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Abstract

Previous research (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. This 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, and rents are notoriously sticky. Furthermore, the use of indexes precludes both cross-sectional and dollar cost comparisons. In this study, we use Consumer Expenditure Interview 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 structure and neighborhood quality. We also make the point that in theory, after-tax user costs should equal *net* rent, i.e., expected rental income, rather than gross rent.

Our findings are striking. In keeping with most previous research, we find tremendous divergence between conventional measures of user costs and net rents, thus ruling out index construction errors as a possible explanation. This divergence does not result from a faulty rent measure: we find that reported rents are sensible, in that they move similarly to official rent indexes, and are not simply out-of-pocket expenses. Instead, and most perplexing, we find a surprisingly *close* correspondence between net rents and a particular estimate of user costs, one implicitly assuming zero transactions costs and constructed using an appreciation measure that is both theoretically suspect and empirically a poor predictor of actual appreciation.

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 economics (which studies the rent-versus-buy decision, landlord decisions, and so on), but also in the fields of tax policy, macroeconomics, and poverty measurement. In practice, different approaches to the measurement of this service flow can lead to rather different conclusions. For example, Frick, Grabka, Smeeding and Tsakloglou (2008)[1] and Garner and Short (2001) demonstrated that distributional measures vary dramatically depending upon the treatment of housing flows; OECD (2005), Cournède (2005) and Eiglsperger (2006) likewise found major impacts on inflation and real output measurement; and Garner and Short (2009) found differences in the estimation of aggregate housing flows and net income for the U.S.

In standard frictionless Jorgensonian capital theory with competitive markets, 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 in a study of the U.S. market, Verbrugge (2008a) demonstrated that not only are housing rents far less volatile than ex ante user costs, but 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 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. (This could be a

[1] Frick et al. (2008) provide a summary of research in seven European countries that focus on poverty and inequality. See also Garner (2005).
[2] See expositions in Gillingham (1980, 1983), Dougherty and Van Order (1982), and Diewert (2003/2010).
[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; see also Johannessen (2004) for evidence. When using BLS rent indexes before 1995, one should make the adjustments suggested by Crone, Nakamura and Voith (2009).

severe problem; for example, Chang, Cutts and Green (2005) stress the importance of adjusting for quality differentials in rent/value comparisons.) 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, 2009). 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 2009). 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 structure and 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 Bureau of Labor Statistics (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 homeowner 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

[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). More realistic user cost expressions are idiosyncratic, and little is known about how user costs, rents, and the shadow price of housing are related to one another in realistic environments with risk and frictions. Sommers, Sullivan and Verbrugge (2009) study this topic; see also Blow and Nesheim (2009), a study which is related but which abstracts from transactions costs.

[5] While both Verbrugge (2008a) and Garner and Verbrugge (2009) 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, 2008) uses CE data to investigate under- and over-valuation of houses both before and after the recent real estate boom.

completely control for unobserved quality variables which may influence rent differentially from house price. In our estimates of user costs, we construct measures 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. In addition to other advantages listed above, an additional advantage to using CE data is that we are able to obtain concurrent rent and user cost estimates; conversely, since market rents typically change on an annual basis, market rents inevitably reflect lagged conditions – and thus, perhaps, lagged rather than current user costs – potentially making it more difficult to discern a relationship between these variables. Given the wealth of information at the individual unit level, and given the expansive geographic coverage, CE data appear to be well-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? Yes and no. When constructing user cost estimates using the expected appreciation measures that most naturally follow from theory, we find striking divergence; indeed, in the cross section, the correlation appears to be negative. While the evidence in Verbrugge (2008a) suggests that constructing user costs using long-horizon forecasts markedly reduces user cost-rent divergence, our evidence suggests that such long-horizon user cost measures still diverge conspicuously from rents. The cross-sectional dispersion of rents versus these user cost estimates is also surprisingly large. In dollar terms over the 2004:I-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.

[6] Others who have noted this concavity include Garner and Short (2001), McBride and Smith (2001), and Heston and Nakamura (2009). Diewert and Nakamura (2009) and Diewert, Nakamura and Nakamura (2009) highlight the implications of this curvature for rent/user cost comparisons and inflation measurement. 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.

However, we find that the use of inflation as the proxy for expected appreciation in the user cost estimate results in striking *correspondence* of user costs and net expected rent earnings, with slightly less correspondence for more expensive homes. Both informal (graphical) and formal (statistical) evidence suggest that, on average, net expected rents are largely a function of user costs (as constructed in this manner). A key to detecting this relationship is to recognize that expected rental earnings lie below market rents: market rents must be adjusted downwards to account for taxes and the rental vacancy rate (as units do not earn rental income when they are vacant). An important area for future research is to explain why a theoretically suspect user cost estimate appears to be so useful for explaining rents.

Since we use CE data, our rent measure is reported rental equivalence, an estimate that CE respondents make regarding the rental values 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, respond to other market-rent-determining factors, and have a correlation with out-of-pocket expenses that is well below unity. Thus, homeowners are doing something other than simply reporting out-of-pocket expenses. However, the relationship of rents to expected appreciation is tenuous.

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 the 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 (2009), which uses IRS tax tables and CE homeowner information data to impute marginal income taxes to CE consumer units. [7]

[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

2.1 Consumer Expenditure Survey Data

CE Interview data, collected between 2004 calendar quarter one and 2007 calendar quarter one (2004:I to 2007:I) from consumer units living in the United States, were used as the basis for estimating user costs and rents for the same structure. 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 Appendix Table 1.

Using personal interviews, CE Interview data are collected by the U.S. Census Bureau from consumer units on behalf of the Bureau of Labor Statistics (BLS). The BLS reviews and edits the data after collection, imputing values when missing using a variety of variable-specific techniques. The CE Interview is designed so that each consumer unit in the sample is interviewed over five consecutive quarters, once every three months; every quarter 20 percent 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

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)

[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

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 during BLS data processing, the observation was dropped from the sample. We also restricted the sample by the family type variable; 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 BLS.[11] We then restricted the sample by house value; in particular, we dropped 4 percent of the observations corresponding to home values in excess of $950,000 within the 2004:I-2007:I 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 5,802 observations. See Appendix Table 2 for sample sizes by PSU. Additional outlier treatment, applied at the regression estimation stage, is discussed below.

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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 percent 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.

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

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

$$uc_t = P_t^h\left(i_t\left(1-\tau_t^{Fed}\right)+\tau_t^{prop}\left(1-\tau_t^{Fed}\right)+g_t-E_t p_t^h\right) \tag{1}$$

where P_t^h is the price of the home; i_t is a nominal mortgage interest rate;[13] g_t is the sum of depreciation, maintenance and repair, and insurance; p_t^h is the 4-quarter constant-quality home 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 (2006/2009) 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 (2009) 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.

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[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 (2003/2010).

[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 Wang, Basu and Fernald 2005 and Verbrugge 2008a for a brief discussion). Chinloy (1991) emphasizes the risk facing homeowners; he estimates an average risk premium in excess of 2% in the California data he examines (conversely, Sarama (2009) estimates premia in the 0.1% range). Chinloy also argues that standard mortgage rates are not appropriate in (1), since they include the prices of options, in particular options to prepay and to default. In (1), the marginal income tax is applied regardless: for debt cost, mortgage interest is deductible, while for the opportunity cost associated with equity, investors only obtain after-tax interest earnings. Note that landlord user costs are fairly similar to (1); the main distinction is that expected appreciation is taxable for landlords. At least during periods of low inflation, owning is typically less costly than renting mainly because landlords pay taxes on rents, while owners obtain shelter services from their housing tax-free.

[14] Note that some authors refer to uc_t/P_t as the user cost. Some authors, e.g. Prescott (1997) and ILO et al. (2004), suggest including expected transactions costs in (1). In Diaz and Luengo-Prado (2008), these costs do appear in the derived user cost expression in the differentiable case. Equation (1) assumes that all owners itemize, but many tax returns are filed using a standard deduction; furthermore some itemizers run up against the alternative minimum tax.

[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 risk, default, and pre-payment premia.

However, imputation of these measures is occasionally necessary, either because the data are missing for a unit or because they are *ex post* and hence 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, perhaps because 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 not only maintenance and repairs, but also depreciation. Depreciation encompasses 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). Thus, to ensure that our estimates line up with comparable measures from the Bureau of Economic Analysis (BEA) and from the Census, we add 1 percent of home value to our maintenance and repair estimates, which may be interpreted as adding an estimate of depreciation, or as an estimate of deferred major maintenance.[17]

The treatment of expected appreciation is central. Rather than restricting attention to a crude proxy, city-by-city *forecasts* for $E\pi^h$ were constructed. This choice is crucial, for at least four reasons. First, home price appreciation is quite persistent, so it has a significant forecastable

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

[17] The BEA estimates for annual depreciation are 1.5% and 1.8% for owner-occupied and renter-occupied housing, respectively. In computing owner costs, the BEA also includes various costs of acquisition and disposal, such as realtor fees.

component; market participants are aware of this, and are expected to take this 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 estimates for each unit. The first measure 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 years; the resulting user cost is defined as *uc*{4}. (We provide a justification for this second measure below.)

The third expected appreciation measure we investigate is current annual overall 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}.[18] There are many different inflation estimates which could be used, and we explore three alternatives. Our baseline measure, *uc*{pi(1)}, is very crude and uses the previous calendar year's overall CPI inflation as the inflation estimate. Our second measure,

[18] While this measure has little theoretical justification, it is nonetheless popular amongst practitioners; see, e.g., Poterba (1992), Blackley and Follain (1996), OECD (2005) and Cournède (2005). A similar user cost measure is also used in Iceland's CPI (see Guðnason, 2004, 2005 and Guðnason and Jónsdóttir 2008), and variants are in use in the system of national accounts statistics in several Western Balkan countries such as Croatia and Serbia (see Roberts 2008) – though Eurostat guidelines are to make the operational assumption that $(i\text{-}E\pi^h)$=2.5% (see Katz 2009). *A priori*, this no-real-capital-gains-in-the-short-run assumption seems strange 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.

uc{pi(2)}, is similar but more timely, and uses the average of the current, and lagged, 4-quarter inflation rate. Our third measure, *uc*{pi(3)}, is identical to the second, except that it uses the overall CPI-less-shelter to compute 4-quarter inflation rates.

