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Abstract

Providing for shelter represents a large portion of the typical household budget. Accordingly, rent, paid either to a landlord or to oneself as an owner-occupant, has a large weight in the CPI and in the personal consumption expenditures deflator, resulting in substantial scrutiny of how tenant rent and owners' equivalent rent are measured in these price indexes. In this paper, we describe how the Bureau of Labor Statistics (BLS) estimates tenant rent and owners' equivalent rent. We then estimate alternative inflation rates for tenant rent and owners' equivalent rent based on American Housing Survey data, following BLS methodology as closely as possible. Our alternative tenant rent inflation series is generally consistent with the corresponding BLS series. However, our alternative owners' equivalent rent inflation series is consistently lower than the corresponding BLS series by an amount large enough to have a significant effect on the overall inflation rate. This result is driven by the inverse relationship between rent inflation and the level of monthly housing cost evident in the American Housing Survey data.

Key words: CPI, housing markets, rental prices, American Housing Survey

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Introduction

The single largest item in most household budgets is payment for shelter. Accordingly, "shelter" or "housing" has a large weight in the Consumer Price Index (CPI) and the Personal Consumption Expenditures (PCE) deflator, the two major indices of consumer prices for the U.S. (Table 1). Within this category, the largest component is the space rent of nonfarm owner-occupied homes (PCE deflator) or owners' equivalent rent (CPI), reflecting the fact that most households own the home in which they live.[1] This component represents the rent that homeowners implicitly pay to themselves to live in their home or, alternatively, the amount they could obtain by renting their home to someone else. The second largest component within shelter is the space rent of nonfarm tenant-occupied housing (PCE deflator) or rent of primary residence (CPI). This component represents the rent that tenants pay to landlords.[2] (Hereafter rent of primary residence will be referred to as "tenant rent.") Chart 1 presents year-over-year percent changes of the owners' equivalent rent (OER) and tenant rent indices from the CPI from 1992 to the present along with the year-over-year change of the CPI excluding food and energy (core CPI). It is apparent that, due to their large weights or relative importance, OER and tenant rent inflation rates exert considerable influence on measures of overall and core inflation.[3]

Tenant rent is a straight-forward and relatively easily measured concept. That is not the case for OER, however. OER is an opportunity cost that is not directly observed, and reasonable people have disagreed over the best way to measure it or even if it should be included in a cost of living measure (see Box 1 for a discussion of this latter issue). When combined with its large relative importance, it is not surprising that OER is often criticized. For example, there have been periods when home prices and housing turnover have risen rapidly while OER inflation slowed, most prominently during 2003-05—a situation which some commentators have regarded as implausible (Chart 2).[4] Conversely, there have been periods when home prices and housing market activity have slowed while OER inflation increased, as in the 2007-07 period. In fact, the contemporaneous correlation between both tenant rent and OER

inflation and the rate of change of home prices or home sales is not statistically different from zero, and economic theory does not suggest that there necessarily should be a correlation.

Given the importance of rent inflation in US inflation measures as well as the frequent misunderstanding of what these measures represent and how they are estimated, a careful examination and explanation is likely to prove useful. This paper addresses that need in two ways. First, we provide an accessible overview of the concepts and measurement of rent inflation. Second, we build on this verbal explanation by deriving alternative estimates of OER and tenant rent inflation using a source of data different from that used in the estimation of CPI.

The paper is organized as follows. We begin by describing how tenant rent and OER inflation are estimated by the Bureau of Labor Statistics (BLS). In the following section, we derive our alternative estimates of tenant rent and OER inflation using data from the American Housing Survey (AHS), following the CPI methodology as closely as possible. We find that our AHS-based measure of tenant rent inflation is quite close to the BLS measure both in terms of levels and movements over time. In contrast, our AHS-based estimate of OER inflation is systematically lower than the BLS measure by an amount large enough to have a meaningful impact on the overall inflation rate. We then discuss possible reasons for the divergence between these two measures of OER inflation, highlighting the effect of increased supply of higher-end housing units over the past two decades. The last section provides some conclusions.

