Treatment of Owner-Occupied Housing in the CPI

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This paper has been prepared for presentation to the Federal Economic Statistics Advisory Committee (FESAC) on December 9, 2005. It represents work in progress and does not represent any agency's final positions on issues addressed. The FESAC is a Federal Advisory Committee sponsored jointly by the Bureau of Labor Statistics of the U.S. Department of Labor and by the Bureau of Economic Analysis and the Bureau of the Census of the Department of Commerce.

The rapid rise in housing prices in recent years coupled with slow increases in the prices of housing services have resulted in a wide range of economists – including some on Wall Street, in academia, and at the Federal Reserve – to inquire about the relationship between measures of housing prices and the treatment of owner-occupied housing services in the Consumer Price Index (CPI).

Much of this recent research shows that the median house price is rising much more rapidly than the CPI measure for owner-occupied housing (or Owners' equivalent rent of primary residence)[1]. While housing prices have shot up, however, the cost of shelter has not increased as rapidly. It is simply wrong to look at just the selling price of the home as a reasonable proxy to changes in the cost of consuming shelter.

The CPI is attempting to measure the changes in the Cost-of-Living for an average urban consumer, which addresses the following question: **"***What is the cost, at this month's market prices, of achieving the standard of living actually attained in the base period?"* This suggests that the CPI must only include the parts of owning a home that affect the standard of living. Hence, the investment portion of owning a house must be separated from the consumption portion, as represented by the service flows that are provided by owning the house.[2]

The first section compares the alternative treatments of the cost of owner-occupied housing, such as the acquisitions, payments or cash flow, user cost, and rental equivalence approaches. It also justifies the conceptual framework currently used in the CPI. The second section reviews the methodology used by BLS in measuring the CPI for Rent of primary residence (Rent) and Owners' equivalent rent of primary residence (OER) and provides a theoretical and historical justification for this methodological choice. Since most of this historical information is not readily available, we have taken this opportunity to get it on the record.[3] Section three describes the current sample design and pricing methods used in constructing the CPI for rent and owners' equivalent rent. Section four describes recent research on the measurement of owner-occupied housing. Finally, section five provides a conclusion and questions for FESAC members.

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[1] See Rosen, R., "Explaining recent changes in home prices," Chicago Fed Letter, July 2005.
[2] Richard Rosen states: "An owner-occupied house combines a flow of services with an investment good."
[3] The historical section is provided for reference; the FESAC presentation will not focus on the historical changes.

1. Conceptual Issues in Measuring Owner-Occupied Housing

As expounded upon in Diewert (2003), there are essentially four different main approaches to estimating inflation of the shelter costs of homeowners:

(1) Acquisitions approaches;

(2) Payments or cash flow approaches (the pre-1983 "asset-price" approach of the BLS is a member of this set);

(3) User cost approaches; and

(4) Rental equivalence approaches (post-1983 BLS practice is a member of this set).

Each approach is discussed in more detail below. In a frictionless world devoid of transactions costs and risk, the user cost approach and the rental equivalence approach will yield identical estimates – which will, implicitly or explicitly, reflect costs of capital and home-value appreciation. (The world, however, does not resemble this frictionless ideal, implying that empirical estimates of user costs and rents diverge markedly over extended periods of time – see Verbrugge, 2005). Diewert (2003) argues that over long horizons, estimates of homeowner shelter costs resulting from a user-cost or rental-equivalence measure will be larger than the estimates resulting from an acquisitions approach. The cash flow approach ignores the effects of home-value appreciation. As a result, such measures are essentially a poor approximation to a user cost measure, and will typically mis-measure the costs of ownership, overstating this cost during periods of house price appreciation, and understating these costs during periods of house price decline.

The **acquisitions approach** treats a house purchase as it does the purchase of a nondurable good, i.e. it attributes all of the expenditure on the house to the period of purchase, and only estimates *net* purchases of houses by the household sector. In principle, this could include the purchase of second-hand dwellings from other sectors (and renovations could also, in principle, be in scope for this approach), but in practice the bulk of these purchases are likely to be newly-built houses and condominiums. Thus,

the long-term price relative for this category would be the quality-adjusted price of new houses relative to the price of new houses in the base period. Although this approach will ignore the somewhat-volatile cost of capital (and will thereby not reflect "affordability"), it will still lead to a relatively cyclical measure, reflecting new housing construction cycles. Furthermore, it cannot hope to reflect accurately the *consumption services* of houses in any period (which would be measured by PQ, where P is given by the acquisitions price index, and Q is the quantity of new homes). To take a stark example, during a macroeconomic crisis in which few new houses are built, shelter costs (as measured by this approach) would be miniscule, even though the actual consumption of housing services is roughly as large as ever. Put differently, new house price appreciation indices don't measure the changing cost of the flow of housing services for owner-occupied houses, since they merely measure the gain of the value of the (new) capital assets, not the value of the service flow consumed by all existing homeowners. To the extent that a price index is intended to reflect the costs of consumption services – as is the CPI – an acquisitions approach would be a poor approximation. As Diewert demonstrates, the expenditures estimated using this approach will, on average, be smaller than those estimated by a user cost or rental equivalence approach.

The **payments** or **cash flow approach** sums up the various out-of-pocket expenses associated with owning a house, such as mortgage payments and required maintenance. This approach came under severe criticism in the U.S. in the 1970's, as noted above. There are several deficiencies, especially from the point of view of attempting to estimate the costs of housing service flows.

First, such measures will move around abnormally in response to modest financial portfolio changes. For example, if someone sells a bond in period t in order to pay off his mortgage, this measure would suggest that his period $t+1$ shelter expenses – ignoring taxes and depreciation –would fall to zero. Since many agents can readily go back and forth between such financing decisions – i.e., reducing or increasing the level of equity in one's house by offsetting actions in financial markets – it is surely not desirable that such changes should so markedly alter the measured cost of shelter. (Related to this, the opportunity cost of tying up equity in the home is not addressed.)

Second, such measures ignore the benefits to homeowners that accrue from home price appreciation. If houses will appreciate 10% by next year, this is a real benefit to a homeowner; the homeowner's perceived cost of living in her house is substantially reduced. However, this reduction in cost would not be captured by this measure. Related to this, cash flow measures use nominal interest rates without any offset for inflation; but it is real interest rates that truly reflect the cost of financing. (As demonstrated below, a user-cost approach implicitly uses real interest rates in that the house price appreciation is subtracted from the nominal interest rate.) One *could* address the deficiencies mentioned above … but upon doing so, one has moved to a user cost approach.

The **user cost approach** is, in principle, very simple. It calculates the cost of purchasing the house at the beginning of the period, using the house for a year (and paying any required taxes, maintenance, etc.), and then selling it at the end of the year.[4] Since the homeowner only obtains the "scrap value" from selling the house at the end of the year, this dollar benefit must be discounted; thus, some measure of interest rates inevitably enters a user cost formula. (A user cost, put differently, inevitably involves pricing the house at two points in time.) The user cost approach is routinely used in other contexts, such as in the capital asset pricing literature, in the analysis of tax depreciation rules, etc.

The commonly-used user cost formulas are appropriate for a frictionless economy with a simple tax code; the simplest user cost formula used is given by:

$$C_t = P_t(i_t + \gamma - E\pi^h)$$

where P_t is a measure of the value of the home, i_t is a nominal interest rate, γ is a term which collects the rates of depreciation, maintenance, and property taxes, and $E\pi^h$ is an estimate of expected house price appreciation rate.

In equilibrium, the rental price of the house would be equal to the user cost (C) and the rent received by the landlord (R^L) would be equal to the rent paid by the tenant (R^T), i.e,

$$RL = C = RT.^5$$

[4] Gillingham (1980, 1983) and Dougherty and Van Order (1982) discuss the concept, and measurement, of a homeowner user cost; see also Katz (1983). The user cost measures studied in these papers, however, are valid only in the context of a frictionless, riskless world.

[5] In 1972, Robert Gillingham stated that, in an imperfect world, the following relation holds: $R^L_t \leq C_t \leq R^T_t$

Computing an *ex ante* or beginning-of-period measure must involve the use of expected prices. This is likely preferable to the alternative for three reasons. First, highly volatile home price dynamics imply that *ex post* or end-of-period user cost measures will be correspondingly extremely volatile. Second, such ex post measures can become *negative* when home value appreciation sufficiently exceeds the interest rate. Finally, it is housing consumption decisions are based upon ex ante rather than ex post user costs.

To accurately estimate a given homeowner's (frictionless) user cost, one must accurately estimate depreciation. Furthermore, due to the preferential tax treatment given to a homeowner, one must estimate both her financing behavior and her local and federal tax rates.

None of these aforementioned hurdles is insurmountable. And many economists prefer a user cost measure, in principle, as being closest to "the cost of homeownership" for a homeowner. However, there are profound theoretical and practical reasons which make a user cost approach troublingly difficult in practice.

First, it is not clear that a user cost measure is conceptually desirable. The conceptual foundation for most price indices is that of a cost-of-living index (or COLI). The cost-of-living index (COLI) is a unifying framework for solving the practical problems of constructing the CPI. For the CPI, the COLI attempts to answer the following question: "What is the cost, at this month's market prices, of achieving the standard of living actually attained in the base period?"[6] A COLI attempts to price the cost of *current* consumption. A purchased home is simultaneously a financial asset and a durable good which yields a flow of consumption services. A user cost measure must explicitly take into account its asset characteristics. Interest rates and asset-price appreciation both inevitably enter user cost formulas, but each of these is often considered out of scope for an index which seeks to estimate the dollar price of *current* consumption. Put differently, it is difficult to justify why the investment returns on one category of assets – namely, the housing unit that the household occupies – should be reflected in the CPI, while other investment returns are excluded. (Conversely, a rental

[6] Although the CPI isn't a true cost-of-living index, the COLI is the CPI's measurement objective and the standard by which it defines any bias in the CPI. The BLS long has stated that it produces the CPI within a cost-of-living framework. That framework has guided, and will continue to guide, operational decisions about the construction of the index.

equivalence approach explicitly focuses upon the cost of the flow of consumption services, and thus fits rather naturally into a COLI framework.)

Second, the extant user cost theory is not sufficiently developed to yield reliable rules for computing operational indexes. The (tractable) user cost measures that have been examined in the literature are, in reality, of questionable relevance, since they are valid only in environments which are devoid of transactions costs and risk.[7] However, transactions costs and risk are clearly of first-order importance in homeowner behavior, and moreover it is straightforward to demonstrate that the presence of transactions costs and idiosyncratic risk implies very different measures of user costs. Given the presence of regions of inaction, these user cost measures are also highly idiosyncratic. Theory has only begun to study the nature of user costs in the presence of such considerations (see the preliminary work of Diaz and Luengo-Prado (2003) and Martin (2004)). We have very little understanding about the dynamic behavior of these measures, how the distribution of user costs evolve over time, and how these measures compare to more traditional measures or to market rents. Extant theory, then, is simply inadequate to inform the construction of a valid estimate of user costs.

Even if one *were* to puzzle out how to adopt either of these recent measures, the information requirements would be staggering. To name several:

- The tax benefit of homeownership is an increasing function of one's marginal tax rate and a decreasing function of the level of equity in one's home; these would each have to be accurately measured.
- A household's user cost involves an idiosyncratic discount factor and a stochastic future selling date, which would have to be estimated.
- The current (unobserved) market value of the house would need to be estimated, as well as unobserved expected appreciation and depreciation.
- The size and composition of a household's financial portfolio would likely be necessary information.

[7] Furthermore, it is typical in such environments for user costs to *equal* rents, so rents could be considered an estimate of user costs (see Gillingham 1983). In practice, measured inflation deriving from simple user cost measures diverges rather markedly from measured rent inflation (see Verbrugge 2005).

Such considerations imply that measuring individual user costs accurately would necessitate the collection of an enormous amount of household-level information, which would be difficult to obtain, at best.

One could, of course, simply adopt one of the simpler (more crude) user cost measures. Even in that case, there is still disagreement over the items which should be included in a user cost measure. Transactions costs, for example, are typically excluded elsewhere in price indices. Further, among the most contentious issues of all is the choice of the relevant interest rate (or rates) – particularly given the plethora of financial instruments now available to home-buyers, and the difficulties involved both in estimating and in appropriately treating the risk premium and the default premium which are separately present in mortgage interest rates. Moreover, crude estimates are so volatile so as to be largely useless to statistical agencies (see Verbrugge 2005), unless ad hoc (i.e., highly controversial) adjustments are imposed in order to reduce their volatility.

The **rental equivalence approach** simply values the shelter services yielded by the use of the home using the corresponding market rental value for the home. Rental equivalence is the approach taken by the *System of National Accounts: 1993* in estimating the value of homeowner shelter consumption services and, like user cost, is an approach often used in a production context (when possible) to value the services of capital.