The fourth and 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 out-of-pocket case, 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: *baseline* out-of-pocket expenses, which include only interest from first and second mortgages; and *extended* out-of-pocket expenses, which include 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 riskless 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.[19] On this basis, one could argue on behalf of a longer horizon forecast in an otherwise standard user cost expression.[20] A second line of argument in favor of long-horizon

[19] The question of the appropriate horizon for comparing renting to homeownership is discussed in Sinai and Souleles (2005).

[20] 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); furthermore this assumption corresponds to a simple random walk view of real house price dynamics. It is also possible that *during this period*, homeowners had zero-real-appreciation forecasts. Schreyer (2008) discusses this assumption in the context of discussing the challenges posed by the existence of bubbles. The literature on bubbles in real estate markets is growing rapidly; we mention only a few papers here. Case and Shiller (2003) provide survey evidence indicating "irrational exuberance." Peterson (2009) combines a search model with a particular behavioral assumption – namely, that market participants ignore the

forecasts derives from postulated landlord behavior: landlords might use long-run appreciation measures in their own cost calculations, and form rents on that basis.[21] However, this explanation requires a theoretical justification for rent inflation stickiness. One such justification is sketched out in Diewert (2003/2010): 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, 2009.) 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 2006); 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.[22] 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

effects of frictions on past prices – and argues that this will generate bubbles. Credit and information frictions (such as rational inattention) can amplify the effects of shocks. Using their measures of fundamentals, Himmelberg, Mayer and Sinai (2005) found “little evidence of housing bubbles” in 2004; see also Smith and Smith (2006), another study comparing prices to fundamentals. Applying a demand/supply analysis and defining bubbles accordingly, over the 2000-2005 period Goodman and Thibodeau (2008) found bubbles in 30% of the U.S. metropolitan areas they study. Ayuso and Restoy (2007) note that many studies do not adequately address frictions which prevent immediate adjustment, so that gaps between data and model predictions might be misinterpreted.

[21] This suggestion is due to Tim Erickson (private communication).

[22] 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. If the data existed, one might want to forecast land and structures separately.

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 Federal Housing Finance Agency house price indexes and the Freddie Mac CMHPIs, which behave similarly. Each of these quarterly indexes uses the same 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 percent of all loan originations. These indexes have been subject to various criticisms, which are briefly sketched out here.[23] 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 riskless 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

[23] See Haurin, Hendershott and Kim (1991), Case, Pollakowski and Wachter (1997), Gatzlaff and Haurin (1997), Dreiman and Pennington-Cross (2004), McCarthy and Peach (2004), and Leventis (2006) for evidence.

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; for this and other best-fit curves, we trimmed the top and bottom 1 percent of rents. This regression also 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 total, 218 observations were dropped.)

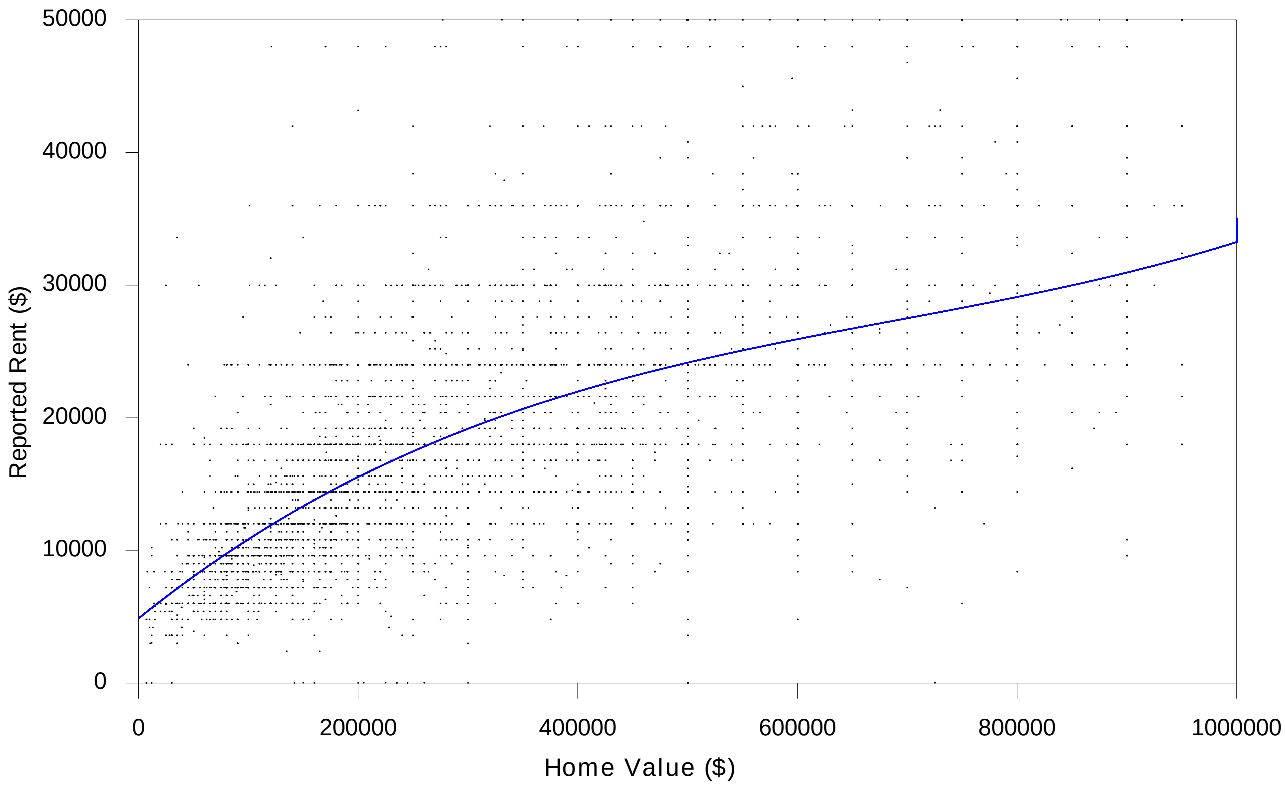

Fig. 1. Reported rents against home values

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 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 trimmed the top and bottom 1 percent of user costs, and which received our standard outlier treatment. (In this case, 178 observations were dropped.)

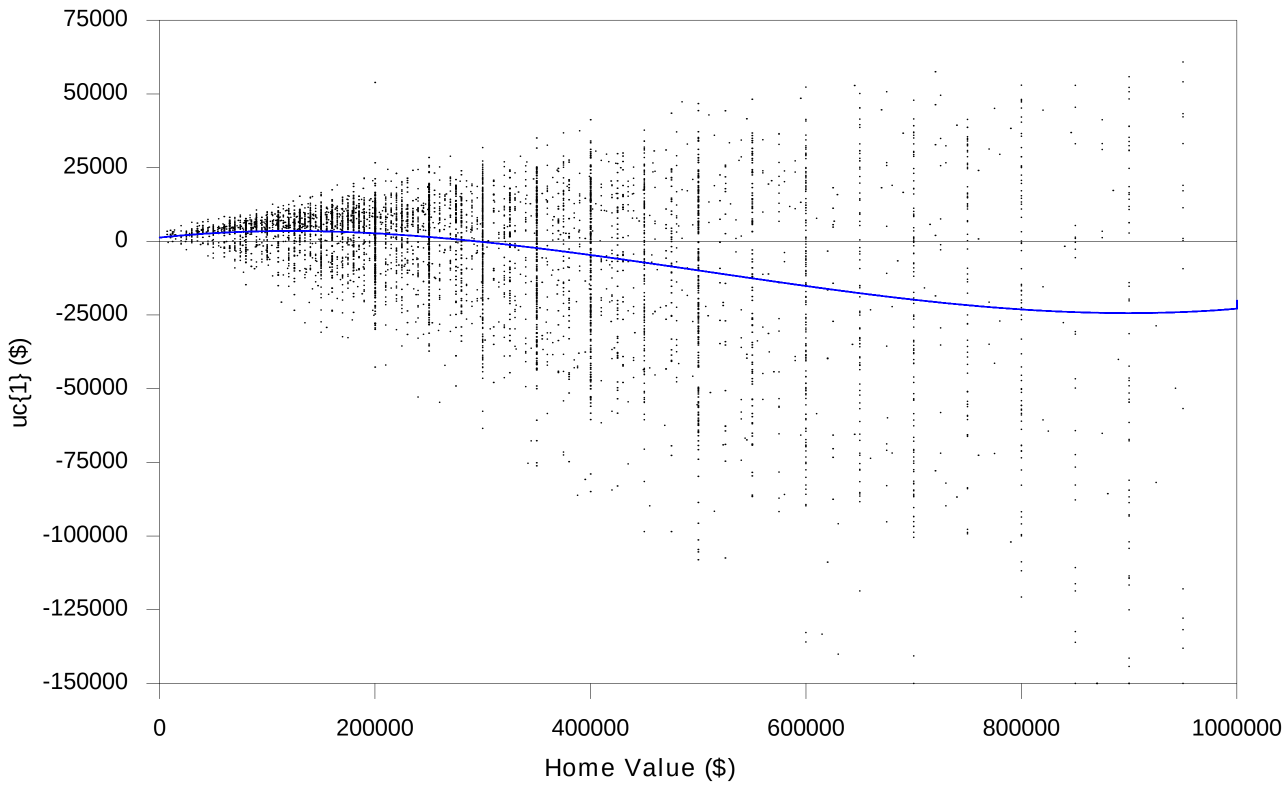

Fig. 2. User costs with conventional annual forecast against home values

In Figure 2, note the expanded vertical scale relative to Figure 1; still, we must drop 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 41percent 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 percent 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, again trimming the top and bottom 1 percent of user costs; thus a total of 344 observations were dropped.