Estimation of OER and Tenant Rent Inflation in the CPI

We begin by providing a brief description of the current methods used by the Bureau of Labor Statistics (BLS) to estimate the price indexes for tenant rent and OER which are used in both the CPI and the PCE deflator (Box 2 provides a brief history of the various methods that have been used to estimate the OER price index).[5] Ultimately, both price indices are derived as weighted average changes of the rents of a single sample of rental housing units. Note that in

both cases the BLS's goal is to produce a measure of the price of the flow of housing services provided by a constant-quality unit of housing.

The underlying data for these price indices are obtained from the CPI Housing Survey, which is drawn from the Census of Population and Housing. The CPI Housing Survey is a longitudinal survey; a renter-occupied housing unit in the sample is surveyed on a regular basis until it is removed from the sample because it is no longer a rental unit. The current sample, introduced in 1999 and drawn from the 1990 Decennial Census, was designed to produce about 50,000 renter-occupied housing units distributed across the eighty-seven primary sampling units (PSUs) covered by the CPI. This sample is augmented each year with a sample of newly constructed units.

Each PSU is divided into segments which are the fundamental units for sampling and weighting. Segments are groupings of Census blocks designed to be geographically contiguous and to include a minimum number of housing units, as determined by the 1990 Decennial Census. On average, a segment contains about 150 housing units. Each segment is assigned an aggregate housing expenditure, defined as the sum of all tenant monthly rents and all owner implicit rents, again based on the 1990 Census.

At that point each PSU is divided into three strata, each of which represents one third of the total housing expenditures of the PSU. Each of these three strata is then divided into two in a manner so as to maximize the difference in the average rent level between the two halves. Then a representative sample of segments is drawn from each of the six strata, with a segment's selection probability proportional to the aggregate housing expenditures within that segment. Finally, a sample of rental units is drawn from each selected segment. Each segment is assigned to one of six panels, with each panel corresponding to two months during the year in which the sampled rental units in the segment are priced. Each panel includes segments from all six strata and so is a representative sample of the PSU.

Once a housing unit has been selected into the sample, the BLS obtains the information used in measuring rent inflation. Two measures of rent are derived for each unit, one used in the estimation of tenant rent and one used in the estimation of OER. For tenant rent, the concept is called "economic rent," which includes the contract rent, or the cash rent that the tenant pays the landlord, plus any government subsidies received by the landlord on the tenant's behalf and the value of in-kind services provided by the tenant in lieu of cash rent payments. For OER, the concept is called "pure rent," which is defined as economic rent less the value of any utilities included in contract rent.[6]

As we noted previously, the goal of the BLS's methodology is to produce price indices of constant-quality shelter services. To do this account must be taken of any change in the quality of shelter services provided by a rental unit. For example, the quality of housing services may deteriorate over time as the rental unit ages. Conversely, the quality of housing services could improve; for example, if air conditioning is provided when in the past it had not been. To account for such changes in quality, BLS collects information on the physical characteristics of the property and neighborhood in which it is located in addition to the information on rent discussed in the previous paragraph.[7] The BLS then runs a hedonic regression of the rent level of sampled housing units on their physical and locational characteristics (including age). The regression coefficients are interpreted to represent the marginal effect of each variable on the rent level. The regression results are then used to adjust rent levels for those units where the physical and locational characteristics have changed from the base period. These results also are used to determine the "age-bias adjustment," which reflects the effect of aging on the quality of the flow of housing services.[8]

Aggregate price changes for tenant rent and OER are then estimated as the weighted average change of economic rent and pure rent, respectively, across the entire sample of rental units. The weighting scheme is complex. Because each sampled rental unit is drawn from the universe of housing units in a segment while the segment is drawn from the universe of

segments in the PSU, two weights are multiplied together to make the sampled housing units representative of the entire PSU. The first of those, the segment weight, is the inverse of the ratio of the aggregate housing expenditures of the segment to the aggregate housing expenditures of the PSU. The second weight is the ratio of the total number of housing units in the segment to the number of sampled housing units in the segment. The product of those two weights is then modified to create specific weights for tenant rent and for OER. The tenant rent weight is created by multiplying that product by the ratio of aggregate renters' housing expenditures in the segment to total housing expenditures for the segment. The OER weight is created by multiplying that product by the ratio of aggregate owners' housing expenditures in the segment over total housing expenditures for the segment.

