BLS WORKING PAPERS

U.S. Department of Labor
U.S. Bureau of Labor Statistics
Office of Prices and Living Conditions

The Puzzling Divergence of U.S. Rents and User Costs, 1980-2004: Summary and Extensions

Thesia I. Garner, U.S. Bureau of Labor Statistics
Randal Verbrugge, U.S. Bureau of Labor Statistics

Chapter 8

THE PUZZLING DIVERGENCE OF U.S. RENTS AND USER COSTS, 1980-2004: SUMMARY AND EXTENSIONS

Thesia I. Garner and Randal Verbrugge[1]

ABSTRACT

This paper constructs, for the five largest cities in the United States, user costs and rents *for the same structure, in levels* (i.e., measured in dollars). The levels formulation is a major advantage over indexes since one can answer questions like "Is it cheaper to rent or to own?" or "Are houses overvalued?" because such questions are essentially about the *levels* of rents and house prices and their fundamentals. These new measures are constructed using Consumer Expenditure Survey (CE) Interview data from 1982 to 2002, along with house price appreciation forecasts from Verbrugge (2007a). Characteristics, current market value, and rental equivalence of owner-occupied housing are used in a regression framework to predict the rent associated with a structure with median characteristics in each city. The property value of this median house is used to construct a user cost estimate for this structure. We find that, for the median structure in each city, estimated user costs and rents diverge to a surprising degree, in keeping with the previously noted findings of Verbrugge (2007a). It is not always cheaper to own: user costs sometimes lie well above rents. Finally, the dynamics of the estimated price-to-rent ratio are generally similar to those found in conventional estimates based upon indexes, suggesting that the present study might be useful for scaling or normalizing other estimates.

---

1.   Introduction

Accurate measurement of the value and costs of homeownership is crucial for estimating inflation dynamics, as well as for generating consumption measures, since shelter occupies such a large fraction of total consumption. Mismeasurement could well alter both the level, and the dynamic properties, of key macroeconomic aggregates. In many simple models, an appropriate measure of homeowner costs is given by an *ex ante* "user cost" measure consisting of the expected financing, maintenance and depreciation costs minus the present value of its expected resale price. But simple frictionless models also imply that the house's rental price will equal its user cost.

Verbrugge (2007a) demonstrated that in the case of U.S. housing data, rents and *ex ante* user costs diverge markedly, for extended periods of time: a seeming failure of arbitrage[2] and a puzzle from the perspective of standard Jorgensonian capital theory. It is well known that *ex post* user cost measures are typically *much* more volatile than the corresponding rent measures (see, e.g., Gillingham 1983). But *ex ante* user cost measures are of greater interest, since theory suggests that rents should equal *ex ante* user costs, and since *ex ante* user costs form the basis upon which economic decisions are made. Thus, prior to Verbrugge's paper, one might have expected a much tighter empirical linkage between rents and *ex ante* user costs. And since *ex ante* measures involve expected rather than actual home price appreciation, one might have expected them to have far less volatility than *ex post* measures. Indeed, such considerations have led some (e.g., Diewert 2003) to suggest that, for the purposes of constructing official statistics, *ex ante* user cost measures are superior to *ex post* measures.

Verbrugge (2007a) constructed several estimates of *ex ante* user costs for U.S. homeowners and compared these to rents. That study had four novel findings, which are reviewed in more detail in Section 4. To summarize: first, even if appropriately smoothed, *ex ante* user costs are far more volatile than rents. Indeed, their extreme volatility probably rules out the use of *ex ante* user costs as a measure of the costs of homeownership in consumer price indexes.[3] Second, rents and user costs diverge not only in the short run, but gaps persist over extended periods of time, contradicting the hypothesis that user costs and rents are roughly equivalent measures of the cost of housing services even in the medium-term. Furthermore, rents do not appear to respond very strongly to their theoretical determinants (see Verbrugge 2007b). [4] These findings constitute a puzzle to the standard theory, and cast grave doubt on the usefulness of user costs for measuring inflation. Third, despite these divergences, and despite the large size

---

[2] Himmelberg, Mayer and Sinai (2005) is focused on explaining house price dynamics, and asked whether these have been driven by bubbles or fundamentals. However, that study did not directly address the issue of rents versus user costs, since its measure of expected appreciation was a one-sided fifteen-year moving average. Such a measure cannot possibly reflect the covariance between interest rates and expected appreciation at higher frequencies, which is crucial for exploring the relationship between rents and *ex ante* user costs.

[3] Statistics Iceland uses an estimate of user costs to compute shelter costs (Diewert, 2003; Guðnason and Jónsdóttir, 2007). In Iceland's user cost measure, CPI inflation is used in place of expected house price appreciation; however, this corresponds to an assumption of no real capital gains even in the short run. Expected inflation will not generally equal expected house price appreciation.

[4] This finding accords with findings of earlier work by Follain, Leavens and Velz (1993), DiPasquale and Wheaton (1992) and Blackley and Follain (1996). In contrast, Green and Malpezzi (2003) find a stronger relationship between rents and user costs.

of the detached unit rental market, this earlier research suggests that there were no unexploited profit opportunities, due to the large transactions costs typifying real estate transactions. Finally, the use of theoretically-inferior expected appreciation measures (such as expected CPI inflation) yield user cost measures which feature less divergence; this suggests that rent inflation stickiness may play a key role in explaining rent-user cost divergence.

This paper extends Verbrugge (2007a) by constructing, for the five largest cities in the United States, user costs and rents *for the same structure, in levels* (i.e., measured in dollars). The levels formulation is a major advantage, since – as stressed by Smith and Smith (2006) – one cannot use the movements of indexes to answer questions like, "Is it cheaper to rent or to own?" or "Are houses overvalued?" because such questions are essentially about the *levels* of rents and house prices and their relationship to each other and to other fundamentals such as interest rates. The fact that a house price index has risen faster than a rent index does not imply that houses are currently overvalued; this conclusion follows only upon the imposition of an additional *assumption* that house prices were free from the influence of speculative or irrational influences (i.e., were close to fundamentals) previously. One must have data on the value of a particular house *and* its associated rent level in order to directly compare that home's user cost to its rent (and if one wants to compute that home's fundamental value, one must use auxiliary assumptions in addition to this; see Smith and Smith 2006).

These new measures are constructed using Consumer Expenditure Survey (CE) Interview data from 1982 to 2002, along with house price appreciation forecasts from Verbrugge (2007a). The CE asks owner-occupants to report the characteristics, current market value, and rental equivalence of their homes. We constructed a regression model for each city that related the log of reported monthly rental equivalence to reported market value and housing characteristics. These estimates were used to predict the rent associated with a structure with median characteristics in each city. The property value of this median house was used to construct a user cost measure for this structure.

We find that, for the median structure in each city, estimated user costs and rents diverge to a surprising degree, in keeping with the previously noted findings. It is not always cheaper to own: user costs sometimes lie well above rents. Finally, the dynamics of the estimated price-to-rent ratio are generally similar to those found in conventional estimates based upon indexes, suggesting that the present study might be useful for scaling other estimates.

The outline of the study is as follows. Section 2 describes the data. Section 3 discusses the construction of the user cost measures. Section 4 presents the findings of Verbrugge (2007a), and section 5 presents new findings based upon CE data. Section 6 offers some conclusions.

2.   Data Description

Several sources of data are used for this study and Verbrugge (2007a). Data used include the internal U.S. Bureau of Labor Statistics (BLS) rental housing data, Consumer Expenditure (CE) Interview data, the Freddie Mac Conventional Mortgage Home Price Indexes (CMHPIs) for the U.S. and for 10 U.S. metropolitan areas, the U.S. Census Bureau's new home price index, the average contract rate on commitments for 30-year conventional fixed rate first mortgages in the United States, and CPI rent indexes for all-U.S. and for 10 metropolitan areas.

2.1   Consumer Expenditure Survey Data

CE Interview data collected between 1982 and 2002[5] from the five largest cities in the United States were used as the basis for estimating user costs and rents for the same structure. CE Interview survey data have been collected on a continuing basis since 1980. On behalf of the BLS, the U.S. Census Bureau collects data from consumer units[6] using personal interviews for this survey. The CE Interview is designed so that each consumer unit in the sample is interviewed over five consecutive quarters, once every three months. The first interview is used to bound expenditure estimates using one-month recall, and to collect other basic data such as housing unit characteristics (e.g., number of rooms). Interviews two through five are used to collect detailed expenditures and related information from the three months prior to each interview, and for the current month in some cases (e.g., rental equivalence).

Among the data collected in the CE Interview are estimated current market values and "rental equivalences" or rental values for owner-occupied and vacation homes. Current market value is asked only in the first interview (if the property was currently owned), and is subsequently inventoried to the following interviews.[7] Since July 1993, the rental values for owner-occupants have been collected each quarter, rather than only once as was the case earlier. Consumer units are asked, "About how much do you think this property would sell for on

---

[5] Data for more recent years are not considered for this study since the character of the data changed markedly in 2003; improvements to the data collection instrument resulted in much higher responses to the rental equivalence question.

[6] A consumer unit is defined as: (1) all members of a particular housing unit who are related by blood, marriage, adoption, or some other legal arrangement, such as foster children; (2) a person living alone or sharing a household with others, or living as a roomer in a private home, lodging house, or in permanent living quarters in a hotel or motel, but who is financially independent; or (3) two or more unrelated people living together who share certain major expenditures. Financial independence is determined by the three major expense categories: housing, food, and other living expenses. To be considered financially independent, at least two of the three major expense categories are to be provided entirely, or in part, by the respondent. Students living in university sponsored housing are included in the sample as separate consumer units. (See http://stats.bls.gov/CE/csxgloss.htm)

[7] If a property is owned when the bounding interview takes place, the interview respondent is asked to estimate the current market value of the property as of the date of the interview. If a property is acquired in a later interview, the current market value of the property is collected as of the time of the first interview after acquisition of the property. Beginning in April 2007, the market value of owner-occupied housing and vacation homes has been asked each quarter, rather than only once.