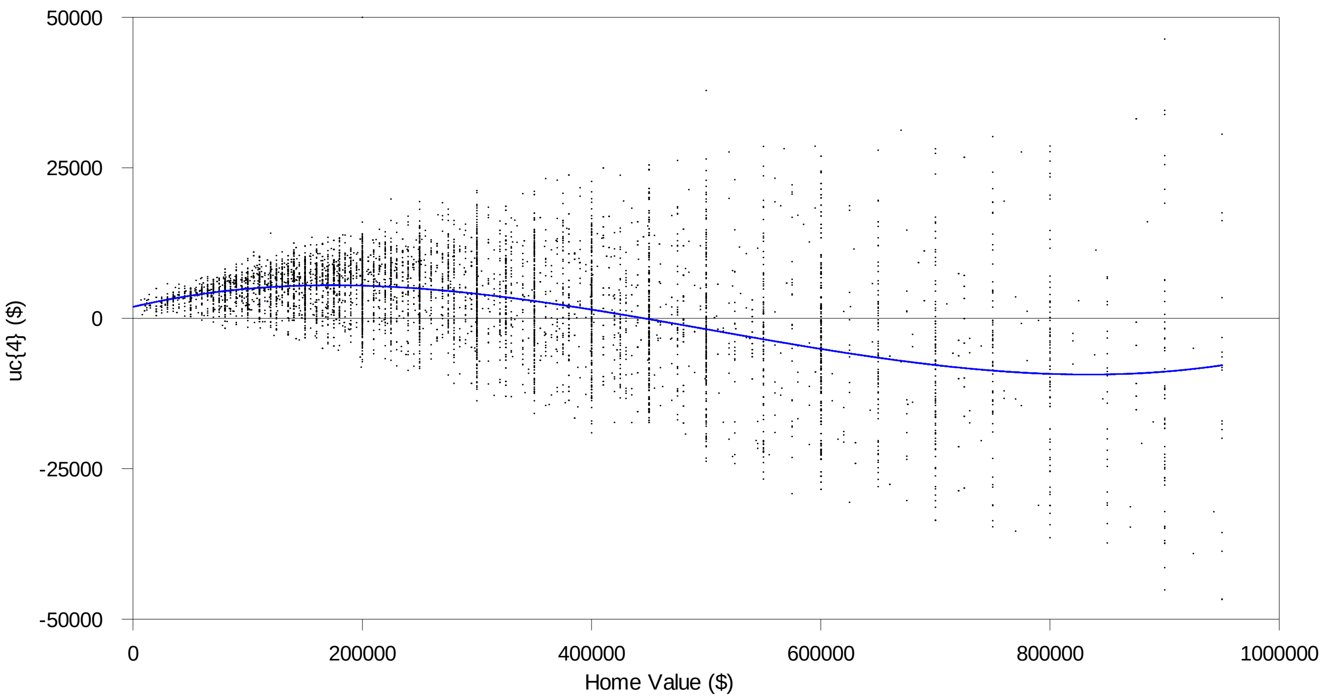

Fig. 3. User costs with annualized four-year forecast against home values

Notice that the scale of Figure 3 is expanded relative to Figure 1, but contracted relative to Figure 2. The dispersion of *uc*{4}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 percent lower on average, still *uc*{4} is negative for 31 percent of the sample; this reflects the fact that even *this* measure of expected annual house price appreciation exceeds 6 percent 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.

As noted above, 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 our baseline version of *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 trimming and outlier treatment; altogether a total of 340 observations were dropped. Unlike the previous user cost measures, these unit-specific *uc*{pi} measures are all positive, and we plot this on the same scale as that for Figure 1. Some concavity is evident in the relationship. Both the mean ($15,053) and the standard deviation ($7,546) are below that of reported rents, facts to which we return below.

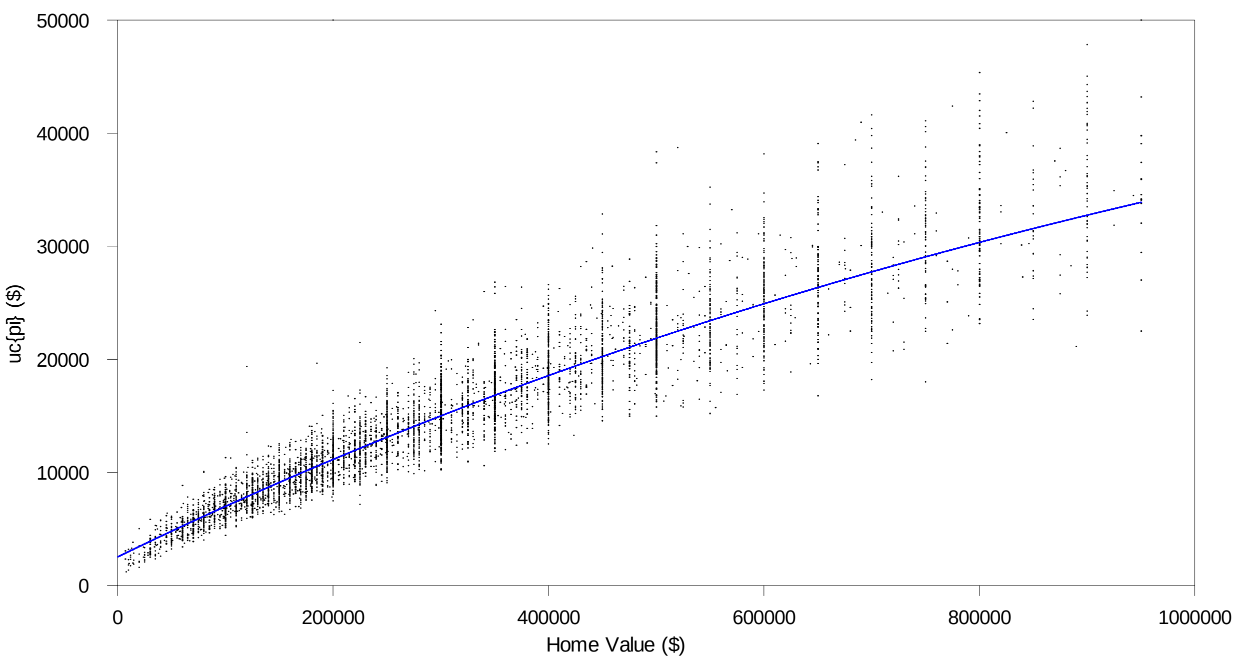

Fig. 4. User costs with inflation as forecast against Home Values

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*{4} and *uc*{pi} correspond to rent. This is particularly interesting since, as shown in Figure 1, higher rent does not correspond perfectly to higher value.

We do not, however, compare the (after-tax) user cost to the reported rent. This is because the net (after-tax) rental earnings that a unit would provide to an owner, in expectation, are given by $(1- vac_t)(1- t_t^{Fed})rent_t$, where vac_t is the vacancy rate in the city. Put differently, for a landlord to break even, rent would need to exceed user costs by the markup factor $(1-vac_t)(1-\tau_t^{Fed})$. Accordingly, we construct an estimate of this net measure for each unit, using the marginal tax rate for the household and the region's vacancy rate.[24]

In Figure 5, we plot *uc*{4}, and our three versions *uc*{pi}, against net, vacancy-corrected, reported rent (in the first column), and then against net, vacancy-corrected, *predicted* rent (in the second column). "Predicted rent" corresponds to the fitted values from a regression of reported rent on the regressors described in Section 4; we use this measure to reduce the level of noise in reported rents. We have included a 45^{o} line, and also the best-fit curve from a regression of each user cost measure against a constant, rent, and rent^2 which received our standard 1 percent trimming (of both variables) and outlier treatment.

[24] PSU-by-PSU vacancy rates are not reported by the Census. Note that the user costs here considered are homeowner user costs, which differ from landlord user costs in that landlords may deduct essentially *all* the expenses of ownership (including interest and maintenance), but may face higher maintenance and depreciation costs due to moral hazard, and must treat capital gains as income (so their user costs are less sensitive to expected appreciation). Landlord user costs usually exceed homeowner user costs.

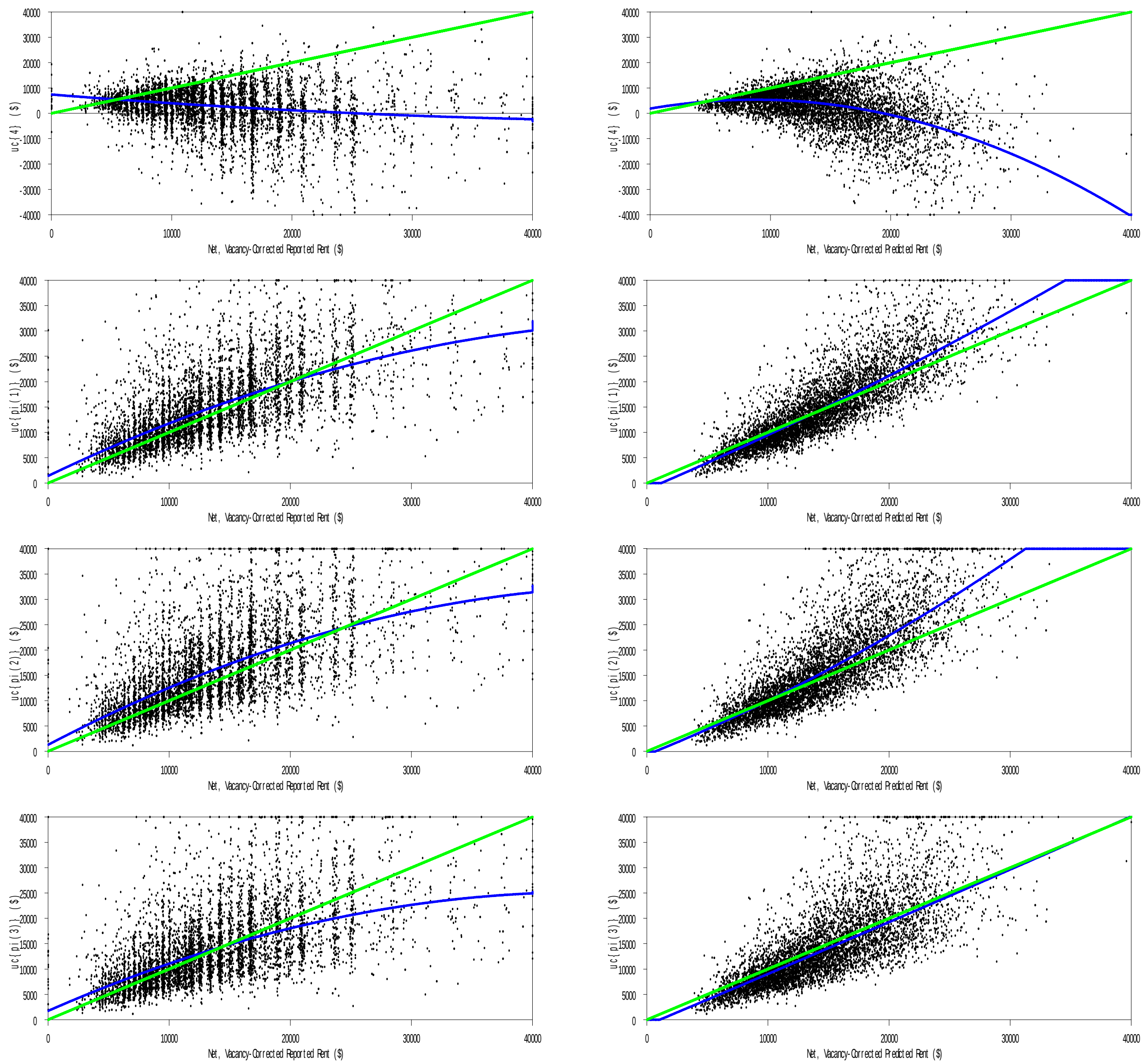

Fig. 5: User costs with inflation as forecast against net, vacancy-corrected, reported and predicted rent

