankings and their standard deviations are much less than the rankings and standard deviations we observed when the four special bundles of the previous section were the reference bundles. So, although the variation among the owner indexes is greater than that among the renter indexes, the variation among the owner indexes is still much less than we observed in the previous section. Two, the source of the larger variation in rankings for owner-occupied units is primarily associated with the New Orleans based index. The correlations among the non-New Orleans affected indexes are all comparable to those obtained for renters (that is, $r \geq .90$). We are unable to determine exactly what it is about the New Orleans bundle which makes indexes based upon it significantly different than indexes based upon other SMSAs. In summary, the owner indexes do show more variation than the renter indexes when the intermetropolitan location of the typical bundle is varied, but not enough to alter the general conclusion of this section -- the price indexes are not very sensitive to the intermetropolitan location of the typical bundle.

Exactly why do we obtain this result? One answer is suggested by examining the correlations among the various mean bundles. The correlations are all greater than .90. Does this mean the bundles are almost identical? No, it simply means that they are correlated and that the <u>relative</u> values of the characteristics are quite similar. For example, units in one SMSA may, on average, have more bedrooms and baths than another SMSA, but the ratio of bedrooms to baths in both SMSAs is quite similar.

Variations in the Index with Respect to the Intrametropolitan Location of the Typical Dwelling

The issue examined in this subsection is the sensitivity of the price indexes of SMSAs to the location of the typical unit inside the SMSA. That is, does the rank of a particular SMSA depend upon whether the reference unit is a suburban unit or a central city unit. Two commonly noted features of central city-suburban differences suggest such a case is possible. One, housing prices frequently decline with distance from the central business district of the central city and the rate of decline is not constant across SMSAs. Two, the quality of housing and neighborhoods inside the central cities of some but not all of our SMSAs have declined relative to their former selves and relative to their suburbs. Determining exactly which of these two factors dominate and the absolute size of the effects upon housing prices is an empirical problem requiring estimation.

The Annual Housing Survey indicates the county in which a housing unit is located (subject to confidentiality requirements) and whether the unit is inside the central city of the SMSA (for SMSAs with two central cities, we use the larger of the two as the central city).[1] By introducing dummy variables which indicate the county residence of the unit and whether it is inside the central city of the SMSA, an estimate

1. For example, in including the cities of Minneapolis-St. Paul, Long Beach-Los Angeles, and San Francisco-Oakland in our study, we used the data pertaining to the larger cities of Minneapolis, Los Angeles, and San Francisco. For a more detailed explanation, see Follain and Malpezzi (4), p. 64.

of the average price differential associated with central city versus suburban residence can be obtained. The estimate of the differential equals the weighted average of the coefficients of the dummy variables, the weights being the fraction of the SMSA household population inside a particular county or the central city. We take into account those cases in which the central city is only a portion of a county.

The full set of central city differentials is listed in table 9. The entry in the table indicates the percentage change in rent or value associated with the move of a dwelling from the suburbs to the central city. For example, a central-city rental unit in Washington, D.C., all else equal, is 7 percent more expensive than a suburban unit of Washington, D.C.

Given this set of price differentials, three indexes are constructed using the typical bundle as the reference bundle. The first is for a suburban unit, the second is for a central-city unit, and the third is a weighted average of the two locations. The weights reflect the portion of the SMSA household population residing inside the central city and the suburbs. The rents, values, indexes, and rankings for the three locations are in table 10 (renters) and table 11 (owners).

The conclusion suggested by the data in tables 10 and 11 is that the location within an SMSA does not alter significantly the ranking of a particular SMSA. Apparently, changes in price due to central city-suburban location are not large enough or different enough to make price indexes extremely sensitive to intrametropolitan location differences. The ranking of most cities changes by only one or two notches.

Table 9

Central City Versus Suburban Differentials in the Rents and Values of Comparable Housing

SMSA	Renters	Owners
Albany	6.2 %	4.8 %
Anaheim	-5.6	-12.5
Atlanta	0.7	3.1
Boston	-7.0	-19.1
Chicago	-6.3	-9.4
Cincinnati	-0.4	-3.4
Columbus	-5.3	-13.5
Dallas	2.6	3.7
Detroit	-18.4	-23.7
Fort Worth	5.4	3.1
Kansas City	2.3	-12.3
Los Angeles	-1.1	7.4
Miami	-5.3	2.8
Milwaukee	-3.7	-5.5
Minneapolis	3.9	-7.7
Newark	-14.0	-26.5
New Orleans	8.8	15.0
Paterson	-17.6	-12.4
Philadelphia	-13.6	-43.8
Phoenix	2.4	-0.1
Pittsburg	9.5	-5.5
Portland	4.0	-9.5
Rochester	3.4	-23.9
San Bernardino	1.9	0.2
San Diego	2.1	0.4
San Francisco	9.6	7.1
Washington, D.C.	6.9	-6.2
Mean	-1.1%	-6.9%
Standard Deviation	7.9	12.7

Table 10

Rents, Index Values, and Ranks for the Typical Bundle
In Three Different Locations (Renters)

	Rent			Index Value			Rank		
SMSA	Suburbs	Central City	Average Location	Suburbs	Central City	Average Location	Suburbs	Central City	Average Location
Albany	184	196	191	1.25	1.35	1.31	34	38	35
Anaheim	250	236	245	1.70	1.63	1.68	39	39	39
Atlanta	127	128	127	.86	.88	.87	12	10	11
Boston	210	195	201	1.43	1.34	1.38	36	37	36
Chicago	166	156	159	1.13	1.08	1.09	31	28	29
Cincinnati	106	106	106	.72	.73	.73	5	5	5
Colorado Springs	138	138	138	.94	.95	.95	17	18	17
Columbus	112	106	107	.76	.73	.73	6	6	6
Dallas	127	130	129	.86	.90	.88	10	13	12
Detroit	156	130	138	1.06	.90	.95	28	11	16
Fort Worth	92	97	95	.63	.67	.65	2	3	3
Hartford	179	179	179	1.22	1.23	1.23	33	33	33
Kansas City	93	95	94	.63	.66	.64	3	2	2
Los Angeles	157	155	156	1.07	1.07	1.07	29	27	28
Madison	127	127	127	.86	.88	.87	11	8	9
Memphis	132	132	132	.90	.91	.40	14	14	13
Miami	153	145	150	1.04	1.00	1.03	25	23	24
Milwaukee	144	138	140	.98	.95	.96	21	19	18
Minneapolis	171	177	173	1.16	1.22	1.18	32	32	32
Newark	218	189	210	1.48	1.30	1.44	38	36	38
New Orleans	117	127	124	.80	.88	.85	7	9	8
Newport News	151	151	151	1.03	1.04	1.03	22	24	25
Orlando	185	185	185	1.26	1.28	1.27	35	35	34
Paterson	214	180	202	1.46	1.24	1.38	37	34	37
Philadelphia	153	133	141	1.04	.92	.97	24	15	21
Phoenix	138	141	140	.94	.97	.96	16	21	19
Pittsburgh	141	154	145	.96	1.06	.99	19	26	23
Portland	125	130	127	.85	.90	.87	9	12	10
Rochester	131	135	133	.89	.93	.91	13	16	14
Salt Lake City	120	120	120	.82	.83	.82	8	7	7
San Antonio	82	82	82	.56	.57	.56	1	1	1
San Bernardino	154	157	155	1.05	1.08	1.06	26	29	27
San Diego	141	144	143	.96	.99	.98	20	22	22
San Francisco	155	170	161	1.05	1.17	1.10	27	30	30
Spokane	140	140	140	.95	.97	.96	18	20	20
Springfield	151	151	151	1.03	1.04	.35	23	25	26
Tacoma	137	137	137	.93	.94	.94	15	17	15
Washington, D.C.	161	173	168	1.10	1.19	1.15	30	31	31
Wichita	100	100	100	.68	.69	.68	4	4	4
Average	147	145	146						

Table 11

House Values, Index Values, and Ranks for the Typical Bundle
In Three Different Locations (Owners)

SMSA	Value: Suburbs	Value: Central City	Value: Average Location	Index Value: Suburbs	Index Value: Central City	Index Value: Average Location	Rank: Suburbs	Rank: Central City	Rank: Average Location
Albany	29493	30935	29766	.92	1.01	.94	21	24	21
Anaheim	43240	38143	41915	1.34	1.25	1.32	36	32	35
Atlanta	28765	29656	29080	.89	.97	.92	20	23	20
Boston	43668	36071	42235	1.36	1.18	1.33	37	30	37
Chicago	38593	35136	37767	1.20	1.15	1.19	30	29	29
Cincinnati	25188	24339	25022	.78	.80	.79	6	6	6
Colorado Springs	26394	26394	26394	.82	.86	.83	11	16	11
Columbus	28278	24709	26487	.88	.81	.83	17	8	12
Dallas	23705	24598	24145	.74	.81	.76	4	7	5
Detroit	33552	26485	30723	1.04	.87	.97	26	17	24
Fort Worth	23381	24129	23759	.73	.79	.75	3	5	4
Hartford	37897	37897	37897	1.18	1.24	1.19	29	31	30
Kansas City	23773	21026	22775	.74	.69	.72	5	1	2
Los Angeles	39334	42361	40499	1.22	1.39	1.28	32	37	32
Madison	32998	32998	32998	1.03	1.08	1.04	25	27	27
Memphis	27143	27143	27143	.84	.89	.86	15	19	15
Miami	38659	39745	38845	1.20	1.30	1.22	31	34	31
Milwaukee	35720	33803	35006	1.11	1.11	1.10	27	28	28
Minneapolis	31092	28789	30652	.97	.94	.97	22	22	23
Newark	51787	39730	51472	1.61	1.30	1.62	39	33	39
New Orleans	26885	31224	28056	.84	1.02	.88	12	25	17
Newport News	28095	28095	28095	.87	.92	.89	16	20	18
Orlando	26333	26333	26333	.82	.86	.83	10	15	10
Paterson	51109	45140	50421	1.59	1.48	1.59	38	39	38
Philadelphia	37148	23975	31403	1.16	.79	.99	28	4	25
Phoenix	25543	25520	25530	.79	.84	.80	7	10	7
Pittsburgh	27077	25627	26872	.84	.84	.85	13	12	13
Portland	28464	25895	27605	.89	.85	.87	18	13	16
Rochester	31621	24896	30007	.98	.82	.95	23	9	22
Salt Lake City	27133	27133	27133	.84	.89	.85	14	18	14
San Antonio	26002	26002	26002	.81	.85	.82	9	14	9
San Bernardino	28583	28654	28601	.89	.94	.90	19	21	19
San Diego	41599	41756	41674	1.29	1.37	1.31	34	36	34
San Francisco	40314	43285	40841	1.25	1.42	1.29	33	38	33
Spokane	21884	21884	21884	.68	.72	.69	1	2	1
Springfield	32512	32512	32512	1.01	1.06	1.02	24	26	26
Tacoma	25620	25620	25620	.80	.84	.81	8	11	8
Washington, D.C.	42769	40188	41937	1.33	1.32	1.32	35	35	36
Wichita	22789	22789	22789	.71	.75	.72	2	3	3
Average	32157	30529	31741						

There are two striking exceptions to this general finding. Prices in suburban Detroit and Philadelphia are ranked much higher than are prices in the central cities of these SMSAs. This finding seems quite consistent with the concern expressed at the outset of this subsection. Namely, price indexes can be sensitive to intrametropolitan location when older declining central cities of the Northeast are in the sample.

