Reconciling User Costs and Rental Equivalence: Evidence from the U.S. Consumer Expenditure Survey

Thesia I. Garner

Randal Verbrugge

Division of Price and Index Number Research, Bureau of Labor Statistics
2 Massachusetts Ave NE, Washington, DC 20212
Email: garner.thesia@bls.gov;
verbrugge.randal@bls.gov

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Abstract

Verbrugge (2008a) demonstrated that housing rents and ex ante user costs diverge markedly for extended periods of time, a finding with profound implications for income and inflation measurement. But the primary data sources in that study were various indexes, based upon largely disjoint data sources, constructed using different aggregation techniques, and each subject to various criticisms. The use of these data sources raised doubts about the quality of the comparison. The relationship between user costs and rents might well be much tighter at the micro level; after all, house prices and rents (and their growth rates) can vary dramatically within cities. Furthermore, the use of indexes precludes both cross-sectional and dollar cost comparisons. In this study, we use Consumer Expenditure Survey (CE) data to examine the relationship between user costs and rents *at the individual unit level*, in dollars, using unit-level information on house value, rent, taxes, and the like. This allows us to accurately estimate unit-specific user costs and to control for unobservables like neighborhood quality. The divergence we find is, if anything, even more striking. Expected appreciation is of crucial importance; a user cost measure with an ad hoc appreciation measure appears to outperform more theoretically rigorous variants. We also investigate how reported rental equivalence is related to cost components and other covariates, and decisively reject the commonly-held hypothesis that these merely reflect out-of-pocket expenditures.

Keywords: user costs; house price appreciation; forecasting; rental equivalence

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1. Introduction

What is the value of the service flow obtained from owned housing? This is an important question, not only in the field of real estate (which studies the rent-versus-buy decision, rental housing landlord decisions, and the like), but also in the field of macroeconomics, as it notably influences real GDP measurement, poverty measurement, and the like. However, in practice different approaches to the measurement of this service flow can lead to rather different conclusions. For example, Garner and Short (2008) and Frick, Grabka, Smeeding and Tsakloglou (2008)[1] demonstrated that distributional measures vary dramatically depending upon the treatment of housing flows; OECD (2005) and Eiglsperger (2006) likewise found major impacts on inflation measurement (and hence real output measurement).

In standard Jorgensonian capital theory, a durable good's rental cost will equal its *ex ante* user cost, suggesting that these alternative measurements of the value of the flow of services should be roughly equivalent.[2] But Verbrugge (2008a) demonstrated that not only are housing rents far less volatile than ex ante user costs, these measures also diverge markedly for extended periods of time, a seeming failure of arbitrage and a puzzle from the perspective of the standard theory. However, that study largely relied upon aggregated indexes – in particular, the Bureau of Labor Statistics (BLS) rent index, Freddie Mac's Conventional Mortgage Home Price Index (CMHPI), and the Census House Price Index.[3] In this context, the use of indexes has several potentially severe drawbacks. First, the use of indexes precludes a comparison in dollars, and precludes a cross-sectional comparison. Second, the use of these particular indexes precludes a comparison of like with like; for example, only about one-quarter of the BLS rent sample

[1] Frick et al. (2008) provide a summary of research in seven European countries that focus on poverty and inequality.
[2] See expositions in Gillingham (1980, 1983), Dougherty and Van Order (1982), and Diewert (2007).
[3] Almost all other related studies have relied upon aggregated data. Perhaps the most prominent is Himmelberg, Mayer and Sinai (2005), a study focused on explaining house price dynamics. It did not directly address the issue of rents versus user costs, given its crude measure of expected appreciation; see Verbrugge (2008a). The treatment of expected appreciation is key, as will be seen below.

consists of detached housing (reflecting the rental housing stock), yet – reflecting the owned housing stock – the vast majority of the Freddie Mac and Census samples consists of detached housing (although neither sample is truly representative of the entire owned housing stock). Third, these indexes are constructed in different ways, using different weights and index forms. It is well-known that rents and house prices have a very strong micro-spatial dimension (see, e.g., Hwang and Quigley 2006), and the same is true of house-price and rent inflation (see, e.g., Poole and Verbrugge, 2008). That being the case, the choices of index form and weighting could well be consequential in this context, as it is in other contexts (see, e.g., Deaton and Heston, 2008 and Poole and Verbrugge, 2008). It would be far superior to begin with a data source in which every variable is available at the unit level (i.e., where there is both a user cost and a rent associated with the same unit); this would remove concerns related to differential index construction and weights, and would allow one to control for unobservables like neighborhood quality. Finally, each of the aforementioned indexes has been subject to its own set of criticisms; for example, there is no extant U.S. aggregate house price index which is built using a truly representative sample, and the utilities adjustment in the BLS Owners' Equivalent Rent (OER) index has been criticized (see Verbrugge 2008b). Thus, it is possible that the use of said indexes in studies of user costs and rents has masked a much tighter relationship between these measures at the micro level.

This study is one of the first to use micro data to study the relationship between user costs and rents.[4] In particular, we use Consumer Expenditure Survey (CE) Interview data collected in 2004:I – 2007:I to examine the relationship between user costs and rents *at the individual unit level*, in dollars, using unit-level information.[5] These data include a rent measure (reported rental equivalence, described below), house value, and almost all of the components of unit-level user costs, such as maintenance and repairs and mortgage information, and income and family characteristics (from which an estimate of tax rates may be obtained). In some of our analysis, we also link these data to Census 2000 data on neighborhood characteristics, in order to more completely control for unobserved quality variables which may influence rent differentially from

[4] Several prior studies have investigated the extent to which rents respond to their user cost determinants; see, for example, DiPasquale and Wheaton (1992), Follain, Leavens and Velz (1993), Blackley and Follain (1996), Green and Malpezzi (2003), and Tian (2008).

[5] While both Verbrugge (2008a) and Garner and Verbrugge (2008a) used CE data in parts of their analysis, neither constructed unit-level user costs; instead, they compared estimates of rents and estimates of user costs pertaining to hypothetical median structures. A companion paper to this one (Garner and Verbrugge 2008b) uses CE data to investigate under- and over-valuation of houses both before and after the recent real estate boom.

house price. In our estimates of user costs, we construct a measure of expected appreciation using a forecasting approach (based upon CMHPIs), and in addition explore a popular ad hoc approach – simply using overall price inflation – which amounts to an assumption of no expected real capital gains even in the short run. The CE data is described in more detail in Section 2. Given the wealth of information at the individual unit level, and given its expansive geographic coverage, it appears to be uniquely suited to a study of this type.

Our two aims in this paper were to compare rents and user costs at the micro level (and then at aggregated levels, where aggregation is done in the same way for both variables), and to study which factors are related to reported rental equivalence, which may provide clues towards understanding how rents relate to user costs.

Is the relationship between rents and user costs tighter in these micro data? No; the divergence we found was, if anything, even more striking. The cross-sectional dispersion of rents and user costs is surprisingly large. In dollar terms over the 2004-2007:I period, expected user costs were generally well below rents – mainly driven by expectations of real appreciation in the short run – and often negative. A priori, we expected concavity in the rent/value relationship[6] to result in reduced divergence for higher-valued properties, but – while the user cost/value relationship is also concave – we find the divergence to be even greater for more expensive properties. While the evidence in Verbrugge (2008a) suggested that constructing user costs using long-horizon forecasts markedly reduces user cost-rent divergence, our evidence suggests that such user cost measures still diverge noticeably from rents. However, we find that the use of inflation as the proxy for expected appreciation *does* result in a user cost measure which is fairly comparable to rents, and in this respect far superior to out-of-pocket expenses.

Since we use CE data, our rent measure is reported rental equivalence, an estimate that CE respondents make regarding the rental value of their homes. It is commonly suggested that respondents are naïve and simply report the out-of-pocket expenses associated with owning their home. However, both informal and formal evidence rule this out decisively. Reported rents appear to grow at the same rate as the BLS OER index, lie well above out-of-pocket expenses, and exhibit elasticity of reported rents with respect to out-of-pocket expenses that is well below unity. Thus, homeowners are doing something other than simply reporting out-of-pocket

[6] Tian (2008) highlights and directly studies this phenomenon, using a unique micro data set; this study also examines the relationship of rents to a measure of user costs. His findings are very much in keeping with those in the present study.

expenses. However, the relationship of rents to standard measures of user costs is tenuous; for example, it is not always possible to discern a statistically significant relationship between reported rents and measures of expected appreciation. An important area for future research is explaining why a popular but ad hoc user cost measure – one which uses overall inflation as the proxy for expected appreciation – is so much more closely related toreported rents. We suspect that this reflects shortcomings in the extant theory, both that of user costs and that of rent determination.

Section 2 describes the data. Section 3 investigates the relationship between rent and value, and the relationship between rent, out-of-pocket expenses, and user costs using a series of graphs and regressions. Section 4 uses regression analysis to study the relationship between homeowner rental estimates, user costs, and other covariates. Section 5 concludes.

2. Data and Measurement Description

The primary source of data for this study is Consumer Expenditure Survey (CE) interview data. Freddie Mac Conventional Mortgage Home Price Indexes (CMHPIs) for the U.S. and for 28 metropolitan areas form the basis of the appreciation forecasts, as described below. We also apply the analysis of Kumcu (2008), which uses IRS tax tables and CE family information data to impute marginal income taxes to CE consumer units.