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

For this study, a number of restrictions were placed upon the data. Only owner-occupied housing was considered. None of the costs of this housing could have been paid for by Federal, State, or local government. Only second interview data were used; this ensured that no households would be double-counted, and that market values and rental equivalences referred to the same time period (pre-July1993 data) or to quarters that were adjacent (post-June 1993 data). The only exception would be for newly acquired properties and for consumer units entering the survey after the bounding interview. If property value, rental equivalence, or number of rooms in the housing unit was missing or imputed, the observation was dropped from the sample. This reduced the sample significantly. In addition, since regression analysis was to be used to estimate the predicted rental values of property types, we wanted to reduce the effect of overly influential observations. Observations were dropped from the sample if the ratio of property value to rental equivalence was plus or minus 2.5 times the standard deviation of the mean of the ratios. This resulted in only 45 observations being dropped. Additional outlier treatment is discussed in section 5.

As noted above, we restricted our attention to the five largest cities in the United States, to facilitate comparisons of results from this study with those of Verbrugge (2007a). In particular, homeowners living in the following primary sampling units (the geographic area designation used for sample selection) were included in the study sample: New York City and New York-Connecticut suburbs; Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD; Chicago-Gary-Kenosha, IL-IN-WI; Houston-Galveston-Brazoria, TX; and Los Angeles County and Los Angeles suburbs, CA. The regression model was run for each year for each of the five geographic areas.

The total number of second interview reports from owner-occupants whose housing was not paid for by the government is 9,243 for the 1982-2002 time period. Our restrictions regarding missing and imputed data and outliers further reduced the sample size to 4,952; this is about 54 percent of the base sample of owners.

2.2   House Price Indexes

The CMHPI indexes, like the more widely known Office of Federal Housing Enterprise Oversight (OFHEO) indexes, are quarterly house price indexes constructed using a weighted repeat sales method (see Case and Shiller, 1987, 1989) based upon Freddie Mac/Fannie Mae repeat mortgage transactions data; the CMHPI construction is described in Stephens et al. (1995). The Census new home price index is an index which 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. Verbrugge (2007a) discusses potential benefits and weaknesses in these indexes. As will be noted below, however, the major conclusions do not depend upon whether the CMHPI, Census, or CE-based house price indexes are used.

2.3   Interest Rate and Marginal vs. Average User Cost

A key component in a user cost series is the interest rate. The choice of the interest rate is contentious. In one view, the interest rate used in a particular agent's user cost should correspond to their idiosyncratic opportunity cost of capital – the rate at which future nominal returns are discounted. However, the work of Wang, Basu and Fernald (2005) implies that the appropriate interest rate is rather the rate which corresponds to risky housing investment; in other words, it should contain the risk premium relevant for mortgages. (One could argue, on the same basis, that the interest rate should also contain a default premium, reflecting the purely idiosyncratic part of the return, i.e., the part that is orthogonal to aggregate housing risk.) These considerations would suggest the use of the current mortgage interest rate, which contains both a risk premium and a default premium. Further lending support to this view is the fact that actual debt in the house must be financed at a mortgage interest rate. (This choice is also convenient in that it leads to a simpler user cost expression.) However, as in the case of the house price index, the resolution of this contentious issue appears not to matter; the basic character of the results is not affected if the T-bill interest rate – a rate that contains neither a risk nor a default premium – is used in place of the mortgage interest rate.

A second issue related to the interest rate is that of marginal versus average user cost. A quarterly user cost measure will most naturally be a *current* user cost, i.e., it will incorporate the current period home price and the current period interest rate. However, rent indexes generally do *not* share this temporal feature. Instead, these indexes are averages constructed from a sample of all existing rent contracts, rather than from a sample of *new* contracts each period; thus, these indexes are implicitly temporally aggregated, being averages of contracts that were renewed this month, renewed last month, and so on. Additionally, in the case of BLS rent indexes in particular, there is an *explicit* temporal aggregation, which is briefly discussed below; see Ptacek and Baskin (1996) for details on the construction of the BLS rent indexes.

Fortunately, it is straightforward to transform the marginal user cost series into a temporally aggregated series which approximately matches the temporal structure of the rent indexes. Most rent contracts are renewed annually; if one assumes that all rental contracts are renewed on an annual basis, and that renewal dates (and new contract dates) are distributed uniformly across all quarters, the user cost series can be put on the same temporal basis by replacing the current user cost with its average over the current and previous three quarters (i.e., a one-sided 4-quarter moving average). This transformation will clearly impact the volatility of the user cost series, but will *not* influence its lower frequency dynamics.

2.4   Comparability of Rent Measure to User Cost Measure

Since the goal is to compare estimated user costs to rents, one would ideally want to construct a measure of user costs that is as comparable as possible to the rental data. Both CPI and CMHPI indexes are constructed on the basis of price *changes* of units in the sample, a procedure which implicitly controls for unit-specific characteristics. But their underlying data sources are not completely comparable. The CPI rent sample includes some rent-regulated units; only about one-quarter of this sample consists of detached housing; and the CPI performs a quality-adjustment

whenever there are major structural changes (such as the addition of air-conditioning).[8] The CMHPI sample consists mostly of detached housing units, and there is no adjustment for major structural changes. This comparability issue was partly addressed in Verbrugge (2007a) via the construction of a detached rent index based upon CPI microdata. Here we address this in a more elegant fashion, using CE data; in these data, the rent and house price measures derive *from the same structure*.

3.   User Costs

In principle, the *ex ante* user cost is simply the expected annual cost associated with purchasing a house, using it for one year, and selling it at the end of the year.[9] With risk neutral landlords, and under the assumption of no transactions costs, this should equal the market rent for an identical home. (For more details and discussion about user cost, see Diewert 2003).

In Verbrugge (2007a), three different (one year) user cost formulas were employed, all of which are standard.[10] Since results were not affected, here we focus on the simplest measure, which ignores the preferential tax treatment given to homeowners:

$$\text{user cost}_t = P_t^h(i_t + \gamma - E\pi_t^h)$$
$$(8\text{-}1) \qquad\qquad\qquad = P_t^h \psi_t$$

In (8-1), P_t^h is the price of the home, i_t is a nominal interest rate,[11] γ is the sum of depreciation, maintenance and repair, insurance, and property tax rates (and potentially a risk premium) – all assumed constant,[12] π_t^h is the 4-quarter (constant quality) home price appreciation between now and 1 year from now, and E represents the expectation operator (so that the final term is expected annual constant quality home price appreciation). As Diewert

---

[8] The rents used to construct Rent indexes are the current dollar rent, plus any other payments or payments-in-kind paid by the tenant in the form of subsidies or work reductions. OER indexes are constructed using different aggregation weights (for example, rent-regulated units are removed), and the rents receive a utilities adjustment; see Verbrugge (2007c). All rents receive an aging-bias adjustment; see Gallin and Verbrugge (2007).

[9] In this paper, transactions costs and financing constraints (such as minimum down payments) are ignored. The relationship between market rents and user costs which take such complications into consideration has yet to be fully explored. (However, see Díaz and Luengo-Prado 2007 and Martin 2004.) The standard frictionless theory, which builds upon Hall and Jorgenson (1967), implies that rents equal user costs, and is exposited in Gillingham (1980, 1983) and Dougherty and Van Order (1982); see also Diewert (2003). Wedges resulting from taxes and transactions costs were considered in Verbrugge (2007a).

[10] See, e.g., Katz (1983), Diewert (2003), Green and Malpezzi (2003), Glaeser and Shapiro (2003), and Katz (2007). The measures here are all end-of-period user costs, easily transformed into beginning-of-period user costs by dividing by $(1 + i_t)$, or to middle-of-period user costs by dividing by the square root of this term (Katz 2007). For the present purposes, this choice turns out to be inconsequential.

[11] See section 2 on the choice of the appropriate interest rate.

[12] BEA estimates of the depreciation rate indicate minimal variation; it remains in the range of 0.015-0.016. Census estimates of maintenance and repairs imply only modest variation once a strong seasonal component is removed. Although it would be preferable to use actual property tax rates, in fact these rates often diverge significantly from official property tax rates, since tax requirements can be based upon out-of-date official appraisal data.

(2003) points out, one may interpret $(i_t - E\pi_t^h)$ as a period t real interest rate.[13] For house price data that are quarterly, this gives rise to a quarterly user cost series. (Note that some authors refer to ψ_t as the user cost.)

Rather than using a crude proxy, Verbrugge (2007a) constructed a *forecast* for $E\pi^h$, as described below. This choice is crucial, for three reasons. First, expected home price appreciation is extremely volatile; setting this term to a constant is strongly at odds with the data, and moreover its level of volatility, and its correlation with i_t, is of central importance to the dynamics of user costs. Second, this term varies considerably across cities, and its temporal dynamics might well vary across cities as well. Finally, the recent surge in $E\pi^h$ is well above its 15-year average, and implies that the user cost/rent ratio has fallen dramatically. A *single* year appreciation rate was used since the study considered the *one year* user cost, in order to remain comparable to the typical rental contract.