> ***Services of owner-occupied dwellings 9.58***: "Persons who own the dwellings in which they live are treated as owning unincorporated enterprises that produce housing services that are consumed by the household to which the owner belongs. The housing services produced are deemed to be equal in value to the rentals that would be paid on the market for accommodations of the same size, quality and type. The imputed values of the housing services are recorded as final consumption expenditures of the owners."

This is also the methodology used in by BEA in constructing the Personal Consumption Expenditures (PCE). The PCE Methodology Paper states: "The imputation for owner-occupied housing creates a business that purchases housing and subsequently sells housing services to persons."

The rental equivalence estimate of the costs of shelter for a homeowner is the amount that the homeowner would have to pay in order to rent their home (or a comparable home), or as the BLS Handbook of Methods puts it: "In essence, [owners' equivalent rent] measures the change in the amount a homeowner would pay to rent, or would earn from renting, his or her home in a competitive market. It is a measure of the change in the price of the shelter service provided by owner-occupied housing."

The rental equivalence approach is also widely accepted and used in many countries. A recent Organization for Economic Development and Cooperation (OECD) report[8] shows that this approach is the one used by a plurality of countries (13 out of 31 countries studied), with the next chosen alternative simply leaving owner occupied housing out of the national CPI (9 countries). Only Australia and New Zealand use an acquisitions or house price approach.

The rental equivalence approach fits naturally into a COLI framework. The CPI as currently constructed attempts to answer the question, "What is the cost of the housing services consumed by the household?" In some sense, rental equivalence may be treated almost as definitional: one might define the (implicit) cost of the shelter services of a home by the amount one would have to pay, on the market, to consume the housing services one is consuming. For renters, "rental equivalence" is easily *measured* as the amount of rent paid. For homeowners, however, this is unobserved because they, in effect, rent to themselves – their cost is an *implicit* rent. However, the conceptual opportunity-cost objective is the same as for renters – how much richer would the homeowner be if he or she did not consume the housing services provided by the dwelling. The rental equivalence technique only required that there are enough houses in the renter sample "which are similar in their most important aspects to those that are owner-occupied." The CPI sample of rental housing could serve that purpose.

Since this is a frequent source of confusion, the argument is amplified upon here. A homeowner always has the option of moving out of his/her house in order to rent it to a tenant for rent r_1, and then moving into another rental unit whose rent is r_2, with $r_2 < r_1$. Doing so would free up $(r_1 - r_2)$ income for other uses. This demonstrates that a

[8] See Christensen, Ane-Kathrine; Dupont, J. and Schreyer, P., "International Comparability of the Consumer Price Index: Owner-occupied housing," OECD Statistics Directorate mimeo, June 2005

homeowner is, in effect, giving up income equal to r_1 if he/she occupies his/her own house. The situation is exactly analogous to the decision to purchase any other good. For example, a consumer might decide to purchase a given laundry detergent, whose cost is X_1. The consumer *could* have instead purchased less expensive laundry detergent for X_2 (which would leave funds available for other uses(X_1 - X_2). The cost of purchasing the detergent is, of course, X. Similarly, the cost of consuming the home's shelter services is r_1. The fact that shelter services are considered essential for survival ("one has to live *somewhere*") is irrelevant to the argument.

In practice, as the quote from the BLS Handbook of Methods indicates, the rental equivalence approach actually involves making a *weaker* assumption. Instead of assuming that the homeowner's rental equivalent cost *equals* the market rent of a comparable property, what is rather assumed in the construction of the CPI shelter indices is that the *change* in the cost of shelter for a homeowner is equal to the *change* in the rent of a comparable property. This allows a divergence between the implicit *level of* rent of a homeowner and the market rent on a comparable property; the operational assumption is merely that the rent *change* is the same for "similar" dwellings. This technicality addresses a frequent criticism of current BLS practice. It is often argued that the average quality of the rental housing stock is lower than the average quality of the owned housing stock, and the implication suggested is that changes in the rents of rental properties are uninformative for cost changes in owned housing units. And indeed, in principle, different-quality dwellings might well experience different rates of rent inflation. However, in practice, BLS research (including the most recent work, Verbrugge et al., 2005) has consistently come to the conclusion that, aside from location, it is difficult to find any convincing predictor of rent change, including initial rent level (which is presumably a fairly good proxy for quality). Put differently, rental units of vastly different quality do not appear to experience vastly different rent inflation rates, once one controls for other influences such as location.[9]

[9] A second piece of evidence is that the rent inflation experienced by the detached rental units in the BLS sample is evidently almost identical to that experienced by other units – see Verbrugge et al. (2005) and Verbrugge (2005).

2. A History of Homeowners' Shelter Cost in the Consumer Price Index

This section[10] describes the numerous changes that the BLS has made over the last 50 years in the CPI methodology for estimating homeowner shelter costs. In particular, we focus in some detail on the background and issues leading up to the 1981 BLS decision to shift from an asset price approach to rental equivalence. It discusses primarily the decision process, but because the change was a technical one, made on the basis of technical merit, a brief technical background is also provided.

Until the early 1950s, the CPI imputed homeowners' costs to rent. Dissatisfaction with this approach, stemming largely from the widespread rent controls, led BLS to change to what later came to be called the "Asset Price" approach. Under that approach, used in the CPI for All Urban Consumers (CPI-U) until January 1983 and in the CPI for Urban Wage Earners and Clerical Workers (CPI-W) until January 1985, homeowners' shelter costs within the CPI were represented by five elements: (1) home purchase, (2) mortgage interest costs, (3) property taxes, (4) homeowner insurance charges and (5) maintenance and repair costs. These are the costs associated with purchasing and maintaining a physical asset - namely a house.

Components	Share of the CPI weight - Dec. 1982
Home purchase	9.9 %
Mortgage interest costs	9.8 %
Property taxes	1.6 %
Homeowner insurance charges	0.6 %
Maintenance and repair costs	3.6 %
Total	25.5 %
Associated Components	
Residential rent (Rent)	5.2 %
Household appliances	0.7 %

[10] The basis of this history was an attachment to a December 1985 letter to Mr. William P. Butz, Associate Director for Demographic Fields, Bureau of the Census. The author of the attachment is unknown.

The basic concept of the CPI is a measure of price change for goods and services bought by consumers for consumption. Investment purchases, such as stocks and bonds, are out of scope and excluded from the index. People do not consume a house at the time of its purchase; rather, they consume the shelter services provided by the house over a period of time. The house is, therefore, a capital asset which provides a service over a long period of time, not a one-time consumption item. Therefore the cost of the shelter service provided by that asset is the conceptually appropriate measurement objective for the CPI.

The BLS explored many difficult conceptual and operational issues in great detail to determine how best to estimate the cost of shelter for owner-occupied dwellings. The BLS concluded that a so-called rental equivalence method was best. That method measures the rate of change in the amount an owner would pay on the open market if they had to rent their own home. It is based on actual market rents collected from a sample of renter-occupied housing units that are representative of owner-occupied housing.

Although some dimensions of this issue reach back to the earliest years of the CPI, a good place to begin this discussion is with the report, The Price Statistics of the Federal Government, prepared by the Price Statistics Review Committee of the National Bureau of Economic Research (NBER) at the request of the Bureau of the Budget and issued in late 1960 (henceforth called the Stigler Report). That report was the subject of a series of hearings by the Joint Economic Committee (JEC) beginning January 24, 1961. The Stigler Report:

- Criticized the Asset Price Approach used in the CPI for housing.
- Strongly endorsed the theoretical principle that the welfare of consumers depends on the flow of services from houses and not upon the stocks acquired in any given period.
- Concluded that "If a satisfactory rent index for units comparable to those that are owner-occupied can be developed, this committee recommends its substitution in the CPI for the asset approach for prices of new houses and related expenses."

That recommendation was too late for inclusion in the CPI revision then underway, but when BLS began the next major revision of the CPI in 1970, it vigorously

investigated better measures for homeowners' shelter costs. A number of technical papers were prepared and circulated widely among users and experts in government, business, labor, and academia.[11] Extensive discussions were held under the auspices of the Subcommittee of Economic Statistics of the Nixon administration's Economic Policy Board, within the two BLS technical advisory committees - the Labor Research Advisory Committee (LRAC) and the Business Research Advisory Committee (BRAC) - and with individual economists who were experts in price measurement. Most technical experts in these forums favored a change in the process. The major exception came from labor union researchers on the LRAC, notably Lazare Teper, Anne Draper, and Markley Roberts[12][13] of the AFL-CIO. Their major objection was that rental properties were not maintained as well as owner-occupied properties and were usually older and smaller than the owner-occupied units. Even among the majority who favored a change, however, there was considerable uncertainty over the best strategy to adopt in this new area and over the operational feasibility of some options.

The issues relevant to measuring homeowners' shelter costs were also summarized in a Monthly Labor Review (MLR) article by then Commissioner Julius Shiskin in July 1974[14]. Although additional public discussion followed, no consensus developed over which alternative to use. Of the methods summarized by the Commissioner, "rental equivalence" and "user cost' received the strongest support. "The first is to use a *rental equivalence* technique – in effect, measure (the change in) what you would charge if you rented the house to yourself in an assumed arms-length transaction. The second is to establish a *user-cost function* for the provision of housing services – that is, to measure (the change in) the major cost components that an owner incurs in providing himself housing." These would include mortgage interest, property taxes, property insurance, maintenance and repair, equity interest and appreciation.

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[11] "On the Measurement of Shelter Costs for Homeowners in the Consumer Price Index," August 9, 1972
"CPI Revision: Option Paper on the Treatment of Housing Prices," October 1973
"Measurement in the Consumer Price Index of the Cost of Shelter for Homeowners," December 31, 1973

[12] Thanks to John Marcoot, former Chief of the Branch of Revision Methodology, Division of Consumer Prices and Price Indexes (DCPPI) (retired).

[13] Thanks to Patrick Jackman, Senior Economist in DCPPI.

[14] "Updating the Consumer Price Index—An Overview," Monthly Labor Review, July 1974

The user cost approach required a source of house prices. At that time, however, the only available source of monthly house price data was the database obtained from the Federal Housing Administration on FHA-insured houses. These houses represented a small segment of the market (only about 6 percent of the home purchase market in 1973). In addition, there were considerable differences between the typical house financed under the FHA programs and those financed under conventional mortgages. Most notably, the FHA ceilings on the size of insurable mortgages limited FHA price data to the lower end of the house price spectrum; and changes in those ceilings effectively altered the truncation point of the sample, resulting in large changes in sample means.[15] Another problematic issue was that the user cost approach required some form of accounting for the capital gains which rise from appreciating home values.

There was a diversity of views among business and labor groups, academicians, other government agencies, administration officials and the public in general. Commissioner Shiskin was in favor of the switch to the rental equivalence technique, but a switch at that time was rejected by both the Ford and Carter Administrations - specifically Burton Malkiel and Lyle Gramley of the Council of Economic Advisors (CEA). Opposition was partly due to use of CPI in collective bargaining agreements and adjustment of social security benefits. Some questioned the workability of the rental equivalence approach. Even within the BLS, there was considerable support for the user cost approach.

Uncertainty over the relative merits of the competing alternatives and a pressing need to complete the CPI revision led Commissioner Shiskin to announce on April 15, 1977, that the old method of homeownership (the Asset Price Approach) would be continued. At the same time, he also directed his staff "to continue research in this area ... and to publish research papers and experimental empirical work."

When the fourth major revision of the CPI was completed in February 1978, the associated documentation[16] again described the homeowner shelter cost issue and summarized the views of the various advisory bodies. Effective with the 1978 revision, BLS began publishing indexes for two different groupings of the population. The CPI for

[15] These issues, and their implications for the CPI shelter indices, were studied formally in Greenlees (1982a, 1982b).
[16] "The Consumer Price Index: Concepts and Content Over the Years," Report 517

Urban Wage Earners and Clerical Workers (CPI-W) continued the reference population from the 1964-1977 CPI. The other CPI was a broader measure covering All Urban Consumers (CPI-U). This differentiation becomes important when the timing of the implementation of rental equivalence is presented below.

BLS continued to conduct extensive investigations of homeowners' shelter cost measurement. At the time, rapid inflation and sharp rises in house prices and mortgage interest rates greatly accentuated the practical implications of homeowners' shelter cost measurement. Those issues were discussed frequently by BLS before the Joint Economic Committee (JEC) in 1979. Throughout the period, BLS pointed to the need to implement an improved homeowners' shelter cost methodology but always cautioned that the evidence and consensus was not yet in hand to choose among the various competing alternatives.

The problems raised by Commissioner Shiskin in 1974 remained and in many cases were exacerbated.

- Large changes in real estate prices and mortgage interest rates magnified the limitations of the asset price approach, highlighting concerns that its continued use could lead to biased index changes.
- Funds for long term mortgages declined sharply.
- New types of mortgage instruments developed.
- Owners selling their homes were offering to provide financing to buyers at below market rates.
- The CPI source for house price data, sales financed through the FHA, was a declining segment of the housing market.