We provide a hypothetical example of this methodology for estimating tenant rent and OER inflation from a single sample of rental units in Box 3. The box also discusses circumstances in which the estimated price changes may differ from the true ones. In this regard, it is important to note that because tenant rent is observed while owner's equivalent rent is not, errors are more likely to occur with OER than with tenant rent.

Data and Methodology Used for Alternative Measure of Rent Inflation

To understand more about changes in rent levels, we derive alternative estimates of tenant rent and OER inflation following BLS methodology as closely as possible. In doing so, we use a readily available source of housing data—the American Housing Survey (AHS). The AHS, conducted by the U.S. Department of Housing and Urban Development in odd-numbered years, is a sample of about 50,000 units weighted to represent the U.S. housing stock. The AHS is a good source of information about trends in the housing market and rent inflation because it collects information about units' physical characteristics, location characteristics, housing costs, values for owner-occupied homes, and other useful information. To calculate alternative rent

inflation series, we use the national samples of the American Housing Survey for the years from 1989 through 2007.

Estimating Tenant Rent Inflation

To calculate our alternative series on tenant rent inflation, we use the AHS monthly housing cost variable for renters, which includes utilities for those units where contract rent excludes utilities. We do this because of the difficulty in measuring utility costs for those units that have utilities included in the rent.[9] We use these data to construct two time series of tenant rent inflation. The first series, which we call AHS raw data, is based on the change in rent of the same units over two-year intervals. We thus end up with nine panels of units—1989-91, 1991-93, 1993-95, 1995-97, 1997-99, 1999-2001, 2001-2003, 2003-2005, and 2005-2007. For each panel, we compute a weighted-average rent change using the AHS weights and the level of housing costs for each unit from the first period of the panel to compute housing expenditure weights. Recall that BLS now aggregates rent changes using expenditure weights rather than unit weights.

While relatively straight-forward, the approach outlined above does not address the possibility that the quality of rental units may have changed over the two years, which might have an effect on the measured change in rent. Thus, we developed a second method to address possible changes in quality. This second AHS tenant rent inflation series is based on a pooled time series, cross section regression of the change in rent. The explanatory variables and the results of the regression are shown in Table 2. After substantial experimentation, we found that the log level of housing cost and geographic location were the primary determinants of the change in rent, consistent with BLS's findings. The sign of the coefficient on the log of housing cost variable term is negative, indicating that the change in rent declines as the level of housing cost increases.[10] This is a key result that will be discussed in greater detail later in the paper. Note also that our experimentation with this regression led us to conclude that 5 percent

trimming of each of the tails of the rent change distribution to mitigate the influence of measurement-error-induced outliers.

Because the AHS-based tenant rent inflation series include utilities, to allow comparison with CPI measures, we construct a CPI series that includes utilities for all units. Our method of doing this is presented in Table 3. Columns 1 and 2 present the annualized percent changes of tenant rent and utilities from the CPI for the relevant two-year intervals. Columns 3 and 4 present the share of utilities in total housing costs for all rental units (based on AHS data) and the average share over the interval. Columns 5 and 6 present the percentage of rental units whose utilities are not included in rent (also based on AHS data) and the average of this percentage for the two-year intervals. Finally, column 7 presents the weighted average percent change of rent and utilities, calculated using the formula displayed at the bottom of the table.

Chart 3 presents our two AHS-based tenant rent inflation series and compares them with that of the CPI. Table 4 summarizes this information. In general, the AHS raw data series is reasonably close to the CPI series: on average, the CPI series is only 0.17 percentage points higher. Of course, there are some relatively large discrepancies in some periods, but they do not appear to be systematic. Moreover, the AHS raw data series follows the same general pattern as the CPI series over these years.[11]

The average discrepancy of the AHS pooled regression series is larger at 0.75 percentage points, however, the discrepancies do not appear to be systematic. On average, the tenant rent inflation rate based on the pooled regression series is below that of the raw data series, as would be expected. The relatively small differences between the raw data and pooled regression series indicate that using the fitted values from the regression in Table 2 is a procedure that leads to "reasonable" estimates of rent inflation. This observation is important because, as will be seen in the next subsection, this regression is a major input into the calculation of our alternative series for OER inflation.