Note that the user cost consists of two terms which are multiplied together: property value P_t^h, and the parenthetical expression ψ_t. Movements in ψ are dominated by changes in the "gap" between interest rates and expected home price appreciation. We would not expect ψ to exceed 20%, nor to drop to 0%; thus, over long periods of time, user costs must track home prices. However, variations in ψ will be *strongly* amplified, since the term is multiplied by the home price. Put differently, unless interest rates and home price appreciation move almost perfectly in sync with each other – implying that expected home price appreciation is driven only by interest rates – we should expect user costs to be highly volatile. The larger is γ, the less volatile are user costs. Furthermore, as Himmelberg, Mayer and Sinai (2005) point out, the smaller is ψ, the more it will move when i moves.

As noted above, to construct user cost measures for each region, one must forecast four-quarter-ahead regional home price appreciation, π_t^h. The forecasting approach settled upon in Verbrugge (2007a) combined three forecasts, and this produced a reasonable fit to the data (in sharp contrast to the traditional 15-year average). Home price appreciation has a significant forecastable component, in that periods of home price appreciation tend to be followed immediately by periods of additional home price appreciation. In keeping with this, both anecdotal and survey evidence (e.g., Case, Quigley and Shiller, 2003) suggest that homebuyers' appreciation expectations appear to be simple extrapolations of recent appreciation rates. There is one caveat: for some cities and some time periods, to ensure that the user cost expression (8-1) remained sensibly bounded below, an alternative "censored" forecast was used. This censored forecast equaled $\hat{\pi}_{t+4}^h$ except when the inequality $(i_t + \gamma - \hat{\pi}_{t+4}^h) < 0.005$ held, in which case the forecast was set to $\hat{\pi}_{t+4}^h = i_t + \gamma - 0.005$. Two final notes regarding Verbrugge (2007a): first, the forecast series were *not* appreciably smoother than the actual home price appreciation series; this plays a key role in the volatility present in *ex ante* user costs, since it turns out that – at least over the more recent period – mortgage interest rates are not perfectly correlated with expected house

---

[13] Many other authors base their user cost measures upon an expression such as $(r + \gamma - E\pi^h)$, where r is a *real* interest rate. This is erroneous, as can be understood by comparing two riskless economies which differ only in their rate of inflation.

price appreciation, leading to substantial volatility in ψ_t. Second, the divergence between rents and user costs does not appear to hinge crucially upon the forecasting method used (see Verbrugge, 2007a).

Note that, though commonly practiced or suggested, it is inappropriate to smooth appreciation forecasts: if expectations about future house price inflation are volatile, then this should be reflected in *ex ante* user costs. Smoothing forecasts using two-sided filters is especially inappropriate, since this implicitly grants the forecaster with information from the future, and distorts parameter estimates (see Ashley and Verbrugge, 2007). The only smoothing which might be justified in this context is the smoothing outlined in section 2.3, a procedure which transforms a marginal user cost series into a (temporally) "averaged" user cost series, in order to mimic the temporal structure of the BLS rent indexes.

## 4.   Review of Results in Verbrugge (2007a)

Over the period January 1980 (1980:1) through January 2005 (2005:1), nominal aggregate home prices (measured by the CMHPI) rose by 125%[14] (or, as measured by the Census price index, by 92%), nominal aggregate CPI rents rose by 100%, and the CPI[15] rose by 82%. But we would not necessarily expect these measures to rise by exactly the same amount: not only are underlying structural characteristics different, but more fundamentally, theory tells us that rents should coincide with *user costs*, not house prices.

Figure 1 compares the movement in two aggregate rental series and two aggregate user cost series. The rental series are the official CPI rent index,[16] and a research series constructed in Verbrugge (2007a) which tracks rental inflation in detached rental units. The user cost series are constructed as in (8-1), using either CMHPI (and CMHPI-based appreciation forecasts) or the Census index (and Census index-based appreciation forecasts). Each series is logged, and user costs are smoothed using a one-sided 4-quarter moving-average to mimic the implicit smoothing in BLS rent series. Then the log user cost series and the log CPI rent series are shifted by a constant so that each has an average value of 1.0 over the time period 1980 through 2005 quarter one. Finally, the log detached rental series is shifted by a constant so that its value in January 1988 equals that of the CPI rent series.

---

[14] Individual cities, of course, had different experiences: Boston's prices rose by 206%; Houston's, only 64%.

[15] More specifically, the CPI-U-RS, a research series constructed with current methods; see Stewart and Reed, 1999.

[16] Verbrugge (2007a) made the historical adjustments to the index recommended in Crone, Nakamura and Voith (2006).

Figure 1. Log User Cost versus Log Rent Based on Indexes for All U.S.
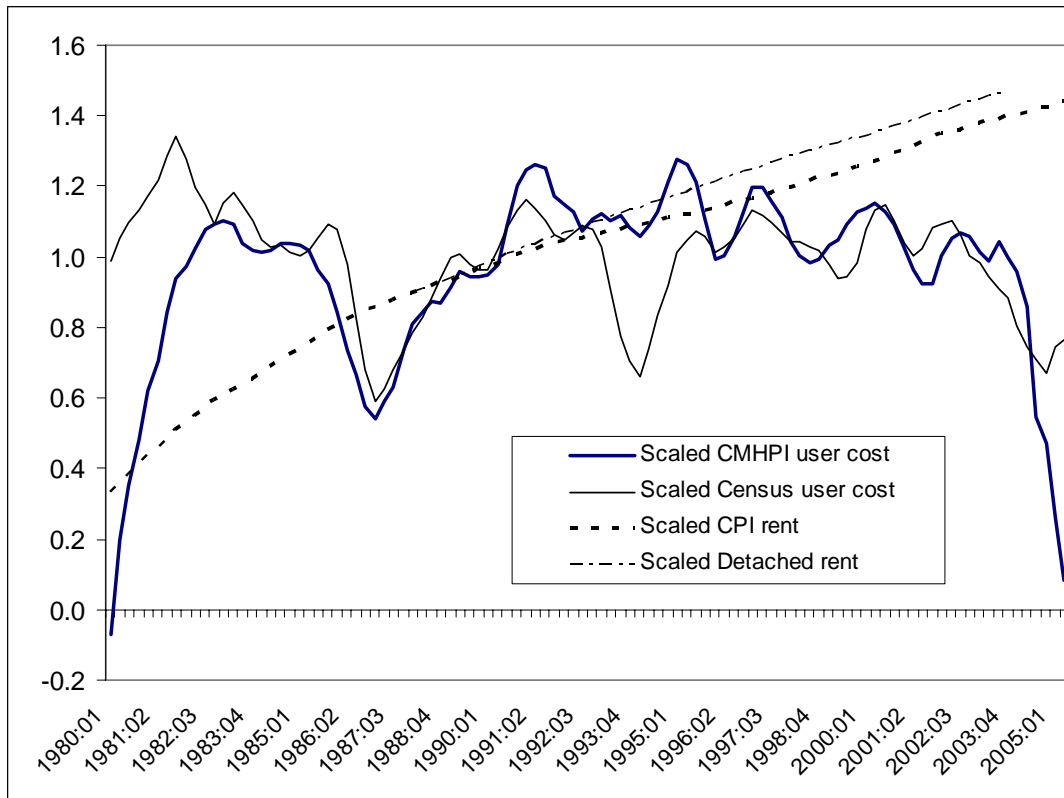
This graph provides little evidence in favor of the hypothesis that user costs and rents are equivalent measures of the cost of housing services – reinforcing the theoretical arguments in Díaz and Luengo-Prado (2007). This is true regardless of which measures of rents or of house prices are used. Rents steadily and smoothly increase over the period. User costs, in contrast, are anything but smooth, and do not even appear to share the trend in rents. In the case of the user cost series constructed using the CMHPI, this series jumps up dramatically at the beginning of the period, and is subsequently more or less trendless, before ending with a significant dip. In the case of the user cost series constructed using the Census index, this series appears to have a slight downward trend over the entire period. Housing *prices* increased steadily over this period; 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 rise in home prices. In other words, the deviation between rents and user costs is largely explained by the movements in ψ_t: seemingly small changes in interest rates or expected appreciation can have very large effects on user costs, since these often represent large *percentage* changes in ψ_t.[17] (To give a sense of the importance of these terms in ψ_t, note that toward the end of this period, expected appreciation in housing prices caused user costs to plummet. If one counterfactually imposed a "pessimistic" expected appreciation of 0% in the final period, the scaled CMHPI user cost index would have risen to a level 26% *above* the scaled rent index.)

---

[17] Recall that $d \ln(\text{user cost}_t) = d \ln P_t^h + d \ln \psi_t$.

Noteworthy are the lengthy periods of divergence. Similar divergence is visible, to a greater or lesser extent, in each of the ten cities that were examined, and across the four Census regions; see Verbrugge (2007a). After 1980, following a period of very low user costs, CMHPI-user costs rose rapidly, driven by rising interest rates and falling expected appreciation rates. The rise in user cost between 1987 and 1990 resulted primarily from a decline in expected home price appreciation. Since 1981, despite rising home prices, user costs – while volatile – have displayed no upward trend at all: the steady upward trend in home prices has been effectively "cancelled out" by a reduction (over this period) in the gap between the mortgage interest rate and the expected home price appreciation. In contrast, rental prices *have* risen steadily over this period. Thus, the relative price of homeownership to renting has fallen substantially over the period. The decline in the relative price of homeownership is consistent with the concurrent uptick in homeownership rates.[18]

We turn next to the second finding, related to volatility. The growth-rate comparison is crucial for statistical agencies which are responsible for producing inflation statistics: measuring inflation in homeowner shelter costs via the rental equivalence method means using rent *inflation* in neighboring rental markets – adjusted for the costs of utilities and so on – as the measure of *inflation* in homeowner shelter costs. Thus, for such agencies, the growth rate comparison is more important. The contrast is stark. Not only are the respective *means* of the rent index growth and user cost index growth series different (rent inflation being, on average, well above user cost inflation over this period), their *volatility* is also strikingly different. In particular, the volatility in the inflation rate of smoothed aggregate user costs is over 10 times larger than that in aggregate rents.[19] The divergence would be even greater on a monthly basis. As owner-occupied housing typically possesses a large weight in consumer price index formulas, this level of volatility would essentially render such indexes useless – such volatile movements in housing costs would drive the entire index on a month-to-month basis, likely drowning out the signal in noise.