By late 1979, BLS had developed some experimental measures of homeowners' shelter costs. They were presented by Commissioner Norwood before the Task Force on Inflation of the Committee on the Budget of the U.S. House of Representatives on December 14, 1979. That task force urged BLS to move more rapidly toward implementing a better homeownership component for the CPI. The task force hearings continued with a variety of witnesses urging a change in the CPI itself or a change in its use in escalation provisions, but representatives of organized labor continued to oppose any change.

The BLS extended the work presented in 1979 by producing, both historically and on a current basis, five experimental indexes using different technical approaches to improve the homeownership component of the CPI. Beginning with the release of the December 1979 CPI in January 1980, BLS provided supplementary tables showing the measures of price change resulting from these experimental indexes in both the "Consumer Price Index News Release" and the CPI Detailed Report. These experimental indexes were labeled CPI-U, X1 through CPI-U, X5. A BLS report[17] documented these experimental indexes in detail and was widely distributed. The experimental measures included:

- CPI-U, X1 - Rental equivalence where the Rent of Primary Residence (Rent) index proxied for the Owners' Equivalent Rent (OER) index
- Two User Cost estimates with 5-year average appreciation
  - CPI-U, X2 using current interest rates
  - CPI-U, X3 using average interest rates
- Two Outlays estimates
  - CPI-U, X4 using current interest rates
  - CPI-U, X5 using average interest rates

These measures differed both in their index movements and in the relative weight assigned to homeownership in the CPI. Therefore, it is most useful to compare them in terms of there impact on movements of the overall CPI. As can be seen in the table and the figures below, the effect of homeownership methodology was significant.

[17] "CPI Issues," BLS Report 593, February 1980

	Share of the CPI Weight Dec. 1977	Percent change 1967 to 1982, Avg Annual All Items	Average Annual percent change
CPI-U	22.8 %	189.1	7.3
CPI-U, X1	14.5 %	163.2	6.7
CPI-U, X2	11.4 %	187.8	7.3
CPI-U, X3	10.0 %	179.1	7.1
CPI-U, X4	10.0 %	184.6	7.2
CPI-U, X5	8.7 %	176.2	7.0

Table 1: CPI-U Experimental Indexes

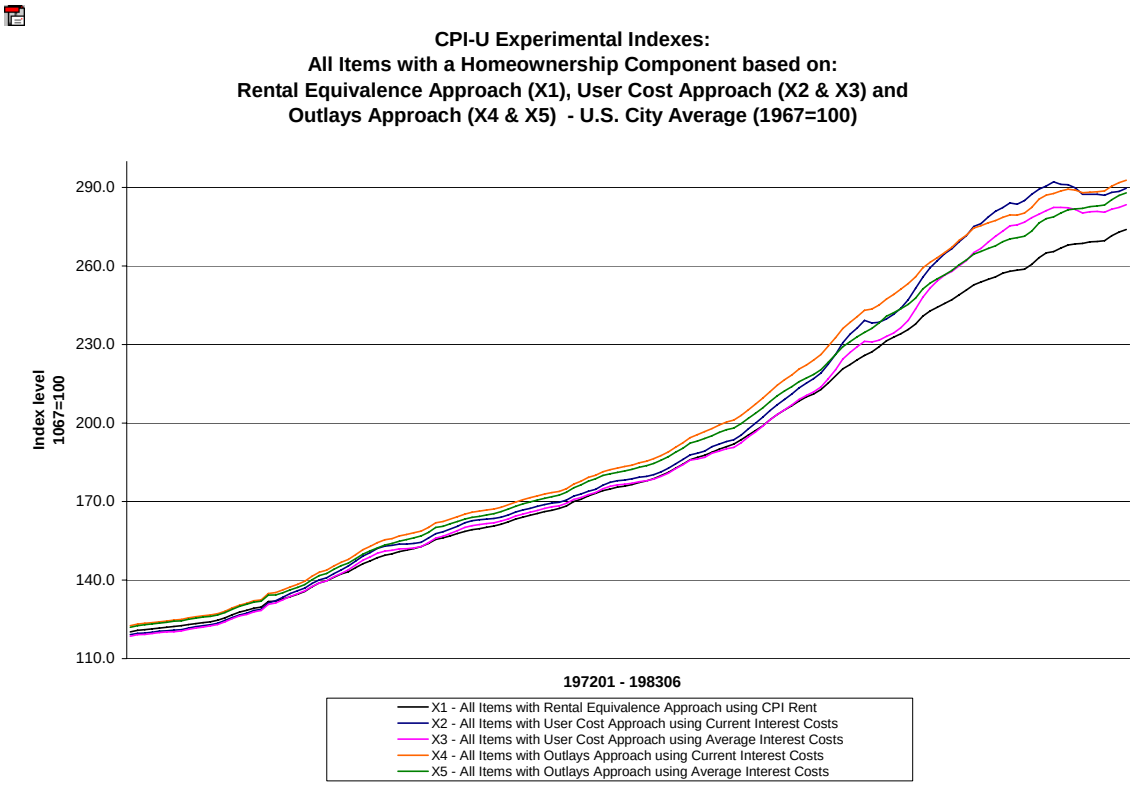

Figure 1: CPI Experimental Indexes

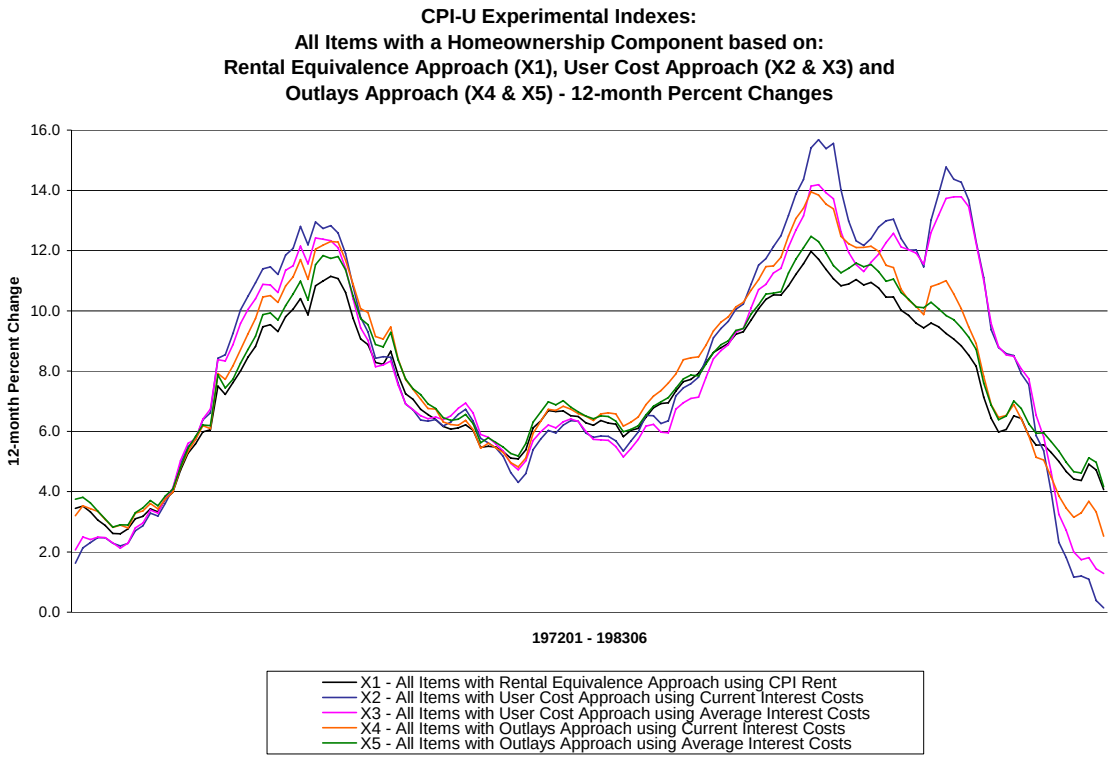

Figure 2: 12-Month Percent Changes in the CPI Experimental Indexes

The two outlays approaches were soon discarded. With regards to the user cost approach, the BLS learned that certain conditions could occur in which an estimate could not be derived. In the late '70s, interest rates jumped to over 16 percent. As interest rates went up, house prices went down and the sales of housing units declined drastically. The user cost model became inoperable and all proponents dropped their support. (See figure 2.) Soon, both empirical evidence and theoretical research at BLS made it clear that the best methodological approach was rental equivalence (the method used in the experimental CPI-U, X1). As figure 1 and table 1 shows, this change would have yielded a 0.6 percentage point decrease in the average annual percent change between 1967 and 1982.

The results of this research were published in an MLR article by BLS economist Robert Gillingham in February 1980[18]. On the strength of this work, BLS formulated a plan to develop the data collection and other operational aspects of a rental equivalence

[18] "Estimating the User Cost of Owner-Occupied Housing," Monthly Labor Review, February 1980

measure. That proposal was submitted as part of the FY 1982 budgetary process. It received full review in the Department of Labor (DOL) and Office of Management and Budget (OMB) and was included as a specific program change in the President's FY 1982 budget submitted to Congress in January 1981.

On January 29, 1981, Commissioner Norwood testified before the Committee on Appropriations of the United States Senate on the experimental CPIs and the BLS proposal. The President's submission of the FY 1982 budget was accompanied by a separate Report on Indexing Federal Programs directed to the Senate and House Budget Committees from the Chairman of the Council of Economic Advisors and Director of OMB. The primary recommendation of the report was that all Federal expenditure escalation provisions use the CPI-U, X1, the rental equivalence experimental measure.

The Task Force on Entitlements, Uncontrollables, and Indexing of the House Budget Committee held another set of hearings during March 1981. Among the topics reviewed was the need to change the homeownership component of the CPI. Among the expert witnesses, there was widespread, although not unanimous, endorsement for a change, and consensus that rental equivalence was the best alternative in spite of its limitations.

The General Accounting Office issued a report[19] on April 16, 1981 recommending that BLS adopt either a rental equivalence or nominal outlays approach to homeowners' shelter costs and urged Congress to appropriate the funds needed for implementation.

By the fall of 1981, four things had become clear and were widely accepted:

1. The old measure for homeownership was giving misleading signals about the course of inflation. For example, while the official CPI-U with the old homeownership method recorded an 11.0 increase for the 12-month period ending in September 1981, the CPI-U, X1 experimental measure based on a rental equivalence measure for homeownership rose only about four-fifths as much, 9.2 percent.
2. Federal expenditures were being driven up sharply by escalation provisions using the CPI.

[19] PAD-81-12, April 16, 1981

3. The quality of the data on house prices and mortgage interest rates was deteriorating. Fewer and fewer houses were being purchased under FHA auspices - the source for CPI house-price data. The fixed-rate, fixed-term mortgage, which served as the basis for CPI mortgage interest costs, was becoming very rare as multiple varieties of bought-down and variable-rate mortgages began to dominate.
4. A clear consensus had formed that some change was needed to the homeownership component, because its ability to measure actual changes in housing costs under then-current conditions was seriously limited. Most technical experts generally favored a rental equivalence measure. The one major group continuing to oppose any change to the homeowners' shelter costs in the CPI was the LRAC composed of labor union research representatives.

Finally, on October 27, 1981, Commissioner Norwood announced that BLS would convert the CPI-U to a rental equivalence measure for homeownership costs effective with the CPI-U for January 1983. The change also meant that the CPI-U for the years 1983 and 1984, the first years the CPI was to be used in the escalation of personal income tax brackets and exemptions would be on the new basis. The CPI-W would be converted to the new method effective with the January 1985 data. More notice was given for the CPI-W because it was the primary index used in cost-of-living adjustments in collective bargaining agreements and in the escalation of government entitlement payments such as Social Security.

That methodological enhancement was reviewed by Commissioner Norwood with the United States Congress in a number of forums[20]. In addition, BLS provided extensive public announcement and documentation. Every "CPI News Release" and CPI Detailed Report contained a notice of the impending changes. An MLR article by Robert Gillingham and Walter Lane was published for June 1982[21]. Full technical

[20] November 6, 1981, the Joint Economic Committee of the United States Congress. November 10, 1981, the Committee of Post Office and Civil Service, Subcommittee on Census and Population, U. S. House of Representatives. November 17, 1981, the House Budget Committee Task Force on Indexing, Entitlements, and Uncontrollables, U. S. House of Representatives. December 8, 1981, Committee on Education and Labor, Subcommittee on Labor Management Relations, U. S. House of Representatives March 3, 1982, Committee on the District of Columbia, Subcommittee on Fiscal Affairs and Health, U. S. House of Representatives. April 20, 1982, Committee on Governmental Affairs, Subcommittee on Congressional Operations and Oversight, United States Senate.

[21] "Changing the Treatment of Shelter Costs for Homeowners in the CPI," Monthly Labor Review, June 1982

documentation on the procedure was published in the CPI Detailed Report for January 1983. Short explanations for the general public were included in two documents[22]. The actual transition to the new method was quite smooth, due in large part to its transparency and the extensive public information effort.