Variation in the Indexes with Respect to the Inclusion of Neighborhood Characteristics

Indexes may vary depending upon the inclusion or exclusion of neighborhood characteristics. Strictly speaking, neighborhood characteristics are not housing characteristics yet they do influence the price of housing. We investigate in this subsection what happens to the price indexes when neighborhood characteristics are excluded. Up to this point, some neighborhood characteristics have always been part of the reference bundle.

Neighborhood characteristics affect our index of rents and values in two ways. One, the intercept term in the hedonic no doubt represents the value of some excluded structural and neighborhood characteristics, so neighborhood factors influence the constant term. Two, the hedonic regression includes specific and measurable neighborhood characteristics such as the occupant's rating of the street and the occupant's opinions regarding traffic, noise, air pollution, etc. In order to investigate the sensitivity of the indexes to neighborhood characteristics, we construct indexes with and without the variables which indicate the influence of neighborhood.

Four specific bundles are analyzed and each is a subset of the "typical" bundles in table 1 (renter) and table 2 (owners). The first bundle (B1) consists of the first eight structural characteristics of the typical bundle without a constant term.[1] This produces the closest index we have of a housing only price. The second bundle (B2) equals the first except the constant is included. The third (B3) adds in all remaining structural characteristics--the first twenty-three (twenty-one for owners) characteristics of the typical bundle plus the constant. The fourth bundle (B4) adds in all the neighborhood characteristics. It is the complete bundle with constant term--the one analyzed earlier. All bundles are in the central city. Indexes based upon these four bundles are in table 12 for renters and owners.

The simplest way to compare the indexes is to do it step by step. That is, a comparison is made of B1 versus B2, B2 versus B3 and, finally, B3 versus B4. Distinctions are made between owners and renters when necessary.

B1 Versus B2. For renters, the differences between the index based upon B1 and the index based upon B2 are extreme. The correlation between the two indexes is -.30 indicating a tendency for cities having high values on one index to have low values on the other. San Antonio, for example, is 12 percent more expensive than the average according to the B1 index and 46 percent less expensive than the average according to the B2 index. Anaheim is 16 percent less expensive than average on the B1 index and 76 percent more expensive than average on the B2 index.

1. The index is constructed using our original characteristic prices but all variables other than the first eight structural characteristics are set to zero. This means that variation in the index from city to city is due only to variation in the prices of these included structural characteristics. A similar procedure is used to construct indexes for the three other bundles discussed here.

Table 12

Index Values for Four Different Portions of the Typical Bundle

	Owners				Renters			
SMSA	B1*	B2	B3	B4	B1**	B2	B3	B4
Albany	.85	.73	.99	1.01	.83	1.32	1.35	1.35
Anaheim	.91	1.60	1.29	1.25	.84	1.76	1.78	1.63
Atlanta	1.05	.98	.93	.97	1.22	.95	.84	.88
Boston	.88	.71	1.19	1.18	.94	.24	1.32	1.34
Chicago	.75	.86	1.16	1.15	1.02	1.01	1.09	1.08
Cincinnati	1.00	.61	.81	.80	1.15	.76	.78	.73
Colorado Springs	.92	.37	.92	.86	.98	1.01	.97	.95
Columbus	.97	.91	.81	.81	1.01	.72	.72	.73
Dallas	1.47	.79	.75	.81	1.06	.97	.92	.90
Detroit	.81	.58	.84	.87	.88	.80	1.38	.90
Fort Worth	1.54	.54	.77	.79	1.03	.64	.62	.67
Hartford	.87	1.31	1.27	1.24	.97	1.30	1.22	1.23
Kansas City	.90	.41	.69	.69	.94	.68	.65	.66
Los Angeles	.94	2.00	1.42	1.39	.95	1.01	1.14	1.07
Madison	.93	.62	1.12	1.08	1.19	.87	.84	.88
Memphis	1.20	.77	.74	.89	1.09	.84	.89	.91
Miami	1.19	1.97	1.25	1.30	1.14	.92	1.00	1.00
Milwaukee	.79	.57	1.17	1.11	1.03	.97	.99	.95
Minneapolis	.73	1.30	.86	.94	1.06	1.16	1.19	1.22
Newark	.75	1.04	1.31	1.30	.74	1.38	1.28	1.30
New Orleans	1.18	2.04	1.08	1.02	1.27	.84	.89	.88
Newport News	.90	.59	.86	.92	.97	1.07	1.04	1.04
Orlando	1.29	1.39	.83	.86	1.10	1.26	1.15	1.28
Paterson	.76	1.39	1.43	1.48	.87	1.29	1.24	1.24
Philadelphia	.88	.31	.81	.79	.96	.93	.91	.92
Phoenix	1.35	1.12	.82	.84	1.07	.95	.93	.97
Pittsburgh	.84	.38	.82	.84	.89	1.07	1.01	1.06
Portland	.99	.76	.84	.85	1.01	.88	.88	.90
Rochester	.81	.68	.81	.82	.83	1.01	.96	.93
Salt Lake City	.73	.90	.87	.89	1.03	.87	.84	.83
San Antonio	1.64	.75	.88	.85	1.12	.54	.57	.57
San Bernardino	1.15	1.41	1.01	.94	.93	.93	1.03	1.08
San Diego	1.28	2.04	1.46	1.37	.93	.99	1.03	.99
San Francisco	1.06	1.90	1.54	1.42	1.13	1.28	1.28	1.17
Spokane	.74	1.05	.71	.72	.83	1.00	1.03	.97
Springfield	.81	.47	1.04	1.06	.95	1.03	1.03	1.04
Tacoma	.97	.78	.78	.84	.90	.88	.88	.95
Washington, D.C.	.94	1.67	1.36	1.32	1.13	1.33	1.24	1.19
Wichita	1.05	.64	.69	.75	.87	.70	.69	.69
Average	1.17	1.37	1.01	.99	1.20	.76	.74	.74

* The four bundles in this table are all subsets of the typical bundle defined in table 2.
B1 = the first 8 characteristics in table 2 without a constant term.
B2 = the first 8 characteristics in table 2 with a constant term.
B3 = the first 21 characteristics in table 2 with a constant term.
B4 = the full set of characteristics in table 2 with a constant term.

** The four bundles in this table are all subsets of the typical bundle defined in table 1.
B1 = the first 8 characteristics without a constant term.
B2 = the first 8 characteristics with a constant term.
B3 = the first 23 characteristics with a constant term.
B4 = the full set of characteristics with a constant term.

The tendency for the B1 and B2 indexes to disagree on rents gives way to a weak tendency to agree on values. Their correlation is a positive .18 for values for owner occupied housing. Such a low correlation, though, indicates that the two indexes are largely unrelated. Examples of extreme differences between the indexes remain; Fort Worth is more than twice as expensive as Minneapolis according to the B1 index yet a mirror image is reflected by the B2 index where Minneapolis is more than twice as expensive as Fort Worth.

A second area of differences between the B1 and B2 indexes is in their range. For both rents and values the B1 index is more closely grouped about the mean than the B2 index. In fact, the standard deviations for the B1 indexes are about half of those for the B2 indexes--.12 versus .24 for rents and .23 versus .54 for values. The difference in range is most striking for values where the B1 index runs from a low of .73 for Salt Lake City to a high of 1.64 for San Antonio while the B2 index runs from a low of .31 for Philadelphia to a high of 2.04 for New Orleans and San Diego.

In summary, it is clear that the indexes based on just the major structural characteristics of a dwelling (B1) differ greatly from those including the constant term (B2). The structure-only indexes show essentially no tendency to move together with the structure-plus-constant indexes and also show about half the variation as the structure-plus-constant indexes. Does this result mean indexes are sensitive to neighborhood values? No, not necessarily. The constant term is influenced by both excluded neighborhood and structural characteristics so it is impossible to know whether either set of omitted variables dominates. The result does indicate, however, that an index of just the major structural variables identified by the hedonic regression are insufficient to give a complete rent or value price index.

B2 Versus B3: The B3 index differs from the B2 index by its inclusion of the remaining structural characteristics identified in the hedonic regressions. For renters this difference is inconsequential. The correlation between B2 and B3 is .97 and the standard deviations differ by only .004. For owners the differences are still notable but much less than between the B1 and B2 indexes. The correlation between the B2 and B3 indexes is .68 and the standard deviation of the B3 index, at .24, is about half of the .54 standard deviation for the B2 index. The greater similarity of the B2 and B3 indexes suggests that either the price of the additional structural variables move with those already included or the core set (B2) dominates the added set.

B3 Versus B4: This comparison is the clearest one available for the purpose of analyzing the influence of neighborhood characteristics on price indexes. The B3 index has no explicitly identified neighborhood variables (omitted neighborhood variables are implicitly identified in the constant term) while the B4 index has all that the hedonic model permits. Interestingly, the differences between the indexes are inconsequential for rents and values. The indexes have .98 correlations and the standard deviations differ by only about .02 for rents and for values. Thus, the inclusion of neighborhood values--at least the ones to which we have access--makes very little difference to the price index. This conclusion applies equally to the indexes of rents and the indexes of value.

Summary

This chapter has presented and analyzed cross-sectional indexes of the price of housing developed using the Annual Housing Survey and the hedonic index approach. One principal finding is that significant variation exists in the hedonic price index of housing across SMSAs. It is not unusual for some SMSAs to be twice as expensive as others, according to this index. The variance in index price is substantial for both renter- and owner-occupied housing.

The other principal finding is that the indexes themselves are sensitive to some changes in the reference bundle and insensitive to others. The hedonic index seems especially sensitive to the following:

- Large differences in the quality and quantity of housing depicted by the reference bundle. This suggests that separate indexes are needed for low-income families and high-income families.
- Exclusion of the hedonic regression constant term. This strikes us as an undesirable aspect of the indexes and work should be done to reduce the influence of the constant. Otherwise, it is difficult to develop price indexes of a purely structural characteristics.