The top two panels in Figure 5 compare *uc*{4} to reported and predicted rent. The divergence of these user cost measures and rents in the cross-section is remarkable; indeed these appear to be *inversely* correlated. Noise in reported rents cannot resolve this puzzle, as the divergence between *uc*{pi} and predicted rents is even more striking than its divergence with reported rents, as evidenced by the best-fit curves and by the respective amounts of dispersion. Evidently, the aggregation implicit in previous studies *understated* the degree of divergence between rents and user costs … when these are defined using a conventional long-horizon forecast.

However, this is not the end of the story. The remainder of the panels in Figure 5 compare our three alternative *uc*{pi} measures to reported and predicted rent; *uc*{pi(1)} is our baseline measure, *uc*{pi(2)} is the measure using the current and lagged 4-quarter inflation rate, and *uc*{pi(3)} is the measure using the inflation in the CPI-less-shelter series. (As the conclusions are similar, henceforth we consider only *uc*{pi(1)}, and refer to this measure as *uc*{pi}.) Using *uc*{pi} as the measure of user costs, one reaches the opposite conclusion. In particular, the *correspondence* between this measure of user costs and net, vacancy-corrected, predicted rent is remarkable. We also note the dispersion of *uc*{pi} for a given reported rent, indicating noise in reported rents. Perhaps *uc*{pi} represents a steady-state user cost notion which anchors rents, despite the fact that it evidently does not guide house purchase decisions. Findings like these cannot be discovered using index data.

In Figure 6 below, we simply plot several best-fit curves against house value, including two which correspond to out-of-pocket expenses. Each curve was constructed in the manner described above: trimming, removing outliers, using a third-degree polynomial, etc.

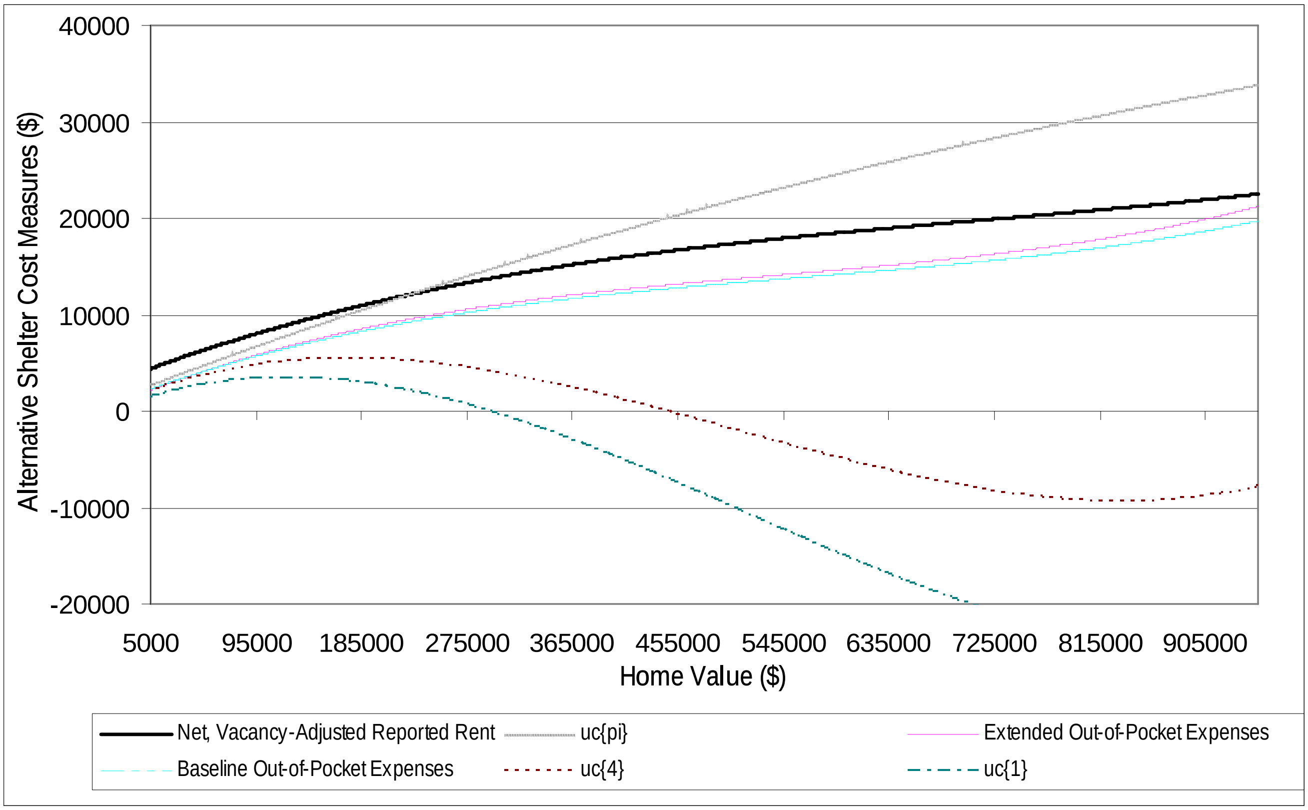

Fig. 6. Best-fit Curves of Cost Measures against Home Value

Several key findings are evident. First, vacancy-corrected, after-tax rents are relatively closely related to *uc*{pi} – at least by the metric of similar cost/value structure over this time period – but not to other user cost measures. Second, on average, *uc*{pi} lies above the rent measure for homes exceeding $230,000, a finding which corresponds to assertions of Diewert (2003/2010) and Diewert and Nakamura (2009) and to assertions and empirical evidence in Heston and Nakamura (2009); these authors, on this basis, argue that statistical agencies should consider an opportunity-cost OOH-services measure which is the *maximum* of rental equivalence and user cost. Third, vacancy-corrected, after-tax rents lie distinctly *above* out-of-pocket expenses for all home values. Furthermore, the relationship of house value to out-of-pocket expenses is about the same regardless of the measure of out-of-pocket expenses used. As we found this to be true of their relationships with other variables as well, henceforth we consider only the simpler 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 subsequently 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.

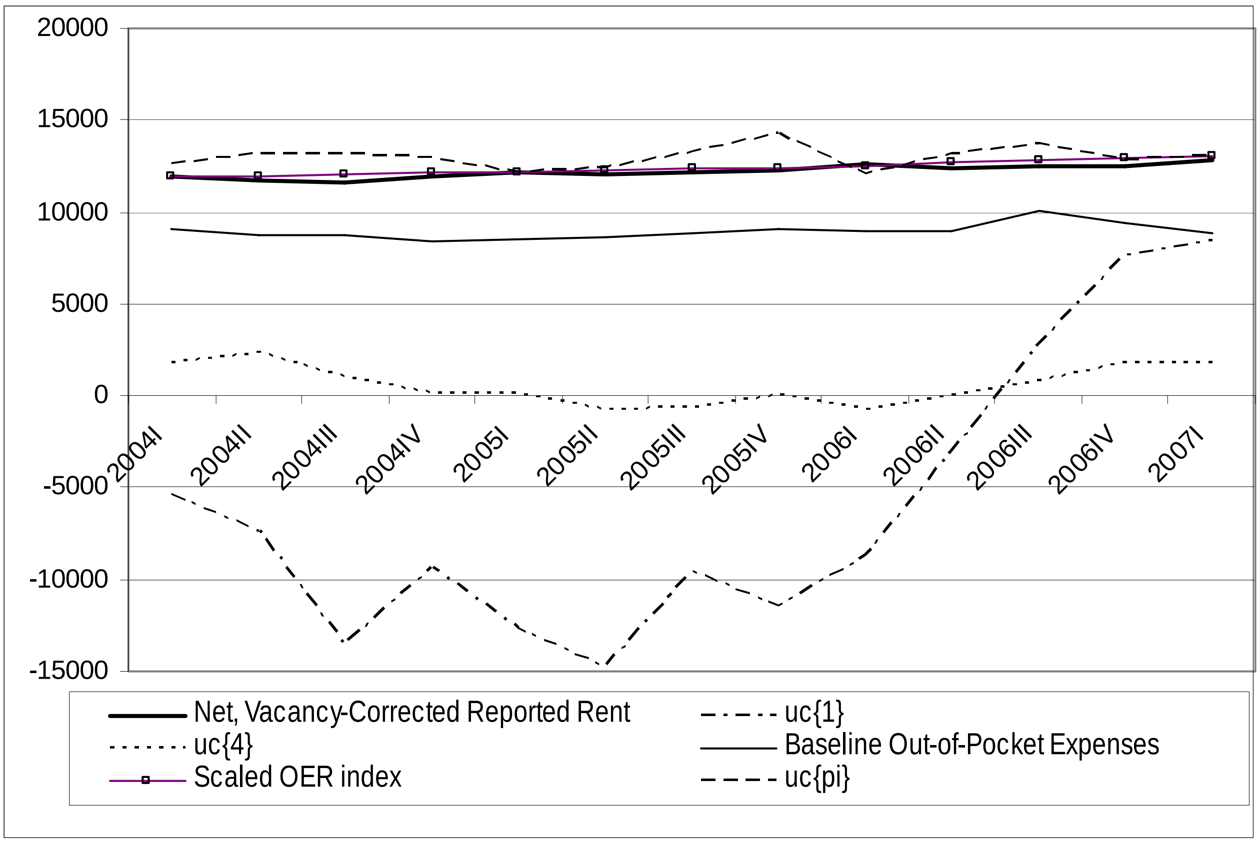

Fig. 7. Alternative Shelter Cost Measures Over Time, National

The evolution of the average of owners' net, vacancy-corrected, self-reported rents fairly closely matches that of the Scaled OER index[25] – 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. The

[25] 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.

correspondence of these measures with *uc*{pi} is also noteworthy. Over the entire time period, reported rents remained well above the other alternative measures of shelter costs. The volatility of the growth rate of the average net, vacancy-corrected rent was considerably lower than other cost measures (out-of-pocket expenses and *uc*{pi} were both about three times as volatile). Over quite long horizons, each cost measure, except the out-of-pocket expenses measure, is likely to grow at the same rate as rents; but the measures can evidently diverge substantially even over the medium term (see Verbrugge (2008a) for more evidence on this topic).