During the period 1983 - 2005 three different methods have been used to measure rental equivalence. During the period 1983 through 1986, the rental equivalence measure was derived by reweighting the renter sample to represent owners. The BLS had not yet developed an owner sample needed to implement owner-renter matching, which was then thought to be the best approach to rental equivalence.

- The renter sample was augmented in heavily owner-occupied areas to better represent the owners.
- The renter weight was recalculated in augmented areas and the owner weights were derived for each area.
- Owner weights were derived by inflating or deflating the renter weights using the number of owners relative to the number of renters in the Enumeration District (ED). (An ED refers to the area assigned to a single Census-taker to count persons and prepare schedules within one Census period.)
- Since the EDs were selected to represent renters, the reweighted sample was inefficient.
- Economic rents were used for both Rent and OER. Economic rents are basically monthly cash rents paid to the landlord plus subsidies received by the landlord plus in kind services performed in lieu of cash that have been adjusted for changes in quality.

In 1987, an owner sample of about 20,000 owner units and the differentiation of Economic and Pure Rents were introduced. Economic rents are basically rents that have been adjusted for quality changes. Since many Economic Rents include utilities, Economic Rents will move in part with utility prices and implicitly will reflect changes in the cost of utilities to renters. Since owners pay for utilities directly, the goal for OER is to measure changes in the rental price with utilities excluded, and so in computing OER,

[22] "Questions and Answers on Housing Costs and the CPI" and "Questions and Answers on Homeownership Costs."

BLS subtracts from the Economic Rent an estimate of the embedded utility cost to yield Pure Rent. The following are differences that were introduced:

- Weights for the owner sample were derived from the 1980 Census.
- An estimate of the rental value of the owned home (the implicit rent) was collected for each owner unit along with other characteristics of the home.
- That implicit rent estimate served as a base rent.
- Changes in the implicit rent estimates collected from the owners over time were NOT used to move the OER indexes.
- A renter sample of about 40,000 renters was collected to move the Residential Rent index, but the renter sample was also used to move the owners' implicit rent estimates.
- Using the locations and other characteristics of the owner and renter units, such as structure type, age, number of rooms and type of air conditioning, a complex matching algorithm was used to match a set of renter units to each owner unit.[23]
- The pure rent price movements of the matched renters were used to move the implicit rent estimates of the owner units.
- The changes in the implicit rents weighted by the owner weights were used to move the OER indexes.

In January 1995, the BLS improved the implementation of owner-renter matching. From January 1987 through December 1994, the average of the pure rent price ratios of the matched renters was used to move the implicit rent estimates of the owner units. This average of ratios formula was biased, so it was changed to the ratios of the average pure rents of the matched renters. In January 1995, the BLS also replaced the Composite Estimator with the 6-month Chained Estimator. The Composite Estimator weighted together the 1-month and 6-month changes derived from the current and previous month data collected in the current month for the Housing survey, along with the current data collected 6 months earlier. Under-reporting of the 1-month rent changes had resulted in missing price change in the Rent and OER indexes. The Composite Estimator also produced higher variances. The 6-month Chained Estimator uses only the

[23] Ptacek, Frank, and Robert Baskin (1996) "Revision of the CPI housing sample and estimators." *Monthly Labor Review*, December, 31-39.

6-month changes. The $1/6^{th}$ root of the 6-month change is then used to move last month's index to the current month.

It was decided to change the rental equivalence measure in 1999 to once again use the renter sample, reweighted to represent owners, to move the OER indexes. Among the advantages of the reweighting approach are:

- In order to find sufficient owner-renter matches, the matching criteria were often relaxed, causing the matches to become much less specific.
- Even with different sampling methodologies, there was no certainty that sufficient numbers of renters could be found to support owner-renter matching.
- Moving implicit rent estimates by using the pure rent movement of matched renters is inherently a reweighting of the rent sample
- By getting rid of the owner sample, resources were saved by not screening, initiating and pricing an owner sample.
- The Housing system was simplified because it did not have to support two types of housing units - owners and renters - with different characteristic.
- In addition, the system did not have to support the complex owner-renter matching algorithm.
- Since the revision samples were selected to support the reweighting methodology
    - The BLS was able to derive owner weights directly from the 1990 Census data, so the owner weights are much better than those used during the 1983 – 1986 period.
    - Mostly owner-occupied neighborhoods, while assured of having the correct probability of selection, did not have to be over-represented.
- It would be better to use the change in the pure rents directly rather than the change in the implicit rents that were moved by the pure rents. The changes in the pure rents, rather than changes in the implicit rents, weighted by the owner weights are now used to move the OER indexes.

3. Current Sample Design and Pricing Methods for the CPI Housing Survey

3.1 Construction of the Indexes

Shelter receives much attention because it is such a large component of the CPI, just over 29% is Rent and OER (As of December, 2004, the Rent strata accounted for 6.1% of the CPI-U and the OER strata accounted for 23.2% of the CPI-U.). To obtain the expenditure weights for the market basket – this is the 29%; the Consumer Expenditure (CE) Interview Survey is used. In this survey, renters are asked:

> What is the rental charge to your Consumer Unit for this unit including any extra charges for garage & parking facilities? Do not include direct payments by local, state or federal agencies. What period of time does this cover?

Homeowners are asked the often-cited question:

> If someone were to rent your home today, how much do you think it would rent for monthly, unfurnished and without utilities?

This is the only place where the answers to this question is used; in determining the share of the market basket. We do not use this question in measuring the change in the price of shelter services. As mentioned in the previous section, the PCE uses a similar methodology and the total aggregate expenditures on owner-occupied housing in both the CE and PCE surveys are similar.[24]

The CPI Housing Survey was last revised in 1999. It is a longitudinal survey of renter-occupied housing units that is used to measure inflation for two CPI item strata: Rent and OER. The initial sample was designed to produce approximately 50,000 renter-occupied housing units in about 10,000 distinct segments (small geographically-contiguous areas comprised of Census blocks) allocated across the 87 Primary Sampling Units (PSUs) included in the CPI. The BLS allocated the sample among the PSUs in

[24] See "The Consumer Expenditure Survey in Comparison: with a Focus on Personal Consumption Expenditures" by Garner, Janini, Passero, Paszkiewicz, and Vendemia presented at the Spring 2003 FESAC meeting.

proportion to the number of housing units in each PSU that existed in 1990. The sample is augmented annually with a sample of new construction permits to represent housing units built after 1990.

The first step in selecting the sample was to create the universe of segments from which the BLS could draw a sample. Census blocks were combined to form BLS segments in each PSU. All segments were created to be geographically contiguous and contain a minimum number of housing units, as defined by the 1990 Decennial Census. In smaller cities, the minimum number of housing units was 30 and in the largest cities the minimum number of housing units for a segment was 50. On average, segments were designed to contain about 150 housing units. Each segment was assigned a total housing expenditure, which was the sum of the aggregate monthly rent and the aggregated owners implicit rent, taken from and derived from 1990 Decennial Census data, respectively.

Prior to sampling segments within the PSUs, each PSU was divided into 6 geographic strata, each strata representing approximately $1/6^{th}$ of the total housing expenditure within the PSU. This ensured adequate coverage across geography, the housing characteristic most correlated with rent change, and to reduce variance. To divide the PSUs, first the smallest rectangle (usually in the center of the PSU) containing $1/3^{rd}$ of the housing expenditure was found. This rectangle was split in two equal parts in terms of expenditure, either by longitude or latitude, depending on which split maximized the difference in average rent level. The remaining portion of the PSU was split into two equal parts, again maximizing the difference between rent levels and those two pieces were split again, perpendicular to the previous split (see Figure 3).

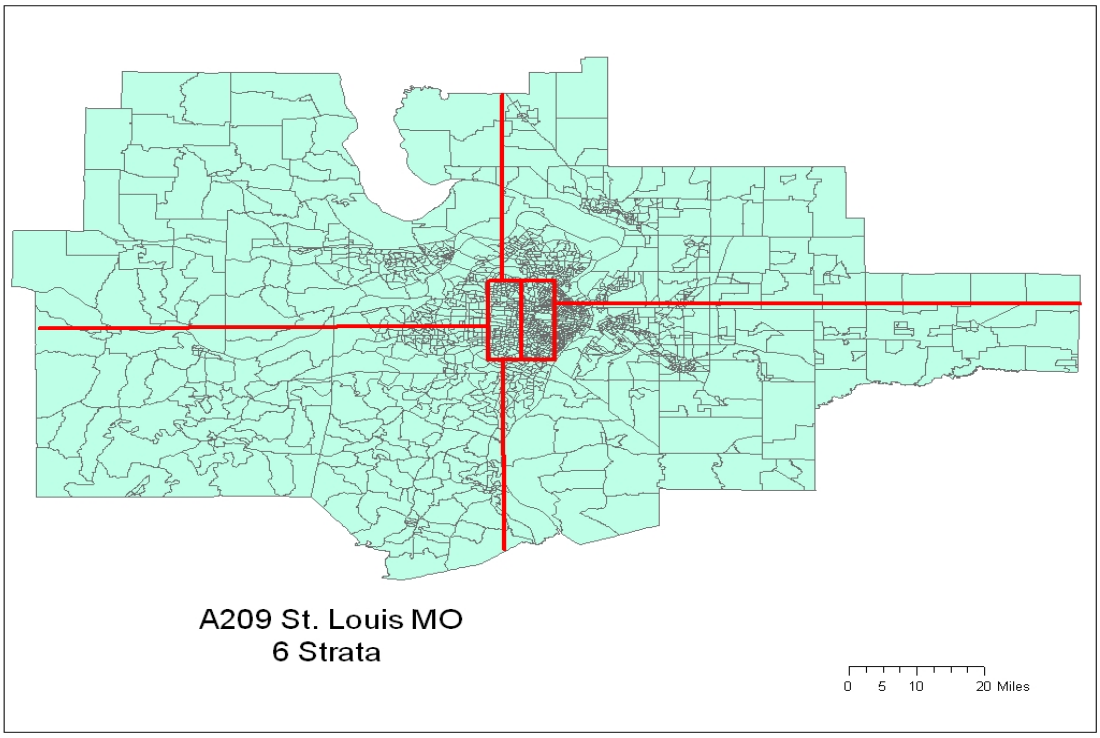

Figure 3: Geographic Strata in St. Louis, MO

After the PSUs were stratified, the segments were ordered by county and by rent level within county and an independent sample of segments was systematically selected from each stratum. The systematic nature of the sampling coupled with the sorting by county and rent level further helped to ensure the sample was distributed geographically and also provided a mix of high rent and low rent level segments, another characteristic that was found to be correlated with rent change. Within the strata, the probability that a segment was selected was proportional to the total housing expenditure in that segment. Sampling by expenditure had the obvious effect of giving higher expenditure segments a larger probability of selection than smaller expenditure segments (see Figure 4).

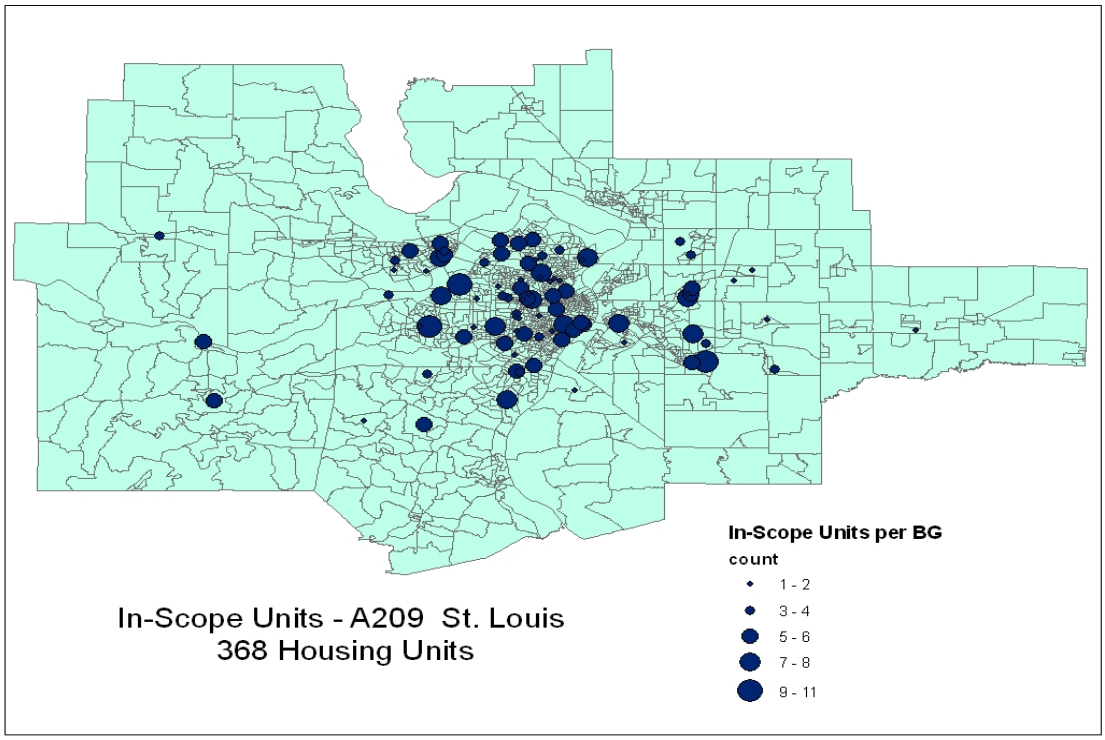

Figure 4: Selected Segments in St. Louis, MO

The selected segments were each assigned to one of six collection panels, with each panel corresponding to two months when prices were collected: Panel 1 corresponds to January and July; Panel 2 corresponds to February and August; etc. Within a PSU, a sample from each stratum was included in every panel and segments were distributed evenly across panels. That made each panel a representative subsample of the PSU and provided for enough sample to support monthly publication of Housing Indexes.