The apparent divergence between rents and user costs highlighted above is confirmed via regression analysis in Verbrugge (2007b): there is only weak evidence that rents respond to the determinants of user costs. In other words, regression analysis confirms the conclusions above: rents and user costs are not related in the expected manner. (Indeed, even cointegration between rents and user costs can be rejected in the aggregate, and in most of the cities as well.)

The third novel finding relates to the issue of arbitrage. The massive divergences suggest the presence of unexploited profit opportunities, particularly since about one-quarter of all rental housing consists of detached units, which are readily moved between owner and renter markets (so that the capital specificity issue highlighted by Ramey and Shapiro (2001) should not play a big role). However, Verbrugge (2007a) found that the large costs associated with real estate transactions would have prevented risk neutral investors from earning expected profits by using the transaction sequence *buy-earn rent on the property-sell*, and would have prevented risk neutral homeowners from earning expected profits by using the transaction sequence *sell-rent from someone else for one year-repurchase*.

---

[18] Chambers, Garriga and Schlagenhauf (2004) attribute much of this uptick to mortgage market innovations such as interest only mortgages. These explanations could be complementary.

[19] As noted earlier, similar temporal and volatility divergences were observed between rents and the two CPI-U experimental *ex post* user cost indexes, which were constructed in 1979 (with a start date of 1967) and published through 1983. Both of these measures used 5-year appreciation rates. See BLS (1980). The large rent-to-price volatility noted by Phillips (1988a,b) is only about one-fifth as large.

The fourth novel finding hints at a possible resolution to the divergence puzzle. As long as one uses a reasonably accurate forecast of annual appreciation in the user cost formula, one finds large divergence. But if one instead replaces expected annual appreciation with expected CPI inflation (which corresponds to an assumption of no real capital gains even in the short run) or alternatively with an annualized longer-horizon forecast, the resultant user cost measures feature appreciably less divergence from rents. Thus, a rationalization for rent inflation stickiness might provide the basis of an explanation for the divergence puzzle.

5.   Extensions: Dollar User Costs and Rents for Median Structures in Five Cities

The research conducted by Verbrugge (2007a) is based on rent and house price data that are in the form of indexes (i.e., the CPI, CMHPI and the Census new home price index); thus, one could not directly compare dollar rents with dollar user costs. Moreover, the indexes used by Verbrugge are not completely comparable; as noted above, BLS rent indexes are based on rents that include multi-unit rental properties, while CMHPI data are dominated by detached owner-occupied homes. However, Consumer Expenditure Survey (CE) Interview data include both property value and characteristics data, *and* rental equivalence data, in dollars, *for the same property* – which does allow the comparison of dollar rents and dollar user costs for a given property (once an appropriate measure of expected appreciation is constructed).[20] It further allows one to compute the house price/rent ratio for a particular property.

Consumer Expenditure Interview data collected from January1982 through December 2002 were used to obtain cross sections (over time) of reported rental equivalence, property value, and number of rooms for owner-occupied structures, for five cities. On an annual basis for each city, the CE data were used to estimate the log rent level based upon the property value and number of rooms of the structure, using the simple regression model specification in (8-2).

$$(8\text{-}2) \quad \ln(\text{rent}_{i,t}) = a + b_1(p_{i,t}^h) + b_2(p_{i,t}^h)^2 + d(\text{rooms}_{i,t}) + gI_{\text{Jan}-\text{Jun}} + e_{i,t}$$

where $I_{\text{Jan}-\text{Jun}}$ is an indicator variable which takes the value 1 if the CE interview takes place in the first half of the year. The indicator variable is included since rents on average rise over time and because we wanted to produce semi-annual indexes rather than annual indexes. The model was estimated separately for each of the five cities under consideration: New York, Philadelphia, Chicago, Houston, and Los Angeles. To prevent the influence of non-representative observations, we dropped each sample observation which, after an initial fit of the model (8-2), possessed an externally studentized residual greater than 2.5. Regression sample sizes ranged from a low of 16 for Houston (in 1984) and Philadelphia (in 1995) to a high of 135 for Los Angeles (in 2000). Regressions were run without weights. The average adjusted R^2 was 0.66, with a minimum of 0.33.

Using coefficient estimates derived from (8-2), after applying the requisite log bias adjustment, one can form an estimate of the expected rent for any hypothetical property with particular characteristics. The characteristic values that we selected are those at the median, i.e.,

---

[20] It is reasonable to assume that property owners have ready access to measures of recent house price appreciation, since these are both important inputs into housing decisions and are frequently reported upon by the popular press.

the median number of rooms and the median property value, within each city. (Hereafter we refer to this hypothetical structure as the median structure.) For each city, taking these estimated rents as true market rental prices, we constructed semi-annual measures of rents for this median structure. We constructed semi-annual measures of user costs using the house price appreciation forecasts from Verbrugge (2007a), along with the median structure price or house value. We then constructed the price/rent ratio for each city, and plotted these in figure 2. The price was the median house value and the rent was the estimated market rent for the median structure. User costs and rents for each city are plotted in figures 3a-3e.

The price/rent ratio has received much attention lately, because several studies (e.g., Leamer 2002, Krainer 2003, Hatzius 2004) have suggested (on the basis of "P/E ratio" logic) that since house price indexes have risen faster than rent indexes, house prices are likely overvalued. (As noted previously, one cannot use indexes to adequately address this question; instead, as in this study, one must have *level* data on rents and house prices, since this question is fundamentally about levels.) Smith and Smith (2006) remind us that, although the fundamental value of a house does depend upon rents, we should not expect the price/rent ratio to be constant. This is because the price/rent ratio depends upon many variables: not only interest rates, tax laws, risk premia, and the like, but also anticipated *future* values of rents, interest rates, and so on. Still, as Krainer (2003) points out, if houses were indeed overvalued, we might expect to see signs of it in the historical price/rent ratio.

Figure 2: Price/Rent Ratio for Median Structure, 1982-2002
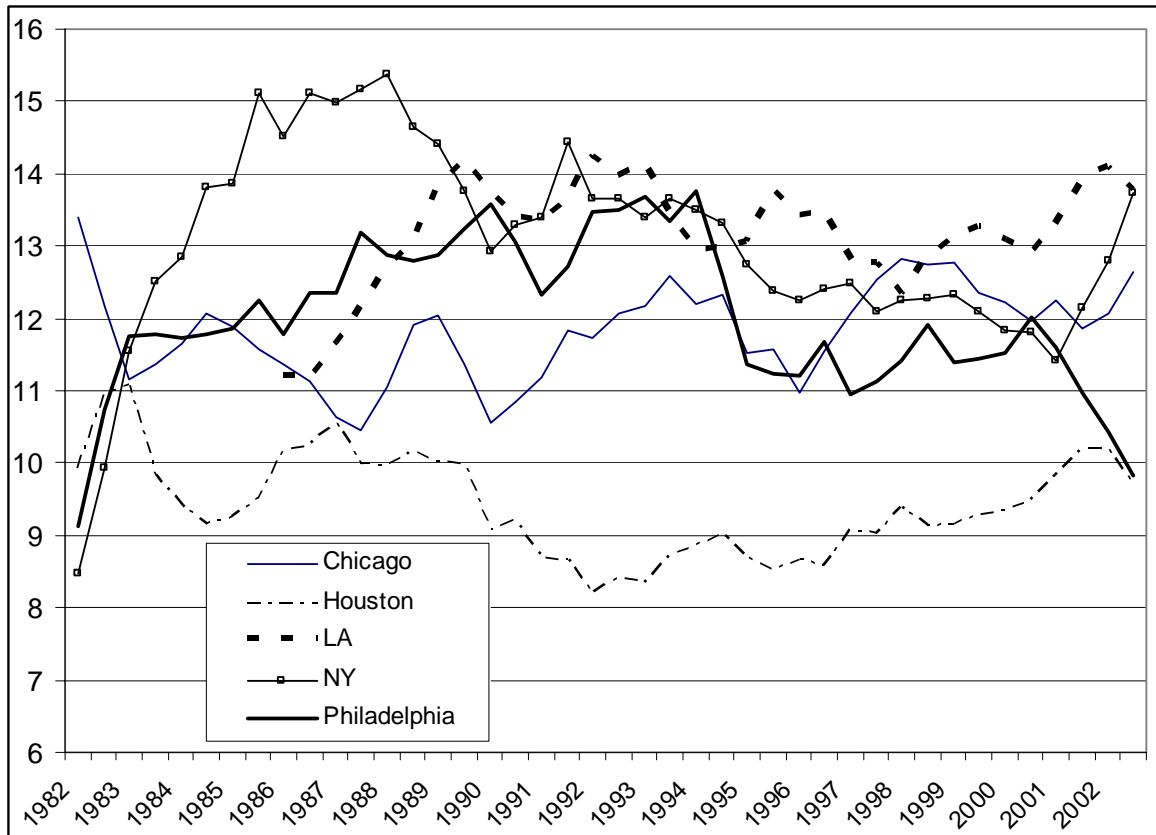
In figure 2, we plot price/rent ratios for the median structure, which are smoothed using a 3-period moving average since there is substantial variation. Over this time period, we observe the following lower frequency movements of these ratios. 1) The price/rent ratio in Chicago displays no discernible trend, with an average of 11.7. 2) The price/rent ratio in Houston is generally low, and displays a decline followed by a slight rebound starting at about 1992. 3) Between 1986 and 1990, the price/rent ratio in Los Angeles climbs rapidly and flattens out, then starts in 1992 to gradually decline to a low of 12 (in early 1998) before rebounding up to 14. 4) The price/rent ratio in New York starts at a very low level and displays rapid growth until 1988 (peaking above 15), followed by a decline until early 2001, then climbs rapidly up to 14. 5) The price/rent ratio in Philadelphia starts at a very low level, grows until 1990 and then falls starting in 1994, ending where it began, with a price/rent ratio of only 10.