2.1 Consumer Expenditure Survey Data

CE Interview data collected between 2004:I and 2007:I from consumer units living in 28 of the largest metropolitan areas in the United States were used as the basis for estimating user costs and rents for the same structure. Using personal inteviews, CE Interview survey data are collected from consumer units[7] on behalf of the Bureau of Labor Statistics (BLS). The BLS reviews and audits the data after collection, and imputes values when missing using a variety of variable-specific techniques. The CE Interview is designed so that each consumer unit in the

[7] 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)

sample is interviewed over five consecutive quarters, once every three months; every quarter 20% of the sample is replaced with new households. 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 both 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.[8] Consumer units are asked, "About how much do you think this property would sell for on today's market?" Rental values for owner-occupants are collected each quarter, by asking consumer units, "If someone were to rent your home today, how much do you think it would rent for monthly, unfurnished and without utilities?" Given the timing and structure of the data, we use only data from the second interview, so that each household enters only once, and the value and rent estimates are only three months apart. (The only exception would be for newly acquired properties and for consumer units entering the survey after the bounding interview.)

Other data collected by the CE include: mortgage information; housing structure type; consumer unit income[9]; property taxes; and expenditures on maintenance and repair and home insurance. For this study, a number of restrictions were placed upon the data. Only owner-occupied housing which was not a condo or coop was considered.[10] None of the costs of this housing could have been paid for by Federal, State, or local government. If property value or rental equivalence was missing or imputed, the observation was dropped from the sample. We also restricted the sample by family type; in particular, in order to be able to accurately estimate marginal tax rates, we dropped observations where family type was coded as "other" by the

[8] 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.

[9] Starting in 2004:I, the BLS began imputing income data when these were missing.

[10] Condo and coop owners comprise less than 5% of the population. Paulin (2005) highlights several reasons, including coop and condo fees, which suggest that condo and coop ownership is a distinct form of housing tenure that should probably modeled separately.

BLS.[11] We then restricted the sample by house value; in particular, we dropped 4% of observations corresponding to home values in excess of $950,000 within the 2004:I-2007:1 survey data period, as these units possess very high leverage and distort parameter estimates. Finally, on a PSU-by-PSU basis, we dropped any observations whose rent/value ratio was outside of two standard deviations from the mean of this ratio; this reduced our sample by about 120 observations. In sum, our restrictions regarding missing and imputed data and outliers reduced the sample size to 5,181 observations. Additional outlier treatment, applied at the regression estimation stage is discussed below.

The CE is a nationwide household survey designed to be representative of the U.S. civilian population. The first step in sampling is the creation and selection of Primary Sampling Units (PSUs), which consist of counties (or parts thereof), groups of counties, or independent cities grouped together into geographic entities (see http://stats.bls.gov/cex for details). The current sample of PSUs consists of 91 areas, most of which are also used by the Consumer Price Index program. For this study we restricted attention to the 28 largest PSUs which were present in the CE sample over the entire 2004-2007:I period; these are listed in the Appendix.

2.2 User cost; tax model; and CMHPI data

While research is progressing on the nature of user costs when owners face frictions of various sorts (see, e.g., Diaz and Luengo-Prado 2008; Luengo-Prado et al. 2008), almost all housing studies use an annual *ex ante* user cost formula[12] associated with a frictionless model, similar to

$$\begin{aligned} uc_t &= P_t^h\left(i_t\left(1-\tau_t^{Fed}\right)+\tau_t^{prop}\left(1-\tau_t^{Fed}\right)+\gamma_t-E_t\pi_t^h\right) \\ &:= P_t^h y_t^t \end{aligned} \tag{1}$$

where P_t^h is the price of the home; i_t is a nominal mortgage interest rate;[13] γ_t is the sum of depreciation, maintenance and repair, and insurance; π_t^h is the 4-quarter constant-quality home

[11] We included singles, single parents, and husband-and-wife families with and without children.

[12] Such user costs are readily derived from the fundamental capital pricing equation. The standard frictionless theory, which builds upon Hall and Jorgenson (1967), implies that rents equal user costs, and is exposited in Gillingham (1980, 1983), Dougherty and Van Order (1982), and Green and Malpezzi (2003). For more details and extensive discussion about user costs and other housing measures, see Diewert (2007).

[13] Sometimes researchers distinguish between the equity in the home and the loan amount, and apply distinct interest rates to them. This is controversial; some hold that the mortgage interest rate is the relevant rate to apply even to equity, given the riskiness of housing investment (see Verbrugge 2008a for a brief discussion). The marginal income

price appreciation between now and 1 year from now; and $E_t p_t^h$ represents the expectation of this appreciation at time *t*. Given the current U.S. tax code, such appreciation will almost certainly remain untaxed for the homes we consider. As Diewert (2007) points out, one may interpret $\left(i_t - Ep_t^h\right)$ as a period-*t* real interest rate.[14]

We use the 30-year fixed mortgage rate as our measure of interest rates, except when computing measures of out-of-pocket costs, when we use actual respondent data.[15] Homeowner marginal income tax rates are computed by applying the analysis of Kumcu (2008) to the CE data. Aside from the measure of expected appreciation (discussed below), all the other elements in (1) are generally available in CE data. However, imputation of these measures is occasionally necessary, either because the data are missing for a unit or because they are of the incorrect form for use within an *ex ante* user cost measure. A handful of units did not report property taxes; this variable was imputed using CE data on the basis of a simple regression model with PSU, year, home value, and Census neighborhood characteristics as the regressors. We use number of rooms as a control variable in some of our regressions; this variable, when missing, was imputed on the basis of each year's set of data, based upon region, PSU, dwelling age, and structure type. More extensive imputation was necessary for maintenance and repair costs and for home insurance. Actual annual maintenance and repair costs are highly variable and seasonal, and CE data include only *ex post* quarterly expenditures, but we are forming *expected* annual user costs. Hence we must construct a *prediction* of annual maintenance and repair costs for every unit. Annual home insurance is often missing, since many homeowners may pay for their insurance less frequently than every quarter,[16] which implies that many respondents do not report any home insurance expenses in their second interview. Both of these variables were imputed in a similar manner. Each used available data from four consecutive interviews (not just second interview data) on a year-by-year basis. Regressors consist of home value, PSU, number of rooms, dwelling age, structure type, and housing amenities (such as air conditioning). Finally, user costs include maintenance and repairs, but also depreciation. Depreciation encompasses

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tax is applied regardless: for debt cost, mortgage interest is deductible; for the opportunity cost associated with equity, investors only obtain after-tax interest earnings.

[14] Note that some authors refer to y_t alone as the user cost.

[15] More specifically, we use the series "average contract rate on commitments for 30-year fixed-rate first mortgages" from the Federal Reserve Board. This rate includes both a risk premium and a default premium.

[16] For example, homeowners who no longer possess mortgages do not have quarterly home insurance expenses.

several notions, not only including physical deterioration (which is accounted for in maintenance and repair), but also the notions of aging and obsolescence (which is not thus accounted for). To ensure that our estimates line up with comparable measures from the Bureau of Economic Analysis and from the Census, we add 1% of home value to our estimates, which may be interpreted as adding an estimate of depreciation.

The treatment of expected appreciation is central. Rather than simply using a crude proxy, a city-by-city *forecast* for $E\pi^h$ was constructed. This choice is crucial, for at least four reasons. First, home price appreciation is quite persistent, so it has a significant forecastable component; market participants are aware of this, and are expected to take it into consideration in their decision making. Second, expected home price appreciation is quite variable across time and across cities, so it would appear to be inappropriate to use a time- or city-averaged rate. Third, this term has an enormous impact on user costs and their divergence from rents. After all, one can always assume the theory is valid and solve for the appropriate appreciation term which makes user costs equal rents; but the resultant appreciation term can be strongly at odds with the data in practice (see Verbrugge 2008a). Finally, there is no agreed-upon model of house price dynamics, so it is more conservative to take a more agnostic, statistical viewpoint to these expectations. Our forecasts are based upon metro-area house price indexes, namely the CMHPIs which are described briefly below. While ex post house price appreciation has a strong microspatial element, differences in housing appreciation rates across neighborhoods within a given city will be extremely hard to predict. Thus, the approach we take is arguably the best that market participants could do.

Based upon popular conjectures and the findings of previous research, we use four alternative measures of $E_t p_t^h$ in (1), which give rise to four different user cost measures. The first is a forecast of expected appreciation over the next year; the resulting user cost is defined as $uc\{1\}$. The second is an *annualized* forecast of expected appreciation over the next four; the resulting user cost is defined as $uc\{4\}$. The third expected appreciation measure we investigate is simply current annual inflation ("pi"); this measure treats overall inflation as a proxy for expected appreciation – which is equivalent to an assumption of zero real capital gains even in the short run. The resulting user cost is defined as *uc*{pi}.[17] The final expected appreciation measure we investigate is *zero*, at least roughly speaking. More specifically, in this case we treat out-of-pocket costs as the measure of "user costs." In this final appreciation measure, two implicit assumptions are thus made: first, expected real capital gains are negative; and second, the opportunity cost of equity in the home is zero. We explore two variants of this latter measure: *baseline* out-of-pocket expenses, which includes only interest from first and second mortgages; and *extended* out-of-pocket expenses, which includes interest from home equity loans and lines of credit. Out-of-pocket expenses refer to after-tax out-of-pocket expenses and, for household *j*, are computed as

$$out\text{-}of\text{-}pocket_j = \left(mort.\ int._j\right)\left(1- t_j^{Fed}\right) + \left(prop.\ tax_j\right)\left(1- t_j^{Fed}\right) + \left(m\,\&\,r_j\right) + \left(ins._j\right)$$

where $mort.\ int._j$ refers to actual annual mortgage interest payments of household *j*, $prop.\ tax._j$ refers to annual property taxes paid by household *j*, $m\ \&\ r_j$ refers to annual maintenance and repair costs by household *j*, $ins._j$ refers to annual home insurance paid by household *j*, and t_j^{Fed} refers to the marginal income tax rate of household *j*.