The hedonic index seems relatively insensitive to the following:

- The metropolitan location of the reference bundle. That is, using the average bundle consumed by households in Miami as the reference bundle produces much the same index as is obtained using the Minneapolis average bundle.

- Intrametropolitan location of the reference bundle, that is, central city versus suburbs. The cities for which it did make a difference--Detroit and Philadelphia--fit the mold of a declining Northeastern central city.
- Inclusion or exclusion of neighborhood characteristics. This could be because the neighborhood variables used in the hedonic are not sufficient measures of the influence of neighborhood rents and values. More work should be done here.

CHAPTER III: AN ALTERNATIVE SET OF INDEXES - THE BLS APPROACH

The purpose of this chapter is to present indexes of rents and values constructed using a method which is an alternative to the hedonic approach. We refer to this method as the BLS method because it is essentially the approach used by the Bureau of Labor Statistics (BLS) to compute the rent component of its index of the cost of living in different metropolitan areas. The construction of the index is quite simple. First, a particular type of housing bundle is specified. For example, a five room unit with central heating might be selected. Then, all dwellings within a particular SMSA sample with such characteristics are selected and the arithmetic mean of the rents of the selected units is computed. The procedure is repeated in other SMSAs using the same set of selected housing characteristics. The resulting schedule of rents (or values) thus constitutes the basis of an index of rents (or values) of constant quality.

As with the hedonic indexes, the discussion below considers several aspects of the BLS indexes. The first part is intended to point out exactly how the index is constructed and to show the cross-sectional variation in price implied by one index of gross rent and one of housing value. The next two parts examine the sensitivity of the indexes to variation in the specification of the bundles which form the basis of the indexes. Finally, one of our BLS indexes is compared to the official BLS rent index.

BLS-Type Indexes of Rent and Value

The purpose of this section is twofold. The first is to explain the BLS method of calculating constant quality indexes of the price of housing in different SMSAs. The second is to present one rent and one value index for a typical renter-occupied and a typical owner-occupied unit. Key attributes of the indexes are highlighted, and a comparison of the indexes of rent and value is made.

The first purpose is easily attained since the BLS method is rather simple. First, a subset of the housing units in a particular SMSA is selected from the entire SMSA sample. Each unit in the subsample contains a specified set of characteristics. For example, a subset might be defined as all rental apartments, houses, and flats with five rooms, one full bath, complete kitchen facilities, and complete plumbing facilities. The subset should represent a set of units of equal, or roughly equal quality and size. The second step consists of calculating the mean rent for units in the subset,

$$R_i = \sum_{j=1}^{N_i} R_{ij}/N_i \qquad i = 1, \ldots 39$$

where R_{ij} gives the rent in SMSA i for dwelling j in the selected subset. N_i is the number of dwellings sampled from the subset in SMSA i and R_i is the average rent in SMSA i for the N_i dwellings of the subset. An R_i is calculated for each SMSA. The resulting schedule of average rents (R_i's) constitutes the cost of renting comparable housing in the different SMSAs. The schedule can be indexed by dividing all R_i's by the value for a base city. We continue to use Albany as the base city.

Four separate indexes are presented in this chapter based on four different specifications. Two are for value, and two measure rent. These four sample specifications are identified in table 13. The Annual Housing Survey data base from which specified dwellings are selected is the same as that used to compute the hedonic regressions and price indexes of chapter 2. Here, the selected units are located inside and outside the central city, so in this sense, the index refers to an average location in each SMSA.

The first index is based upon a typical renter-occupied unit we call BLS2. BLS2 is an unfurnished apartment or flat with five rooms, one full bath, and complete kitchen and plumbing facilities. The occupant rates the quality of the unit and the neighborhood as either excellent, good, or fair and considers whether access to public transportation is satisfactory. The rents for this bundle and the index values based upon them (with Albany as the base) are presented in table 14.

The average rent of the typical bundle ranges from a high of $231 (Miami) to a low of $140 (New Orleans). The simple average of all the index rents is $172 and their standard deviation is $24. There are seven SMSAs with average rents greater than $200 and seven less than $150. The remainder are evenly distributed between $150 and $190. The most expensive SMSAs are Miami, Newark, San Francisco, Boston, Anaheim, and Washington, D.C. The least expensive are New Orleans, Detroit, Springfield, Dallas, and Albany.

Table 13

Specifications of the Housing Bundles
Used to Calculate the BLS Indexes

Bundle Name		Description
1.	BLS1	BLS1 is a five room house, apartment or flat which has one full bath, complete kitchen facilities, and complete plumbing facilities.
2.	BLS2	BLS2 is a particular type of BLS1 dwelling. In addition to the features of BLS1, BLS2 units also a. have occupant ratings of house quality and neighborhood of either excellent, good or fair. That is, units with poor ratings of either the street or housing unit are excluded (i.e., V276 and V277 are less than or equal to 4). b. are unfurnished (i.e., V156 = 0). c. have adequate public transportation in the opinion of the occupant (i.e., the occupant answers no to the question, "Do you have inadequate public transportation?" d. have adequate heating systems (i.e., excludes dwellings whose heating equipment is either a system of heaters without flues, a fireplace, a stove, or no equipment at all). e. are <u>not</u> single-family detached (that is, the units are either apartments or flats, V050SF = 0).
3.	EDR1	EDR1 is a renter-occupied, single-family detached unit with seven rooms and three bedrooms.
4.	GDO1	GDO1 is an owner-occupied, single-family detached unit with seven rooms and three bedrooms. In other words, the specifications are the same as those for EDR1.

Table 14

Rents and Index Values of a Typical Rental Unit (BLS2) Based Upon the BLS Method

SMSA	Rent	Index
Miami	$231	1.34
Newark	215	1.25
San Francisco	213	1.24
Boston	207	1.20
Anaheim	204	1.19
Washington, D.C.	204	1.19
Paterson	202	1.17
Orlando	199	1.16
Rochester	191	1.11
Hartford	187	1.09
Phoenix	185	1.08
Madison	180	1.05
Spokane	180	1.05
Minneapolis	179	1.04
Los Angeles	176	1.02
Chicago	175	1.02
San Diego	175	1.02
Philadelphia	171	.99
Atlanta	169	.98
Milwaukee	167	.97
Colorado Springs	166	.97
Fort Worth	165	.96
Portland	164	.95
Pittsburgh	163	.95
Tacoma	161	.94
Wichita	160	.94
Newport News	158	.92
San Bernardino	158	.92
Cincinnati	154	.90
San Antonio	152	.88
Columbus	151	.88
Kansas City	148	.86
Memphis	148	.86
Salt Lake City	147	.85
Albany	145	.84
Dallas	144	.84
Springfield	144	.84
Detroit	143	.83
New Orleans	140	.81
Average	172	
Standard Deviation	24	

The second index is based upon a typical owner-occupied unit we call GD01. GD01 is a single-family detached, seven room house with three bedrooms. The values for this unit and the index values based upon them (with Albany as the base) are presented in table 15.

The average value of the typical owner-occupied unit is $40,198. The values range from $29,247 (Spokane) to $56,187 (Paterson). The price of this bundle is over 90 percent greater in Paterson than Spokane. Seven SMSAs have averages greater than $50,000 and ten have averages less than $35,000. Most of the others are evenly distributed between $35,000 and $45,000. The most expensive SMSAs are Paterson, Washington, D.C., Anaheim, Newark, and San Francisco. The least expensive are Spokane, Detroit, Pittsburgh, Fort Worth, and Wichita.

A comparison of the renter and owner indexes suggests that the two are closely related but not identical. An SMSA which is expensive in terms of value, is likely to be expensive in terms of rents. The simple correlation between the two is .64. The five most expensive SMSAs for owners are also ranked as relatively expensive by the rent index. The major exception is Boston, an SMSA which is ranked as being relatively expensive for renters but only moderately expensive for owners. There are differences at the bottom part of the scale, too. Of the five least expensive SMSAs for owners, only Detroit is comparably ranked for renters.

Sensitivity of BLS-Type Index to the Precision of Bundle Specification

A tradeoff exists with respect to the precision of a BLS based index of the price of constant quality housing. As the specification of a unit becomes more precise, variations in rent due to quality

Table 15

Values and Value Indexes of a Typical
Owner-Occupied Unit (GD01) Based Upon the BLS Method

SMSA	Rent	Index
Paterson	$56187	1.40
Washington, D.C.	52553	1.31
Anaheim	51947	1.29
Newark	51938	1.29
San Francisco	51788	1.29
San Diego	50993	1.27
Miami	50465	1.26
Chicago	47001	1.17
Los Angeles	45994	1.14
Hartford	45611	1.13
Milwaukee	44108	1.10
Atlanta	41998	1.04
Phildelphia	41407	1.03
Madison	41145	1.02
Phoenix	41140	1.02
Newport News	40980	1.02
Boston	40612	1.01
New Orleans	40110	1.00
Columbus	39018	.97
Dallas	38076	.95
Minneapolis	37920	.94
San Bernardino	36993	.92
Cincinnati	36862	.92
Albany	36642	.91
Salt Lake City	36437	.91
Orlando	35722	.89
Memphis	35636	.89
Rochester	35475	.88
Springfield	35231	.88
Portland	34664	.86
San Antonio	34003	.85
Kansas City	33597	.84
Colorado Springs	33158	.82
Tacoma	33041	.82
Wichita	32773	.82
Fort Worth	32571	.81
Pittsburgh	32418	.81
Detroit	32255	.80
Spokane	29247	.73
Average	40198	
Standard Deviation	7052	

variations diminish. On the other hand, a more precise definition reduces the number of units in the Annual Housing Survey sample which meet the longer list of specifications. The first effect of a more precise definition is desirable because it produces a sample which is more homogenous with respect to housing quality. The second effect is undesirable, however, because it reduces the number of observations available to compute a mean rent which in turn reduces the precision of the estimate of the mean. For example, the estimate of the mean is more sensitive to unusual cases the smaller the number of cases being averaged.

To gauge the net effects of the tradeoff on the precision of a BLS based index, an experiment is conducted. Two units are specified, BLS1 and BLS2. BLS1 is simply a five room house, apartment, or flat with one full bath and complete plumbing and kitchen facilities. BLS2 is as defined earlier. Note it is a subset of the units meeting the BLS1 specifications, that is, BLS2 is a BLS1 unit, but the reverse is not necessarily true.

Since BLS2 is more precisely defined than BLS1, we expect the quality variations among units meeting BLS2's specifications to be less than those of BLS1's. This is supported by the information in table 16 which shows the standard deviations of rents among dwellings meeting the BLS2 definitions to be smaller than for dwellings meeting the BLS1 definition in all but seven SMSAs (see columns 5 and 6). The sample of units meeting BLS2's specifications is, however, smaller than that for BLS1 (see columns 7 and 8 of table 16), and hence the variation in rents is prone to unusual cases.