The segments were then sent to the field for listing and sampling of housing units. Economic Assistants in the field were provided a map of each segment and they traveled around each segment sequentially recording each housing unit. After the listing was completed, a systematic sample of housing units was taken from the listing. To achieve a target number of renters from each segment, the number of housing units selected within a segment was inversely proportional to the expected percent renter in that segment. The sample of housing units was then screened to find the renters eligible for inclusion in the Housing survey. When an eligible renter was found, the housing unit was initiated into the housing sample by collecting various data about the characteristics of the housing

unit, most importantly the rent. After initiation, the housing units are priced on-panel every 6 months. For the new construction samples, rather than listing a segment and sampling housing units from a segment, the Economic Assistants are given a list of permits to locate, screen, and initiate (see Figure 5).

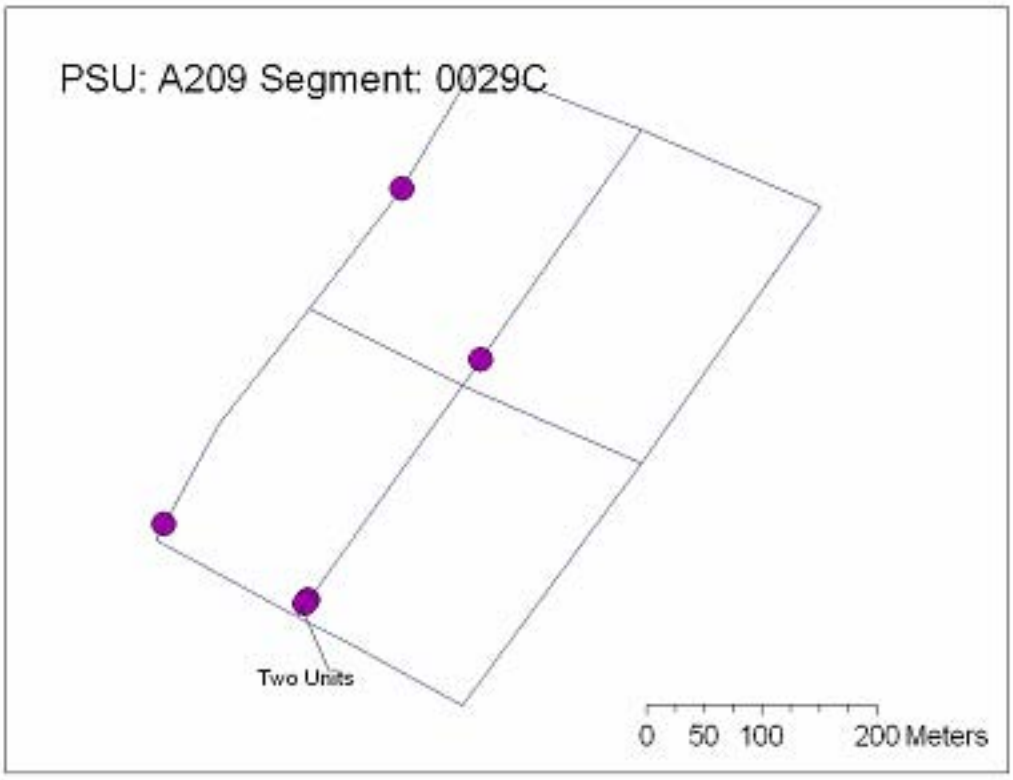

Figure 5: In-Scope Housing Units in a Selected Segment in St. Louis, MO

In order to calculate a price relative to move the Rent and OER Indexes, each unit must have a segment weight and a rent. First, consider the segment weights. Each segment is assigned two weights, one for Rent and one for OER, and each housing unit in the segment uses the same weights. Put simply, the Rent weight represents the relative importance of the sampled housing unit in the calculation of the Rent price relative and the Owner weight represents the relative importance of that same sampled housing unit in the calculation of the OER price relative. Segment weights are also adjusted to account for non-response of initiated rental units by distributing the weight of those units proportionally among rental units in the same geographic stratum. If an insufficient

number of housing units are available within a stratum, a scheme is used to collapse strata together until enough rental units are found or all the strata have been collapsed.

The second requirement to calculate the price relatives is a rent. Effectively, each rental unit that is priced does double duty: two rents are derived for each priced housing unit, one for use in the Rent price relative and one for use in the OER price relative. For the Rent price relative, an Economic Rent is calculated as the monthly amount paid to the landlord in cash, plus subsidies received by the landlord, plus in kind services performed in lieu of cash, adjusted for changes in the quality of the housing unit. For the OER price relative, a Pure Rent is similarly derived, except that the value of landlord-provided utilities is excluded.

Pure **R**ent **= [C**ontract **R**ent **+** Rent Reductions **+** Subsidies **]** x monthly factor
- Value of Utilities **+/- v**alue of changed non-utility items included in **CR**

Economic **R**ent **= [C**ontract **R**ent + Rent Reductions + Subsidies **]** x monthly factor
+/- value of changed items included in **CR**

For vacant units, Pure and Economic rents are imputed in one of two ways: For newly-vacant units, rent changes observed in newly-occupied housing units, that is housing units with a new occupant within the last six months, are used to impute rents. For units that have stood vacant for longer than six months, rent changes observed in housing units without a change in occupant are used to impute the rents.

The rents are adjusted to account for changes in the flow of services included in the rent paid to the landlord and provided by the housing unit to the tenant over time. While these adjustments are made to only a small portion of rents, an adjustment for the age of the unit is made for every unit. Hedonic regressions are used to estimate the effects of aging on the housing stock. A subsequent small adjustment is applied to the rents to increase price change to reflect that as time wears on, housing units age and deteriorate.

Along with the housing sample drawn from the 1990 Census, the age bias model specification was revised (Appendix 1:). One of the major decisions was to use zip codes to match Census data to the CPI data in the initial set-up phase of the process. Doing this allowed new construction units to become a part of the analysis. Previously, new construction was not included because they could not be matched to Census's track and

block location variables. The other decision was to use unweighted rent data. This eliminated the process facilitating the maximum likelihood estimation. The new regression model is summarized as:

Log(rent) = *f*(10 structural characteristics variables, various location and survey variables
(detached, bedrooms, bedrooms squared, other rooms, other rooms squared, oil heat, electric heat, central air conditioning, window air conditioning, bathrooms),
10 neighborhood characteristics variables
(race white, large buildings, two or more autos, air-conditioned, children age 6 to 18, some college, families below poverty level, elderly 65 & over, mobile homes, unemployment),
3 dummy variables for services provided with rent
(gas, electric, parking),
5 depreciation variables and a random error term
(age, age squared, age*old, age*detached, age*all rooms))

The regressions are run at the Census region level and parameter estimates are derived for the 5 depreciation variables. Averages are computed at the PSU level for age, old, detached and all rooms. Age bias factors are calculated for each PSU and all units in the PSU use the same age bias factor. The average annual age bias factor over the last 10 years is approximately 0.0029, which basically increases the indexes for Rent and OER by about 0.3 percentage points annually. Structural change adjustments for bedrooms, bathrooms and other rooms are derived as a by-product of the age bias regressions.

Research was performed to determine the effect of doing the regressions at the CPI Index Area levels and deriving age bias factors at the unit level. Regressions were run for each of the 38 Index Areas and the parameter estimates were saved. Age bias factors were calculated for the housing unit using the unit characteristics and the Index Area parameter estimates. The unit level age bias factors were then averaged at the PSU level so that they could be compared to the normal production age bias factors. The following table shows the average annual age bias factors being used in 2005 production and comparable data from the unit level derivations:

Regions	Production	Unit Level
Northeast	0.0026	0.0019
Midwest	0.0028	0.0028
South	0.0034	0.0040
West	0.0007	0.0035
U.S. city average	0.0025	0.0033

One of the problems with unit-level derivation is the lack of year built data for many units. The unit's year built is needed to derive the age and old regression variables. There were approximately 14,000 units without year built data, but in most cases we are able to impute year built values at a level below the PSU level. "Real" values, of course, would be best. We recently completed an effort with the Office of Field Operations to collect missing year built data and acquired values for about 11,000 of the 14,000 units. Even with this improvement, there would still be units without real or acceptably-imputed year built data.

Each month, a 6-month price relative is calculated for each index area for both Rent and OER. The price relatives for OER are calculated using the Owner weights and the Pure Rents and the price relatives for Rent are calculated using the Renter weights and Economic Rents:

For OER in area A

$$\mathrm{Re}\,l_{t-6,t} = \frac{\sum_{S \in A}\left(\sum_{i \in S} OW_S * PR_{S,i,t}\right)}{\sum_{S \in A}\left(\sum_{i \in S} OW_S * PR_{S,i,t-6}\right)}$$

For Rent in area A

$$\mathrm{Re}\,l_{t-6,t} = \frac{\sum_{S \in A}\left(\sum_{i \in S} RW_S * ER_{S,i,t}\right)}{\sum_{S \in A}\left(\sum_{i \in S} RW_S * ER_{S,i,t-6}\right)}$$

where

OW_S = Owner weight for housing units in segment S,

$PR_{S,i,t}$ = Pure Rent at time t of unit i in segment S in area A,

RW_S = Renter weight for housing units in segment S, and

$ER_{S,i,t}$ = Economic Rent at time t of unit i in segment S in area A.

These price relatives produce an estimate of 6-month price change for OER and Rent. To move the monthly index for OER and Rent, the previous index is multiplied by the sixth root of the 6-month price relative.

3.2 Fuel Prices and the Divergence of Rent and OER

Since utilities are often included in many rents, changes in the price of utilities, which are not associated with changes in economic rents, amount to changes in implicit subsidies to renters. Rents are notoriously slow to respond to shocks, so periods of rapid change in utility prices are likely to result in divergences between Rent and OER. Therefore, periods of rapid change in utility prices are likely to result in divergences between Rent and OER. (See Figure 3.) To give a concrete example: suppose utility prices rise, while economic rents remain constant. To compute pure rents, these increased utility costs are deducted from economic rents, implying that pure rents would *decrease*. Figure 3 demonstrates that this phenomenon has been important in recent periods.

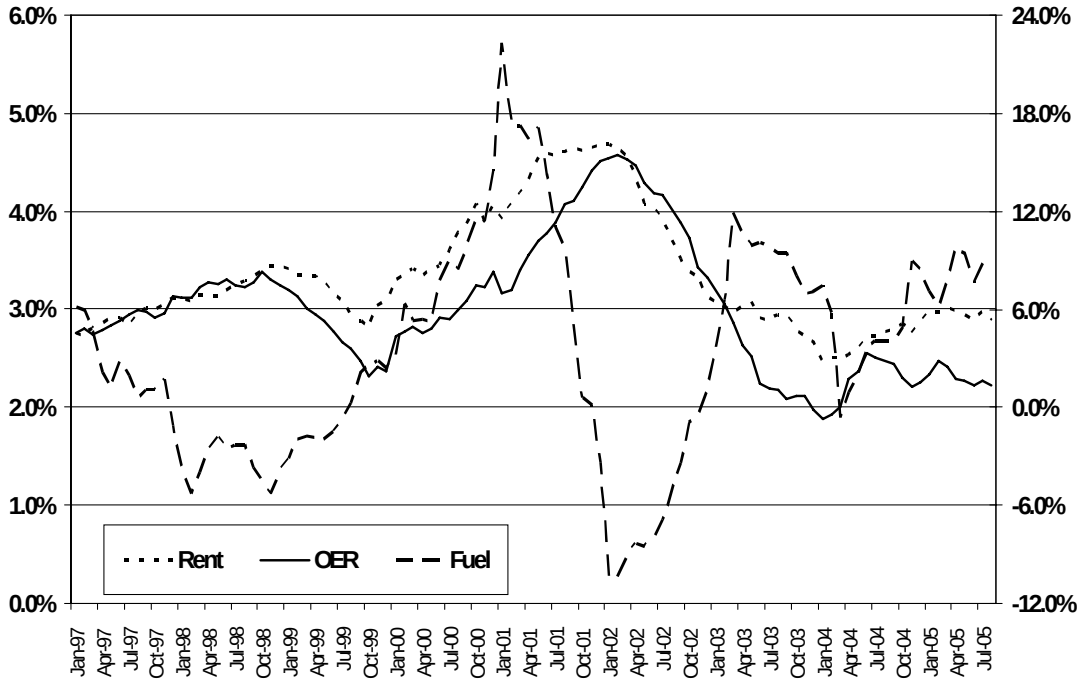

Figure 6: Rent, OER and Fuel 12-month price change, 1997-2005

Utility prices, especially for natural gas, have been increasing rapidly. From February 2002 (the trough for Household fuels) to October 2005, Household fuels increased 42.4 percent; while Rent increased 10.6 percent and OER increased only 9.2 percent.