The standard theory leading to equation (1) and to its equality with rent is derived from a frictionless model, in which continuous asset rebalancing occurs. But long-horizon-forecast advocates correctly point out that, owing to large transactions costs, the expected tenure for homeowners is much longer than one year; indeed, it is actually closer to a decade. Thus, the forecasting horizon of the typical owner is far longer than one year. The expected tenure for renters is shorter, but is still itself about four years. This suggests that the margin of indifference between homeownership and renting has an implied horizon longer than the one-year horizon of a rental contract.[18] On this basis, one could argue on behalf of a longer horizon forecast in an otherwise standard user cost expression.[19] A second line of argument in favor of long-horizon forecasts derives from postulated landlord behavior: landlords might use long-run appreciation

[17] While this measure has little theoretical justification, it is nonetheless popular amongst practitioners; see, e.g., Poterba (1992) and OECD (2005). This user cost measure is also used in Iceland's CPI (see Guðnason, 2004, 2005). *A priori*, this no-real-capital-gains-in-the-short-run assumption seems odd since it is both so strongly at odds with the U.S. data, and is also so theoretically dubious – in that, at least outside of steady state, there is no reason to believe that expected inflation equals expected home price appreciation.
[18] The question of the appropriate horizon for comparing renting to homeownership is discussed in Sinai and Souleles, 2005.
[19] Over extremely large horizons, say decades or longer, one might argue that a no-real-capital-gains assumption is not too unrealistic (see, e.g., Eichholtz 1997).

measures in their own cost calculations, and form rents on that basis.[20] However, this explanation requires a theoretical justification for rent inflation stickiness. One such justification is sketched out in Diewert (2007): landlords, reflecting the preferences of tenants, may attempt to minimize volatility in rent changes. (Rent control, which surprisingly turns out to impact *aggregate* rent inflation, may also provide a partial answer; see Poole and Verbrugge, 2008.) A desire to avoid rent inflation volatility leads directly to the use of long-run appreciation rates in landlord user cost calculations.

Forecasts were constructed as follows. Following best practices in the forecasting literature, we use averages of several different forecasting models (see, e.g., Granger and Jeon 2004, Stock and Watson 2004 or Timmerman 2005); the data, CMHPI indexes, are described below. For one-year forecasts, for each city and for every quarter we constructed a weighted average of five different models: four distinct forecasting models, and a model which is simply the four-year moving average of annual appreciation rates. The dependent variable in each of the forecasting models was the latest-available four-quarter appreciation rate, and the independent variables included four-quarter city-specific appreciation rates at lags greater than three quarters, four-quarter all-US appreciation rates at lags greater than three quarters, and lagged *quarterly* appreciation rates.[21] In all cases, models were re-estimated every quarter, and forecasts were formed using only information available at time *t*. In particular, the models and weights were: a Bayesian Vector Autoregression (VAR) model with four lags of city-specific and aggregate annual (four-quarter) appreciation rates, estimated with a tight random walk prior, receiving a weight of 0.4; a VAR model with one lag each of city-specific and aggregate annual appreciation rates, receiving a weight of 0.1; a univariate model with three lags of *quarterly* city-specific appreciation rates, receiving a weight of 0.3; a naïve unit root model (i.e., simply using the last annual appreciation rate as the forecast), receiving a weight of 0.1; and the four-year moving average, receiving a weight of 0.1. For four-year forecasts, we used the simple average of the four-year moving average and a model with the (annualized) *four-year* appreciation rate as the dependent variable and with lags 16-18 of this variable as independent variables.

We end this section with a brief description of CMHPIs. The most widely-used US home price data series which are available for most cities are the OFHEO house price indexes and the

[20] This suggestion is due to Tim Erickson (private communication).
[21] We considered other independent variables, such as interest rates, but these did not significantly aid prediction; we also considered Autoregressive Moving Average (ARMA) models, but did not find a model which significantly improved prediction.

Freddie Mac CMHPIs, which behave similarly. Each of these quarterly indexes uses a common data to construct an index using a weighted repeat-sales method (see Case and Shiller, 1987, 1989); CMHPI construction is described in Stephens et al. (1995). The common data source consists of repeat mortgage transactions – both purchases and refinancings – for single family homes in a database of loans purchased or securitized by Freddie Mac or Fannie Mae. Over our data period, these comprised approximately 60% of all loan originations. These indexes have been subject to various criticisms, which are here sketched briefly (for more extensive discussion, see Verbrugge 2008s). These data do not fully represent the housing stock of the U.S., as neither the lower end nor the upper end of the market is fully represented. While repeat-sales methods limit the extent to which changes in the composition of the sample influence the estimated index – since only price changes on the same property are used in estimating the index – still homes which turn over more frequently are overrepresented, and major renovations are poorly captured. Since we only use these indexes for estimating appreciation rates, and since they are almost certainly the best-available data for market participants (imperfect though they may be), we do not believe that these criticisms are of major importance for our analysis.

Because we form our expectation forecasts using a statistical model, from time to time our estimated user costs are negative. As noted above, expression (1) derives from a model without transactions costs and in which continuous portfolio rebalancing occurs. In reality, transactions costs imply a region of inaction, and imply that user costs are idiosyncratic and depend upon the agent's current housing portfolio, idiosyncratic shocks, expectations of switching domiciles (and incurring transactions costs), and the like. These considerations will greatly alter estimated user costs, and will likely imply that expected user costs are nonnegative, at least for *prospective* homeowners. However, this theory is not yet developed, so measures like (1) are the estimates being used by practitioners. Given our use of (1), we believe it preferable to be transparent about the implications of our assumptions, rather than apply ad hoc adjustments that would ensure user costs remained nonnegative – since these would potentially change our implications.

3. Rents, Out-of-Pocket Expenses, and User Costs

We plot the entire 2004:I-2007:I cross-section of reported annual rents against home values in Figure 1. We also plot the best-fit curve from a regression of reported annual rents on a constant, value, value^2, and value^3. This received our standard outlier treatment: after the initial regression, all observations with externally studentized residuals which were greater than 2.5 in absolute value were removed, and the regression re-estimated. (In this case, 131 observations were dropped.)

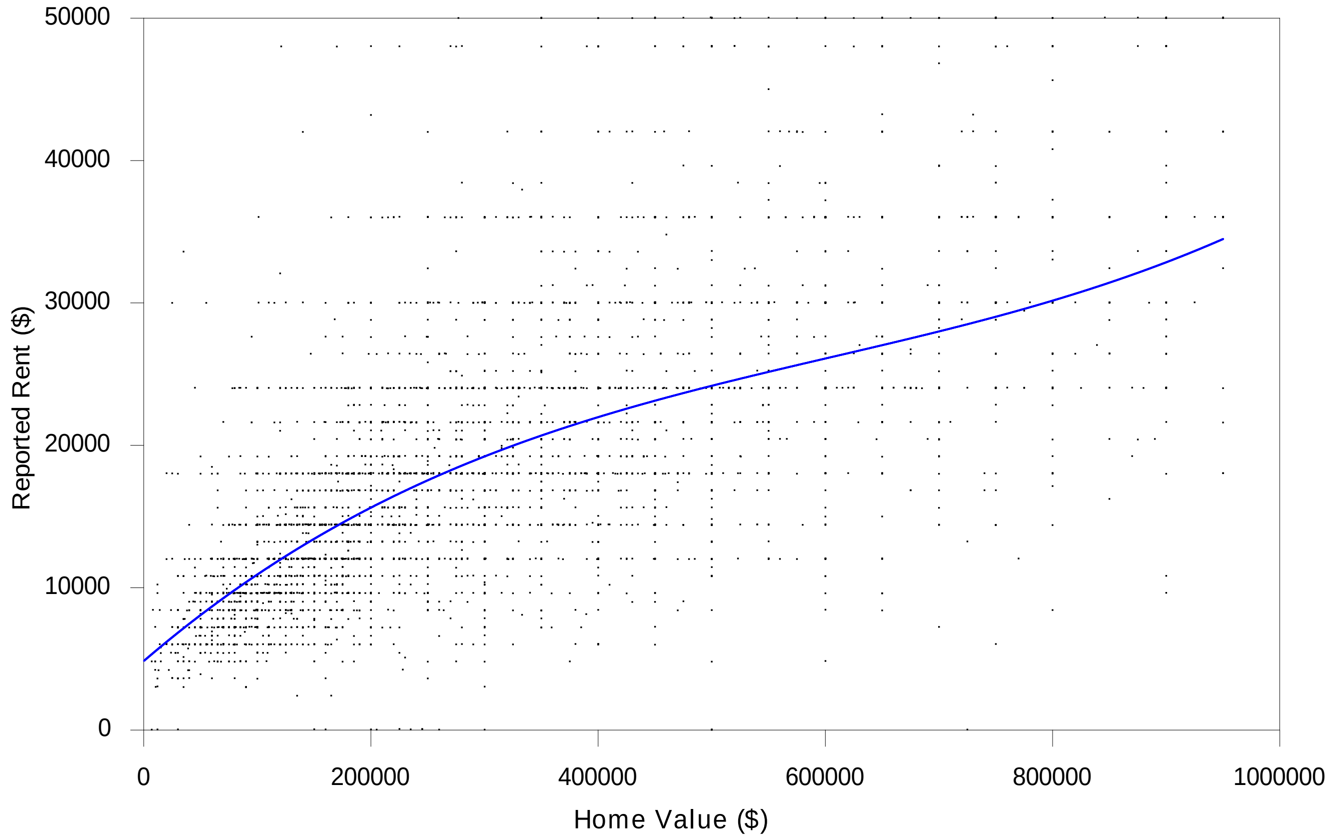

Fig. 1. Reported rents against home values

As can be seen, there is both a fair amount of dispersion (reflecting variation in the rent/value ratio within as well as across cities) and considerable rounding in the reported numbers. It is evident that the relationship is relatively concave. Average user costs will also feature some concavity, as a result of the correlation of higher marginal income tax rates and higher home values in conjunction with the federal income tax treatment of interest expenses and/or income (see equation (1)). But all homes within a metropolitan area are expected to share a common appreciation expectation, so it is not *a priori* obvious how much concavity user costs will possess.