How do these dynamics compare to those in the ratio of the CMHPI index to the BLS rent index? There are broad similarities, but some key differences as well. The ratio of indexes is much smoother. The comparison is closest for New York, Los Angeles, and Houston, where both the general character and the turning points are very similar to those based upon CE data. Most of the differences relate to behavior toward the end of the period. In particular, the index ratio starts to climb in *every* city somewhere in the 1996-1999 period, eventually rising to meet or exceed the level of its previous peak in all cities except Houston. This is not true of the CE-based ratios, and indeed, in Philadelphia the CE-based ratio *falls* at the end. And as for Chicago, the CMHPI/BLS rent ratio rises modestly until 1990 (in contrast to the CE-based ratio, which falls),

plateaus, then rises again starting in 1999. It is difficult to discern these dynamics in the CE-based ratio.

What explains the divergences between these measures? Turning points are likely influenced by sampling variation, and such variation can also conceal broad trends. Price/rent ratios vary by price level. This can exacerbate the effect of sample size if the data are dissimilar; and it implies that the estimated ratio is sensitive to the dynamics of the sample median.[21] And the low frequency divergences, particularly toward the end of the sample, may partly reflect the greater house price inflation suggested by CMHPI indexes than by other indexes, such as the Census home price index. (Similarly, the CMHPI index for Philadelphia displays about 5% greater growth between 1990 and 2002 than does Gillen's hedonic Philadelphia House Price Index (Gillen, 2005).[22])

Overall, the behavior of our CE-based measures are not too dissimilar from index-based measures, which is reassuring and perhaps suggests that it might be useful to scale or normalize conventional measures to match the estimates here. Some may question the use of reported rental equivalence as an accurate measure of rents. But, previous research finds these to be similar for similar renter and owner structures. Francois (1989) analyzed CPI housing survey data which were collected from renters and owners to compare owners' reported rental equivalence with imputed rents based on renters' rents for structures with the same characteristics. After accounting for renter length-of-residency discounts and rent-control in his regression-based analysis, Francois found that imputed rents and reported rental equivalence on average were not statistically significantly different. Francois noted that this is in contrast to the findings of others who reported rental equivalence estimates to be substantially higher than imputed rents.

Figures 3a-3e demonstrate that there are large divergences between rents and user costs in these five cities. For these graphs, we use the following user cost formula, which captures the tax advantages to homeownership:

$$(8\text{-}3) \quad \text{user cost}_t = P_t^h[i_t(1-\tau_t^{Fed}) + \tau_t^{prop}(1-\tau_t^{Fed}) + (\breve{\gamma} - E\pi_t^h)]$$

In (8-3), τ_t^{prop} is the property tax rate (assumed fixed at 2%), τ_t^{Fed} is the marginal federal income tax rate facing a family of four with twice the median income,[23] $\breve{\gamma}$ (which, unlike in (8-1), does not include the property tax rate) equals 5%, and $E\pi_t^h$ is censored as above.[24]

---

[21] For this reason, we actually use a smoothed time estimate of the median, rather than the sample median.

[22] Philadelphia is an interesting case for other reasons: for example, in 1999, 60% of the housing units in Philadelphia were priced at less than 90% of construction costs (Glaeser and Gyourko 2002, based upon American Housing Survey Data), and house prices in that year were roughly where they were in 1990. The CE data for Philadelphia are also unusual; for example, the median property value displays quite large swings over time.

[23] These tax rates were constructed, and graciously shared, by Elaine Maag; see Maag (2003).

[24] The 2% property tax and 5% marginal federal income tax rate facing a family of four with twice the median income are fairly typical in the literature. The family of four with this income was selected as being representative of homeowners.

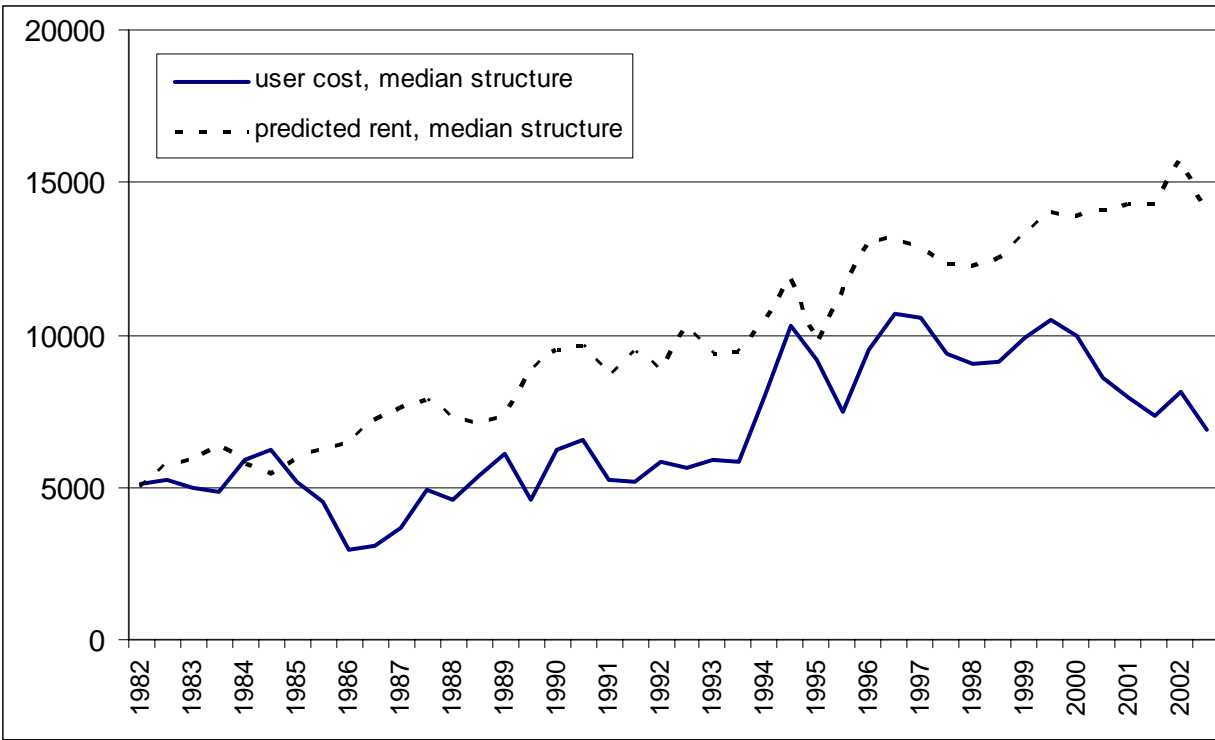**Figure 3a: Rent and User Cost for Median Structure, Chicago**

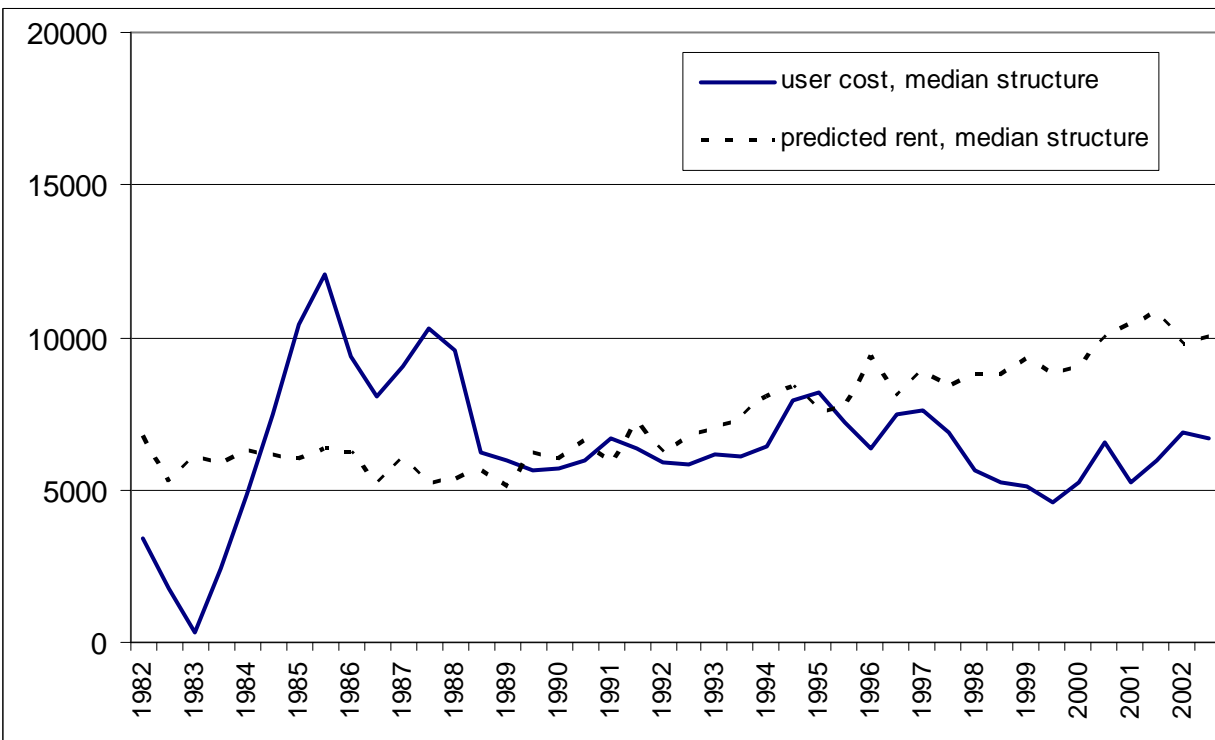**Figure 3b: Rent and User Cost for Median Structure, Houston**