Table 16

The Effects of Modest Changes in the Specification of a Unit Upon the BLS Index

SMSAs	Rent of BLS1	Rent of BLS2	Rank Based Upon BLS1	Rank Based Upon BLS2	Standard Deviation of BLS1 Sample	Standard Deviation of BLS2 Sample	Sample Size for BLS1	Sample Size for BLS2	Standard Deviation of BLS1 Rent Estimate	Standard Deviation of BLS2 Rent Estimate
Albany	153	145	10	5	54	48	220	131	3.64	4.19
Anaheim	205	204	33	35	52	44	108	38	5.00	7.14
Atlanta	163	169	17	21	51	50	496	198	2.29	3.55
Boston	206	207	34	36	58	59	1311	989	1.60	1.88
Chicago	183	175	27	24	60	51	875	591	2.03	2.10
Cincinnati	155	154	12	11	43	43	154	83	3.47	4.72
Colorado Springs	169	166	19	19	38	29	194	34	2.73	4.97
Columbus	151	151	9	9	40	37	260	133	2.48	3.21
Dallas	142	144	5	4	44	27	151	8	3.58	9.55
Detroit	154	143	11	2	48	40	763	359	1.74	2.11
Fort Worth	131	165	2	18	41	50	178	14	2.07	13.36
Hartford	189	187	30	30	44	37	286	187	2.60	2.71
Kansas City	160	148	15	7	49	49	230	44	3.23	2.39
Los Angeles	183	176	28	25	56	61	567	147	2.35	5.03
Madison	190	180	32	27	55	39	219	104	3.72	3.82
Memphis	140	148	4	8	41	35	169	43	3.15	3.34
Miami	215	231	39	39	66	46	80	11	7.38	13.87
Milwaukee	170	167	20	20	39	37	317	197	2.19	2.64
Minneapolis	182	179	26	26	48	46	146	98	3.97	4.65
Newark	211	215	37	38	55	53	296	201	3.20	3.74
New Orleans	130	140	1	1	38	43	215	66	2.59	5.29
Newport News	175	158	25	13	47	31	239	61	3.04	3.97
Orlando	172	199	23	32	49	28	134	21	4.23	6.11
Philadelphia	174	171	24	22	66	63	475	290	3.03	3.70
Phoenix	170	185	21	29	53	41	83	9	6.53	13.67
Pittsburgh	155	163	13	16	47	48	171	99	3.59	4.82
Portland	171	164	22	17	48	39	193	54	3.46	5.31
Rochester	190	191	31	31	40	39	185	101	2.94	3.88
Salt Lake City	146	147	6	6	46	49	139	53	3.90	6.73
San Antonio	137	152	3	10	48	56	193	19	3.46	12.85
San Bernardino	156	158	14	12	39	27	144	9	3.25	9.00
San Diego	188	175	29	23	56	41	142	22	4.70	8.74
San Francisco	214	213	38	37	65	63	648	317	2.55	3.54
Spokane	162	180	16	28	42	42	165	45	3.27	6.26
Springfield	147	144	7	3	46	37	393	230	2.32	2.44
Tacoma	167	161	18	15	42	35	163	14	3.29	9.35
Washington, D.C.	208	204	35	34	54	50	709	465	2.03	2.32
Wichita	149	160	8	14	49	43	286	48	2.90	6.21
Average	171	172	-	-	49	44	-	-	3.19	5.65
Standard Deviation	24	24	-	-	-	10	-	-	-	-

If the gains in precision due to a more precise definition outweigh the losses due to a smaller sample size, then the standard deviation of the estimates of the mean rents for BLS2 units should be smaller than those for BLS1 units. The standard deviation of the estimates of mean rents are calculated as the ratio of the standard deviation of the sample divided by the square root of the sample size. These figures, given in columns 9 and 10 of table 16, consistently show higher value for BLS2 than BLS1. The standard deviation of the estimated rents are larger for BLS2 in every SMSA. Thus, the BLS1 index is more precise than the BLS index as the advantages of a larger sample outweigh those of a more precise definition.

How important is this difference in precision between the two indexes? If it were very important we would expect sizeable differences in the actual estimate of the mean rents and the rankings based upon the two indexes. Estimates of the rents for the BLS1 and BLS2 units and the set of rankings based upon the two units of the rents are contained in table 16, columns 1 to 4. The rents change very little between the BLS1 and BLS2 definitions. The average rent across all thirty-nine SMSAs for the BLS1 unit is only one dollar less than for the BLS2 unit. Rents for BLS1 are higher than those for BLS2 in some SMSAs, but the reverse is also true. There are few examples of large changes in predicted rent--Miami, Orlando, Spokane, Newport News, and Fort Worth. Most differences are less than ten dollars. This same pattern holds with respect to changes in ranks. Only three differences are greater than ten, twenty-seven of the thirty-nine are less than five. The simple correlation between the two indexes is .91. The similarity in average rents and ranks between the two indexes suggests that the greater precision of the BLS1 index does not lead to important differences in actual index values.

Sensitivity of the BLS-Type Index to Basic Quality Changes

In the preceding section we examined changes in bundle specification which affect the precision of the BLS method. For the particular change analyzed, there was little effect in either the rent schedule or the rankings of the SMSAs, although BLS1 was consistently more precise for this survey data. Now, two indexes are analyzed which are based upon two quality levels. The first, BLS2, is the one used throughout this chapter. The other is EDR1, a single-family detached house with seven rooms and three bedrooms. This is a much larger unit than BLS2 and might be occupied by richer, larger, or more suburban households than those in a BLS2 dwelling. If the relative demands for these two types of units vary across markets, then we might expect to find an index based on BLS2 to show differences from the one based on EDR1. Table 17 contains the rankings of the SMSAs based upon the two bundles.

Analysis of the rankings reveals several differences. In one-fourth of the cases, the differences in ranks between the two indexes are greater than ten. Thus, for SMSAs like Spokane or Springfield the indexes give quite different readings about the relative expensiveness of rental housing. Spokane is ranked as the eleventh most expensive SMSA when BLS2 is used, but the eighth least expensive by EDR1. The opposite occurs for Springfield. It is the third least expensive

Table 17

Ranks of the SMSAs According to Two Different Renter-Occupied Units

SMSAs	BLS2	EDR1
Albany	5	26
Anaheim	35	33
Atlanta	21	9
Boston	36	36
Chicago	24	30
Cincinnati	11	13
Colorado Springs	19	19
Columbus	9	7
Dallas	4	10
Detroit	2	6
Fort Worth	18	12
Hartford	30	32
Kansas City	7	4
Los Angeles	25	28
Madison	27	31
Memphis	8	1
Miami	39	35
Milwaukee	20	13
Minnesota	26	15
Newark	38	38
New Orleans	1	16
Newport News	13	22
Orlando	32	14
Paterson	33	34
Philadelphia	22	29
Phoenix	29	21
Pittsburgh	16	3
Portland	17	17
Rochester	31	18
Salt Lake City	6	23
San Antonio	10	5
San Bernardino	12	11
San Diego	23	25
San Francisco	37	37
Spokane	28	8
Springfield	3	27
Tacoma	15	20
Washington, D.C.	34	39
Wichita	14	2

according to BLS2, but the twelfth most expensive by EDR1. There are, as mentioned above, eight other cases of changes in rankings by more than ten places.

It could be argued that these indexes are actually quite close in spite of the above differences because the simple correlation between the two indexes is .73. However, the differences are large relative to those found for the hedonic based indexes. In that analysis, two bundles are analyzed which closely resemble EDR1 and BLS2. Of the four special bundles analyzed in chapter 2, Good Dwelling closely resembles BLS2 and Excellent Dwelling closely resembles EDR1. The correlation between Excellent Dwelling and Good Dwelling is .90, larger than that between BLS4 and EDR1. Further, there is only one difference in rankings greater than ten between Good Dwelling and Excellent Dwelling. The rest of the differences are usually less than three. It is in this sense that we describe differences in the two BLS indexes as significant. That is, the BLS based index is more sensitive to this change in bundle definition than the hedonic based index.

Comparison of our BLS-Type Index with the Official BLS Index

As mentioned at the outset of this chapter, our BLS method is that used by the Bureau of Labor Statistics to compute its index of the cost of comparable rental housing in different SMSAs. In this section, the official index is compared to our version of the BLS index. BLS2 is used in the comparison because the specifications of the BLS2 unit are almost identical to those used by the Bureau of Labor Statistics.[1] This minimizes the differences between our index and that of the Bureau of Labor Statistics due to differences in bundle specification.

The two indexes and the differences between them (absolute and percentage) are contained in table 18. Only eighteen SMSAs are listed because only these eighteen SMSAs are in the BLS survey and in the first two waves of the Annual Housing Survey.

The most noticeable aspect of table 18 is that the BLS2 schedule of rents exceeds the official BLS schedule in seventeen of the eighteen SMSAs. The average of the BLS2 schedule ($174) exceeds the official schedule by over $20. The only SMSA in which the official index exceeds our BLS2 schedule is Cincinnati. For the remainder, the differences generally exceed $20, or roughly 10 to 35 percent above the official BLS schedule.

One possible explanation for the difference is that the BLS2 bundle is of higher quality than the one used by the Bureau of Labor Statistics, hence, the BLS2 bundle costs more. While possible, it seems unlikely because the specifications which define BLS2 are quite close to those used by the Bureau. Furthermore, both the Bureau's and our pricing methods approximate the average rent among those units with identical specifications.

1. The BLS description of the unit they price is quoted here and can be matched against the specification of BLS2 on table 13, "For renter families, the shelter called for an unfurnished five-room unit (house or apartment) in sound condition; a complete, private bath; a fully-equipped kitchen: hot and cold running water; electricity, central or other installed heating; access to public transportation; schools, grocery stores, play space for children; and location in residential neighborhoods free from hazards or nuisances." BLS (11), p. 42.