We next provide, in Figure 2, a plot of annual user costs as defined in equation (1) with the conventional one-year forecast (i.e., $uc\{1\}$) against home values. We also plot the best-fit curve from a regression of user costs on a constant, value, value^2, and value^3, which received our standard outlier treatment. (In this case, 178 observations were dropped.)

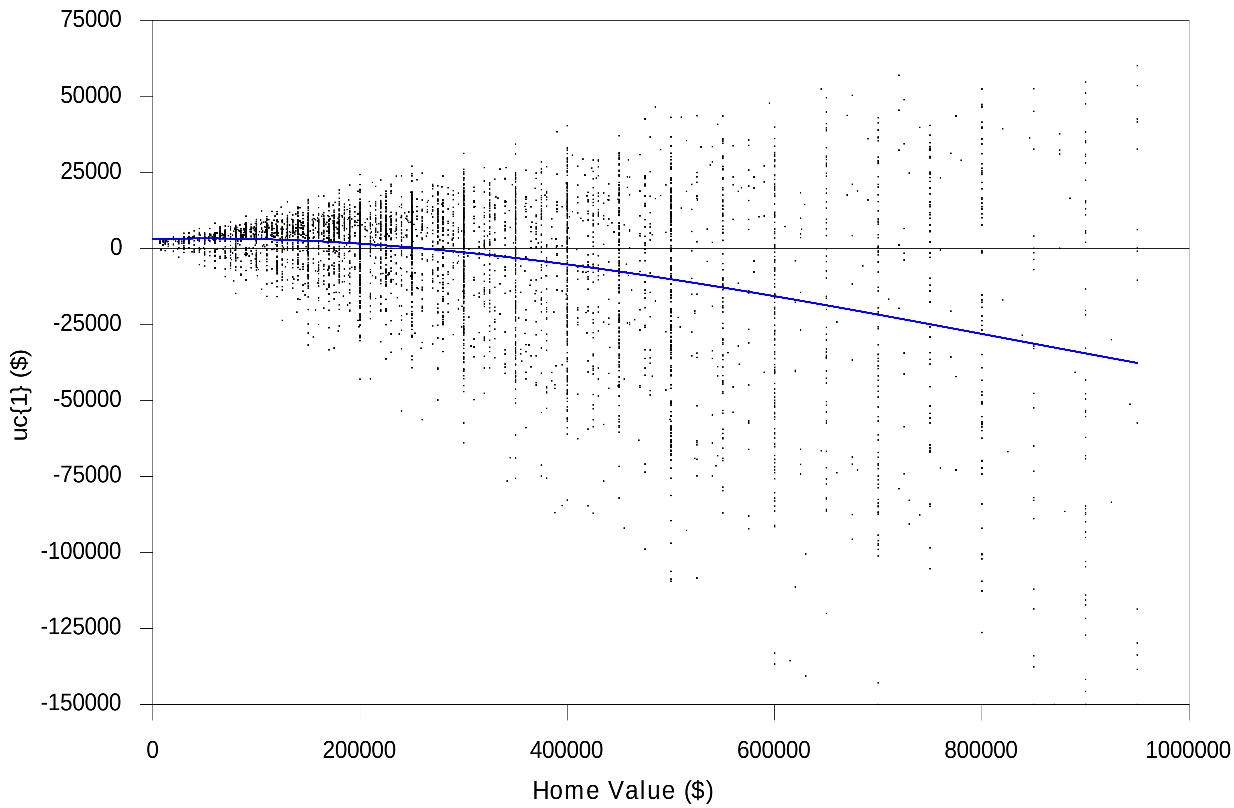

Fig. 2. User costs with conventional annual forecast against home values

In Figure 2, even given the expanded vertical scale relative to Figure 1, results in dropping 8 observations with estimated user costs below $-150,000. As can be seen, there is a tremendous amount of cross-sectional dispersion (three times that of reported rents), and $uc\{1\}$ is estimated to be *negative* for 41% of the homes. This reflects both the deductibility of mortgage interest and property taxes in the federal income tax code, and the fact that expected annual house price appreciation exceeds 6% for over half of the observations. Furthermore, in these data, expected annual house price appreciation is modestly positively correlated with home value: more expensive metro areas evidently featured higher expected appreciation during this period.

Previous work (Verbrugge 2008a) explored the use of longer-horizon forecasts in equation (1), and found much closer coherence of rents and user costs dynamics when these were used. Figure 3 below accordingly plots *uc*{4} – user costs with an annualized four-year inflation forecast – against home values. As before, we plot the best-fit curve from a regression of user costs on a constant, value, value^2, and value^3, which received our standard outlier treatment. (In this case, 165 observations were dropped.)

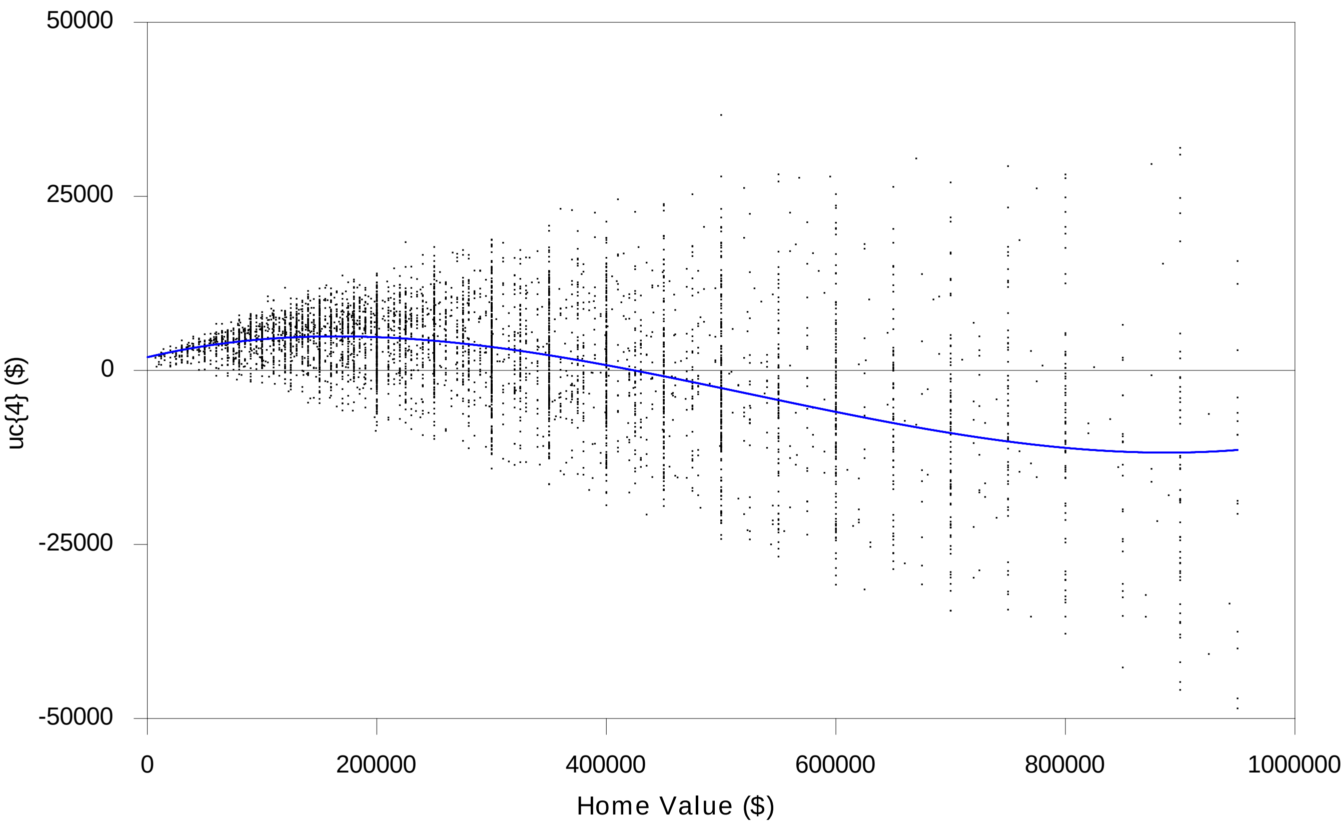

Fig. 3. User costs with annualized four-year forecast against home values

The dispersion of this measure is roughly equal to that of reported rents (at $9,000), but on average *uc*{4} lies well below average rent ($1,700 versus $18,700). While expected annual appreciation derived from longer-horizon forecasts is 2% lower on average, still *uc*{4} is negative for 31% of the sample; this reflects the fact that even *this* measure of expected annual house price appreciation exceeds 6% for over half of the observations. Clearly the use of a long-horizon forecast does not guarantee that the corresponding user cost will be close to rent.

There are two other measures of owner costs which have been considered in the literature: user costs with inflation as the measure of expected appreciation, and out-of-pocket costs. Neither of these is completely defensible on theoretical grounds: the first assumes zero expected real capital gains, while the second – by implicitly assuming a nominal appreciation rate of 0 – assumes *negative* expected real capital gains. Nonetheless, it is of interest to investigate the correspondence of these measures to reported rents.

Figure 4 below accordingly plots *uc*{pi} against home values. As before, we plot the best-fit curve from a regression of user costs on a constant, value, value^2, and value^3, which received our standard outlier treatment. (In this case, 163 observations were dropped.) Unlike the previous user cost measures, these unit-specific *uc*{pi} measures are all positive. Some concavity is evident in the relationship. While both the mean ($14,000) and the standard deviation ($7,000) are below that of reported rents, still this measure diverges from rent far less than more standard measures of user costs.