Figures 8a-8e plot our estimated measures for 27 of the 28 the metro areas in our sample; Houston, omitted in order to limit each graph to 6 panels, features dynamics very similar to those of Dallas/Forth Worth.

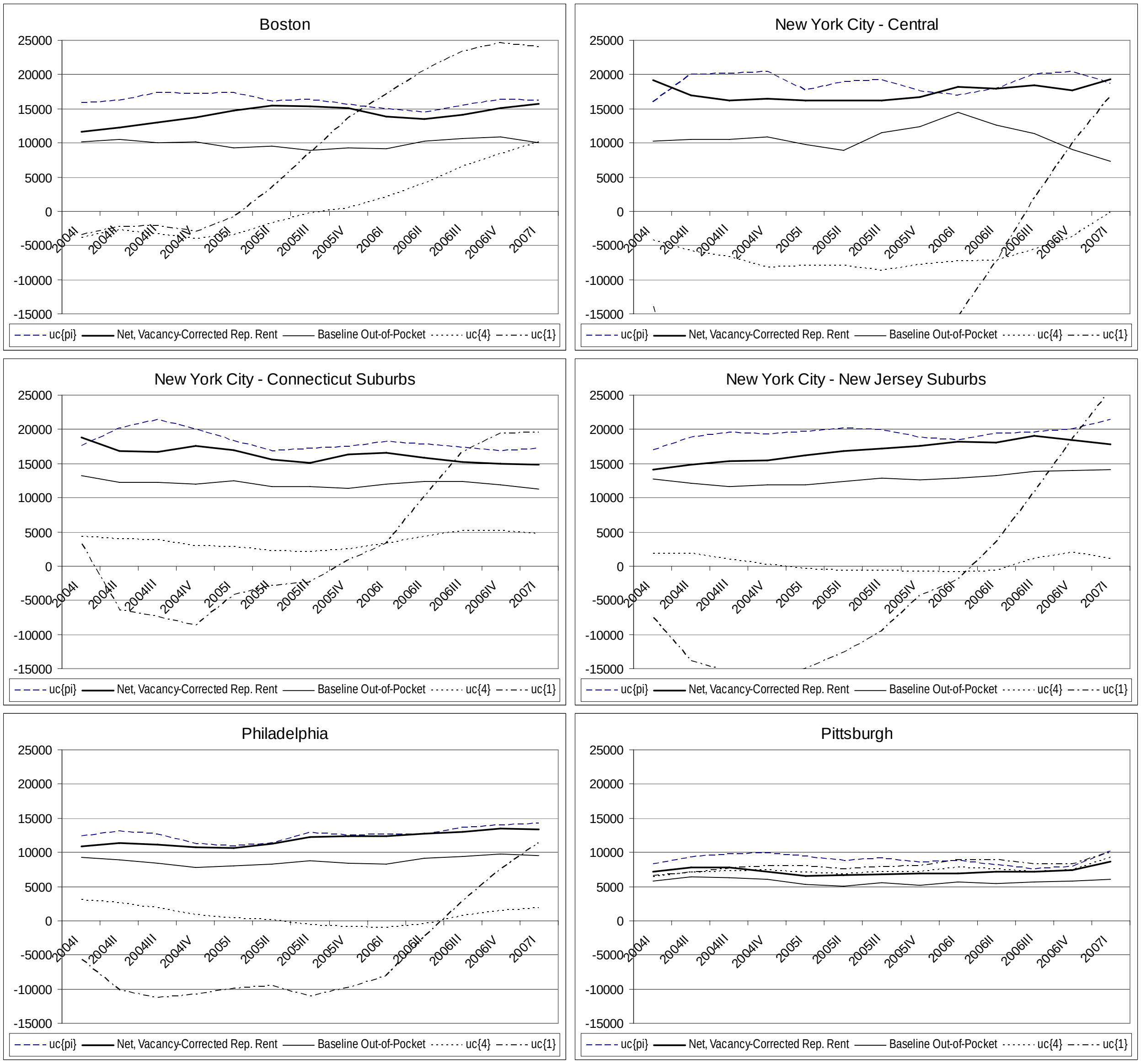

Fig. 8a. Alternative Shelter Cost Measures Over Time, Northeast Metro Areas

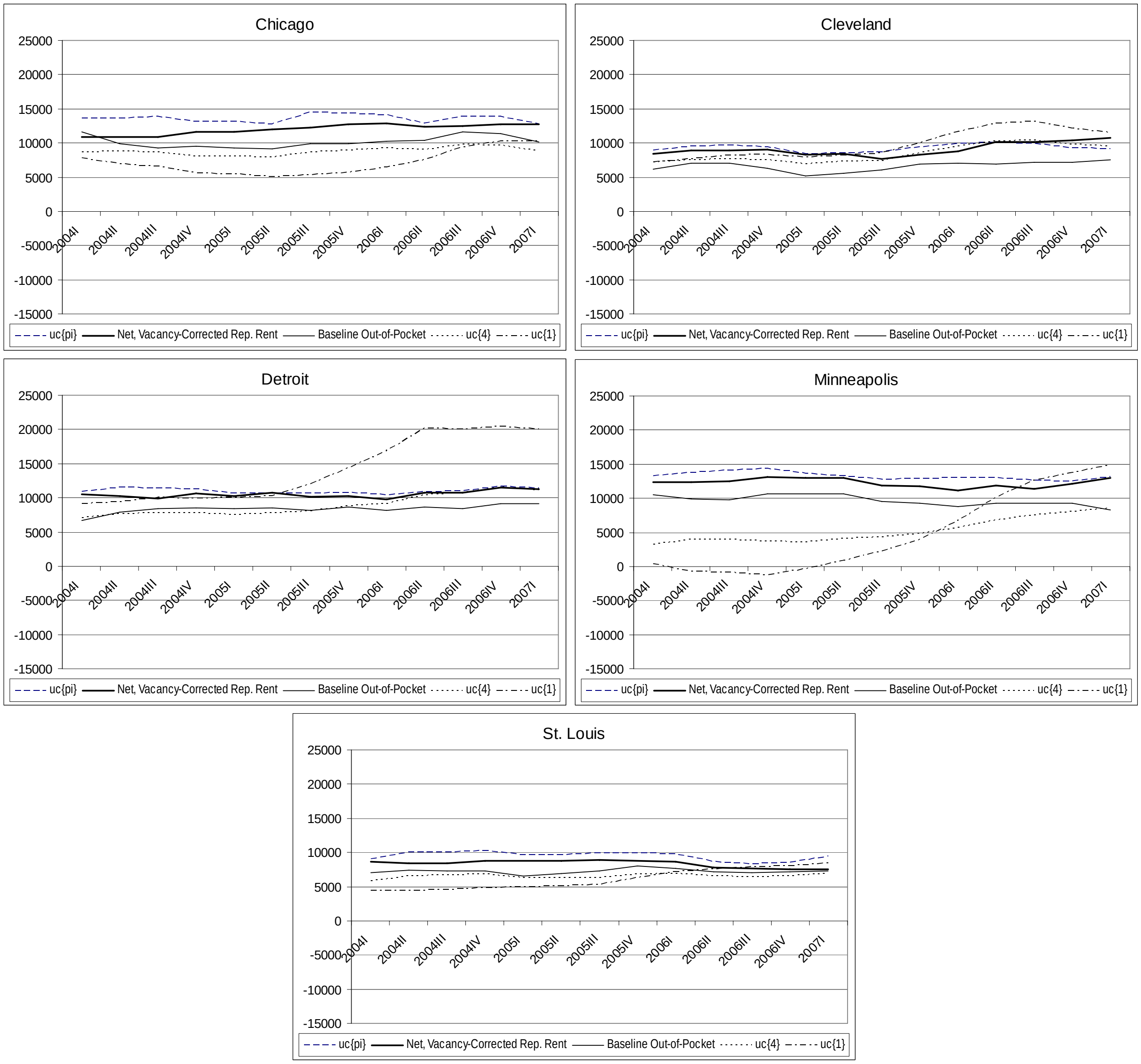

Fig. 8b. Alternative Shelter Cost Measures Over Time, Midwest Metro Areas

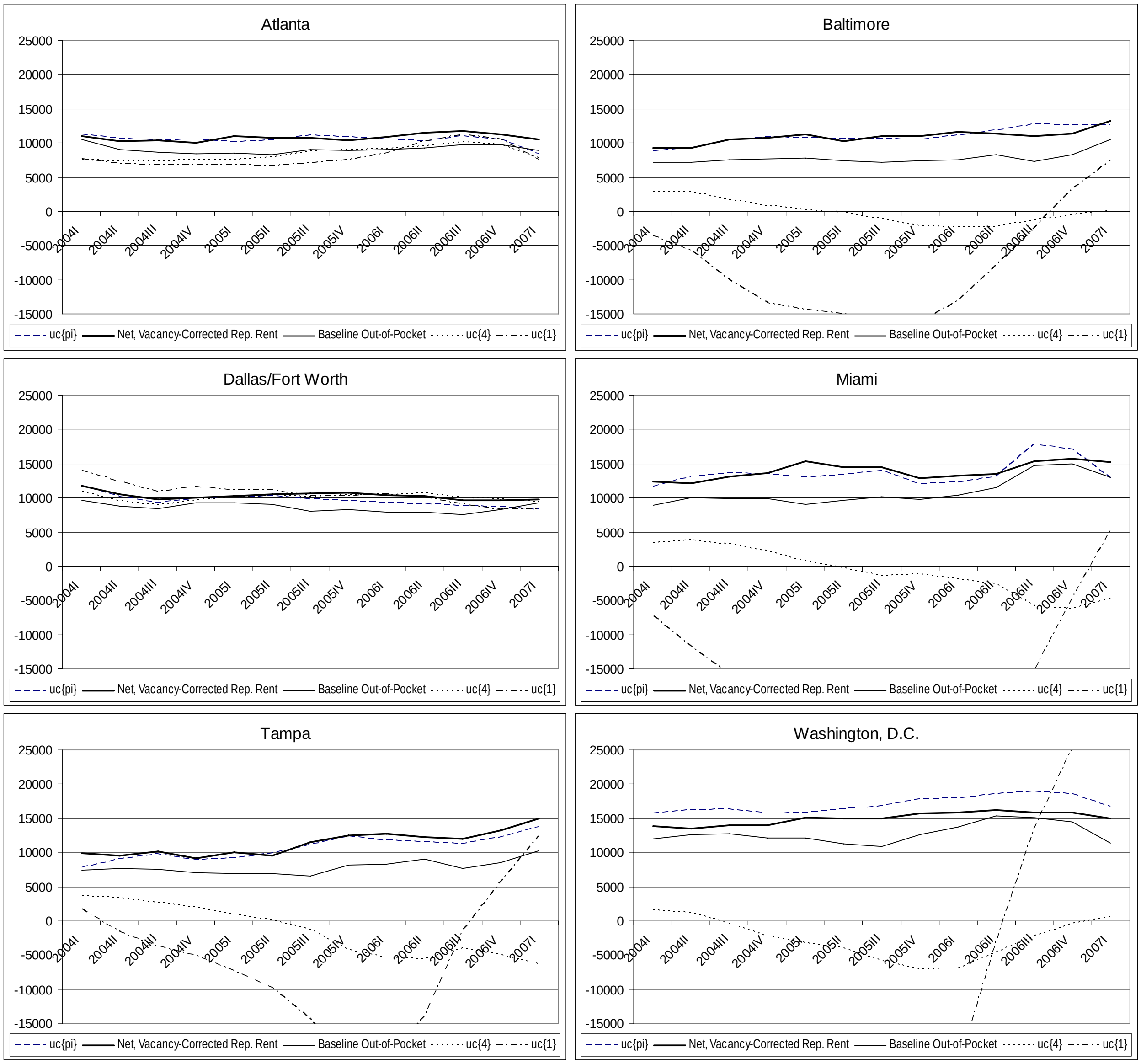

Fig. 8c. Alternative Shelter Cost Measures Over Time, Southern Metro Areas

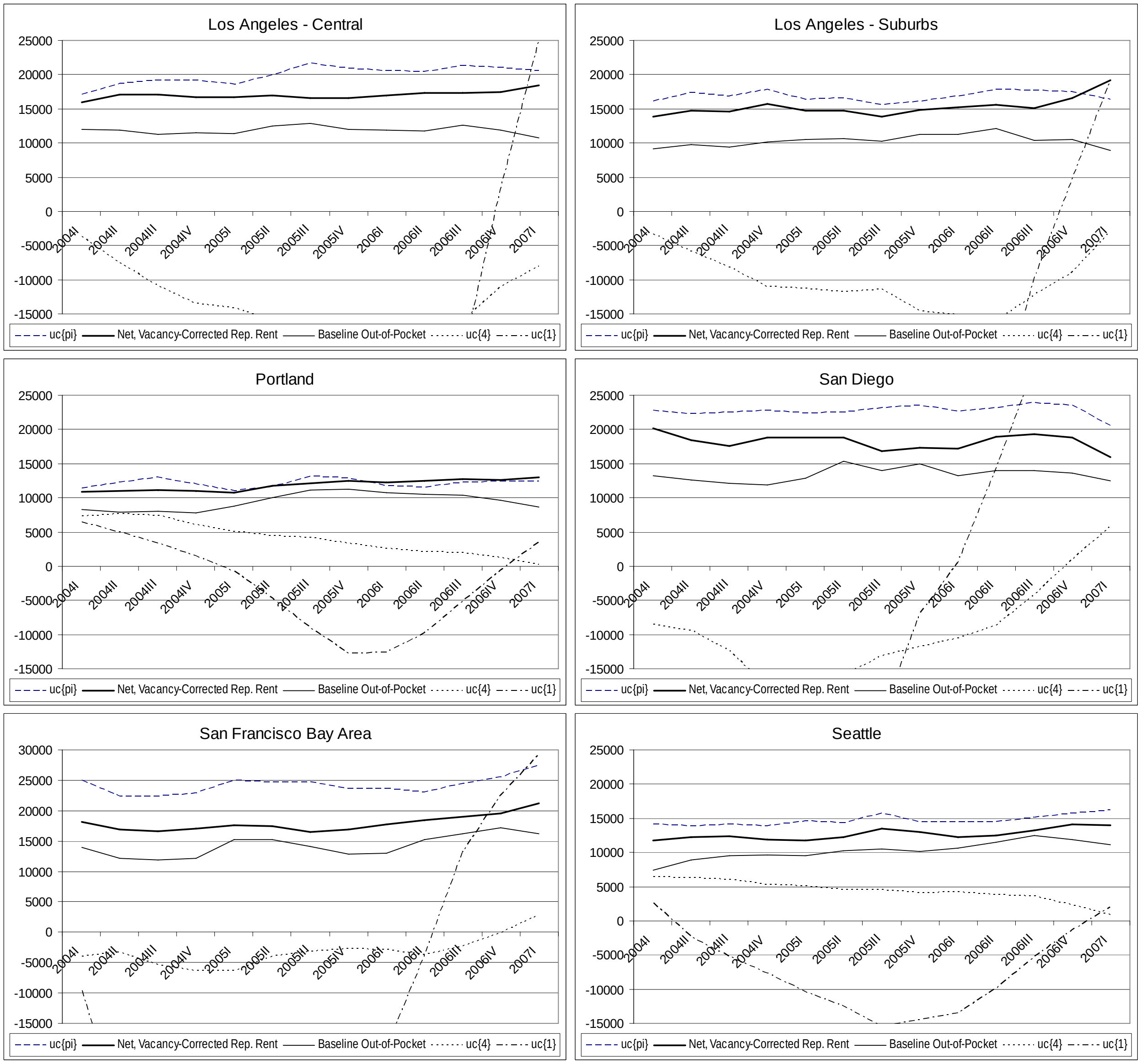

Fig. 8d. Alternative Shelter Cost Measures Over Time, West-Coast Metro Areas

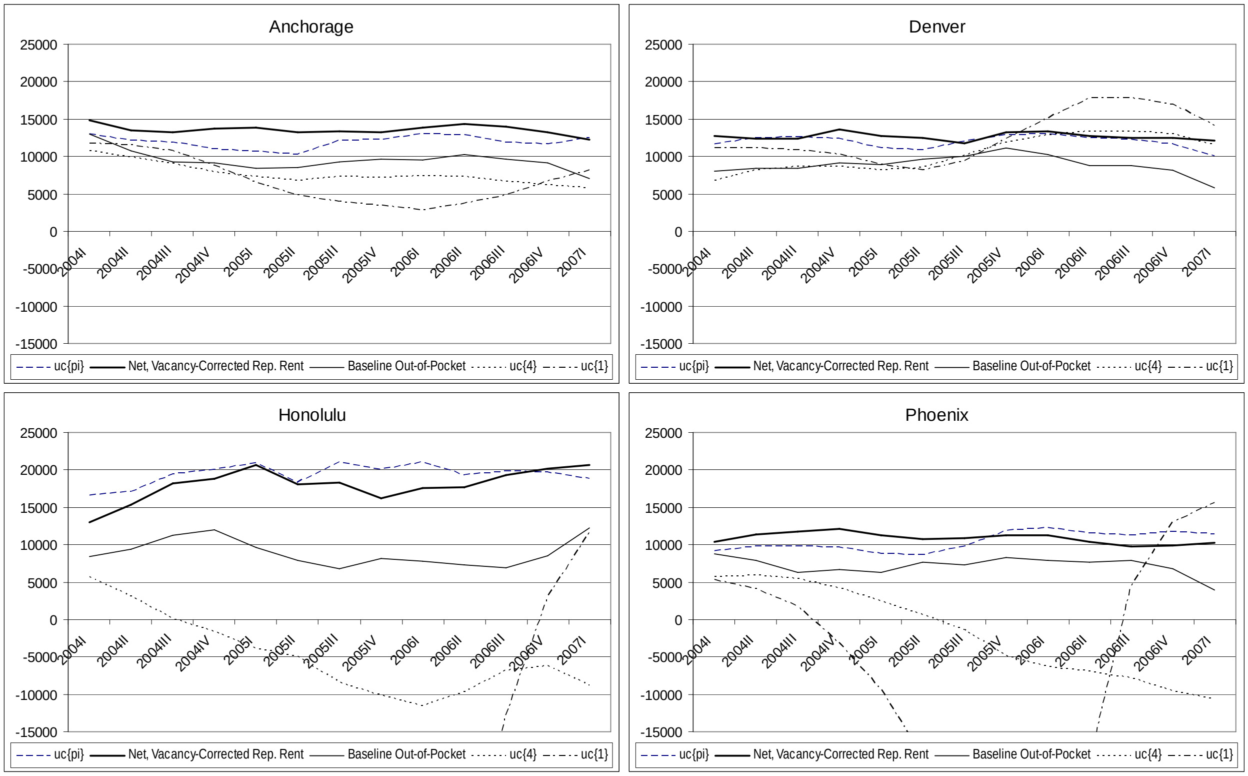

Fig. 8e. Alternative Shelter Cost Measures Over Time, Other Western Metro Areas

At the level of the metro area, more sampling variation is evident; however, the general conclusions regarding the cost measure dynamics remain unchanged, and an examination of the cross-metro variation yields interesting insights. Net rents generally adhere closely to *uc*{pi}, though there is a tendency for *uc*{pi} to lie above net rents in more expensive metro areas, perhaps reflecting smaller depreciation rates where land is a bigger proportion of value. In some metro regions – regions which did not experience large house price inflation – all the alternative measures of housing costs move together fairly closely. Out-of-pocket expenses lie distinctly below net rents; the remaining user cost measures, *uc*{4} and *uc*{1}, almost always lie below the other measures (and sometimes below zero) early in the period. Late in the period, collapsing house prices drove *uc*{1} far above net rents in several metro areas, which illustrates the extent to which expected appreciation drives user costs. The examples of Phoenix and San Diego are noteworthy. These markets experienced strong appreciation prior to the middle of the period, driving *uc*{1} *well* below 0, which reversed later on. Examination of the *uc*{4} measure across metro areas illustrates a key weakness in user costs with long-horizon forecasts: they will tend to respond sluggishly, even to sharp and obvious changes in house price dynamics. We suspect few market participants in early 2007 would have expected the low (or negative) user costs indicated by $uc\{4\}$ in some regions.