Table 18

Comparison of Our BLS2 Index With the
Official Index of the Bureau of Labor Statistics

SMSA	BLS2 Rents	BLS2 Rank	Official BLS Rents	Official BLS Rank	Absolute Difference	Percentage Difference
Atlanta	169	8	124	2	-45	36
Boston	207	17	173	16	-34	20
Chicago	175	10	166	14	- 9	5
Cincinnati	154	4	179	17	25	-14
Dallas	144	2	129	3	-15	12
Detroit	143	1	137	5	- 6	4
Hartford	187	14	168	15	-19	11
Kansas City	148	3	132	5	-16	12
Los Angeles	176	12	156	12	-20	13
Milwaukee	167	7	152	11	-15	10
Minneapolis	179	13	144	9	-35	24
Orlando	199	15	151	10	-48	32
Philadelphia	171	9	131	4	-40	31
Pittsburgh	163	6	120	1	-43	36
San Diego	175	11	143	8	-32	22
San Francisco	213	18	209	18	- 4	2
Washington, D.C.	204	16	163	13	-41	25
Wichita	160	5	137	7	-23	17
Average	174		151			
Standard Deviation	21		23			
Correlation of Rents	.65					

Urban Family Budgets, Annual Costs of an Intermediate Budget, table 2, Autumn 1974 and 1975, (9) and (10).

Another possibility is related to the method used by the Bureau to update its estimates of gross rent. The actual pricing of the bundle on which the official index is based took place in 1969. Since then, it has been updated, not by direct pricing, but rather, by the rent component of the CPI. If the CPI understates inflation, then it is not surprising that the BLS2 estimates obtained by direct pricing in 1974-75 exceed the official numbers of the Bureau. In fact, some evidence exists to support the idea that the CPI does underestimate the inflation in rents. The argument is that the CPI understates inflation because it does not adequately account for depreciation and discounts to long-time tenants.[1]

Considering the large difference in average rents, the relative ranking of cities is surprisingly similar. Three of the five most expensive cities are the same on both indexes, San Francisco, Boston, and Hartford. The other two most expensive cities in the BLS2 ranking, Washington, D.C., and Orlando, rank as above average in expense on the official BLS index. That index lists Chicago and Cincinnati as its other two most expensive cities. Chicago is also above average on the BLS2 index. Cincinnati, on the other hand, is the only expensive city on one index listed as an inexpensive city on the other. Cincinnati is one of the five least expensive cities on the BLS2 index along with Wichita, Kansas City, Dallas, and Detroit. These latter four all rank as below average expense on the official BLS index as well, with Dallas and Kansas City being among the five cheapest in the official ranking. The three other cheapest cities by the BLS ranking are

1. For a fuller explanation of this argument and the evidence in its behalf, see Follain and Malpezzi (3), pp. 106-107.

Philadelphia, Atlanta, and Pittsburgh. These cities are ranked below average on the BLS2 index as well. Cincinnati, then is the only city to be ranked at an extreme by one index and not to be at least closer than average to that extreme on the other. The overall correlation among rents is .65 which also indicates a fairly strong tendency for the two indexes to move together.

Our comparison of the BLS2 index based on Annual Housing Survey data with the official BLS Index suggests that there is severe understatement in the official estimate of rental costs. On the other hand, both indexes show similar rankings on relative rental costs. Thus, the official index appears useful for adjusting, for example, incomes, to reflect relative housing purchasing power among cities, but the index does not appear useful for reflecting the share of income going to housing in any one city.

Summary

This chapter has presented housing price indexes among SMSAs developed from an application of the BLS procedure to the Annual Housing Survey for thirty-nine SMSAs. The procedure is to identify a sample of units with common characteristics in each SMSA and obtain their average rent. This average rent for each SMSA forms the price index across SMSAs.

Indexes constructed from the BLS procedure using the Annual Housing Survey data show significant variation in housing costs across SMSAs. Rents for the BLS2 index range from \$140 to over \$230. House values for the GD01 index range from about \$29,000 to \$56,000. These wide variations in index levels are consistent with those found using the hedonic index procedure in chapter 2.

Indexes constructed following the BLS procedure appear to be sensitive to the type of unit being priced. The five-room apartment represented by the BLS2 index and the seven-room house represented by the EDR1 index showed considerable differences in their rankings of cities. These differences were larger than those found for similarly specified units using the hedonic procedure.

Comparison of the BLS2 index constructed from Annual Housing Survey data to the official BLS index found a substantial difference in the levels of the two rent schedules. The BLS2 index averaged $20 above the official index and only one of eighteen cities had a lower rent in the BLS2 index than the official one. This difference arises even though very similar dwelling specifications are used to construct the two indexes, suggesting that there is some shortcoming in the procedure for updating the official index over time. In spite of differences in the levels of rents, the BLS2 and the official index give fairly similar rankings of cities from most to least expensive.

Finally, an experiment was conducted to test the sensitivity of the BLS-type index to the degree of specificity in dwellings priced. For the Annual Housing Survey data, we found that a less restrictively defined index gave more precise estimates because the benefits of a larger sample size offset the losses of the less restrictive definition. However, these differences in precision were not accompanied by substantial differences in index values or rankings and therefore are of little consequence in our data.

CHAPTER IV: COMPARING THE HEDONIC AND BLS-TYPE INDEXES

In the preceding chapters we have implemented two alternative procedures for constructing indexes of housing prices. The hedonic index approach of chapter 2 and the BLS procedure of chapter 3 each have yielded renter and owner price indexes for our thirty-nine SMSAs. In this chapter we compare the indexes. First, we examine how the indexes rank the SMSAs from most expensive to least expensive and how much spread they show between the extremes. Next, we compare the precision with which the indexes represent prices within each SMSA. From the results of these comparisons we develop hypotheses to explain how the indexes differ. The hypotheses are tested using data from the thirty-nine SMSAs.

Before moving on to the comparisons, it may be helpful to review major features of the two procedures. It is also necessary to introduce new hedonic indexes which match the BLS specifications of chapter 3.

The hedonic index procedure uses regression analysis to obtain prices for a large number of individual components in the housing bundle. These individual prices are estimated separately for each of our thirty-nine metropolitan markets using nearly all Annual Housing Survey observations on rental or owner-occupied dwellings in that market. Each renter equation estimates prices for thirty-three dwelling characteristics and each owner equation has prices for thirty-two dwelling characteristics.[1] The next step is to specify one rental unit and one owner-occupied house in terms of the thirty-three and thirty-two characteristics and then to calculate the dwelling's rent or value in each market. It is these rents and values for identical dwellings in every market that make up our indexes.[2]

The BLS procedure contrasts with the hedonic procedure in that it first specifies the type of dwelling to be priced among markets and then uses rent and value information for only those units meeting the initial specification. The dwelling specifications actually used by the Bureau of Labor Statistics are not as extensive as those used in our hedonic regressions, and we have followed the Bureau's specifications in constructing our BLS-type indexes in chapter 3. Rents and values for the sample of dwellings meeting the shorter list of specifications are averaged in each market to give that market's index component.[3]

The BLS-type indexes used in the comparisons of this chapter are the main renter and owner indexes of chapter 3 identified there as BLS2 and GD01. Their specifications are given in table 13. None of the hedonic indexes described in chapter 2 are calculated from specifications consistent with the specifications in table 13. Consequently, we have calculated new hedonic indexes using specifications similar to

1. The equations differ in that the dwelling characteristics of garbage collection, garage, basement, and tax rate are included for owners but not for renters; while number of units, hallway, rent and furnishings, single family, and utilities and rent are included for renters but not for owners. See table 19 for a specific breakdown of all variables and appendix A for their definitions.

2. Our indexes are standardized relative to the mean rent or value of all the cities.

3. We scale these average rents or values for each market relative to the mean.

those used in the BLS procedure. The full listing of hedonic variable specifications for renter and owner indexes are given on table 19.

Rankings of SMSAs By the Hedonic and BLS Procedures

The hedonic and BLS-type indexes are specified for similar dwellings and are calculated from the same Annual Housing Survey data. For these reasons one expects them to predict similar rankings among SMSAs. In fact, if they are both unbiased measures of the same price, then a change in one index should tend to be matched dollar for dollar by a change in the other. Of course, there would be random differences in the indexes since the BLS-procedures employ a subset of the sample used to construct the hedonic index.

In table 20, we present the hedonic and BLS Indexes for rental housing. The first column gives the predicted rent of the hedonic-specified unit for all thirty-nine SMSAs; the second column has the average rent for units meeting the BLS specification, also in thirty-nine SMSAs. The average of the hedonic-predicted rents is $175 and the average of the BLS-type rents is $172, suggesting that the two methods are pricing roughly similar quality housing. On the other hand, the standard deviation of the hedonic-predicted rents is nearly double that for the BLS-type rents.[1] Thus, the hedonic method shows substantially greater variation in rents among cities even though average levels are similar. Columns 3 and 4 give the hedonic and BLS-type indexes standardized by their average rents.

Columns 5 and 6 give the rank ordering of the indexes from cheapest (=1) to most expensive (=39). These columns show a general tendency

1. Gillingham (5) found nearly the opposite in his study. His hedonic rent index showed about half the variation of the BLS index in the ten cities of his sample.

Table 19

Bundle Specifications Used to Compute
Hedonic Price Indexes for Renters and Owners in
Comparison with BLS-Type Indexes

Characteristics for Renters			Characteristics for Owners		
Description	Variable*	Renter Specification	Description	Variable	Owner Specification
Baths	V074	1.00	Baths	V074	2.00
Age	V005LN	1.61	Age	V005LN	1.61
Rooms	V056	5.00	Rooms	V056	7.00
Bedrooms	V059	2.00	Bedrooms	V059	3.00
House Rating	V277	2.00	House Rating	V277	2.00
Central Heat	V086CH	1.00	Central Heat	V086CH	1.00
Add Heat	V088	0.00	Add Heat	V088	0.00
Central Air	V099	0.00	Central Air	V099	0.00
Privacy	V6162	0.00	Privacy	V6162	0.00
Rats	V114	0.00	Rats	V114	0.00
Fuses	V102FB	0.00	Fuses	V102FB	0.00
Rooms Without Heat	V090B	0.00	Rooms Without Heat	V090B	0.00
Number Units	V050G5	0.00	Garbage Collection	V104	0.00
Cooking Fuel	V066E	0.00	Garage	V125	1.00
Heating Fuel	V084E	0.00	Basement	V107	1.00
Hallway	V028012	0.00	Cooking Fuel	V066E	0.00
Cracks	V110	0.00	Heating Fuel	V084E	0.00
Rent and Furnishings	V156	0.00	Cracks	V110	0.00
Broken Plaster	V112	0.00	Broken Plaster	V112	0.00
Single Family	V050SF	0.00	Breakdowns	BRKDWS	0.00
Breakdowns	BRKDWS	0.00	Tax Rate	TAXRTLN	-4.02
Utilities and Rent	EXTRAS	1.00	Street Rating	V276	2.00
Street Rating	V276	2.00	Bad Housing	V278	0.00
Bad Housing	V278	0.00	Airplane Noise	AIR	0.00
Airplane Noise	AIR	0.00	Inadequate Schools	SCHOOL	0.00
Inadequate Schools	SCHOOL	0.00	Inadequate Shops	SHOPS	0.00
Inadequate Shops	SHOPS	0.00	Street Crime	CRIME	0.00
Street Crime	CRIME	0.00	Street Noise	NOISE	0.00
Street Noise	NOISE	0.00	Street Traffic	TRAFFIC	0.00
Street Traffic	TRAFFIC	0.00	Race	V031B	0.00
Race	V031B	0.00	Crowding	V347	0.62
Crowding	V347	0.62	Length of Tenure	V040YRS	0.00
Length of Tenure	V040YRS	0.00			

*Variable specifications appear in appendix A.