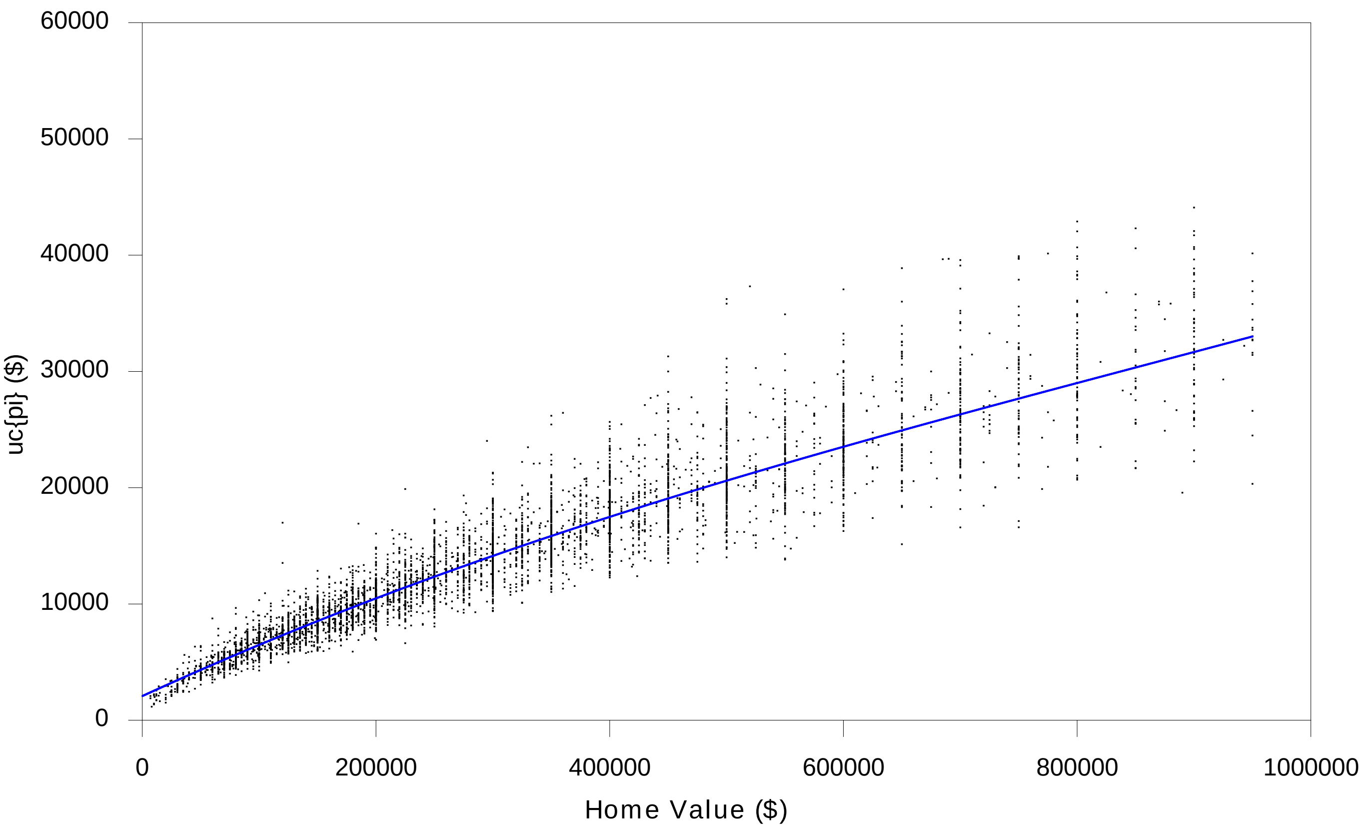

Fig. 4. User costs with inflation as forecast against Home Values

Given the degree of dispersion of reported rents for a given house value, it is of interest to see how, on a unit-by-unit basis, *uc*{pi} corresponds to rent. This is particularly interesting since, as shown in Figure 1, higher rent does not correspond perfectly to higher value. Accordingly, we plot *uc*{pi} against reported rent, and then against *predicted* rent, in Figure 5 below. ("Predicted rent" corresponds to the fitted values from a regression of reported rent on the regressors described in Section 4.) We have included the best-fit curve from a regression of *uc*{pi} against a constant, rent, and rent^2, and also a 45º line.

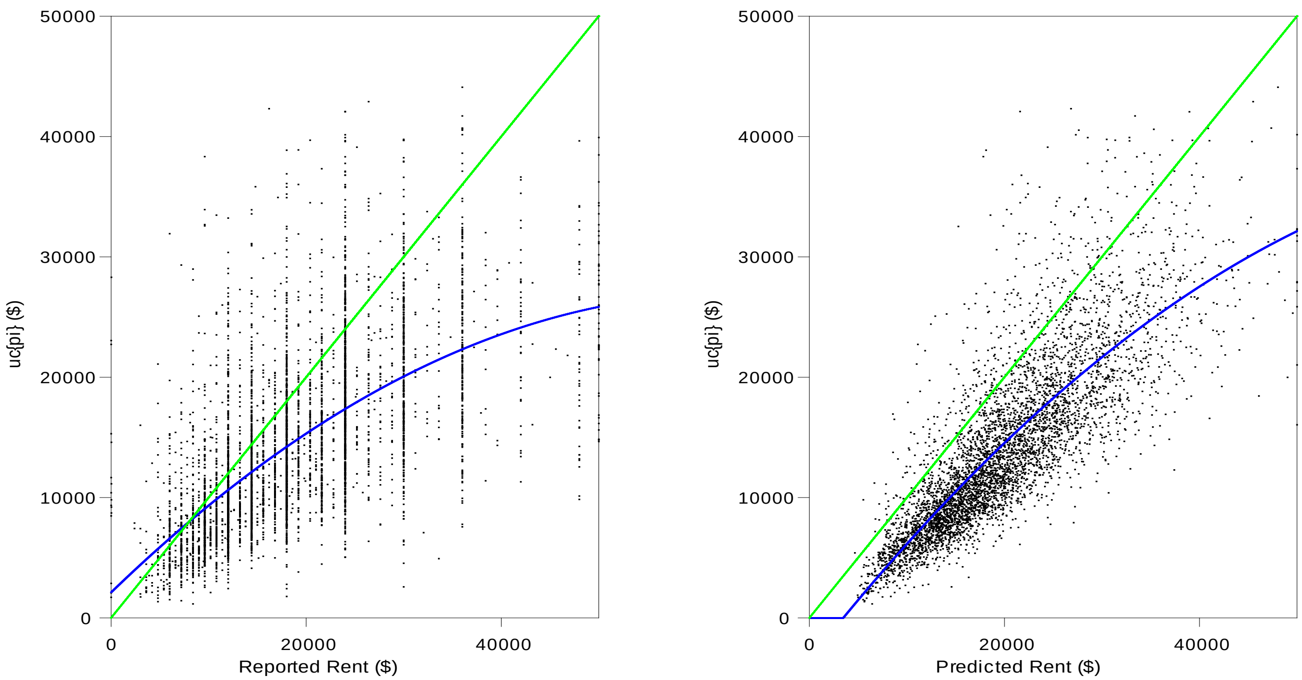

Fig. 5: User costs with inflation as forecast against reported and predicted rent

The first panel demonstrates that, on a unit-by-unit basis, *uc*{pi} *can* exceed reported rent, but *generally* lies below reported rent, with a divergence that increases as reported rent rises.[22] The dispersion of *uc*{pi} for a given reported rent is surprising. The second panel demonstrates that the relationship between *uc*{pi} and predicted rents is much tighter, pointing to the level of noise in reported rents. Findings like these cannot be discovered using index data.

[22] Adding a cubic term had almost no effect upon the best-fit curve.

In Figure 6 below, we simply plot several best-fit curves against house value. Each curve was constructed in the manner described above.