For both series the largest discrepancy occurs in the 2001-2003 panel. This period is one where the housing market was facing notable contrasting developments: rent and OER inflation was slowing considerably (Chart 1) while housing turnover was rising as part of the early-2000s housing boom (Chart 2). We return later to a discussion of the influence of these developments on our alternative rent inflation measures when we discuss factors affecting our alternative measure of OER inflation.

Estimating OER Inflation

To estimate OER inflation using the AHS data, we assume that the change in implicit rent of an owner-occupied unit is equal to the observed change in the rent of a rental unit with the same level of monthly housing cost and similar locational characteristics. The first and most crucial step in this process is to assign a value of initial monthly housing cost to each owner-occupied unit in our panels. Although the AHS calculates a monthly housing cost variable for owner-occupied units, it is not conceptually comparable to the monthly housing cost of renters that we used in the previous section. To calculate our owner-occupied housing cost variable, we use the economic intuition that rents ultimately are determined by the user cost of capital of the owner of the property (see, for example, Poterba 1984), and thus construct an estimate of the level of owners' housing costs based on the level of the user cost of capital for owner-occupied housing.[12] [13] The calculated user cost can be represented as:

$$c_t^o = \frac{1}{12}\left[(1-\tau_t^i)[r_t^m p_t^h + \tau_t^p] + m_t + d_t - E_t(\Delta p_{t+1}^h)\right]$$

In this equation, p_{t+1}^h is the estimated value of the property reported in the AHS, and r_t^m is the prevailing yield on mortgage-backed securities; the product of the two is the opportunity cost of capital invested. The variable τ_t^p is real estate taxes as reported in the AHS, and τ_t^i is the marginal federal income tax rate likely faced by the owner of the housing unit.[14] To this we add utilities, insurance, and maintenance costs as reported in the AHS (m_t) plus

depreciation assumed to equal 0.75 percent of the value of the property (d_t). Finally, $E_t(\Delta p^h_{t+1})$ is the expected annual change in property value, estimated as one-half the change in the owner's estimate of the value of the property over the two years of the panel. This annual housing cost then is divided by 12 to convert it to a monthly cost.

Using the estimated housing cost from the first year of the panel along with the other characteristic variables of the unit, we assign changes in rent to owner-occupied units based on the regression presented in Table 2. We then compute an aggregate percent change in implicit rent for owner-occupied units using housing expenditure weights, as discussed above. Finally, since our AHS tenant rents include utilities, we construct a comparable CPI series by taking a weighted (using homeowners shares from the AHS) average of the CPI estimate of the change in OER and the change in utilities in a manner similar to Table 3.

The results of these calculations are shown in Chart 4 and summarized in Table 4. In general, our AHS-based estimates of OER inflation are consistently lower than the CPI estimates, with the average difference being a full 2.7 percentage points. The difference is especially large for the 2001-03 panel: CPI OER inflation was 3 percent while our AHS estimate indicates *deflation* of 2.6 percent.

Why is the AHS-based estimate of OER inflation so low?

Our AHS-based estimate of OER inflation is consistently lower than the CPI estimate by an average amount that seems relatively large. What is driving this result? One answer to this question is rather mechanical. As mentioned above, our analysis of the AHS data consistently reveals that the rate of change of rents is inversely related to the level of monthly housing cost. This fact is shown quite clearly in Table 5 which presents the annualized percentage change in rent for rental units in our various panels broken into quintiles based on the level of monthly housing cost in the first year of the panel; also shown are the changes in rents

for the top 10 percent and the top 5 percent of rental units. Note that for most panels rent increases are highest in the lowest quintile and lowest in the highest quintile, and in some cases—namely, 1995-1997, 2001-2003, and 2005-2007—rents in the highest quintile declined. Referring back to Table 2, this inverse relationship is very statistically significant.