3.3 Problems with the 1999 CPI Housing Survey Revision and Planned Improvements

The last revision of the Consumer Price Index Housing Survey in 1999 was designed to produce approximately 50,000 renter-occupied housing units distributed evenly across approximately 10,000 distinct neighborhoods (BLS segments) in the 87 metropolitan areas (that BLS calls Primary Sampling Units (PSUs)) currently included in the CPI. At the end of the initiation period, the sample yielded roughly 25,000 rental units. The shortfall was distributed across PSUs but principally was focused in low percent-renter segments. That is, the screening process failed to find rental housing units in numerous segments, despite the fact that the 1990 Census data indicated that renters did reside in those segments. Despite efforts by BLS during 1998 and 1999 to solve the problem, the reason for the failure remains a mystery, although one possibility is that the slow growth in U.S. homeownership rates during the 1990s was particularly pronounced in low-percent-renter areas. An augmentation effort in 1992 - 1994 succeeded in bringing the number of renters in the sample up to about 34,000 units, but the shortfall in low percent-renter areas persisted.

Complicating things further, with respect to representing these low percent renter areas, is sample attrition over time. Attrition occurs when a sample unit becomes permanently ineligible for use in the calculation of the price relatives. The most common cause for attrition is when a renter-occupied unit converts to an owner-occupied unit. The attrition rates in our sample are higher in low percent renter areas. Table 2 and figure 7 below illustrates the effect of the initial shortfall in renters and the effect of attrition on our sample of renters:

Table 2: Sample Design, Shortfall, and Attrition

	Designed Sample		End of 2001		End of 2004	
Percent Renter	Desired Units	Proportion of Sample	Actual Units	Proportion of Sample	Actual Units	Proportion of Sample
0-10%	5418	10.7%	1946	5.7%	1561	5.0%
> 10-20%	13675	26.9%	6441	19.0%	5443	17.5%
> 20-30%	10460	20.6%	6789	20.0%	6042	19.5%
> 30-40%	3840	7.6%	2898	8.5%	2632	8.5%
> 40-50%	3075	6.1%	2482	7.3%	2290	7.4%
> 50-60%	2535	5.0%	2214	6.5%	2123	6.8%
> 60-70%	2395	4.7%	2274	6.7%	2179	7.0%
> 70-80%	2480	4.9%	2457	7.2%	2382	7.7%
> 80-90%	2290	4.5%	2198	6.5%	2162	7.0%
> 90%	4610	9.1%	4261	12.5%	4250	13.7%
TOTAL	50778		33960		31064	

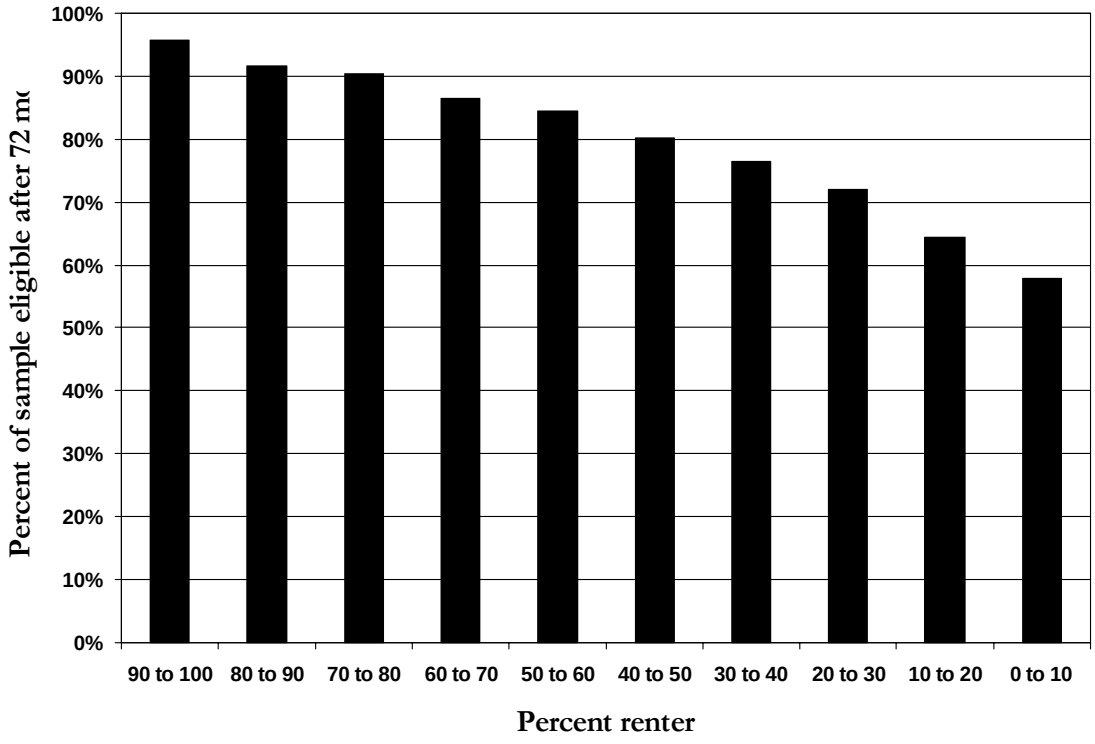

Figure 7: Attrition rate varies with percent renter

Comparing the designed sample to the sample as it existed at the end of 2001 (after the augmentation effort), the table illustrates that the initial sample shortfall caused

the sample to under represent low percent renter areas and over represent high percent renter areas relative to what the design was supposed to produce. Comparing the sample as it existed at the end of 2001 to the sample as it existed at the end of 2004 shows a further movement in the proportion of our sample away from low percent renter areas as the result of attrition. Not shown in the table above is the effect of our annual new construction sample. The new construction samples have slowed the overall attrition rate but the new construction sample is drawn from the entire PSU and can not be classified by renter percentage.

Starting in the 2009 revision, the Housing sample will begin a continuous rotation scheme where one sixth of the sample will be rotated each year and the entire sample will be rotated in a six year period. This is in contrast to previous sample rotations which were conducted at the same time the sample design was revised, roughly every decade. This will have the effect of reducing the burden on the average respondent in the sample by about 40 percent. The average age of the sample will be reduced and will become consistent over time. While sample attrition will not be eliminated, constantly dropping old sample and adding new sample will reduce the effects of sample attrition.

Along with continuous rotation will come periodic reweighting of the sample. The initial weights will be derived from 2000 Decennial Census data and are expected to be revised annually with American Community Survey data, to more accurately reflect changing expenditure patterns within each PSU. There will also be an adjustment to how weights are derived. The principal advancement in the weighting will be the incorporation of Consumer Expenditure Survey's OER data in the modeling of implicit rent estimates for the sample. There will be one other minor change in the sampling and weighting of segments. The explicit geographic stratification that was used in the previous revision will be dropped. The geographic stratification did not lead to a significant change in variance. A geographic distribution of selected segments will be achieved by sorting the segments geographically prior to the systematic selection.

Another major change in the sample design is the shift from block-based segments to block group-based segments. The demographic data which have been used to select segments in the past, namely average rents and home values, are no longer available at the Census block level. The lowest level at which they are available from the

2000 Decennial Census, and will likely be available from the American Community Survey, is at the block group level.

This development has also led to a change in the way our segment sample frames are developed. It is anticipated that the shift from block-based segments to block group-based segments will significantly increase the size of our segments. In a recent field study, the average number of addresses in a sampled block group was just shy of 600, as compared to about 150 under the block-based 1990 design. Rather than manually listing all the addresses in an entire block group, a process that was costly when it was done at the smaller block level, the CPI Housing Survey will make use of commercially available address lists. In addition to reducing frame development costs, these address lists also provide an opportunity to enhance screening processes.

Some of the address lists being researched by the CPI contain codes that identify an address as being rented or owned. One list in particular codes the addresses on a zero to nine scale, with nines being almost certain owners. Research has shown that these nine codes are very accurate in identifying owners, with just shy of 99% of the nine codes being owner occupied when compared with our own screening results.[25] Filtering out these nine codes will enable the CPI to over-sample the remaining addresses and reduce the chance of another sample shortfall by focusing on addresses that are more likely to be renter-occupied. In a recent field test in block groups with high owner percentages, we realized a yield of about 15% renter in our sample[26]. When compared with a roughly 4% renter yield in our current sample in these same areas, despite methodological differences between the field test and our last sample, this represents the potential for a marked improvement.

The address lists will also facilitate the introduction of a mail screening survey to be conducted in advance of our traditional screening. This mail screening will significantly reduce the number of personal visits needed to screen our sample by identifying owner-occupied housing units beforehand. This will be of most benefit in the low percent renter areas where the CPI had difficulty identifying renters in the previous revision and spent considerable resources screening out owners. The lists will also have

[25] Medlar, Jeffrey. "Automated and Manual Matching Analysis of the Housing Sample Address Listings to the Purchased MSG Address List" Internal BLS Memo, November 26, 2003.
[26] Poole, Robert. "Draft Report on the Address List Field Test" Internal BLS Memo, June, 2005.

telephone numbers to aid our screening efforts and GPS data may also be available to help locate the sampled housing units.

4. Investigating homeowner cost inflation measures

4.1 Recent research on user costs and rents

Verbrugge (2005) constructs estimates of *ex-ante* user costs for the entire economy and for various PSU's. Recall from section 1 that the user cost formula used is given by:

$$C_t = P_t(i_t + \gamma - E\pi^h)$$

where P_t is a measure of the value of the home, i_t is a nominal interest rate, γ is a term which collects the rates of depreciation, maintenance, and property taxes, and $E\pi^h$ is an estimate of the expected house price appreciation rate.

Several measures of house prices are considered, including the Census new house price index (Appendix 1:) and the Fannie Mae/Freddie Mac conventional home mortgage price index (whose behavior is nearly identical to that of the *Office of Federal Housing Enterprise Oversight (OFHEO)* index). The Census index uses hedonic regression techniques to estimate a price index for constant-quality *newly-constructed* homes over time; independent variables include numbers of bedrooms and bathrooms, air conditioning, and so on. This index does not, however, control for variations in building materials or in the quality of the land (and neighborhood) upon which the house is located. (Since new housing tends to be concentrated in more outlying regions, location is a potentially serious omission.) The CHMPI/OFHEO indices are repeat-sales-type indices. Repeat-sales methodologies limit the extent to which changes in the composition of the sample can influence the estimated index – since only price *changes* on the *same property* are used in estimating the index. There are, however, four potential sources of bias:

- First, these methods do not control for changes in the physical characteristics of the home, such as improvements, additions, or deterioration. McCarthy and Peach (2004) argue that the repeat sales indices are hopelessly contaminated by unmeasured quality change.

- Second, refinancing comprise more than 80% of the data, which is problematic since: a) appraisers might have an upward bias; and b) low appraisals are less likely than high appraisals to result in loan closure.
- Third, there may be a re-sale bias: homes which are resold more often are more likely to be "starter homes" or "lemons."
- Finally, the variance assumptions underlying the repeat-sales methodology might lead to bias: Dreiman and Pennington-Cross (2004) demonstrate that these assumptions are violated by the data and create an upward bias of between 0.1 and 0.6 percentage points a year.

Verbrugge compares these estimates of user costs to BLS rent indices across PSU's, and in the aggregate case, both to official BLS rent indices and to an estimate of the rent inflation experienced only by detached units in the BLS rent sample.[27] Verbrugge finds that rents and estimated user costs diverge markedly, and for extended periods of time. Between 1980 and 2004, rent steadily and smoothly increased. User costs, however measured, diverge markedly from rents and do not even appear to share the same trend. The conclusion of divergence does not hinge upon the house price index used; but the house price index choice *does* influence both shorter-run dynamics and longer-run trends, since the Census index is less volatile than the CHMPI index, and has not grown as rapidly. Regardless, estimated user cost inflation has been well below that of rents (which, in turn, has been well below that of house prices themselves, at least as measured by the CHMPI). The reduction in the differential between mortgage interest rates and expected home price appreciation over this period is responsible for the failure of user costs to track the rapid rise in home prices.