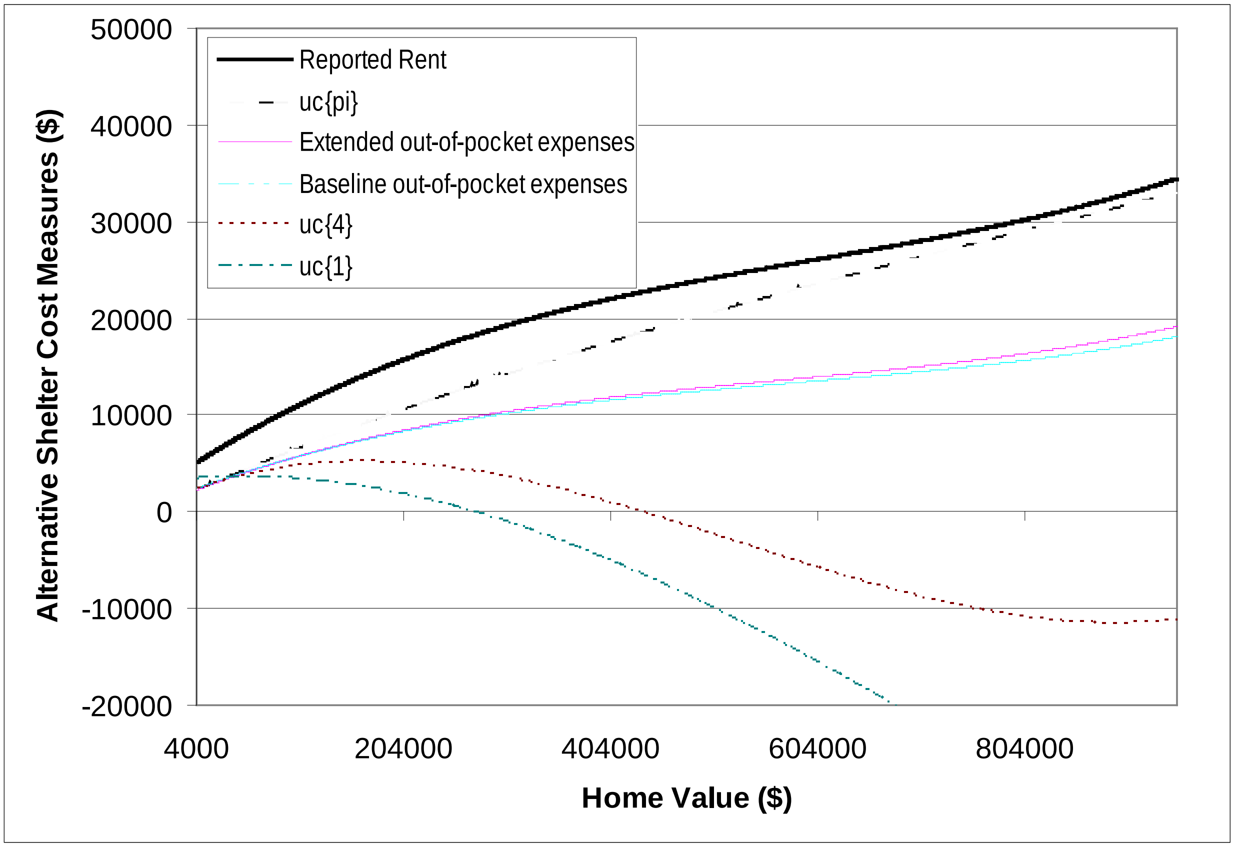

Fig. 6. Best-fit Curves of Cost Measures against Home Value

Two key findings are evident. First, rents, user costs and out-of-pocket expenses are not equivalent measures of the cost of housing services. Second, among the cost measures investigated, clearly *uc*{pi} is the measure most closely associated with rent – at least by the metric of similar cost/value structure over this time period. We also note that both out-of-pocket expenses have a nearly identical relationship with value. As we found this to be true of its relationships with other variables as well, henceforth we discuss only baseline out-of-pocket expenses.

Up until this point, we have focused attention on cross-sectional comparisons. But for inflation measurement, what matters more is the similarity of evolution over time. Figure 7 accordingly plots these measures over time. These estimates were obtained by regressions of the measure in question on time and PSU dummy variables; each regression is estimated once, then outliers specific to that regression are identified. Finally, all regressions are re-estimated after the union of all the outliers from each regression is removed. Thus, each resulting "index" has the character of a simple average, and each is estimated over the same data. In Figure 7, we also plot an index whose initial value matches that of our initial average rent estimate and which is adjusted by the movements in the CPI's OER index. Movements in the OER index are based upon changes in the market rents of about 25,000 rental properties located in 87 PSUs.

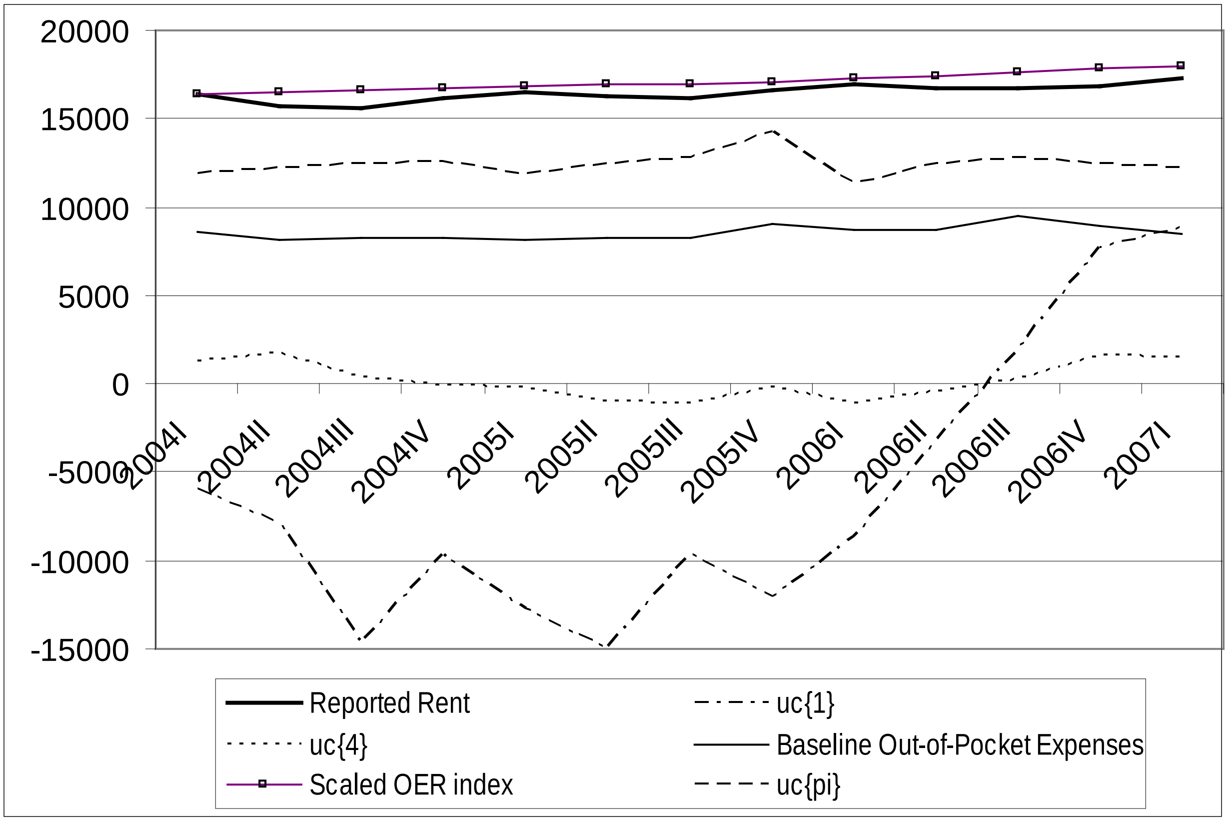

Fig. 7. Alternative Shelter Cost Measures Over Time, National

The evolution of the average of owners' self-reported rents fairly closely matches that of the Scaled OER index[23] – meaning that reported rents grow, on average, at the same rate as do market rents, a finding that is reassuring to users of these CE data. Over the entire time period, reported rents remained well above all four other alternative measures of shelter costs, and the volatility of the growth rate of the average was considerably lower as well (out-of-pocket expenses were about twice as volatile, and *uc*{pi} was about 4 times as volatile). Over very long

[23] Recall that over 300 observations have been dropped, due to our outlier treatment. If these are included in the estimation, the evolution of the estimated measure even more closely matches that of the OER index. Arguably, including all the observations results in a more appropriate comparison, since BLS rent indexes are constructed using every observation, even an "outlier," as long as its accuracy has been verified by BLS commodity analysts.

horizons, each of these measures of user costs is likely to grow at the same rate as rents; but over even medium horizons, they can evidently diverge substantially (see Verbrugge (2008a) for move evidence on this topic).

Figure 8 plots our estimated measures for a selection of the metro areas. All except San Diego are plotted on the same scale.