Next, Chart 5 presents distributions of renter-occupied units (top panel) and owner-occupied units (lower panel) by the level of monthly housing cost from the 2007 AHS.[15] Note that the distribution of housing costs for owner-occupied units is skewed well toward the right relative to the distribution for renter-occupied units. For example, the expenditure-weighted median monthly housing cost of the owner distribution in 2007 was $1,599, 76 percent above that of the renter distribution. The BLS estimate of OER inflation is based on a re-weighting of the renter distribution while our AHS-based estimate is based on the owner distribution.

But why are rent increases consistently inversely related to the level of monthly housing costs? Trends in real income growth, shown in Table 6, would suggest just the opposite. The rate of real income gains over 1989 to 2007 have been strongly positively correlated with the level of income, which suggests stronger increases in demand from higher-income households (presumably for higher-rent units).

Given this behavior of an important demand factor, examining the supply side of the housing market probably is key in shedding some light on this puzzle. Table 7 presents compound annual growth rates of the US housing stock from 1989 to 2007 by type of structure and occupancy status. The total housing stock grew about 1.2 percent per year with vacant units rising considerably faster than occupied units. By type of structure, single-family units accounted for the bulk of the growth, and there were quite large increases in vacant single-family units. By tenure, owner-occupied units increased at a faster rate than the total stock while renter-occupied units showed minimal growth, a difference even more striking for single-family units. These patterns are consistent with other well-known trends over the period—an

increase in the homeownership rate and an increase in rental vacancy rates, particularly for single-family units.

Digging somewhat deeper, Table 8 investigates the dynamics of the occupied housing stock over the period from 1989 to 2007. In this analysis, we divide the 1989 stock of occupied housing units into quintiles based on the reported household income associated with the unit (quintile 1 is the lowest income quintile while 5 is the highest). We then bring forward to 2007 the boundaries of these quintiles, using the personal consumption expenditures (PCE) deflator to inflate the incomes so that real incomes associated with the boundaries of the quintiles remain the same. Looking at how this distribution evolved over the 1989-2007 period, we observe that the number of households in the lowest two and highest two income groups increased while the number in the middle quintile declined, consistent with what is known about the evolution of the income distribution over this period.

We next look at the sources of the change between 1989 and 2007 in the number of homes in each income quintile. The sources include net filtering (movement of homes between income groups), new construction, and a residual, which we interpret as the net of conversions from nonresidential to residential use and losses. The AHS data indicate substantial net filtering of housing units, with units from middle-income groups moving toward the lowest and highest quintiles. Even though net filtering has increased the number of units in both the lowest and highest quintiles, it comprises a larger share of the increase in housing units for the lowest two quintiles than for the highest quintiles. In contrast, new construction comprises the vast majority of the increase of housing units in the highest quintile.

Concentrating on the rental market, new rental units were increasingly concentrated toward the higher end of the market as the housing boom progressed. In Chart 6, the upper panel shows the distribution of housing costs of all rental-occupied units in 2007 from the AHS, a repeat of some of the information presented in Chart 5. The lower panel displays the rent distribution of new apartments in 2007 from Census Bureau data. The distribution of new

apartment rents is more heavily weighted toward higher rents than is the distribution of housing costs of all renter-occupied units; in particular, the median for new apartments ($1,034) is well above the median for all rental units ($722). This indicates that recent increases in rental supply have been concentrated in the upper end of the market.

In summary, this information on the housing stock provides a clear picture that new housing supply has been largely geared toward the upper half of the income distribution whereas downward filtering has been a more important source of supply for the bottom half of the income distribution. These findings showing an increase in supply at the upper end of the housing market thus provide a plausible explanation for our finding in Table 2 that rent increases have been inversely related to the rent levels over the 1989-2007 period as well as for the lower OER inflation levels in our alternative AHS calculations.

Conclusion

In this paper we have discussed the concept of OER as well as describe in some detail the procedures BLS uses to estimate tenant rent and OER inflation. In addition, we estimated alternative tenant rent and OER inflation rates based on AHS data, following BLS methodology as closely as possible. For tenant rent inflation our two alternative inflation series were quite close to the official BLS series. However, for OER our alternative series was consistently lower and by an amount which, if accurate, would significantly lower the overall rate of inflation as measured by both the CPI and PCE deflator. Our explanation for this result is that rent increases were inversely related to rent levels over the 1989-2007 period, and the BLS methodology of measuring OER inflation from a sample of rental units could miss a significant portion of the upper end of the distribution of owner-occupied housing units. At this point, our results are only suggestive; for example, it is not clear how the developments in the housing market over the past two years may affect the relationships between rent levels and rent inflation and thus on our alternative measures of rent and OER inflation. Consequently, additional research into this issue is warranted.