Table 20

Rents, Indexes, and Ranking for Hedonic and BLS-Type Rental Unit Specifications

City	Rents		Indexes		Ranking	
	Hedonic	BLS	Hedonic	BLS	Hedonic	BLS
Albany	221	145	1.26	.84	34	5
Anaheim	300	204	1.71	1.19	39	34
Atlanta	161	169	.92	.98	15	21
Boston	220	207	1.26	1.20	33	36
Chicago	171	175	.98	1.02	22	23
Cincinnati	123	154	.70	.90	5	11
Colorado Springs	161	166	.92	.97	15	19
Columbus	123	151	.70	.88	5	9
Dallas	151	144	.86	.84	9	3
Detroit	160	143	.91	.83	13	2
Fort Worth	119	165	.68	.96	3	18
Hartford	223	187	1.27	1.09	35	30
Kansas City	105	148	.06	.86	2	7
Los Angeles	179	176	1.02	1.02	27	25
Madison	167	180	.95	1.05	18	27
Memphis	153	148	.87	.86	11	7
Miami	153	231	.87	1.34	11	39
Milwaukee	170	167	.97	.97	21	20
Minneapolis	214	179	1.22	1.04	31	26
Newark	275	215	1.57	1.25	38	38
New Orleans	139	140	.79	.81	7	1
Newport News	169	158	.97	.92	20	12
Orlando	239	199	1.37	1.16	36	32
Paterson	254	202	1.45	1.17	37	33
Philadelphia	152	171	.87	.99	10	22
Phoenix	175	185	1.00	1.08	25	29
Pittsburgh	201	163	1.15	.95	30	16
Portland	144	164	.82	.95	8	17
Rochester	161	191	.92	1.11	15	31
Salt Lake City	160	147	.91	.85	13	6
San Antonio	80	152	.46	.88	1	10
San Bernardino	172	158	.98	.92	23	12
San Diego	168	175	.96	1.02	19	23
San Francisco	199	213	1.14	1.24	29	37
Spokane	191	180	1.09	1.05	28	28
Springfield	176	144	1.01	.84	26	3
Tacoma	174	161	.99	.94	24	15
Washington, D.C.	214	204	1.22	1.19	31	34
Wichita	122	160	.70	.93	4	14
Average	175	172				
Standard Deviation	45	24				

for the two indexes to give similar rankings; thirty of thirty-nine SMSAs have rankings within ten positions of each other on the two indexes. This apparent trend is borne out by a .61 correlation of index rents in columns 1 and 2. On the other hand, these rankings are far from identical. The five most expensive markets on both indexes have only Anaheim and Newark in common; the five cheapest markets on the two indexes show no overlap.

The indexes for the price of owner-occupied houses are reported on table 21, which follows the format of table 20. The majority of BLS-type house prices in column 2 are above the corresponding hedonic prices in column 1. The average difference is close to $4,000 compared to average house values of $42,000 in column 2. This suggests that the quality of the dwellings included in our BLS procedure are moderately higher than the quality specified for the hedonic-priced dwelling. The standard deviation of rents predicted by the two methods are nearly equal.

Columns 3 and 4 of table 21 give the value indexes standardized by their average prices, and columns 5 and 6 give the SMSA rankings from cheapest (=1) to most expensive (=39). The rankings appear to have a slightly weaker tendency to agree than did the renter indexes as only twenty-six out of thirty-nine joint rankings lie within ten places of each other. On the other hand, the .75 correlation between index prices is substantially stronger than with the rent indexes. The two owner indexes agree on three areas--Paterson, San Francisco, and Newark--of their five most expensive SMSAs but the indexes agree on only one area--Wichita--among their five cheapest SMSAs.

Table 21

Values, Indexes and Rankings for Hedonic and BLS-Type Owner Unit Specifications

City	Values Hedonic	Values BLS	Indexes Hedonic	Indexes BLS	Ranking Hedonic	Ranking BLS
Albany	37965	36642	1.05	.91	25	16
Anaheim	41721	51947	1.16	1.29	31	36
Atlanta	34220	41998	1.24	1.01	18	28
Boston	44642	40612	.78	.95	35	23
Chicago	40525	47001	.97	.80	28	32
Cincinnati	27148	36862	.85	.81	3	17
Colorado Springs	27603	33158	1.31	1.14	4	6
Columbus	28922	39018	1.00	.89	7	21
Dallas	28005	38076	.99	.94	6	20
Detroit	34868	32255	1.31	1.29	19	2
Fort Worth	30652	32571	.85	.89	9	4
Hartford	43720	45611	.87	1.02	34	30
Kansas City	25746	33597	.98	.81	1	8
Los Angeles	47176	45994	.87	.91	36	31
Madison	37761	41145	.89	.73	24	24
Memphis	36108	35636	.86	.82	23	12
Miami	41049	50465	1.15	1.31	29	33
Milwaukee	43169	44108	.77	.82	33	29
Minneapolis	35833	37920	.95	1.04	22	19
Newark	47277	51938	1.12	1.17	37	36
New Orleans	38587	40110	.75	.92	26	22
Newport News	30159	40980	.77	.82	8	26
Orlando	30771	35722	.80	.97	9	12
Paterson	52062	56187	1.21	1.13	39	39
Philadelphia	26582	41407	.71	.84	2	27
Phoenix	31328	41140	1.05	1.02	13	24
Pittsburgh	35467	32418	1.14	1.26	20	2
Portland	31821	34664	1.20	1.10	15	10
Rochester	30758	35475	1.07	1.00	9	12
Salt Lake City	31327	36437	.84	1.02	13	15
San Antonio	33937	34003	1.44	1.40	17	9
San Bernardino	35614	36993	.74	1.03	20	17
San Diego	43034	50993	.88	.86	32	34
San Francisco	48896	51788	.85	.88	38	35
Spokane	32003	29247	.94	.85	15	1
Springfield	40056	35231	.99	.92	27	11
Tacoma	31102	33041	1.19	1.27	12	6
Washington, D.C.	41372	52553	1.36	1.29	30	38
Wichita	27781	32773	1.11	.88	4	4
Average	36071	40198				
Standard Deviation	6885	7051				

Precision of the Hedonic and BLS Procedures Within SMSAs

In the preceding section we have compared the hedonic and BLS procedures in terms of their variation in index levels among thirty-nine SMSAs. In this section, we compare them in terms of the variation of individual dwelling rents and values around index levels within SMSAs. That is, we compare the two procedures in terms of how precisely they represent the rents and values of dwellings meeting index specifications.

Any pricing procedure will find reported rents or values diverging from predicted prices for such reasons as unique features of a dwelling, its location, special arrangements in the rental contract, or differences between the owner's estimate of value and market valuations. This variation cannot be avoided and should not be represented in a market price index. Other sources of variation come from shortcomings in the procedure used to calculate price. Each procedure considered in this paper has its own shortcomings which can add to the variation of individual rents and values around the price index.

The BLS procedure selects a subsample of dwellings which satisfy a common set of specifications from the Annual Housing Survey's SMSA sample. The procedure then uses the average rent or value of the subsample for the SMSA price. The subsample must be large enough to give a precise estimate of the average rent or value. However, the more extensive the set of dwelling specifications, the smaller the subsample of dwellings which meets all the specifications. This means that the list of dwelling specifications must be kept to a minimum. The shorter the list of specifications, though, the greater are the ways in which the subsample dwellings can differ among themselves and, therefore, the greater is their variation in rents or values. Thus, the BLS procedure is subject to additional variation because of its limited control on the characteristics of dwellings priced.

The hedonic procedure is subject to less variation from incomplete quality control because it uses a much more extensive list of dwelling characteristics. The hedonic procedure can use a longer list of dwelling specifications because it uses the complete sample in estimating its characteristic prices. However, this adds another source of error because an SMSA's characteristic prices may vary among submarkets of different quality housing. The hedonic regression can only represent an average of these submarket prices and therefore will be less accurate in predicting prices for any specific quality level.

In summary, we expect to find differences in the precision of the two procedures because each is subject to its own source of error. The BLS procedure loses precision because it must rely on limited controls of dwelling characteristics. On the other hand, it avoids imprecision arising from market segmentation because it samples only a limited cross-section of the market. The hedonic procedure loses precision because of market segmentation since it uses a marketwide sample. It avoids imprecision by controlling for an extensive list of dwelling characteristics.

We can assess the relative importance of these sources of imprecision using the Annual Housing Survey in our thirty-nine SMSAs. Since the BLS procedure uses the average rent or value of the subsampled dwellings for its index level, the standard deviation of rent for the subsample is an appropriate measure of precision for the index. To take account of differences in price levels across sites and between index procedures, we divide the standard deviation by the BLS index level. For the hedonic procedure we measure precision with the standard error of the regression which, of course, is calculated over the entire survey sample. It would be impractical to restrict the measure of precision to only those dwellings satisfying the full list of hedonic specifications because there would be at most a mere handful of such dwellings per SMSA. The hedonic regression is estimated in semi-logarithmic form which can be shown to be comparable to the relative standard error from the BLS procedure.

Table 22 reports the errors of the alternative index procedures for rents and house values. In both cases the hedonic procedure has lower average errors. The difference is small in the case of rents -- .25 versus .26 -- but not for house values -- .28 versus .35. Even though the average difference in precision is small for renters, the hedonic procedure is as precise, or more so, than the BLS-type index in twenty-nine of thirty-nine SMSAs. For owner-occupied housing, the hedonic index is as precise or more so in every SMSA.

The results of table 22 indicate that in our data the loss of precision from inadequate control over dwelling characteristics is greater than from market segmentation. Not only is the BLS procedure consistently less precise than the hedonic procedure, but the BLS-type owner index, which uses fewer controls than the renter index, is relatively less precise than its renter counterpart.