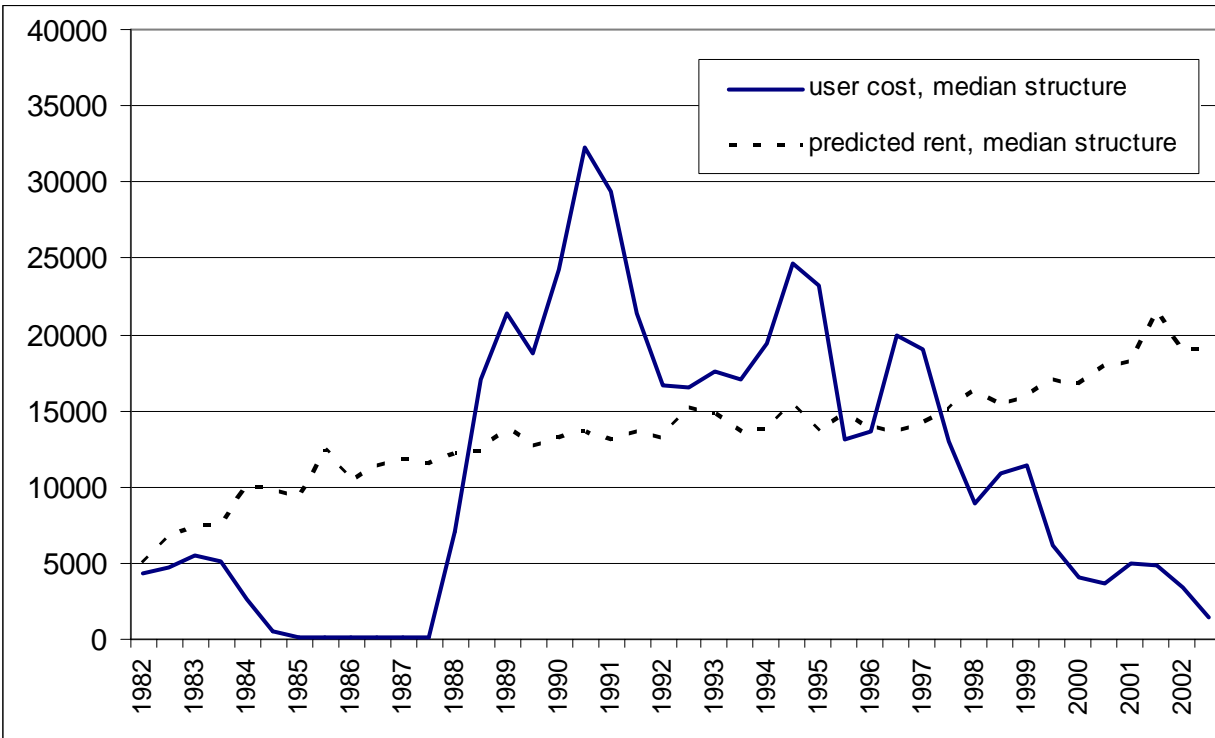**Figure 3c: Rent and User Cost for Median Structure, New York City**

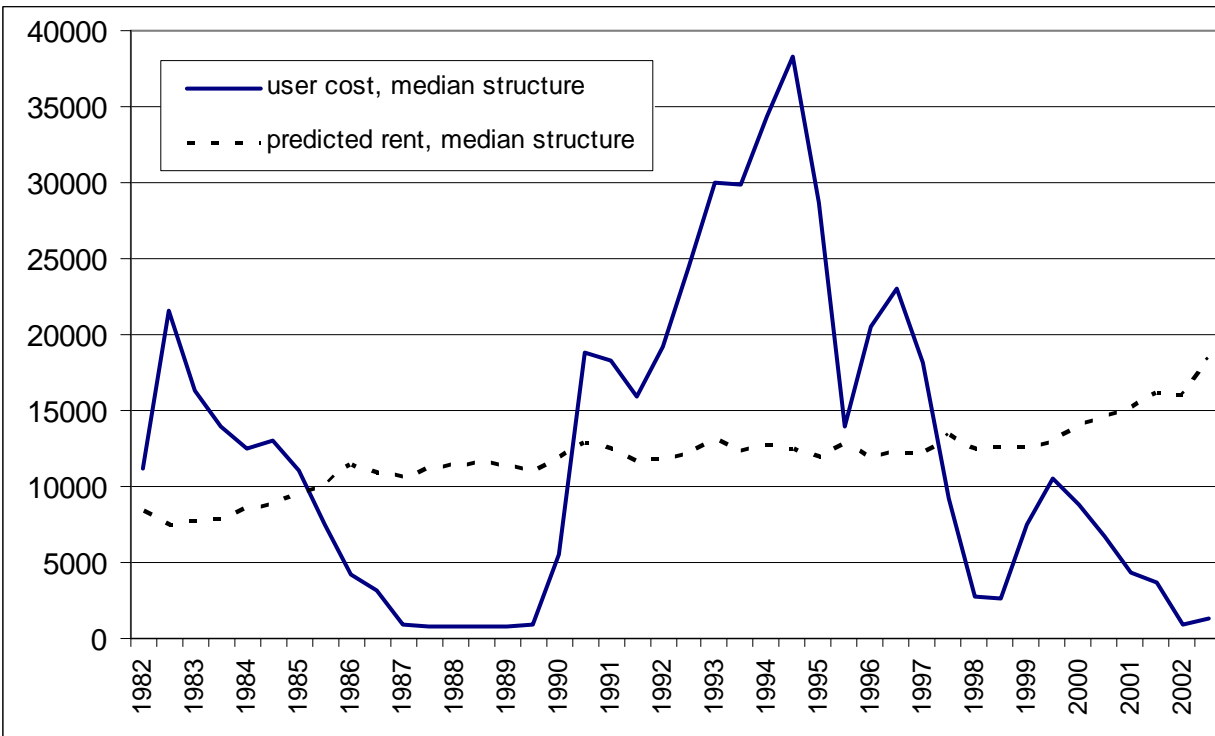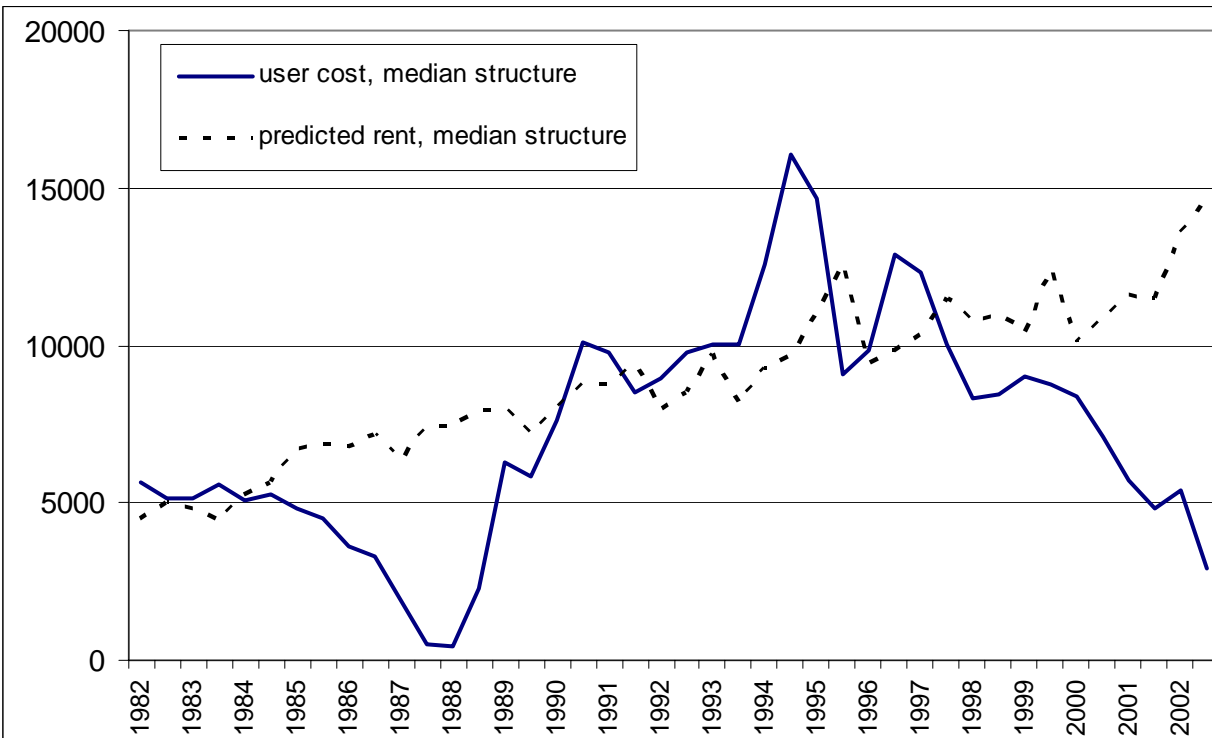**Figure 3d: Rent and User Cost for Median Structure, Los Angeles**

Figure 3e: Rent and User Cost for Median Structure, Philadelphia

For each city, we observe significant and lengthy divergences between rents and user costs. User costs are much more volatile than rents. Low frequency movements appear to be only loosely related. Indeed, in New York, Los Angeles and Philadelphia, the two series appear almost unrelated. It is not surprising that researchers have difficulty detecting a relationship between rents and user costs over extended periods of time.