Box 1. Should OER be included in consumer price indices?

The rise in OER inflation in 2006 accounted for a significant portion of the overall rise in core consumer inflation measures during the year. This increase in OER inflation corresponded to a marked cooling in home sales and construction and a pronounced slowing of the rate of increase of home prices. As was the case when OER inflation was slowing as the housing market was booming, these divergent trends led some commentators to argue that the increase in OER inflation was an anomaly that should be ignored, particularly for monetary policy purposes. The logic of this argument is that by raising interest rates and therefore the cost of buying a home, the tightening of monetary policy actually induced the increase in OER by simultaneously slowing the rate of growth of the housing stock and shifting demand away from owner-occupancy and toward renting. Some critics went so far as to argue that OER should not be included in U.S. consumer price measures. Others proposed OER should be replaced with a measure of home prices; in effect, returning to the pre-1983 measurement of homeownership costs in the CPI.[1]

In fact, the official consumer price indexes for some countries, including the United Kingdom and the Euro area, exclude the rental services provided by owner–occupied residences, although the reason differs from that of the commentators described above. In the view of these countries, the ownership arrangement creates a significant economic difference (compared to the tenant-landlord arrangement) because increases in homeowners' implicit rent simultaneously increases homeowners' implicit income from their home by the same amount. Consequently, increases in implicit rents do not affect the living standard of such households, and thus can be excluded from cost-of-living indices.

[1] Indeed, a few countries, including Australia, Finland, and New Zealand, use the net acquisition approach in which changes in the price of housing services for homeowners are measured by the change in the price of new homes (excluding land prices) as well as changes in the price of related transactions prices.

Clearly, U.S. statistical agencies disagree with their European counterparts in that OER is included in both the CPI and the PCE deflator and, as discussed earlier, has a large relative importance in each. While we cannot speak for those agencies, the logic of their position is quite sound in our opinion. That logic is to divorce the ownership of the asset, and therefore the income derived from it, from the price of the service provided by that asset. For example, if consumer preferences shift toward apples and drive up the price of apples, the incomes of owners of orchards and the value of those orchards both are likely to increase. However, the fact that owners of apple orchards are better off financially does not negate the fact that the price of apples has increased. All else equal, this change increases the cost of the typical consumer's market basket of goods and services and so increases the cost of living.

Distinguishing between the asset and the price of the service provided by that asset also drives the logic of how OER should be measured. Home prices reflect the discounted presented value of the expected future net rental income from the property. As such, they are strongly influenced by expectations of future rent levels as well as current interest rates. Indeed, the factors that drive the investment decision of whether to buy a home and how much to pay for it can have relatively little to do with how much rents have increased over the past year. That is exactly the reason the pre-1983 approach of including home prices and mortgage interest rates in the CPI as a measure of homeowners' costs was dropped following severe and appropriate criticism from the academic and policy-making communities.[2]

Finally, it is not an anomaly or a distortion for rents to rise in response to an increase in interest rates and resulting slowing in home sales and home price appreciation. All else equal, the increase in interest rates raises the income needed to qualify for a mortgage to purchase a home. Thus, demand likely shifts from the ownership market to the rental market, inducing an increase in rents. Ultimately that increase in rents is likely to subside as existing housing units

[2] See, for example, the discussion in Gillingham (1983).

are shifted from the ownership market to the rental market and the pace of construction of new rental units increases. However, that could take some time. Thus, changes in OER inflation should not be discounted any more than changes in the inflation rate for apples. An increase in apple prices is likely to result in expanded supply at some time in the future as well.

Box 2: The History of OER Measurement Methodology

Conceptually, it is generally agreed that owners' equivalent rent (OER) is the amount a homeowner would pay to rent, or would earn from renting, his or her home in a competitive market. However, since OER is not observed, its measurement is not at all straight forward. Reflecting this difficulty, the methods used to estimate OER have changed several times over the years.