Table 22

Standard Errors as Fractions of Mean Rents and Values

City	Rent Indexes		Value Indexes	
	Hedonic[a]	BLS-Type[b]	Hedonic[a]	BLS-Type[b]
Albany	.29	.34	.29	.34
Anaheim	.21	.22	.22	.26
Atlanta	.25	.29	.28	.34
Boston	.27	.30	.24	.32
Chicago	.25	.28	.25	.32
Cincinnati	.25	.28	.28	.36
Colorado Springs	.22	.17	.24	.35
Columbus	.21	.23	.28	.38
Dallas	.27	.20	.32	.46
Detroit	.23	.28	.27	.45
Fort Worth	.24	.31	.34	.44
Hartford	.22	.19	.21	.26
Kansas City	.24	.32	.31	.41
Los Angeles	.25	.36	.28	.37
Madison	.20	.21	.23	.31
Memphis	.24	.24	.33	.39
Miami	.24	.19	.26	.30
Milwaukee	.22	.22	.26	.33
Minneapolis	.21	.26	.24	.38
Newark	.23	.26	.22	.27
New Orleans	.27	.29	.28	.34
Newport News	.19	.19	.27	.32
Orlando	.23	.14	.32	.38
Paterson	.25	.32	.21	.22
Philadelphia	.30	.35	.31	.31
Phoenix	.27	.22	.30	.36
Pittsburgh	.29	.30	.32	.40
Portland	.23	.23	.29	.34
Rochester	.24	.20	.27	.39
Salt Lake City	.26	.34	.29	.39
San Antonio	.29	.35	.37	.51
San Bernardino	.28	.16	.29	.34
San Diego	.26	.22	.25	.27
San Francisco	.26	.28	.25	.27
Spokane	.27	.24	.31	.41
Springfield	.24	.25	.24	.39
Tacoma	.23	.23	.30	.38
Washington, D.C.	.23	.25	.21	.26
Wichita	.23	.28	.32	.50
Average	.25	.26	.28	.35

a. Standard error of hedonic regression with logarithm of rent or value as dependent variable.

b. Standard deviation of rents or values used to estimate level of rent or value index relative to index level.

c. Indicates sample size below 15. Smallest sample size is 8 in Dallas.

An Explanation for Differences in the Two Index Procedures

Comparisons of the hedonic and BLS price index procedures in the preceding two sections have revealed that the BLS-type index shows less variation among SMSAs (for rental housing) and less precision within SMSAs (for rental and owner housing) than the hedonic index. The greater imprecision of the BLS procedure within SMSAs seems due to its weaker control over dwelling characteristics. Dwellings meeting BLS-type requirements apparently have considerable variation in non-BLS characteristics. This lack of control over dwelling characteristics could also contribute to less variation in the BLS-type indexes among SMSAs. In higher-priced areas, households may forgo the more expensive extras that go unspecified in the BLS-type index while in lower priced areas, these extras could be added to the basic package. Such substitution would be reflected in reduced variation in BLS-type indexes such as we observe in figures 2 and 3.

The possibililties for substitution within the BLS-specification need not be limited to variations in price. Lower-income SMSAs could also have fewer extras on the average BLS-dwelling while higher income areas might have more. Thus, the BLS-procedure would overstate price differences between high and low-income areas.

In this section, we develop these and additional hypotheses in an attempt to explain differences between the hedonic and BLS-type price indexes. We will test the hypotheses by using data characterizing the thirty-nine SMSAs in conjunction with our price indexes. We believe our hypotheses and test results are relevant to the published BLS rent index even though we cannot go beyond our own indexes. Our hypotheses are directly transferable to the BLS rent index on the conceptual level, and we have closely followed the BLS dwelling specifications and pricing procedures in constructing our BLS-type rent index. Our home-value index does not have a published BLS analog, but we feel its analysis adds a useful second test for our hypotheses about the BLS rent index.

Our basic hypothesis is that movement in the BLS-type index from SMSA to SMSA includes a component of changing housing consumption which is not present in the hedonic index, and that this consumption component contributes to the divergence between the two indexes. Thus, for example, in SMSAs with expensive housing or low income households, the BLS-specified dwelling actually provides <u>less</u> housing than in areas with inexpensive housing or high income households.

An alternative hypothesis would be that there is a shift in the composition of the BLS-type bundle among SMSAs but that the level of housing services provided by the bundle remains the same. In this case, the hedonic price index, which prohibits such substitution, would be overstating price differences among SMSAs as is normal for a Lasperyres price index. The BLS-type index would be giving true price differences. However, in chapter 2, we found little substitution among components of the typical housing bundle among SMSAs. Instead, we found substantial differences in the levels of major components, for example, average number of rooms and bathrooms.[1] These findings suggest that variation in the level of housing quality across areas is more important than substitution within the bundle. Consequently,

1. Refer to chapter 2.

we pursue here hypotheses about variation in the level of services provided by the BLS-type dwellings rather than those about variation in the composition of a constant quality bundle.

We test our basic hypothesis about changing consumption in the BLS-type index by determining whether factors which normally affect housing consumption contribute to explaining divergences between the BLS-type and hedonic indexes. Specifically, we let RB represent our BLS-type rent index and RH our hedonic rent index.[1] Under our assumption that RB reflects housing consumption and price while RH is a pure price measure, the ratio of the two indexes, RB/RH, measures the housing consumption component of the BLS-type index. Differences in housing consumption commonly are related to factors of demand and supply. We posit that the consumption component demanded in the BLS-type bundle is a function of the following variables:

(1) RQ = F(RH, RY, P, ES, M)

RQ = RB/RH is a measure of the quantity of housing services included in the BLS-type index.

RH = hedonic price index for rental housing per SMSA.

RY = median income for renter households in an SMSA.

P = price of nonhousing consumption in the SMSA.

ES = fraction of households that are elderly or single in the SMSA.

M = fraction of households headed by a black or spanish speaking person.

1. Here and in the remainder of chapter 4 the terms RB and RH refer to our price indexes as calculated for the midpoint of the year in which they were estimated. The reason for adjusting the indexes in this manner is that the associated data used in the following analysis apply to the midpoint of the years in which the particular surveys were conducted. See chapter 2 for a discussion of how time is adjusted in the hedonic indexes.

The quantity of rental housing supplied in the BLS-type bundle is given as a function of the price of rental housing and the prices of inputs used in the provision of rental housing. Writing the supply equation with price as the dependent variable we have

$$(2) \quad RH = F_2 (RQ, CC, I, N, W, U)$$

where the newly denoted variables are

CC = construction cost index.

I = mortgage interest rate.

N = number of households in SMSA.

W = wage rate for janitors and accountants.

U = utilities price index.

We specify similar equations for the quantity of housing structure represented in the BLS-type price index for houses. Two modifications are introduced to reflect the difference between renting and owning. Utility prices enter the demand equation as they are a separate expense for homeowners, and wages of janitors and accountants are dropped entirely because homeowners normally perform these tasks themselves. The demand and supply equations become, respectively,

$$(3) \quad VQ = F_3 (VH, VY, U, P, ES, M)$$

$$(4) \quad VH = F_4 (VQ, CC, I, N)$$

where the newly denoted variables are

VH = hedonic price index for house values.

VQ = ratio of the BLS-type and hedonic indexes for house price. The ratio measures the quantity of house structure included in the BLS-type index.

VY = median income of owners.

Supply and demand equations can be solved for a reduced-form equation which expresses the quantity of housing as a function of the exogenous parameters only. These reduced-form equations give direct tests of the net effects of supply and demand determinants on the ratio of the two indexes. This occurs because the ratio of indexes is the measure of quantity used in the equations. Solving equations (1) and (2), and separately, equations (3) and (4), we get

$$(5) \quad RQ = F_5 \, (RY, P, ES, M, CC, I, N, U, W)$$

$$(6) \quad VQ = F_6 \, (VY, P, ES, M, CC, I, N, U)$$

Higher prices for inputs raise the price of housing and thereby discourage consumption. Consequently, variables CC, I, N, U and W should have negative influences on RQ and VQ (population (N) is included as a measure of the price of land). High incomes and high prices for other goods should encourage housing consumption and, therefore, variables RY, VY, and P should have positive influences on RQ and VQ. Elderly and single person households usually show stronger demand for housing than nonelderly families. Therefore, ES should show positive influences on RQ and VQ. Minority households appear to pay a lower price for housing than whites pay in most of our thirty-nine SMSAs which should lead to greater consumption of housing by minorities and possibly less consumption by whites.[1] Thus, M could have either positive or negative effects on RQ and VQ.

The hypotheses proposed here can be tested by estimating equations (1)-(6). We estimate equations (5) and (6) using ordinary least

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1. Follain and Malpezzi (3), pp. 50-62.

using a variety of sources. Their complete definitions and sources are given in table 23. Each regression uses the full complement of thirty-nine SMSAs.

The results of estimating reduced form equations (5) and (6) are given in table 24 and the results for the simultaneous equations (1)-(4) are in table 25. The results of the reduced form equations show little support for our major hypotheses. Neither income nor the cost coefficients are statistically different from zero in the renter or owner regressions. The income coefficient is positively related to the index ratios just for homeowners. Only two of five renter cost coefficients and two of four owner cost coefficients are negatively related to the index ratios. The coefficient of the proportion of minority households is the single statistically significant coefficient, and we have stated no prior hypothesis about its sign.

The results for the jointly estimated supply and demand equations are similar to the reduced form results. In the renter-demand equation the minority variable is the only significant one and income has the wrong sign. However, the price of rental housing is negatively related to the ratio of indexes as hypothesized. In the renter-supply equation, the ratio of indexes has a highly significant negative relation to price although we hypothesized a positive relation. The other statistically significant variable in the renter-supply equation is the utility price index which has its expected positive sign. The owner demand equation has no statistically significant coefficients. The coefficient of income is positive, as predicted, but the price

Table 23

Explanatory Variables in Equations (1)-(6)

Name	Definition	Source	Mean	Standard Deviation
RH	Hedonic Price Index for Rental Housing	Table 4-1	175.86	43.25
RB	BLS-Type Rent Index	Table 4-2	173.31	23.73
VH	Hedonic Price Index for House Values	Table 4-1	36098.05	7181.23
VB	BLS House Price Index	Table 4-3	40253.92	7479.24
RQ	Measures the Quantity of Housing Services (RB/RH)	See RH & RB	1.03	.24
VQ	Measures the Quantity of House Structure (VB/VH)	See VH & VB	1.13	.16
RY	Median Income for Renter Households	Annual Housing Survey, 1974, 1975	8446.15	1086.24
VY	Median Income for Owner Households	Annual Housing Survey, 1974, 1975	15482.05	2142.66
P	Price of Non-Housing Consumption	BLS Urban Family Budgets, 1974, 1975	8.57	.41
ES	Households That Are Elderly or Single	Annual Housing Survey, 1974, 1975	.31	.09

Table 23 (cont'd)

Explanatory Variables in Equations (1)-(6)