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 tax- and vacancy-corrected 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

Linear regression of tax- and vacancy-adjusted reported rents on user costs and cost measures[a]

Variable	*uc*{1}	*uc*{4}	*uc*{pi} I	*uc*{pi} II	Out-of-Pocket I[b]	Out-of-Pocket II	Out-of-Pocket III[c]	*uc*{0}[d] I	*uc*{0}[d] II
Constant	12,941 (174)	13,564 (185)	5,087 (42.6)	2,277 (10.9)	8,418 (63.3)	7,034 (34.7)	7,377 (63.9)	5,795 (44.5)	5,432 (42.2)
uc{1}	-0.05 (-17.4)								
uc{4}		-0.18 (-20.5)							
uc{pi}			0.55 (63.2)	0.94 (32.4)					
$uc\{\text{pi}\}^2$				-1.1E-5 (-13.1)					
Out-of-pocket expenses					0.46 (37.8)	0.71 (21.6)	0.24 (19.2)		
Out-of-pocket expenses^2						-8.6E-6 (-8.00)			
uc{0}								0.32 (27.6)	0.43 (22.5)
$P_tE\pi_{4,t}$ [e]							0.16 (38.5)	-0.01 (-0.69)	
$P_tE\pi_{pi,t}$ [f]									-0.26 (-6.16)
N	5671	5665	5643	5653	5654	5653	5656	5651	5651
Adjusted R^2	0.06	0.08	0.50	0.50	0.29	0.29	0.46	0.50	0.50

[a] Coefficient estimates are reported; associated *t*-statistics are reported underneath, in parentheses.
[b] Using a more inclusive measure of out-of-pocket expenses yields essentially identical results.
[c] Using $P_tE\pi_{pi,t}$ yields an even larger positive coefficient on expected dollar appreciation. Including home value as a control variable results in an economically and statistically insignificant coefficient estimate on $P_tE\pi$.
[d] This term refers to user costs computed as *uc*{pi}, but with $E\pi_t$ removed (i.e., set to 0).
[e] This term is expected appreciation in dollars, using the annualized 4-yr. forecast.
[f] This term is expected appreciation in dollars, using expected inflation (pi) as expected appreciation.

Regression analysis confirms the conclusions above: *uc*{pi} is much more closely related to rents than are *uc*{1} and *uc*{4}; indeed both of these latter measures are estimated to have an *inverse* relationship to rents, a vivid rejection of the theory. Model *uc*{pi} II, in particular, suggests a very close relationship between net rents and *uc*{pi} – a finding hinted at in Figure 5 –

although the fit of this model is nearly identical to that of the simpler linear model, Model *uc*{pi} I. Reported rents are not simply out-of-pocket expenses either;[26] net rents are much more closely related to *uc*{pi} than to out-of-pocket expenses.[27] Adding an expected appreciation term (Model Out-of-pocket III) improves the fit of the model, but the coefficient estimate has the wrong sign. Models *uc*{0} I and II are obtained by taking different versions of (1) and splitting these into two parts, the $P_t E_t p_t^h$ term, and everything else. Model *uc*{0} I results from starting with *uc*{4}, and undertaking this split; this improves the model fit dramatically. It also suggests that rents do not respond at all to expected appreciation, which is a puzzle, since even professional landlords receive the bulk of the benefits of appreciation. Conversely, splitting *uc*{pi} into two parts – i.e., moving from Model *uc*{pi} to Model *uc*{0} II – does not improve the fit, and reduces the size of the estimated coefficient(s), although these coefficients do have the expected sign.

We next investigate how reported rents are related to a wider variety of covariates. In these log-linear specifications, log(net rent) becomes the dependent variable, with levels of each variable as independent variables. We are most interested in the relationship of rents to the various components of user costs, including expected appreciation. The hypothesis that respondents merely report out-of-pocket expenses formally corresponds to the hypothesis that the estimated coefficients on these expenses are non-zero (and is consistent with a one-for-one transmission of costs into rents) *and* that the estimated coefficients on all other regressors are zero. Regression results are reported in Table 2.

[26] 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.

[27] A log-log specification yields coefficient estimates of 0.65 for *uc*{pi}, and 0.40 for out-of-pocket expenses.

Table 2
Log-linear regression: Linear regression of log (tax- and vacancy-adjusted reported rents) on shelter cost measures and other covariates

	Model 1: Out-of-Pocket		Model 2: Components of (1)	
Variable	Estimate	(t-stat.)	Estimate	(t-stat.)
Constant	8.896	(97.1)	8.867	(97.1)
Value[a]	0.153	(6.34)	0.211	(5.78)
Value^{2}[a]	-0.010	(-6.95)	-0.007	(-4.06)
User cost components				
Out-of-pocket expenses[b]	0.089	(7.92)		
(1-τ)(mortgage payments)[b,c]			0.102	(7.22)
(1-τ)(property tax payments)[b,c]			0.287	(5.90)
Home insurance residual[d]			0.608	(4.14)
Maintenance and repairs[b]			0.441	(1.72)
$P_t E \pi_{pi,t}$[a,e]	-0.147	(-0.20)	-0.489	(-0.65)
Other covariates				
Rooms	0.071	(4.90)	0.045	(2.94)
Rooms^2	-0.003	(-3.01)	-0.002	(-2.38)
Bathrooms[f]	0.413	(1.16)	0.153	(0.42)
Bathrooms^{2}[f]	0.024	(0.03)	-1.082	(-1.19)
Single detached	0.136	(5.81)	0.155	(6.55)
Mobile home	-0.329	(-6.84)	-0.318	(-6.63)
Age of dwelling[f]	-0.033	(-5.89)	-0.042	(-6.30)
Age of dwelling^{2}[f]	0.001	(3.48)	0.001	(3.10)
Central City	0.030	(1.59)	0.005	(0.28)
Block % renter in 2000	-0.125	(-0.92)	-0.148	(-1.09)
% renter^2	0.447	(2.42)	0.450	(2.45)
Block % poverty in 2000	-1.01	(-6.94)	-0.86	(-5.87)
CU Education medium[g]	0.006	(0.26)	0.008	(0.32)
CU Education high[h]	0.041	(1.65)	0.040	(1.61)
F-test *p*-value: PSUs	0.000		0.000	
F-test *p*-value: dates	0.565		0.040	
N	5793		5795	
Adjusted R^2	0.37		0.38	

[a] We divided *value* and expected appreciation by 100,000.
[b] We divided components of user costs by 10,000.
[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.
[d] As home insurance is typically a fixed percentage of value, we instead include the residual of a regression of home insurance on value.

[e] This term is expected dollar appreciation, using expected inflation (pi) as the appreciation forecast.
[f] We divided bathrooms and age of dwelling by 10.
[g] This variable equals 1 when the consumer unit reference person has education level between that of high school graduate and of bachelors degree.
[h] 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, and most important, we can easily reject the hypothesis that respondents merely report out-of-pocket expenses. Variables such as home value, number of rooms, structure type, and so on each have an impact on reported rent over and above their indirect impact on expenses. Of course, higher costs of ownership – in particular, interest rates, property taxes conditional on value, home insurance, and expected maintenance and repair costs, do translate into higher rents. However, the semi-elasticity with respect to out-of-pocket cost is modest. Clearly, homeowners are not simply reporting their out-of-pocket expenses. This low semi-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).

Second, as noted previously, the rent/value relationship is concave. Third, expected appreciation does not appear to exert a statistically-significant influence on net, vacancy-corrected reported rent, once time- and PSU-dummies and the separate components of user costs are included as regressors. This is not surprising: in these data, expected dollar appreciation is highly collinear with out-of-pocket expenses and time- and PSU-dummies. 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 the metro-region median might have a separate influence on rent, but this does not appear to be the case, and we eliminated this variable. Similarly, the national vacancy rate was not estimated to be statistically significant in an earlier specification of the model, and thus was eliminated as a covariate. This lack of statistical significance 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: percent of renters 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 the percentage of the population in poverty (with an increased percentage of those living in poverty reducing quality conditional on house price).

5. Conclusion

The comparison between alternative measures of housing services consumption is a topic of key interest in many fields of economics. In the standard frictionless theory, rents should equal ex ante user costs. But prior research, most notably Verbrugge (2008a) and Garner and Verbrugge (2009), highlighted the dramatic divergence between these measures. However, such prior research has mostly used aggregated (and dissimilar) index data; when micro data were used, these relied exclusively upon 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, compare rents and user costs at a point in time, and to control for unobservables like neighborhood quality.

There are three key findings. First, at the unit level, rents diverge significantly from user costs – at least as these costs are conventionally estimated using house price appreciation forecasts. Second, reported rents in the CE appear to be noisy but sensible; over this time period, they evolve similarly to OER, and the hypothesis that respondents simply report out-of-pocket expenses is rejected. Third, while noisy, reported rents are ‘‘well-explained” inasmuch as expected net rental earnings correspond closely to an ad hoc estimate of user costs, namely one which counterfactually imposes an assumption of no real capital gains in the short run.