From the early 1950's through 1983, the BLS used an "asset price" approach that measured the cost of buying a home and so involved tracking home prices and financing costs. However, in the late 1970s and early 1980s, when home prices and mortgage interest rates were rising rapidly, the asset price approach came under severe criticism. It became clear under those circumstances that this approach overstated inflation of housing services because it could not separate the investment aspect of homeownership, which is beyond the scope of a cost of living index, from the current consumption of housing services. Ironically, as discussed in Box 1, some analysts have advocated a return to the asset price approach.

In response, the BLS adopted the "rental equivalence" approach in 1983. This approach imputes to owner-occupied units the same rate of change of rent as that observed for comparable rental units.[16] The implementation of the rental equivalence approach has changed over time. From 1983 through 1986, the change in OER was calculated using the sample of rental housing units used to estimate tenant rent. In the calculation, rental units in areas with a high proportion of owner-occupied units were given more weight in the OER index than in the tenant rent index. From 1987 through 1998, the BLS turned to a split-sample approach. This involved expanding the CPI housing sample to include owner-occupied units as well as rental units and linked each sampled owner unit with two or more rental units with similar locational and physical characteristics. It then estimated the change in OER for the owner unit using the change in the rents of the matched rental units.[17]

The split-sample approach was expensive. It required a sample of owner units, plus rental units with characteristics similar to those of owner units had to be oversampled to provide sufficient matches to owner units. More importantly, BLS research indicated that this method did not improve the estimates of rent inflation.[18] So, beginning with the publication of the January 1999 CPI, the BLS returned to estimating the change in OER based on a reweighted sample of rental units. Moreover, the BLS made a number of technical changes intended to reduce or eliminate many of the then-known biases in measuring shelter prices (Moulton 1997).

These changes in methodology coincide with some of the changes in the relative behavior of these two inflation rates (Chart 1). Generally, OER inflation was somewhat less than tenant rent inflation in the two periods (1983-86 and 1999-present) when OER inflation has been measured using a re-weighted sample. In contrast, OER inflation generally was above tenant rent inflation during most of the matched-sample period (1987-98).[19] But while we note these relationships, we have no basis for concluding that they are the result of the changes in methodology.

Box 3. Current methodology of measuring tenant rent and OER inflation

This box provides more detail as well as a hypothetical example of the methodology for using a single sample of rental units to derive price indices for both tenant rent and OER. Recall that the sampled rental units in the CPI Housing Survey are drawn from a sample of segments. The observations of rents from this sample must be weighted so as to be representative of the entire PSU. Furthermore, the weights must be modified to reflect separately the rental units and the owner occupied units in the PSU.

The first step in this process is to create the "segment weight." The segment weight is the inverse of the ratio of the aggregate housing expenditure of the segment to the aggregate housing expenditure of the PSU. Aggregate housing expenditure is derived as (number of renters) x (average rent) + (number of owners) x (average implicit rent).[a] For example, if a segment represents five percent of the aggregate housing expenditure of the PSU, the segment weight is then 20. This segment weight is then modified to create specific weights for determining the change in tenant rent (renters' weight) and for determining the change in OER (owners' weight). The segment weight is first multiplied by the ratio of total housing units in a segment over the number of sampled units from that segment (HU/SU). Then that product is multiplied by the ratio of renters' costs (RC) to total housing expenditures (TC) for the segment, to create the renters' weight, or the ratio of owners' costs (OC) over total housing expenditures (TC) for the segment, to create the owners' weight. The renters' and owners' weights are then given by:

*renters' weight = segment weight * (HU/SU) * (RC/TC)*

*owners' weight = segment weight * (HU/SU) * (OC/TC).*

These weights are based on housing expenditures at some set base year.