A second divergence of user costs and rents is observed in second moments: the estimated *ex-ante* user costs are about ten times more volatile than rents, even if these user costs estimates are smoothed so as to mimic the smoothing that is implicit in the BLS rent indices. This is consistent with the results from the BLS experimental indexes in the 1970s-80s.

[27] Detached rental units comprise about 20% of the entire sample. Despite differences in the estimation procedure, the estimated detached-unit inflation is nearly identical to official BLS rent inflation. Thus, whether one compares user costs to official BLS indices, or to the detached index, the conclusions are the same.

The paper then goes on to study the empirical determinants of rent inflation, and to determine the extent to which arbitrage-like opportunities exist. (Another recent paper which is focused upon explaining house price dynamics but which also constructs a measure of user costs and compares these to rents across cities is Himmelberg, Mayer and Sinai (2005). Earlier studies, such as Blackley and Follain (1996), have also failed to discover the expected tight linkage between user costs and rents.)

Martin (2004) outlines a model which incorporates an endogenous (perfectly competitive) rental market alongside an owner market for housing. This model features transactions costs, which (as is well known) drives a wedge between rents and user costs. The open question is the extent to which these variables move differently (over short and/or long horizons) in response to economic shocks. In his model, the decision rules of owners and landlords are not identical, and this ultimately leads to a divergence between user cost inflation and rent inflation. In particular, different shocks affect user costs and rents differently, mainly because shocks can affect the respective expected *selling* dates of owners and landlords differently. This differential impact on selling dates occurs because landlords do not *personally* consume the housing services of the rental properties they own; rather, landlords view these as strictly financial investments. Thus, shocks influencing the value of those services won't impact the sale-date of a landlord in the same way that they would an owner-occupier. In Martin's framework, for example, during periods of rapidly rising house prices, it is likely that user costs will fall more rapidly than rents.

Díaz and Luengo-Prado (2003) construct a model in which heterogeneous agents have a rent-vs.-buy decision. In this model, rents are set in a perfectly competitive market. Rents and user costs diverge, and the tax treatment of homeownership implies that wealthier agents become homeowners. In their model, renters are young, are credit constrained, and move too frequently for the advantages of home ownership to offset transactions costs. Liquidity constraints play a key role, with constrained and unconstrained agents having different user costs. Away from the margin, user costs differ from rental prices. Inspection of the relevant expressions suggests that in this setup as well, different shocks would influence rents differently than average user costs.

4.2 Recent research on "bias" in the CPI rent index

A number of recent papers use American Housing Survey (AHS) data to construct rent indices, and compare these indices to official BLS measures. Along dimensions over which the data are comparable, AHS data are similar to BLS data; for example, the distribution of rents in AHS data corresponds closely to that in the BLS sample.[28] The publicly-available AHS data contains very little locational data; in particular, academic researchers only observe the Census region of each unit, as well as a binary variable indicating whether the unit is urban vs. non-urban.[29]

Gordon and vanGoethem (2005) (hereafter, GvG) provide a fairly thorough description of the AHS data, and discuss some of its problems and weaknesses, as well as improvements that have occurred over time. Unfortunately, some of the most desirable neighborhood-level data are unreliable. These authors, referring to HUD documentation, argue that the AHS has important discontinuities between '83-'85 and '95-'97, rendering estimates spanning these time periods problematic.

McCarthy and Peach (2003) use the AHS data to construct an alternative rent index, computing weighted averages of 2-year price changes. For estimating REQ, they map the distribution of rental units onto the distribution of owner units on the basis of an estimate of monthly user cost. They exclude outliers and new construction, and do not adjust for age bias. Comparing their results to the CPI using annual rates of change: Over the '95-'97 period, their estimate of rent inflation is 1.9% smaller than that of the CPI; over the '97-'99 period, their estimate of rent inflation is 0.4% larger than that of the CPI; and over the '99-'01 period, their estimate of rent inflation is 1.1% larger than that of the CPI. For OER, their estimate over '95-'97 is 1.0% lower, their estimate over '97-'99 is 0.5% higher than the CPI's, and over '99-'01, their estimate is 0.5% lower than the CPI's. They do not provide measures of accuracy, so it is not possible to conclude whether or not these deviations are statistically significant.

[28] The CPI rent data are similar to those collected in the AHS. In fact, the median rent in the AHS increased only 19 percent between 1997 and 2003, while the CPI for rent increased 23 percent (this includes about 1.5 percent for age-bias).

[29] Current research by Randal Verbrugge (in conjunction with Josh Gallin from the Fed) is estimating a hedonic rent estimate based upon BLS rent microdata.

Crone, Nakamura and Voith (2004a) focus on the biases in the historical CPI. They discuss the numerous improvements made to the CPI rent indices and suggest that the biases have been eliminated.

Crone, Nakamura and Voith (2003) (hereafter, CNV (03))construct a rent index using hedonic methods and based upon AHS data, and compare this index both to the official BLS rent index and to a BLS rent index which they have adjusted (in the earlier part of their sample) for methodology improvements. In this paper, the dependent variable is a Box-Cox transformation of rent as the dependent variable; the Box-Cox parameter is estimated every year. (This contrasts with the more standard natural-log-of-rent. which is the measure used in Crone, Nakamura and Voith (2004b) and in GvG.) In addition, they construct a rent index based upon a repeat-rent method (akin to the repeat-sales index for home prices). From '85-'99, particularly for their repeat rent measure, their estimates are very close to those of the BLS; their claim is that over this period, "the published CPI seems to have underestimated rental increases only slightly, if at all." Presumably, CPI measures would fall well within 90% confidence intervals surrounding their estimates.

Crone, Nakamura and Voith (2004b) (hereafter, CNV (04)) use hedonic methods, pooling data for homeowners and for renters, in an attempt to estimate the value of the flow of services to homeowners. If

$$\ln V_{it} = \beta_t X_{it} + e_{it}$$

and one defines the "capitalization rate" as

$$R_{it} = \text{Homeowner flow of services}_{it} \equiv C_t V_{it}$$

then

$$\ln R_{it} = \ln C_t + \beta_t X_{it} + e_{it}$$

The rent hedonic specified is

$$\ln R_{jt} = + \gamma_t X_{jt} + e_{it}$$

CNV (04) make the heroic identifying assumption that $\beta_t = \gamma_t$, even though it is far from clear that their data even supports this. This assumption allows them to pool the data and estimate C_t (which is the coefficient on an owner dummy variable) in addition to the marginals, β_t. This in turn allows these researchers to produce various indices which

estimate both rent and homeowner housing services inflation. CNV (04) produce multiple 2-year estimates from ‘85-‘99 and compare these estimates to official BLS estimates. Their two-year estimates of rent change are alternating between being higher and lower than the BLS measures, with an average divergence of about 1.1%. Over the entire ’85-’99 period, these divergences cancel out, and their rent inflation estimate agrees with the BLS measure. Conversely, their estimates for OER share this alternating-sign pattern only after 1987 (with an average divergence of 1.2%); but between ’85 and ’87, their estimates are a full 3.4% lower than the official BLS measure of OER. Focusing on the more recent period: Over the ‘95-‘97 period, their estimate of rent inflation is 1.7% smaller than that of the CPI; and over the ‘97-‘99 period, their estimate of rent inflation is 0.7% larger than that of the CPI. For OER, their estimate over ’95-’97 is 1.1% lower, and their estimate over ‘97-‘99 is 0.2% higher than the CPI’s. CNV (04) do not report confidence intervals.

Gordon and vanGoethem (2005) (hereafter, GvG) is focused on rent movements over the entire century. We focus here on their results pertaining to the last decade. In studying the latter part of the century, GvG pool AHS data into three time periods – ‘77-‘83, ‘85-‘95, and 97–’03 – and estimate a separate rent hedonic index for each period. Their specification is double-log, with time-dummy variables capturing the increase in rent over the respective periods. Within each of these three time intervals, all coefficients are assumed to be constant. Between 1997 and 2003, their estimates imply annual rent inflation of about 4.3% per year, vs. an annual inflation of 3.2% per year in BLS rent. However, this divergence is entirely driven by the GvG estimate of 6.5% annual rent inflation between 1997 and 1999; the BLS rent index rose at a 3% rate over this period. Between 1999 and 2003, both the GvG estimate and the BLS rent index rose at almost identical average annual rate: 3.3% and 3.4%, respectively.

The results of these studies (GvG, CNV (03), CNV (04), and McP) are displayed in figures 8 and 9. Recall that each of these studies is based upon the same data source (the AHS) so these alternative estimates are not independent. Basically, there is no consistent evidence that the CPI is systematically upward or downward biased.

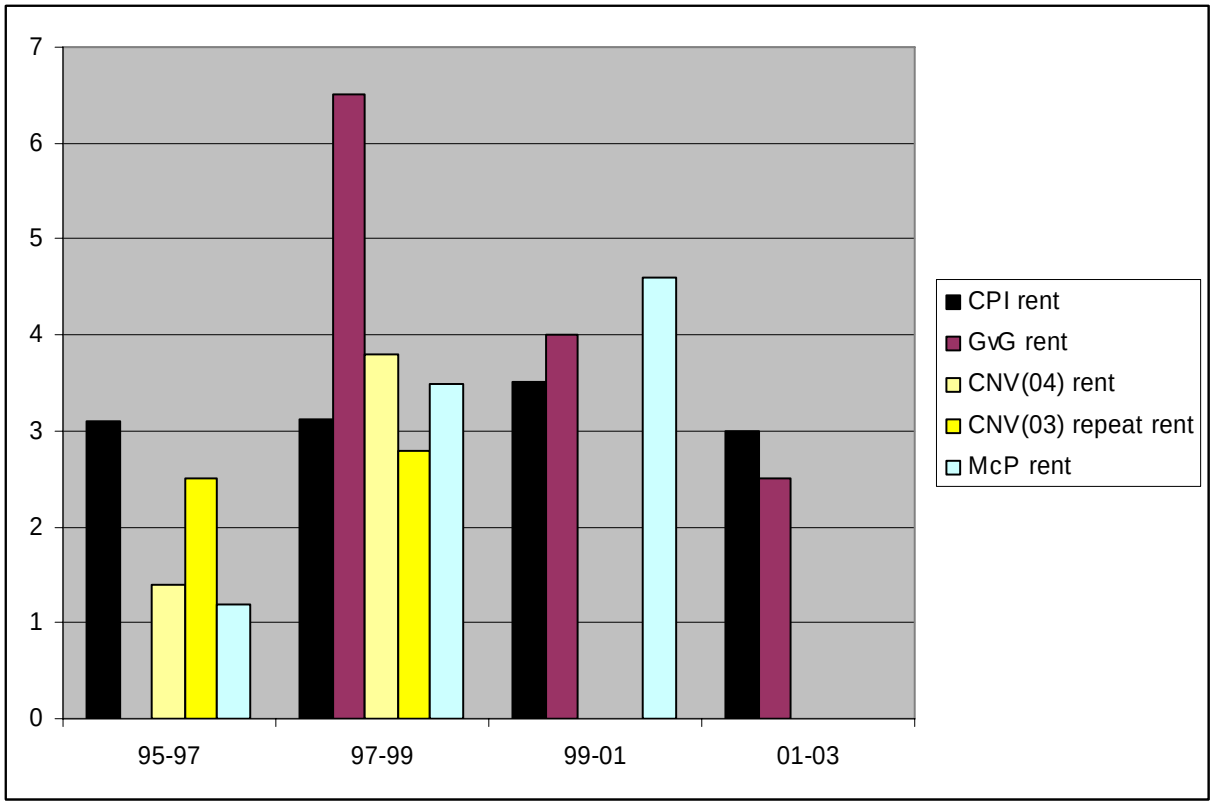

Figure 8: Estimates of rent inflation, 1995-2003 (percent)