These three findings jointly constitute an important but puzzling set of facts regarding the relationship between rents and user costs. The first finding, considered alone, could have been easily explained had not the other two findings been made. This first finding is consistent with those from, e.g., Cournède (2005) and Verbrugge (2008a), which point to marked divergence between market rents and user costs. Indeed, the evidence here suggests that the divergence is even more striking at the micro level: even with long-horizon forecasts, the dispersion of rents about the user cost estimate is large, user costs lie well below rents, and the estimated relationship is actually inverse. Since we find this divergence at the micro level, we have basically ruled out index construction errors as the cause of rent-user cost divergence – though there remain numerous other potential explanations related to deficiencies in the theories of rent determination, of user costs, and of house price dynamics (see Verbrugge 2008a for a more thorough discussion).[28]

The fact that the rent measures in CE data are respondent estimates rather than actual arms-length transaction prices would have seemed to offer an additional and promising explanation for the striking divergence of conventional user costs and rents that is present in these data. However, the second finding appears to rule this explanation out. Reported rents are not simply chosen at random, nor are they simply out-of-pocket expenses. Rather, they seem to be quite sensible, and move similarly to OER, suggesting that respondents (on average) have a reasonably good idea about what their homes would rent for. Still, without the third finding, the first finding could potentially have been explained using the standard explanations alluded to above.

The third finding is a conundrum. Current-generation user costs measures are constructed on the basis of frictionless Hall-Jorgenson theory. But there are significant frictions in real estate: pricing frictions, perhaps relating to asymmetric information; construction lags, associated with land acquisition, permits, and the construction process itself; information frictions, relating to search and to distinguishing permanent from transitory movements, and prompting delay; and, of

[28] Of course, an alternative argument is that perceived user costs were indeed very low, much lower than rents, and that such divergence is simply reflecting disequilibrium in the market, so one should not try to figure out a technique that manages to make estimated user costs equal to rents.

course, the sizable transactions costs associated with buying and selling properties.[29] Adding transactions costs renders user cost formulas more complicated and, indeed, there is uncertainty even about the form that user costs take in a more realistic framework (though Diaz and Luengo-Prado 2008 have made some progress; see also Luengo-Prado et al. 2008 and Sommer, Sullivan and Verbrugge 2009, who study the relationship between rents, user costs, and the shadow price of housing in a more realistic framework with transactions costs). We would certainly expect, though, that given the significant frictions associated with real estate, a formula premised upon a frictionless environment would be a decidedly weak foundation to start from. Hence one would have thought that making a second dubious assumption, one decidedly at odds with the data – i.e., zero expected real capital gains in the short run – would have made things much worse, rather than better. Adding to the puzzle is the fact that previous research has largely failed to find a tight linkage between rents and this ad hoc user cost measure; see, e.g., Blackley and Follain (1996). Even those studies which did find some evidence for a significant relationship nonetheless found it to be deficient along some dimensions; for example, Verbrugge (2008a) found that while this measure evolved more similarly to rents than did more conventional alternatives, nevertheless significant divergence remained;[30] and while Green and Malpezzi (2003) located a statistically significant relationship between rents and lagged user costs, the coefficient estimates were well below their theoretical magnitudes.

It will be quite important to determine whether these three findings carry over to other data sets, as few micro data sets contain information on value and rent simultaneously. Similarly, these findings motivate further research into rent determination, house price dynamics, and user costs. An important area for future research in particular is explaining why user costs constructed using the ad hoc proxy for expected appreciation – a proxy which is suspect theoretically, and poor predictor of actual appreciation in practice – appear to be so useful for explaining rents.

[29] Quigley (2002) lists many transactions costs associated with housing markets. Smith and Smith (2006) emphasize the weakness of the mechanisms which would correct inefficiency in the housing market. In a principal-agent framework, Bruce and Santore (2006) study optimal real estate commissions.
[30] This point was also made by Cournède (2005) and Eiglsperger (2006).

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Appendix Table 1. Analysis Based on Data from Homeowners Liviing in the Following Primary Sampling Units (PSUs)

Northeast Region	Midwest Region	South Region	West Region
psu1102 Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD CMSA NJ portion: Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Salem DE portion: New Castle MD portion: Cecil PA portion: Bucks, Chester, Delaware, Montgomery, Philadelphia	psu1207 Chicago-Gary-Kenosha, IL-IN-WI CMSA IL portion: Cook, DeKalb, DuPage, Grundy, Kane, Kankakee, Kendall, Lake, McHenry, Will IN portion: Lake, Porter WI portion: Kenosha	psu1312 Washington, DC-MD-VA-WV DC portion: District of Columbia MD portion: Calvert, Charles, Frederick, Montgomery, Prince George's, Washington VA portion: Arlington, Clarke, Culpeper, Fairfax, Fauquier, King George, Loudoun, Prince William, Spotsylvania, Stafford, Warren, Alexandria city, Fairfax city, Falls Church city, Fredericksburg city, Manassas city, Manassas Park city WV portion: Berkeley, Jefferson	psu1419 Los Angeles-Long Beach, CA PMSA Los Angeles
psu1103 Boston-Brockton-Nashua, MA-NH-ME-CT CMSA CT portion: Windham (part) MA portion: Bristol (part), Essex, Hampden (part), Middlesex, Norfolk, Plymouth, Suffolk, Worcester (part) ME portion: York (part) NH portion: Hillsborough (part), Merrimack (part), Rockingham (part), Strafford (part)	psu1208 Detroit-Ann Arbor-Flint, MI CMSA Genesee, Lapeer, Lenawee, Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, Wayne	psu1313 Baltimore, MD PMSA Anne Arundel, Baltimore, Carroll, Harford, Howard, Queen Anne's, Baltimore city	psu1420 Los Angeles Suburbs, CA Orange, Riverside, San Bernardino, Ventura
psu1104 Pittsburgh, PA MSA Allegheny, Beaver, Butler	psu1209 St. Louis, MO-IL MSA IL portion: Clinton, Jersey, Madison, Monroe, St. Clair MO portion: Franklin, Jefferson, Lincoln, St. Charles, St. Louis, Warren, St. Louis city	psu1316 Dallas-Fort Worth, TX CMSA Collin, Dallas, Denton, Ellis, Henderson, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant	psu1422 San Francisco-Oakland-San Jose, CA CMSA Alameda, Contra Costa, Marin, Napa, Santa Clara, Santa Cruz, San Francisco, San Mateo, Solano, Sonoma
psu1109 New York City Bronx, Kings, New York Queens, Richmond	psu1210 Cleveland-Akron, OH CMSA Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, Summit	psu1318 Houston-Galveston-Brazoria, TX CMSA Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller	psu1423 Seattle-Tacoma-Bremerton, WA CMSA Island, King, Kitsap, Pierce, Snohomish, Thurston
psu1110 New York-Connecticut Suburbs NY portion: Dutchess, Nassau, Orange, Putnam, Rockland, Suffolk, Westchester CT portion: Fairfield, Litchfield (part), Middlesex (part), New Haven (part)	psu1211 Minneapolis-St. Paul, MN-WI MSA MN portion: Anoka, Carver, Chisago, Dakota, Hennepin, Isanti, Ramsey, Scott, Sherburne, Washington, Wright WI portion: Pierce, St. Croix	psu1319 Atlanta, GA MSA Barrow, Bartow, Carroll, Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Henry, Newton, Paulding, Pickens, Rockdale, Spalding, Walton	psu1424 San Diego, CA MSA San Diego
			psu1425 Portland-Salem, OR-WA CMSA OR portion: Clackamas, Columbia, Marion, Multnomah, Polk, Washington, Yamhill WA portion: Clark
			psu1426 Honolulu, HI MSA Honolulu
			psu1427 Anchorage, AK MSA Anchorage
			psu1429 Phoenix-Mesa, AZ MSA Maricopa, Pinal
			psu1433 Denver-Boulder-Greeley, CO CMSA Adams, Arapahoe, Boulder, Denver, Douglas, Jefferson, Weld

Appendix Table 1. Analysis Based on Data from Homeowners Liviing in the Following Primary Sampling Units (PSUs) *(continued)*

Northeast Region		Midwest Region	South Region		West Region
psu1111	New Jersey-Pennsylvania Suburbs NJ portion: Bergen, Essex, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Somerset, Sussex, Union, Warren PA portion: Pike		psu1320	Miami-Fort Lauderdale, FL CMSA Broward, Dade	
			psu1321	Tampa-St. Petersburg-Clearwater, FL MSA Hernando, Hillsborough, Pasco, Pinellas	

Reference: BLS Handbook of Methods, Chapter 17. Consumer Price Index (Updated 06/2007), Appendix 5. Sample areas, population weights, and pricing cycles.
Available at: http://stats.bls.gov/opub/hom/pdf/homch17.pdf

Appendix Table 2. Sample Sizes of Homeowners by Primary Sampling Unit (PSU)

PSU Number	Abbreviated PSU Area Description	Number of Observations
psu1102	Philadelphia	368
psu1103	Boston	271
psu1104	Pittsburgh PA	199
psu1109	New York City	93
psu1110	New York-Connecticut suburbs	329
psu1111	New Jersey Suburbs, NJ	249
psu1207	Chicago	411
psu1208	Detroit	271
psu1209	St. Louis MO-IL	180
psu1210	Cleveland	177
psu1211	Minneapolis	185
psu1312	Washington, DC	264
psu1313	Baltimore	163
psu1316	Dallas	234
psu1318	Houston	197
psu1319	Atlanta	239
psu1320	Miami	133
psu1321	Tampa-St. Petersburg-Clearwate	113
psu1419	Los Angeles	295
psu1420	Los Angeles suburbs	188
psu1422	San Francisco	212
psu1423	Seattle	181
psu1424	San Diego	106
psu1425	Portland, OR	163
psu1426	Honolulu HI	92
psu1427	Anchorage AK	166
psu1429	Phoenix AZ	163
psu1433	Denver CO	160
TOTAL		5802

Source: Authors' own calculations based on the U.S. Consumer Expenditure Interview Survey Data 2004 quarter one through 2007 quarter 1.