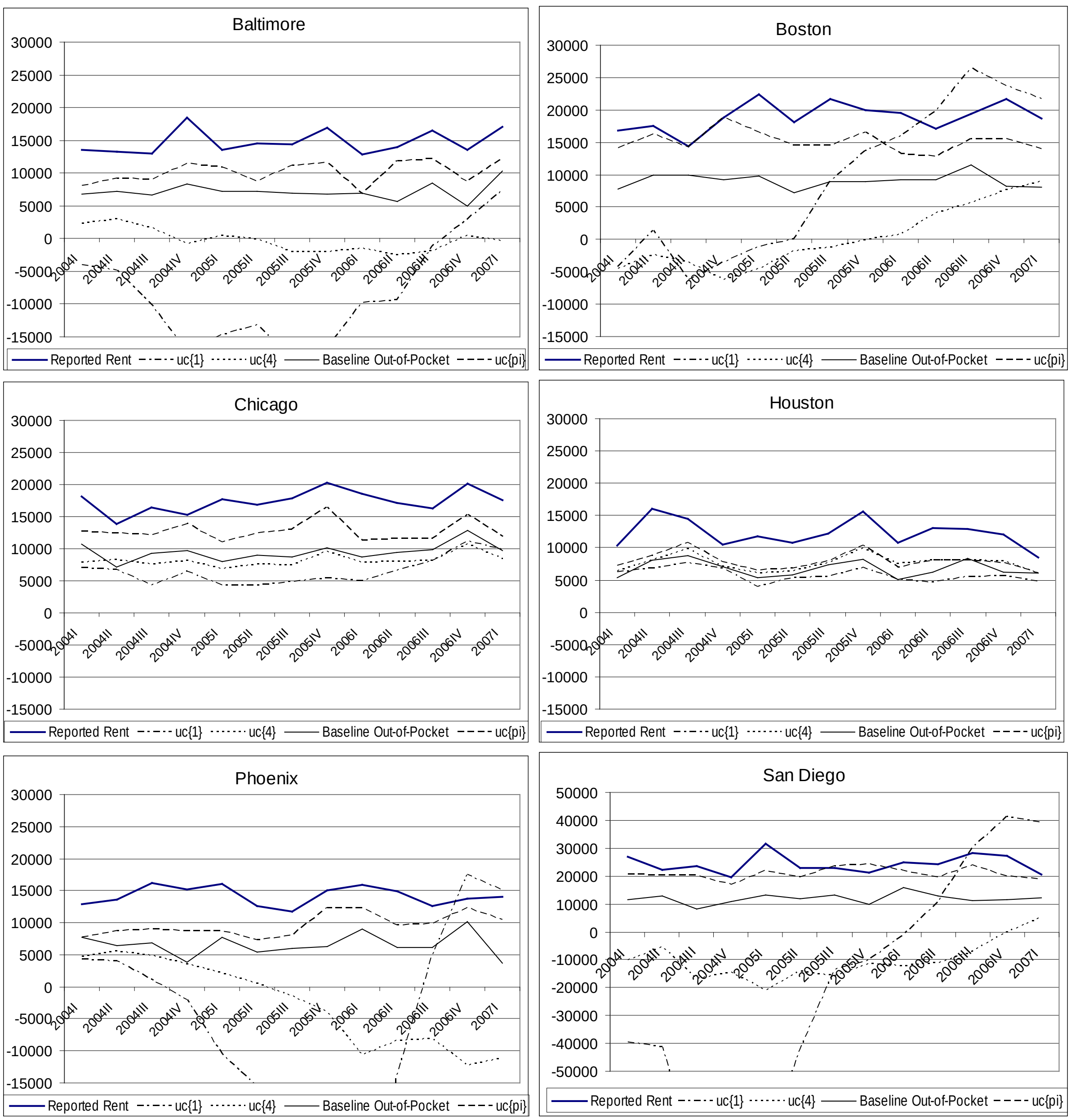

Fig. 8. Alternative Shelter Cost Measures Over Time, Six Metro Areas

At the level of the metro area, more sampling variation is evident, but the general character of shelter cost measure dynamics is similar to that of the U.S. as a whole. Reported rents generally lie above all other measures, followed by $uc\{\text{pi}\}$, then out-of-pocket expenses, then the other two user cost measures. In some metro areas, plummeting house prices drove $uc\{1\}$ above rents towards the end of the period. The examples of Phoenix and San Diego demonstrate the extent to which expected appreciation drives user costs. These markets experienced strong appreciation prior to the middle of the period, driving $uc\{1\}$ *well* below 0, which reversed later on. Also illustrated is a key weakness in user costs with long-horizon forecasts: they will tend to respond sluggishly to sharp developments in house price dynamics. We suspect few market participants in early 2007 would have expected the low (or negative) user costs indicated by $uc\{4\}$.

We now turn to using regression analysis to study the relationship between rents and the alternative shelter cost measures.

4. Regression Analysis

We begin with the most basic comparison: that of reported rents to the various alternative measures of costs, with a minimum of other control variables. As our user cost estimates are often negative, we cannot take logs and compute elasticities; accordingly, in Table 1, we present results from simple linear regressions in levels. Each model received our standard outlier treatment, and we report the number of observations which remain after outliers are removed. Estimated *t*-statistics are reported in parentheses. The null hypothesis in each case corresponds to a coefficient estimate of one on the cost variable (or variables), and zero on the constant.

Table 1
Simple linear regression of reported rents on user costs or cost components

	Model							
Variable	*uc*{1} Estimate (t-stat.)	*uc*{4} Estimate (t-stat.)	*uc*{pi} Estimate (t-stat.)	Out-of-pocket Estimate (t-stat.)	Out-of-pocket+ I Estimate (t-stat.)	Out-of-pocket+ II Estimate (t-stat.)	*uc*{4}+ Estimate (t-stat.)	Out-of-pocket+ III Estimate (t-stat.)
Constant	17,595 (157)	18,411 (170)	7,120 (38.5)	11,202 (56.5)	7,682 (45.0)	6,437 (14.8)	7,440 (16.3)	1,311 (2.34)
uc{1}	-0.08 (-16.2)							
uc{4}		-0.26 (-20.1)						
uc{pi}			0.79 (54.2)					
Out-of-pocket expenses				0.72 (36.1)	0.28 (14.1)	0.25 (13.0)		
uc{0}[a]							-0.08 -(1.81)	
$P_t E\pi_t$[b]					-0.03 (-2.38)	-0.07 (-3.10)	-0.10 (-4.12)	-0.04 (-1.57)
Value					0.03 (20.1)	0.04 (20.1)	0.06 (14.8)	0.026 (10.66)
Value^2						-0.000 (-7.58)	-0.000 (-8.78)	-0.000 (-4.01)
(1-τ)(mortgage payments)[c]								0.20 (10.01)
(1-τ)(property tax payments)[c]								0.71 (8.12)
Home insurance								12.45 (11.28)
Maintenance and repair costs								-0.16 (-0.56)
F-test *p*-value: PSUs						0.00	0.00	0.00
F-test *p*-value: dates						0.37	0.58	0.00
N	5064	5065	5034	5072	5041	5038	5047	5034
Adjusted R^2	0.06	0.09	0.46	0.29	0.53	0.56	0.53	0.56

[a] This term refers to user costs computed as *uc*{1}, but with $E\pi_t$ removed (or set to 0).

[b] This term is expected appreciation in dollars, using the annualized 4-yr. forecast, as discussed below.

[c] Mortgage interest payments and property tax payments are tax-deductible in the federal income tax code; see (1) and discussion in Section 2.2.

Regression analysis confirms the conclusions above: *uc*{pi} is much more closely related to rents than are the other user cost measures; indeed both of these latter measures are estimated to have an *inverse* relationship to rents, a vivid rejection of the theory. Reported rents are not simply out-of-pocket expenses either.[24] While the coefficient estimate of 0.72 in the Out-of-pocket model appears to validate the "reported rents equal expenses" hypothesis, there are good reasons to reject this hypothesis. First, the estimated standard error on this coefficient is 0.02, implying that we can formally reject the hypothesis of unity. Second, this model is inferior to the *uc*{pi} model, to the Out-of-pocket+ models, and to the *uc*{4}+ model, each of which includes expected appreciation in some manner. The superiority of the *uc*{pi} model suggests that rent-setters expect housing appreciation to equal to overall inflation (zero real capital gains) *at a minimum*, and take this into account in their rent setting.

Moreover, there is some evidence that rent-setters take shorter-horizon expected appreciation into consideration. Define expected dollar appreciation as $P_t^h E_t \rho_t^h$, the expected increase in the dollar value of the home, using the annualized four-year forecast of home price appreciation. [25] Obviously, this measure is correlated with value by construction; but we desire to isolate the impact of expected dollar appreciation, controlling for home value. Thus, in Out-of-pocket+ I we include both of these terms in the regression. This results in a dollar appreciation coefficient estimate which is statistically significant at the 5% level, albeit with a size far smaller its theoretical value of -1. In both *uc*{4}+ and Out-of-pocket+ II we also include other covariates, including Value^2, PSU dummy variables, and time dummy variables. In this case, there is somewhat stronger evidence that expected dollar appreciation impacts reported rents. However, the comparison of these two models reveals that reported rents are more closely related to the more narrow measure of out-of-pocket costs, one computed using after-tax actual mortgage payments rather than the more complete measure of interest costs, $(1-\tau)P_t i_t$; for this reason, henceforth we considered only after-tax actual mortgage payments. Finally, in Out-of-pocket+ III we split these out-of-pocket expenses into its various components. In this specification, the evidence that expected dollar appreciation matters is much weaker.[26] We do not report estimated

[24] In Tables 1 and 2, we use baseline out-of-pocket expenses in the specification. As alluded to above, using extended out-of-pocket expenses yields essentially the same results.

[25] Since by design the expected appreciation rate, overall inflation, is common across all PSUs, using inflation as the measure of expected appreciation results in a variable with almost perfect correlation with value.

[26] The results are qualitatively very similar when we run this model in logs – i.e., when the dependent variable is log(rent) and the regressors are log(value), log[(1-τ)mortgage], log($P_t E \pi_t$), etc., Elasticities are estimated to be 0.03

coefficients on our PSU dummy variables in order to conserve space; but our estimates suggest that, in these data and of the 28 metro areas covered, and conditional on the other covariates in the final two models, rents in Honolulu are highest, followed by the New Jersey suburbs of New York City, while those in Pittsburgh are the lowest.

We now investigate how reported rents are related to a wider variety of covariates. In these specifications, log(reported rent) becomes the dependent variable. Since many respondents do not have any mortgage payments, we could not use the log transformation of this variable, so we left all cost components in levels. We are most interested in the relationship of rents to the various components of user costs, including expected appreciation. Regression results are reported in Table 2.

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for mortgage payments, 0.1 for property tax payments, 0.6 for home insurance, -0.1 for maintenance and repair – each of these statistically significant at the 2% level, at least – and -0.07 for dollar appreciation, with a t-statistic of -1.63.