Name	Definition	Source	Mean	Standard Deviation
M	Households Headed by a Black or Spanish-Speaking Person	Annual Housing Survey, 1974, 1975	.14	.10
CC	Construction Cost Index	Average of Selected Boeckh Building Cost Index Numbers, March-April 1974, 1975, 1976	643.62	71.68
J	SMSA or Regional Mortgage Interest Rate	Mortgage Finance Review, 1974-1977, FHLMC	8.95	.69
N	Number of Households in SMSA Population	Annual Housing Survey, 1974, 1975	496.68	499.21
W	Average Wage Rate for Accounting Clerks (Class A) and for Male Janitors/Porters	Area Wage Surveys, Selected Metropolitan Areas, 1972-1976	3.54	.39
U	State Average of Utility Prices	"Energy Fuel Prices By Sector/Units" From Federal Energy Administration and Federal Energy Data System (FEDS) Statistical Summary	351.79	115.16

Table 24

Reduced Form Equations with Ratios of BLS-Type Index to Hedonic Index as Dependent Variables

Variable Name	Dependent Variable RQ (rent)	VQ (value)
RY	-.07	
	(.04)[a]	
VY		.02
		(.02)
P	.16	-.03
	(.14)	(.11)
ES	.07	-.37
	(.48)	(.35)
M	1.39*	.07
	(.55)	(.38)
CC	.38	-.31
	(.97)	(.70)
I	.02	-.04
	(.08)	(.05)
N	-.0001	.00
	(.0001)	(.00)
U	-.04	.01
	(.04)	(.03)
W	.02	
	(.14)	
Constant	-.25	1.66
R^2	.32	.21

a. Numbers in parenthesis are Standard Errors.

* Indicates statistical significance as .05 level for 2-tail test.

Table 25

Supply and Demand Equations for Consumption
Component of BLS-Type Index

	Renter Equations		Owner Equations	
	Demand	Supply	Demand	Supply
Dependent Variables	RQ	RH	VQ	VH
Explanatory Variables				
RH	-.002			
	(.002)[a]			
VH			.000	
			(.000)	
RQ		-168*		
		(33)		
VQ				45402
				(36825)
RY	-.037			
	(.047)			
VY			.017	
			(.022)	
P	.120		.028	
	(.079)		(.095)	
ES	.016			
	(.347)		(.339)	

a. Figures in parenthesis are Standard Errors.
* Indicates statistical significance at the .05 level for 2-tail test.

Table 25 (Cont'd)

Supply and Demand Equations for Consumption
Component of BLS-Type Index

	Renter Equations		Owner Equations	
	Demand	Supply	Demand	Supply
Dependent Variables	RQ	RH	VQ	VH
Explanatory Variables				
M	.774 (.304)		.148 (.311)	
CC		.133 (.083)		40.7 36.7
I		1.62 (7.83)		-1178 (3292)
N	-.003 (.010)			1.73 4.87
W		1.37 (15.6)		
U		12.7*	.010 (.027)	
Constant	.54	201	1.10	-31651

coefficient is also positive (and very close to zero). There are no significant coefficients in the owner supply equation, but price and the index ratios are positively related, as predicted.

Our main hypothesis has been that differences between the BLS-type index and the hedonic index--as measured by their ratio--would respond to the normal determinants of supply and demand. This hypothesis is based on the assumption that differences between the indexes can be attributed to a consumption component in the BLS-type index. We find little support for this hypothesis in our regressions. In particular, we find little evidence that households substitute for luxury components of the BLS-type dwelling in high priced areas or purchase more luxury components in high-income areas. We reported in preceding sections of this chapter a strong tendency for our BLS-type index to rise less rapidly than our hedonic index; we conclude here that better data or alternative hypotheses are needed to explain this relation.

Summary

In this paper, we have presented two indexes of housing prices across SMSAs, one using the hedonic procedure and the other the BLS procedure. These indexes have been calculated using the Annual Housing Survey data for thirty-nine SMSAs for 1974-1975. For the present, we cannot provide empirical evidence which clearly identifies one of our index procedures as preferable to the other. Yet our analysis of the indexes has led us to some principal findings. These are as follows:

1. Significant variation exists under both index procedures in the price of housing across SMSAs. It is not unusual for some SMSAs

to be twice as expensive as the less expensive ones. The variance is substantial for both renter and owner-occupied housing.

2. The indexes themselves are sensitive to changes in the reference bundles. This suggests that separate indexes are needed for low and high-income families.

3. Additional experimentation with the hedonic index finds it to be relatively insensitive to the following:

- The metropolitan location of the reference bundle. That is, using the average bundle consumed by households in Miami as the reference bundle produces much the same index as is obtained using the Minneapolis average bundle.
- Intrametropolitan location of the reference bundle, that is central city versus suburbs. The cities for which it did make a difference--Detroit and Philadelphia--are not surprises since they seem to fit the mold of a declining Northeastern central city.
- Inclusion or exclusion of neighborhood characteristics. This could be because the neighborhood variables used in the hedonic are not sufficient measures of the influence of neighborhood rents and values. More work should be done here.

4. The BLS procedure applied to the Annual Housing Survey data yields an index with average rents substantially above those of the official BLS index. The difference does not seem due to differences in dwelling unit specifications but could result from shortcomings in the

updating of the official index over time. In spite of this major difference in levels, the relative rankings of ours and the official index are close.

Appendix A

Hedonic Variables List

Variable Label	Tenure*	Variable Name	Hedonic Variable Definitions
<u>Structural and Quality Variables</u>			
V005LN	B	Age	Log of average age of structure in each category.
V050G5	R	Number units	More than 5 units=1, else=0.
V050SF	R	Single family	Single-family, detached unit =1, else=0.
V054	R	Number floors	1-3=1, 4-6=2, 7-12=3, GT12=4.
V055	R	Elevator	Yes=1, else=0.
V056	B	Rooms	Number of rooms, including bedrooms.
V059	B	Bedrooms	Number of bedrooms.
V066E	B	Cooking fuel	Electricity=1, else=0.
V074	B	Baths	Recoded to actual number of bathrooms (shared=0).
V084E	B	Electric heat	Electric heat=1, else=0.
V086CH	B	Central heat	Central warm air=1, else=0.
V086NH	B	Poor heating	Heaters without flue, fireplace, stove, or no heat=1, else=0.
V086SH	B	Steam heat	Steam or hot water=1, else=0.

*Indicates in which regressions variable appears as an independent variable: O, Owners; R, Renters; B, Both.

Appendix A (cont'd)

Hedonic Variables List

Variable Label	Tenure	Variable Name	Hedonic Variable Definitions
V088	B	Add heat	Additional heating equipment used=1, else=0.
V090B	B	Rooms without heat	More than 1 room without heat=1, else=0.
V099	B	Central air	Central air conditioning=1, else=0.
V102FB	B	Fuses	Fuses blown=1, else=0.
V107	0	Basement	Yes=1, else=0.
V110	B	Cracks	Cracks in wall, ceiling=1, else=0.
V112	B	Broken plaster	Yes=1, else=0.
V114	B	Rats	Signs of rats or mice; yes=1, else=0.
V125	0	Garage	Garage or carport=1, else=0.
V277	B	House rating	Rated by occupant (excellent=1, good or N.A.=2, fair=3, poor=4).
V6162	B	Privacy	Pass through bedrooms to bath or bedroom=1, through to both=2, else=0.
V28012	R	Hallway	V280 + V281 - V282: (1) light fixtures not working =1, else=0, plus (2) bad stairways=1, else=0, plus (3) railing attached firmly=1, else=0.

Appendix A (cont'd)

Hedonic Variables List

Variable Label	Tenure	Variable Name	Hedonic Variable Definitions
BRKDWS	B	Breakdowns	Value increases by 1 for each of the following breakdown, sewer breakdown, toilet breakdown, leaky roof, leaky basement, holes in floor, broken plaster, large plaster breaks.
<u>Neighborhood Variables</u>			
V276	B	Street rating	Rated by occupant (excellent=1, good, N.A.=2, fair=3, poor=4).
V278	B	Bad housing	Deteriorated housing on street=1, else=0 (Enumerator response).
AIR	B	Airplane noise	Yes=1, noise bothersome=2, wish to move=3, else=0.
CRIME	B	Street crime	Same as AIR.
NOISE	B	Street noise	Same as AIR.
SCHOOL	B	Schools inadequate	Yes=1, wish to move=2, else=0.
SHOPS	B	Shopping inadequate	Same as SCHOOL.
TRAFFIC	B	Street traffic	Same as AIR.

Appendix A (cont'd)

Hedonic Variables List

Variable Label	Tenure	Variable Name	Hedonic Variable Definitions
<u>Locational Variables</u>			
V405xxx*	B	County	Countyxxx=1, else=0.
V408A	B	Central city	In central city=1, else=0.
CC**	B	Central city	St. Paul, Long Beach central city=1, else=0.
OAKLAND**	B	Central city	Oakland Central City=1, else=0.
"State Name"	B	State	Said state=1, else=0.
<u>Selected Tenant Characteristics</u>			
V031B	B	Race	Black=1, else=0.
VO40YRS	B	Length of tenure	Recode to average length in each category.
V347	B	Crowding	Persons per room.

*For example, in the D.C. regression V405PG is a dummy variable for Prince Georges County. County variables and other locational variables are listed by SMSA in James R. Follain and Stephen Malpezzi, "Hedonic Indexes for Housing Value and Rent in 39 SMSAs: Technical Appendix to <u>Dissecting Housing Value and Rent</u>," Contract Report 249-18, Washington, D.C.: The Urban Institute, June 1979.

**Minneapolis, Los Angeles, and San Francisco SMSAs contain locational information on two central cities.

Appendix A (cont'd)

Hedonic Variables List

Variable Label	Tenure	Variable Name	Hedonic Variable Definitions
<u>Other Independent Variables</u>			
V156	R	Rent and furnishings	Included in rent=1, else=0.
V410	B	Interview date	Recode to April 1974=1, ... March 1975=12 (Year 1, similar for year 2).
EXTRAS	R	Utilities and rent	Value increases by 1 for each of the following utilities paid for separately from rent: electricity, gas, water, coal, and oil.
<u>Structural and Quality Variables</u>	<u>Tenure</u>	<u>Variable Name</u>	<u>Hedonic Variable Definitions</u>
TAXRTLN	O	Tax rate	Log (real estate taxes/value).
<u>Dependent Variables</u>			
V117LN	O	Value	Log value of house, recoded as interval midpoints (1=2000, 2=3750, ..., 15=70,000).
V363LN	R	Rent	Log gross monthly rent, includes utilities.

NOTE: Numbered variables correspond to tape positions on 1974 survey public use tapes.

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