Since these series are in levels, we may directly compare user costs and rents in dollars at each point in time. The most surprising conclusion is that, even taking account the tax advantages of homeownership, user costs sometimes lay *well above* rents. It is not always cheaper to own than rent (when comparing the same structure). However, in the latter part of the period, user costs were well *below* rents in every city, contrary to what popular press accounts had suggested.

These results are very similar to those in Verbrugge (2007a) in which different rent and house price measures are used. This leads to two conclusions. First, different rent and house price measures (and different tax adjustments) will lead to different low frequency dynamics; but the differential between the interest rate and expected appreciation, which is likely the key driver of user costs, appears to dominate even the medium frequency dynamics. Second, since these CE-based measures also display the large divergences observed between CMHPI based user costs and BLS rents, this suggests that these divergences do not stem from index construction errors.

6.   Conclusions

Verbrugge (2007a) demonstrated that appropriately smoothed *ex ante* user costs diverge markedly from rents, a puzzle from the perspective of standard Jorgensonian theory. In particular, these measures diverge markedly both in growth rates – user costs are substantially more volatile – and in levels – user costs diverge from rents over extended periods of time. These divergences hold at both aggregate and disaggregate levels. These findings are of substantial importance to statistical agencies, since housing services form a large proportion of the typical household's total consumption, so that the choice of the homeowner inflation measure is crucial for inflation measurement. We offer our conclusions below.

In this paper, we extend Verbrugge (2007a) by comparing, for five cities, user costs and rents for the same median structure, in levels (i.e., measured in dollars). These measures are constructed using Consumer Expenditure Interview Survey data, combined with house price appreciation forecasts. The overall picture that emerges is similar: our estimated user costs and rents diverge to a surprising degree. Surprisingly, even after taking account of the tax advantages to homeownership, it is sometimes far cheaper to rent. (Still, it is doubtful that it would have been profitable to become a renter temporarily: Verbrugge (2007a) found that the large costs associated with real estate transactions would have prevented risk neutral agents from making profits in expectation by selling one's home, renting for a year, then repurchasing the house.) Arbitrage is evidently rather slow, likely compounded by the search process that plays a key role in real estate transactions. We also found that the dynamics of the estimated price/rent ratio is broadly similar to the dynamics of conventional price/rent ratio measures for housing.

Do any other factors contribute to the measured divergence? Verbrugge (2007a) used indexes from multiple sources, leaving open the possibility that errors in the construction of these indexes might have been responsible for some or all of the divergence. But our finding of divergence in CE-based measures suggests that the explanation lies elsewhere. It is possible that the expected house price appreciation measure could be improved upon; but evidence in Verbrugge (2007a) suggests that results are not sensitive to details in how this is constructed.[25] Our understanding of user costs is almost certainly deficient; but Verbrugge (2007a) argues that even using current generation user cost approximations (e.g., Díaz and Luengo-Prado 2007, Martin 2004) would not result in an elimination of the puzzling divergence.

We believe that the empirical puzzles found here suggest that there is some industrial organization work to be done regarding rent determination. A challenge for this theory will be the marked non-specificity of detached housing, which forms a sizable proportion of the rental market.

In the context of this volume, we re-emphasize the point that the findings herein favor rental equivalence, over user cost, as the measure that official statistical agencies use for

---

[25] Imposing the equality of rents and user costs and solving for expected appreciation as a residual results in an implied expected appreciation series which diverges markedly from actual appreciation. The correct expected appreciation measure derives from applying the correct model to the data; in other words, "fundamentalist" forecasts are required. However, we do not fully understand house price dynamics; we don't even know if there was or is a bubble, for example. Martin (2006) provides a structural model of house price dynamics with surprising implications.

estimating homeowner shelter cost inflation. First, extant measures of *ex ante* user costs, even if smoothed to mimic the implicit smoothing in the CPI rent series, would be too volatile to be of practical use. Second, until the divergence between rents and user costs is explained, it is more conservative to continue to use rental equivalence; the alternative is to use a potentially suspect user cost formula and an appreciation forecast which will remain controversial, no matter how it is done, until the economics profession settles on a model of house price dynamics. Finally, while it can no longer be claimed that user costs are an alternative way to measure rents, there remain other theoretical justifications for using rental equivalence, outlined in detail in Poole, Ptacek and Verbrugge (2005). To summarize some of the argument, consumer price indexes seek to track inflation in *current consumption*. But for a homeowner, a house is not only a consumption good; it is also an investment good, so that housing is akin to a bundled commodity. The statistical agency must estimate the price or value of the consumption services, but – since these are considered out-of-scope for most price indexes – must separate out the financial aspects of homeownership. Hypothetical rents are arguably the correct measure of the flow of services consumed by the homeowner. The fact that user costs diverge from rents merely reflects, in this view, out-of-scope financial asset movements. The fact that homeowners might misjudge their own property's market rent level does not rule out the use of rental equivalence; as long as the true measure of homeowner rental equivalence grows at the rate of market rents, the inflation rate in rental equivalence will be correctly measured.

Bibliography

Ashley, R. and R. Verbrugge (2003), "To Difference or Not to Difference: a Monte Carlo Investigation of Spurious Regression in Vector Autoregressive Models," Virginia Tech.

Ashley, R. and R. Verbrugge (2007), "Frequency Dependence in Regression Model Coefficients: An Alternative Approach for Modeling Nonlinear Dynamic Relationships in Time Series," *Econometric Reviews*, forthcoming.

Baker, D. (2004), "Too Much Bubbly at the Fed? The New York Federal Reserve Board's Analysis of the Run-Up in Home Prices," Center for Economic and Policy Research.

Baxter, M. (1994), "Real exchange rates and real interest differentials: have we missed the business cycle relationship?" *Journal of Monetary Economics* 33.1, 5-37.

Blackley, D.M. and J.R. Follain (1996), "In Search of Empirical Evidence that Links Rent and User Cost," *Regional Science and Urban Economics* 26, 409-431.

Brookings Institution (2003), "CPI Housing: Summary," Summary of Workshop: *Two Topics in Services: CPI Housing and Computer Software*, May 23, 2003, Brookings Institution.

Bureau of Labor Statistics (1980), "CPI Issues," Bureau of Labor Statistics Report 593, February.

Calhoun, C, (1996), "OFHEO House Price Indices: HPI Technical Description," manuscript, OFHEO.

Case, B, H.O. Pollakowski and S.M. Wachter (1997), "Frequency of transaction and house price modeling." *Journal of Real Estate Economics* 14, 173-187.

Case, K. and R. Shiller (1987), "Prices of Single-Family Homes since 1970: New Indices for Four Cities." *New England Economic Review* (September/October), 45-56.

Case, K. and R. Shiller (1989), "The efficiency of the market for single-family homes," *American Economic Review* 79, 125-137.

Case, K., J.M. Quigley and R. Shiller (2003), "Home-Buyers, Housing and the Macroeconomy," in A. Richards and T. Robinson (eds.), *Asset Prices and Monetary Policy*, Reserve Bank of Australia, 149-188.

Chambers, M., C. Garriga, and D.E. Schlagenhauf (2004), "Accounting for Changes in the Homeownership Rate," Florida State University.

Clemen, R.T. (1989) "Combining Forecasts: A Review and Annotated Bibliography," *International Journal of Forecasting* 5, 559-583.

Crone, T., L.I. Nakamura and R. Voith (2000), "Measuring Housing Services Inflation," *Journal of Economic and Social Measurement* 26, 153-171.

Crone, T., L.I. Nakamura and R. Voith (2006) "The CPI for Rents: A Case of Understated Inflation," Working Paper 06-7, January 2006, Federal Reserve Bank of Philadelphia.

Davis, M. and J. Heathcote (2005), "The price and quantity of residential land in the United States," Georgetown University.

Díaz, A. and M.J. Luengo-Prado. (2007), "On the User Cost and Home Ownership," manuscript, Northeastern University.

Diewert, W.E. (2003), "The Treatment of Owner Occupied Housing and Other Durables in a Consumer Price Index," Discussion Paper 03-08, Department of Economics, University of British Columbia, Vancouver, Canada, available at http://www.econ.ubc.ca/discpapers/dp0308.pdf; forthcoming in W.E. Diewert, J. Greenlees and C. Hulten (eds.), *Price Index Concepts and Measurement,* NBER Studies in Income and Wealth, U. of Chicago Press.