Table 2
Linear regression of log(reported rents) on shelter cost measures and other covariates

Variable	Model 1: Out-of-Pocket Estimate (t-stat.)	Model 2: Out-of-Pocket + $PE\pi$ Estimate (t-stat.)	Model 3: Components of (1) Estimate (t-stat.)
Constant	8.783 (61.7)	8.889 (60.8)	9.108 (66.8)
Value[a]	0.016 (8.47)	0.018 (8.86)	0.011 (4.64)
Value^{2}[a]	-0.0001 (-5.74)	-0.0001 (-4.58)	-0.000 (-3.82)
User cost components			
Log(out-of-pocket expenses)	0.024 (3.38)	0.023 (3.34)	
$(1-\tau)$(mortgage payments)[b]			0.0000 (4.21)
$(1-\tau)$(property tax payments)[b]			0.0000 (4.96)
Home insurance			0.0002 (1.85)
Maintenance and repairs			0.0001 (2.94)
$P_t E\pi_t$[c]		-0.0000 (-2.95)	-0.0000 (-1.27)
Other covariates			
Log(rooms)	0.300 (9.49)	0.294 (9.26)	0.173 (4.06)
Single detached	0.129 (5.09)	0.133 (5.28)	0.141 (5.56)
Mobile home	-0.329 (-6.35)	-0.333 (-6.46)	-0.318 (-6.16)
Age of dwelling	-0.004 (-7.19)	-0.004 (-7.21)	-0.004 (-7.05)
Age^2	0.0000 (3.85)	0.0000 (3.83)	0.000 (3.48)
Value above median in city	0.023 (1.02)	0.026 (1.19)	0.027 (1.26)
Central City	0.032 (1.55)	0.031 (1.51)	0.013 (0.59)
Vacancy rate	0.005 (0.40)	-0.0000 (-0.00)	0.001 (0.08)
Block % renter in 2000	0.236 (3.84)	0.229 (3.73)	0.208 (3.41)
Block % poverty in 2000	-1.12 (-7.22)	-1.12 (-7.24)	-1.003 (-6.63)
Income residual[d]	0.0008 (5.02)	0.0008 (4.83)	0.0006 (4.07)
CU Education above median[e]	0.043 (1.68)	0.043 (1.71)	0.038 (1.50)

CU Education high[f]	0.121 (4.44)	0.112 (4.40)	0.103 (3.79)
F-test *p*-value: PSUs	0.000	0.000	0.000
F-test *p*-value: dates	0.410	0.265	0.051
N	5175	5175	5177
Adjusted R^2	0.40	0.40	0.41

Note. Dependent variable: Log(Reported Rent).

[a] Here we divide *value* by 10,000, and also use this adjusted value to compute $value^2$.

[b] Mortgage interest payments and property tax payments are tax-deductible in the federal income tax code; see (1) and discussion in Section 2.2.

[c] This term is expected dollar appreciation, using the annualized 4-year forecasts.

[d] This variable is the residual from a regression of income on marginal tax rate.

[e] This variable equals 1 when the consumer unit reference person has education level between that of high school graduate and of bachelors degree.

[f] This variable equals 1 when the consumer unit reference person has education level with a bachelors degree or higher.

There are several things to note. First, as noted above, the rent/value relationship is concave. Second, higher costs of ownership – in particular, interest rates, property taxes conditional on value, home insurance, and expected maintenance and repair costs, translate into higher rents. However, as is evident from Models 1 and 2, the elasticity with respect to out-of-pocket cost is modest, to say the least. Clearly, homeowners are not simply reporting their out-of-pocket expenses – although as noted above, reported rents are more closely associated with actual mortgage costs rather than the more complete measure of interest costs which includes the opportunity cost of equity in the home. This low elasticity must reflect the influence of market conditions; these potential landlords are not ignorant of the market and recognize that their costs might well diverge from the rents their properties would likely command (see Tian 2008). Third, in keeping with the results from our simple levels regressions, expected appreciation does not appear to exert a strong influence on reported rent once the components of user costs are included as separate regressors. Evidently the influence of expected real appreciation is small enough so that, in some specifications, this influence is indistinguishable from zero. Fourth, most other coefficient estimates are intuitively plausible. Several unit characteristics influence reported rent as one would expect: rooms (more rooms means a higher quantity of housing, given house price); single detached housing and mobile home (detached being higher quality, and mobile home being lower quality, given house price); and age (increased age leading to lower rents conditional on house price). We conjectured that value above metro-region median might have a separate influence on rent, but this does not appear to be the case. Similarly, the national vacancy rate is not estimated to be statistically significant; but this is not that surprising, since it is a national measure, its variability is not terribly high in these data, and we include time dummy variables. Several other variables seem to be functioning as proxies for neighborhood quality – although it is worth keeping in mind that this refers to an increased desirability (or increased cost of production) of rental properties *conditional on house value*, so that these effects influence rent in a way that is not fully reflected in the price of the home. Variables in this category include: % renter in the neighborhood (more renters leads to higher rents conditional on house price – either reflecting more demand for rental housing in the neighborhood, given house prices, or reflecting depressed house prices in high renter neighborhoods); income and the percentage of homeowners with high education (more of these variables perhaps point to higher quality of housing, given house price); and percentage of the population in poverty (increased percentage of those living in poverty reducing quality conditional on house price).

5. Conclusion

In the standard frictionless theory, rents should equal ex ante user costs. Prior research, most notably Verbrugge (2008a) and Garner and Verbrugge (2008a), highlighted the dramatic divergence between these measures. However, such prior research has been mostly confined to using aggregated (and dissimilar) index data, or – when micro data were used – made use of crude proxies for expected appreciation. Thus, the relationship between these measures at the micro level is an important issue that has not been adequately explored.

Herein, we use data from the Consumer Expenditure Survey to examine the relationship between user costs and rents *at the individual unit level*, in dollars, using unit-level information on house value, rent, taxes, and the like. This allows us to accurately estimate unit-specific user costs and to control for unobservables like neighborhood quality. We find that, in these micro data, the divergence between these measures is even more striking. Rents generally exceed both user costs and out-of-pocket expenses – although in some cities, declining real estate prices have driven some user cost measures above rent. Expected appreciation is of crucial importance. The natural expectation measure, a forecast of appreciation over the next year, results in a user cost measure that is often negative and has no evident relationship to rents at all. Even long-horizon forecasts, which appeared to be somewhat successful in earlier studies (e.g., Verbrugge 2008a), resulted in measures which were quite divergent. Thus, this study has basically ruled out index construction errors as the cause of rent-user cost divergence. Interestingly, an ad hoc appreciation measure – namely, overall inflation– results in a user cost measure that appears to outperform more theoretically rigorous variants, at least in the sense of generating a measure which is more closely related to rent.

We also study the factors related to reported rental equivalence. We decisively reject the commonly-held hypothesis that these merely reflect out-of-pocket expenditures.

The finding that rents only appear weakly related to their user cost determinants, while not completely new to this study, is nonetheless an important puzzle. One might approach the puzzle from the perspective of rent dynamics. Construction is inherently slow – and hinges upon the availability of suitable land, and so on – so sluggish adjustment of rents to user costs (or vice versa) might result either from costs of converting structures between owned and rental properties. Both construction lags, and information frictions related to search and to distinguishing permanent from transitory movements, should slow down adjustment. Smith and Smith (2006) emphasize the weakness of the mechanisms which would correct inefficiency in the housing market. Yet the non-specificity of detached housing suggests that these structures could be moved rather readily between the owner and renter markets. (However, as noted above, the sizable real estate transactions costs have a first-order impact on adjustment.) There are pricing frictions in rental markets, perhaps resulting from asymmetric information between landlords and tenants and/or implicit insurance to tenants; but the theory has yet to be fully developed. Rents are much smoother than smoothed user costs, so rent inflation stickiness may part of the answer. In short, there is likely some interesting industrial organization work to be done.

Alternatively, the puzzle might be approached from the perspective of user cost measurement. There are two sources of weakness in the theory or its application. First, there is the issue of the appropriate measure of expected appreciation. The above analysis generally assumes that expectations are formed via a statistical forecasting approach. While there is a good deal of evidence in favor of this hypothesis, and while home price appreciation is extremely persistent, one might nonetheless argue that rational agents admit the possibility of rational bubbles, and hence – during periods in which bubbles are suspected – would reduce their appreciation forecast via attaching positive probability to a bubble burst. This point was made more generally by Matthew Shapiro (2005),[27] who noted that determining the *correct* measure of expected appreciation would be challenging. Said correct measure derives not from a statistical forecasting exercise, but rather from applying the correct model to the data. In other words, "fundamentalist" forecasts are required, i.e., forecasts of home price appreciation should hinge upon the true underlying structural factors … as difficult as these may be to determine.[28] This fundamentalist model will likely distinguish between land price and structure price dynamics. But until the profession agrees upon the correct model of house price dynamics – which does not appear likely in the near future – forecasting approaches are probably the best one can do.

What about a better user cost measure? There are important frictions in real estate markets, and these alter user costs. Would the user-cost measures derived from more realistic (current-generation) models featuring adjustment costs have similar dynamics? It is somewhat difficult to say, given the complexity of those models. Presumably such user costs will differ from the frictionless user costs outlined in section 2 in that, in place of the expected appreciation term, there will be a term reflecting the *average probability of adjustment and realization of the after-costs capital gain*. However, many of the same forces – home prices, interest rates, and expected home price appreciation – will surely continue to be important determinants of user cost dynamics. Home price appreciation is extremely persistent, and mortgage interest rates are not that tightly related to this appreciation. A substantial reduction in volatility of user costs would appear to require substantial negative correlation between the probability of moving and the gap between interest rates and expected appreciation. This does not seem plausible. For example, consider a period of sluggish interest rates and a sudden increase in home price appreciation, such as occurred during 2003. Standard user cost measures fall dramatically during such episodes; only an equally large *decrease* in the probability of moving would keep a more realistic user cost measure from falling dramatically. On the other hand, user costs are idiosyncratic, so compositional effects brought about by a shifting margin might move in the opposite direction. This underscores the need for continued research on user costs.

[27] Private communication, December 2005.
[28] Martin (2006) provides a structural model of house price dynamics, with some surprising implications. Glaeser and Gyourko (2007) also provide a dynamic rational expectations model of house price dynamics.

Appendix

PSUs in this study

Northeast

Boston
New York City - Central
New York City - CT Suburbs
New York City - NJ Suburbs
Philadelphia
Pittsburgh

Midwest

Chicago
Cleveland
Detroit
Minneapolis
St. Louis

South

Atlanta
Baltimore
Dallas
Houston
Miami
Tampa
Washington, D.C.

West

Anchorage
Denver
Honolulu
Los Angeles - Central
Los Angeles - Suburbs
Phoenix
Portland
San Diego
San Francisco Bay Area
Seattle

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