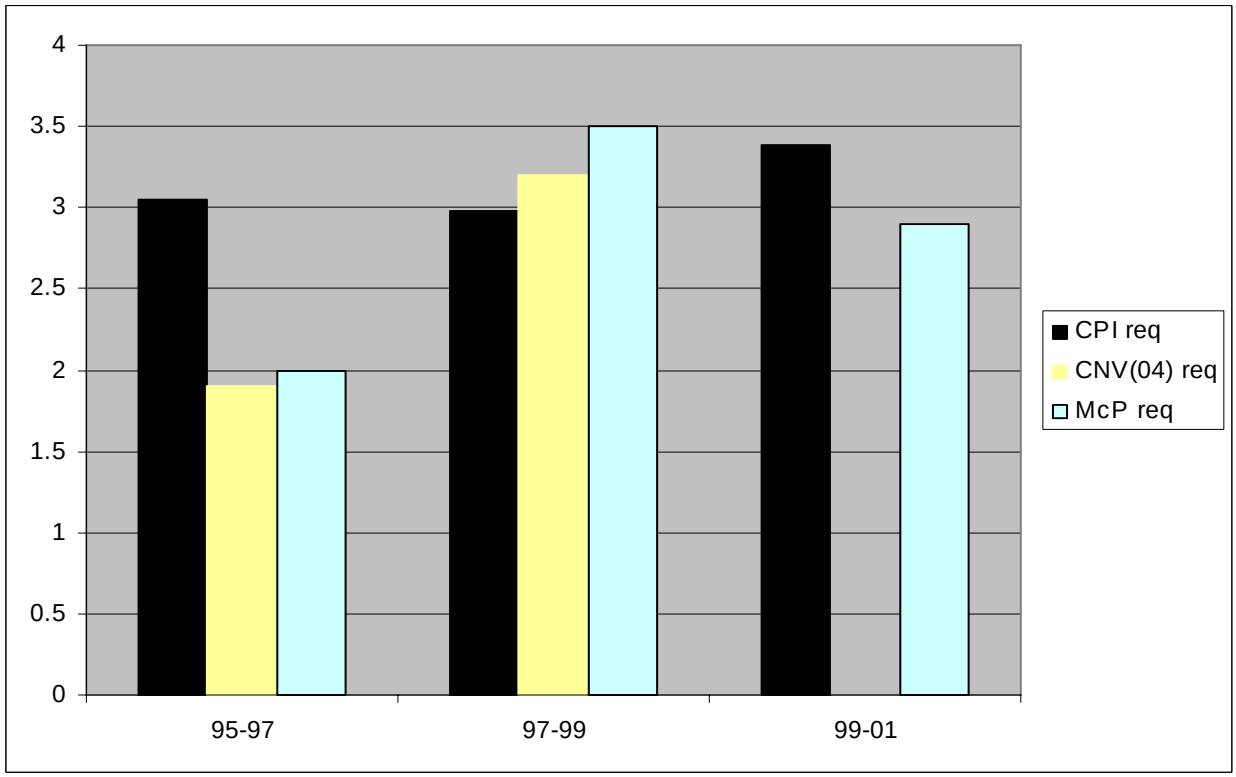

Figure 9: Estimates of OER inflation, 1995-2001 (percent)

Finally, Carson (2004) estimates a rent hedonic which includes the rental vacancy rate, then substitutes the homeowner vacancy rate into his empirical specification and claims the resulting log-rent estimate is an estimate of owners-equivalent rent. There are several criticisms of his approach. First, his empirical specification is flawed, especially since he does not adequately treat persistence: in the case of persistent variables, spurious regression problems arise in small samples even if the variables are actually stationary (see Ashley and Verbrugge, 2003). Carson's failure to adequately deal with this issue turns out to be consequential in this case. Second, his specification ignores the distinction between real and nominal rent inflation. Third, and most important, there is no theoretical justification for the substitution he performs. There is no clear theoretical relationship between the homeowner vacancy rate and owners' equivalent rent. This lack of a theoretical relationship contrasts with the clear theoretical relationship between rental vacancy rates and rents. In particular, rent inflation is related to the *deviation* of the rental vacancy rate *from its natural rate*. This distinction is at the heart of the fourth major criticism of Carson's work: Carson implicitly assumes that this natural rate is zero, which drastically increases the size of the imputation. Upon re-specifying Carson's work, adequately treating persistence, the real-versus-nominal distinction, and the natural rate, even Carson's faulty substitution doesn't deliver an estimate of OER rent that is measurably different from the official BLS measure.[30]

5.0 Conclusion and Questions for FESAC:

5.1 Conclusion

The recent focus on BLS measures of the cost of shelter has alerted us to some misunderstandings of the relevant conceptual issues and BLS methodology. Hopefully, this paper has provided useful and clarifying information on the owner-occupied housing component of the CPI. The paper presented the alternative treatments of the cost of owner-occupied housing. We also provided our justification for using the current methodology in measuring the CPI for Rent of primary residence (Rent) and Owners' equivalent rent of primary residence (OER) to produce a timely, accurate and relevant measure of the price change of shelter services faced by both renters and owners.

[30] More details on this analysis are available in Verbrugge, "Comments on Carson," BLS mimeo, 2005.

We reviewed the current research on estimating "bias" in the indexes for Rent and OER, and presented our research on estimating user costs. We are committed to continuing this research to evaluate alternative user cost methods. One important issue that we are examining is that of determining a conceptual model of user cost that considers the presence of friction in the market and transaction costs. As discussed above, there are only a few research papers that have examined this issue. Finally, we are committed to improving the sample of renters used in the index.

5.2 Questions for FESAC members

- Do members of the economic and statistical community understand that the CPI measures changes in the implicit cost of consuming housing services and not changes in the price of new housing, and if not, what can we do to better explain the measure?
- Is there a perception that the changes in rent have been different than the changes in the cost of shelter services for owners, and how can we at BLS address this perception?
- Do members agree with our choice of the rental equivalence approach to measuring the services of owner-occupied housing, or should we investigate implementing a user cost approach?
- Have you had experiences using (or do you know of potential sources of) address lists that might be relevant to our planned use of them? And do you know of any potential deficiencies in the data available from address list vendors?
- In rotating the housing sample more frequently, are there concerns with the treatment of sample replacement?

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Appendix 1:

Census Price Index of New One-Family Houses Sold - Detached Houses					CPI Age Bias Regression				
Characteristic	**Northeast**	**Midwest**	**South**	**West**	**Characteristic**	**Northeast**	**Midwest**	**South**	**West**
SIZE OF HOUSE (FLOOR AREA)									
Average logarithm of square feet	7.72	7.55	7.6	7.55					
Average square feet	2,388	2,008	2,132	2,006					
GEOGRAPHIC LOCATION									
New England	35.2%	(X)	(X)	(X)					
Middle Atlantic	64.8%	(X)	(X)	(X)					
South Atlantic (except Florida)	(X)	(X)	43.6%	(X)					
Florida	(X)	(X)	15.4%	(X)					
East South Central	(X)	(X)	11.4%	(X)					
West South Central	(X)	(X)	29.6%	(X)					
Mountain (except Arizona and Nevada)	(X)	(X)	(X)	22.1%					
Southwest (Arizona and Nevada)	(X)	(X)	(X)	25.1%					
Pacific (except California and Hawaii)	(X)	(X)	(X)	15.4%					
California and Hawaii	(X)	(X)	(X)	37.4%					

Census Price Index of New One-Family Houses Sold - Detached Houses					CPI Age Bias Regression				
METROPOLITAN AREA LOCATION									
Inside Metropolitan Areas	(X)	90.1%	(X)	(X)					
Outside Metropolitan Areas	(X)	9.9%	(X)	(X)					
					SIZE OF METROPOLITAN AREA				
					A-Size (More than 1,500,000)	73.1%	56.7%	40.2%	66.0%
					X-Size (50,000 to 1,500,000)	26.9%	33.9%	53.3%	27.3%
					D-Size (less than 50,000)	0.0%	9.4%	6.5%	0.0%
					AGE (Current year - year built)				
					Average	59.4	44.8	32.6	33.2
					OLD (Year built less than 1920)				
					Average	17.7%	9.3%	1.4%	2.1%
					DETACHED				
					Average	13.1%	22.9%	25.9%	25.2%
NUMBER OF BEDROOMS					**NUMBER OF BEDROOMS**				
Less than two bedrooms	9.7%	7.0%	2.3%	5.6%	Average	1.922	1.954	2.034	2.045
Three bedrooms	44.1%	55.9%	61.7%	54.1%					
Four or more bedrooms	46.2%	37.1%	36.0%	40.3%					

Census Price Index of New One-Family Houses Sold - Detached Houses					CPI Age Bias Regression				
NUMBER OF BATHROOMS					**NUMBER OF BATHROOMS**				
Less than two bathrooms	(X)	(X)	2.1%	(X)	Average	119.6%	125.8%	146.0%	141.8%
Two or two and one-half bathrooms	(X)	(X)	83.6%	(X)					
Less than three bathrooms	84.7%	89.4%	(X)	81.3%					
Three or more bathrooms	15.3%	10.6%	14.3%	18.7%					
					NUMBER OF OTHER ROOMS				
					Average	2.335	2.229	2.137	2.111
					NUMBER OF ALL ROOMS				
					Average	5.454	5.441	5.631	5.573
NUMBER OF FIREPLACES									
No fireplace	35.3%	28.5%	26.8%	28.3%					
One fireplace	59.9%	69.1%	71.1%	67.3%					
Two or more fireplaces	4.8%	2.4%	2.1%	4.4%					
TYPE OF PARKING FACILITY					**FREE OFF-STREET PARKING**	68.5%	90.6%	96.1%	92.2%
No garage	6.0%	2.2%	11.6%	1.3%					
One or two-car garage	85.5%	75.6%	83.2%	70.6%					
Three or more car garage	8.5%	22.1%	5.2%	28.1%					

Census Price Index of New One-Family Houses Sold - Detached Houses					CPI Age Bias Regression				
TYPE OF FOUNDATION									
No basement	19.2%	27.2%	86.5%	85.5%					
Unfinished basement	80.8%	72.8%	13.5%	14.5%					
PRESENCE OF A DECK									
Deck	57.5%	32.3%	29.0%	17.7%					
No Deck	42.5%	67.7%	71.0%	82.3%					
CONSTRUCTION METHOD									
Stick-built	(X)	93.3%	(X)	(X)					
Modular, precut, or panelized	(X)	6.7%	(X)	(X)					
PRIMARY EXTERIOR WALL MATERIAL									
Vinyl	75.7%	(X)	(X)	(X)					
Everything (except vinyl)	24.3%	(X)	(X)	(X)					
Vinyl	(X)	55.1%	(X)	(X)					
Wood	(X)	22.8%	(X)	(X)					
Everything (except vinyl and wood)	(X)	22.1%	(X)	(X)					
Brick in West South Central and South Atlantic, including Florida	(X)	(X)	33.6%	(X)					
Stucco houses	(X)	(X)	13.8%	(X)					

Census Price Index of New One-Family Houses Sold - Detached Houses					CPI Age Bias Regression				
Vinyl, aluminum, and other in South Atlantic, excluding Florida	(X)	(X)	23.1%	(X)					
Wood, brick in East South Central, and vinyl, aluminum, and other in West South Central, East South Central, and Florida	(X)	(X)	29.5%	(X)					
Wood	(X)	(X)	(X)	30.9%					
Everything (except wood)	(X)	(X)	(X)	69.1%					
HEATING SYSTEM AND CENTRAL AIR CONDITIONING					**HEATING FUEL**				
Gas steam heat with central air-conditioning	4.5%	(X)	(X)	(X)	Electric	18.7%	24.0%	69.7%	40.9%
Gas steam heat without central air-conditioning	6.4%	(X)	(X)	(X)	Natural Gas	52.5%	73.5%	26.4%	53.7%
Heating system other than gas steam heat, with central air-conditioning	61.8%	(X)	(X)	(X)	LP Gas	2.0%	1.0%	0.9%	0.6%

Census Price Index of New One-Family Houses Sold - Detached Houses					CPI Age Bias Regression				
Heating system other than gas steam heat, without central air-conditioning	27.3%	(X)	(X)	(X)	Fuel Oil	26.0%	1.2%	1.4%	0.4%
Central air-conditioning in California and Hawaii	(X)	(X)	(X)	27.6%	Other	0.9%	0.2%	0.7%	0.5%
Central air-conditioning in Mountain, Southwest, and West excluding California and Hawaii	(X)	(X)	(X)	29.9%	No Heat	0.0%	0.0%	0.9%	3.9%
No central air-conditioning	(X)	(X)	(X)	42.0%					
					AIR CONDITIONING				
					Central	13.8%	44.9%	79.9%	29.6%
					Window	11.9%	16.0%	4.4%	10.8%
					Other	28.8%	17.4%	12.4%	5.0%
					None	45.6%	21.7%	3.3%	54.7%
					UTILITIES INCLUDED				
					Electricity	8.7%	7.5%	6.1%	5.5%
					Heating Fuel	40.0%	25.0%	8.0%	8.5%

Census Price Index of New One-Family Houses Sold - Detached Houses					CPI Age Bias Regression				
					Demographic Variables Derived from 2000 Census Data				
					Percentage of the population age 65 or greater	1.9%	12.4%	11.5%	11.0%
					Percentage of all housing structures with 50 or more units	9.6%	3.6%	5.0%	5.7%
					Percentage of the population that is white	86.1%	90.8%	79.7%	81.6%
					Percentage of the population age 6 to 18	15.7%	17.7%	17.3%	16.5%

Census Price Index of New One-Family Houses Sold - Detached Houses					CPI Age Bias Regression				
					Percentage of population 25 years & older who have some college	46.3%	49.6%	50.7%	58.8%
					Percentage of the population under the poverty line	10.1%	10.3%	14.3%	11.9%
					Percentage Renter Occupied	41.1%	34.2%	39.4%	45.1%
					Percentage of all housing units that are classified as mobile home	1.9%	3.5%	6.8%	5.6%