Diewert, W.E. and A.O. Nakamura (2007), "The State of the Art on Accounting for Housing in a CPI," chapter 9 in W.E. Diewert, B.M. Balk, D. Fixler, K.J. Fox and A.O. Nakamura (eds.), *Price and Productivity Measurement, Volume 1: Housing* Trafford Press.

DiPasquale, D. and W.C. Wheaton (1992), "The Costs of Capital, Tax Reform, and the Future of the Rental Housing Market," *Journal of Urban Economics* 31, 337-359.

Dougherty, A. and R. Van Order (1982), "Inflation, Housing Costs, and the Consumer Price Index," *American Economic Review* 72 (1), March, 154-164.

Dreiman, M.H. and A. Pennington-Cross (2004), "Alternative Methods of Increasing the Precision of Weighted Repeat Sales House Price Indices," *Journal of Real Estate Finance and Economics* 28(4), 299-317.

Follain, J.R., D.R. Leavens, and O.T. Velz (1993), "Identifying the Effects of Tax Reform on Multifamily Rental Housing," *Journal of Urban Economics* 24, 275–98.

Francois, J. (1989), "Estimating Homeownership Costs: Owners' Estimates of Implicit Rents and the Relative Importance of Rental Equivalence in the Consumer Price Index," *American Real Estate Economics Association Journal* 17, 87-99.

Fratantoni, M. and S. Schuh (2003), "Monetary Policy, Housing Investment, and Heterogeneous Regional Markets," *Journal of Money, Credit and Banking* 35 (4), 557-590.

Gallin, J. (2003), "The Long-Run Relationship between House Prices and Income: Evidence from Local Housing Markets," Federal Reserve Board.

Gallin, J. (2004), "The Long-Run Relationship between House Prices and Rents," Federal Reserve Board.

Gallin, J., and R. Verbrugge (2007), "Improving the CPI's Age-Bias Adjustment: Leverage, Disaggregation and Model-Averaging," submitted for publication in the Bureau of Labor Statistics (BLS) Working Paper Series.

Gatzlaff, D.H., and D.R. Haurin (1997), "Sample-selection bias and repeat-sales index estimates." *Journal of Real Estate Economics* 14, 33-50.

Gillen, K.C. (2005), "Philadelphia House Price Indices: Technical FAQ and Documentation," Wharton School, University of Pennsylvania.

Gillingham, R. (1980), "Estimating the User Cost of Owner-Occupied Housing," *Monthly Labor Review* 103 (2), 31-35.

Gillingham, R. (1983), "Measuring the Cost of Shelter for Homeowners: Theoretical and Empirical Considerations." *Review of Economics and Statistics* 65 (2), 254-265.

Glaeser, E. and Y. Gyourko (2002), "Zoning's Steep Price." *Regulation* 25.3, 24-30.

Glaeser, E. and J. Shapiro (2003), "The Benefits of the Home Mortgage Interest Deduction," *Tax Policy and the Economy* 17, 37-82.

Goodman, J. and E. Belsky (1996), "Explaining the Vacancy Rate-Rent Paradox of the 1980s," *Journal of Real Estate Research* 11.3, 309-323.

Green, R. and S. Malpezzi (2003), *A Primer on U.S. Housing Markets and Housing Policy*, Urban Institute Press.

Greenlees, J.S. (1982a), "An Empirical Evaluation of the CPI Home Purchase Index, 1973-1978," *American Real Estate and Urban Economics Journal* 10 (1) Spring, 1-24.

Greenlees, J.S. (1982b), "Sample Truncation in FHA Data: Implications for Home Purchase Indexes," *Southern Economic Journal* 48 (4), 917-931.

Guðnason, R. and G. Jónsdóttir (2007), "The House Price Index, Market Prices and Flow of Services Methods," chapter 5 in W.E. Diewert, B.M. Balk, D. Fixler, K.J. Fox and A.O. Nakamura (eds.) *Price and Productivity Measurement, Volume 1: Housing* Trafford Press; an earlier version was presented at the OECD-IMF Workshop on Real Estate Price Indexes held in Paris, November 6-7, 2006. http://www.oecd.org/dataoecd/2/42/37583740.pdf.

Hall, R.E. and D.W. Jorgenson. (1967), "Tax Policy and Investment Behavior," *American Economic Review* 57 (3) June, 391-414.

Hatzius, J. (2004), "Housing and the U.S. Consumer: Mortgaging the Economy's Future," *Goldman Sachs Global Economics Paper* 83.

Haurin, D., P. Hendershott and D. Kim (1991), "Local House Price Indexes: 1982-1991," *Journal of the American Real Estate and Urban Economics Association*, 451-472.

Himmelberg, C., C. Mayer and T. Sinai (2005), "Assessing High House Prices: Bubbles, Fundamentals, and Misperceptions," *Journal of Economic Perspectives* 19 (4), 67-92.

Hinich, M.J. (1982), "Testing for Gaussianity and Linearity of a Stationary Time Series," *Journal of Time Series Analysis* 3 (3), 169-176.

Hinich, M.J. (1996), "Testing for Dependence in the Input to a Linear Time Series Model," *Nonparametric Statistics* 6, 205-221.

Katz, A.J. (1983), "Valuing the Services of Consumer Durables," *Review of Income and Wealth* 29, 405-427.

Katz, A.J. (2007), "Estimating Dwelling Services in the Candidate Countries: Theoretical and Practical Considerations in Developing Methodologies Based on a User Cost of Capital Measure," chapter 6 in W.E. Diewert, B.M. Balk, D. Fixler, K.J. Fox and A.O. Nakamura (eds.), *Price and Productivity Measurement, Volume 1: Housing* Trafford Press.

Krainer, J. (2003), "House Price Bubbles," *Federal Reserve Bank of San Francisco Economic Letter* 2003-6.

Landefeld, J.S. and S.H. McCulla (2000), "Accounting for Nonmarket Household Production within a National Accounts Framework," *Review of Income and Wealth* 46 (3), 289-307.

Leamer, E.E. (2002), "Bubble Trouble? Your House has a P/E Ratio Too," UCLA Anderson Forecast.

Maag, E. (2003), "A Brief History of Marginal Tax Rates," *Urban Institute* (www.urban.org).

Martin, R. (2004), "Paper on User Costs and Rents," manuscript in progress, Board of Governors of the Federal Reserve System.

Martin, R. (2006), "The Baby Boom: Predictability in House Prices and Interest Rates," Board of Governors of the Federal Reserve System.

Max, S. (2004), "For Rent, Cheap," *CNN Money*, February 11.

McCarthy, J., R.W. Peach, and Alisdair McKay (2004), "Housing Trends in the 1990s: The Effects on Rent Inflation and Its Measurement in the CPI," manuscript, Federal Reserve Bank of New York.

McCarthy, J. and R.W. Peach (2004), "Are Home Prices the Next "Bubble"? *FRBNY Economic Policy Review*, December.

Phillips, R. (1988a), "Residential Capitalization Rate: Explaining Inter-Metropolitan Variation, 1974-1979," *Journal of Urban Economics* 23, 278-290.

Phillips, R. (1988b), "Unraveling the Residential Rent-Value Puzzle: An Empirical Investigation," *Urban Studies* 25 (6), 487-496.

Poole, R., F. Ptacek, and R. Verbrugge (2005), "Treatment of Owner-Occupied Housing in the CPI," manuscript prepared for FESAC, Bureau of Labor Statistics, submitted for publication in the Bureau of Labor Statistics (BLS) Working Paper Series.

Ptacek, F. and R.M. Baskin (1996), "Revision of the CPI Housing Sample and Estimators," *Monthly Labor Review* (December), 31-9.

Ramey, V. and M. Shapiro (2001), "Displaced Capital: A Study of Aerospace Plant Closings." *Journal of Political Economy* 109 (5), 958-992.

Sims, C. (1988), "Bayesian Skepticism on Unit Root Econometrics," *Journal of Economic Dynamics and Control* 12, 463-474.

Stephens, W., Y. Li, V. Lekkas, J. Abraham, C. Calhoun, and T. Kimner (1995), "Conventional Mortgage Home Price Index," *Journal of Housing Research*, 6(3), 389-418.

Stewart, K., and S. Reed (1999), **"**CPI research series using current methods, 1978-98," *Monthly Labor Review*, 122(6), 29-38.

Stock, James H. and Mark Watson (1999), "A Comparison of Linear and Nonlinear Univariate Models for Forecasting Macroeconomic Time Series," in R.F. Engle and H. White (eds.), *Cointegration, Causality, and Forecasting : A Festschrift in Honour of Clive Granger*, Oxford University Press, 1-44.

Smith, L.B., K.T. Rosen, and G. Fallis (1988), "Recent Developments in Economic Models of Housing Markets," *Journal of Economic Literature* 26, 29-64.

Smith, M.H., and G. Smith (2006), "Bubble, Bubble, Where's the Housing Bubble?" Pomona College.

Verbrugge, R. (2007a), "The Puzzling Divergence of Rents and User Costs, 1980-2004," submitted for publication in the Bureau of Labor Statistics (BLS) Working Paper Series.

Verbrugge, R. (2007b), "Investigating the Rent-User Cost Paradox," manuscript in progress, Bureau of Labor Statistics.

Verbrugge, R. (2007c), "Do the CPI's Utilities Adjustments for OER Distort Inflation Measurement?," submitted for publication in the Bureau of Labor Statistics (BLS) Working Paper Series.

Wang, C., S. Basu and J. Fernald (2005), "A General-Equilibrium Asset-Pricing Approach to the Measurement of Nominal and Real Bank Output," University of Michigan.
http://www.ipeer.ca/papers/Wang_Basu_Fernald_Oct_15_2004.pdf