The "price relative" for tenant rent (Rel^{R}) and for OER (Rel^{OER}) are given by the following:

$$Rel^{R} = \left[\frac{\sum_{j}\sum_{i}(renters'\ weight)_i\, economic\ rent_{it}}{\sum_{j}\sum_{i}(renters'\ weight)_i\, economic\ rent_{it-6}e^{F_{it}}} \right]^{1/6}$$

$$Rel^{OER} = \left[\frac{\sum_{j}\sum_{i}(owners'\ weight)_i\, pure\ rent_{it}}{\sum_{j}\sum_{i}(owners'\ weight)_i\, pure\ rent_{it-6}e^{F_{it}}} \right]^{1/6}$$

Where *i* represents all sampled rental units within a sampled segment and j represents all sampled segments within the PSU. Note that these ratios are taken to the 1/6 power to convert the observed six-month rent change to a monthly rate. Also, the age bias adjustment factor ($e^{F_{it}}$) modestly lowers the rent level of period *t-6* to account for the fact that the observed change in rent understates the constant quality change in rent due to the effect of aging on the quality of shelter services provided. These price relatives are multiplied by the respective price indices for the previous period to move the index forward one period.

The accompanying table provides a hypothetical example of this procedure and also illustrates some circumstances where the procedure may yield inaccurate estimates. In this example, we assume that the universe consists of twenty geographic segments, each of which has 250 housing units. We further assume these twenty segments are divided into equal numbers of Type 1 segments, that have primarily owner-occupied units and relatively high rents, and Type 2 segments, that have primarily renter-occupied units and lower rents.

A sample of three segments is chosen to calculate the OER and tenant rent price indexes. The observed rents and unobserved implicit rents in each segment are assumed to be equal. Rent levels in Type 1 segments are double those in Type 2 segments, so Type 1 housing expenditures are double those of Type 2 segments. Since the probability of a segment being selected in the sample depends upon total housing expenditures, the sample includes two Type 1 segments and

one Type 2 segment to reflect the higher expenditures in the Type 1 segments. A segments' housing expenditures divided by the total housing expenditures of the universe determines that segment's probability of selection, and the inverse of that probability is the segment's weight. Since each segment has 250 housing units, and a sample of 25 units is drawn from each segment, the ratio HU/SU is equal to 10 for each segment.

From period 1 to period 2, observed tenant rents are assumed to increase 4 percent in Type 1 segments and 2 percent in Type 2 segments. We shall also assume in this example that unobserved owner equivalent rents in each segment rise by the same percentage as observed tenant rents. Under this rather long list of assumptions, the estimated increases in tenant rent and OER are equal to the actual increases for the entire universe, as shown by the rates of change of the sample and universe in the table.

Of course, whenever estimates are derived from a sample there is the risk of sample bias. But beyond sample bias, this example illustrates situations where the estimated price changes may differ from the true ones. Key potential sources of error lie in two areas. First, the level of OER in the base period is estimated as a nonlinear function of property values, derived from data on tenant rents and property values in census blocks. Errors in the estimation of the level of OER would result in incorrect renter's and owner's weights and produce errors in both price series. Second, the true rate of change of OER in a segment may not be the same as the observed rate of change of tenant rents in that segment, resulting in errors in the estimated change in OER. Both of these potential sources of error are more likely to occur in areas with relatively few rental units.

[a] This is a technical change introduced in 1999. During the 1983-87 period, this segment weight was based on the number of housing units, rather than total housing expenditures. In practice, implicit rents in a segment are estimated using a nonlinear regression relating rents in census blocks within a metropolitan statistical area with home values.

REFERENCES

Armijo, Gretchen A., David W. Berson, Mark H. Obrinsky, and Bragi Valgeirsson. 1990. "Demographic and Economic Trends." Journal of Housing Research 1, no. 1: 21-42.

Armknecht, Paul A., Brent R. Moulton, and Kenneth J. Stewart. 1995. "Improvements to the Food at Home, Shelter, and Prescription Drug Indexes in the U.S. Consumer Price Index." Bureau of Labor Statistics Working Paper no. 263.

Bryan, Michael F., and Stephen G. Cecchetti. 1994. "Measuring Core Inflation." In N. Gregory Mankiw, ed., Monetary Policy. NBER Studies in Business Cycles, Vol. 29, 195-215. Chicago: University of Chicago Press.

Bryan, Michael F., Stephen G. Cecchetti, and Rodney L. Wiggins II. 1997. "Efficient Inflation Estimation." NBER Working Paper no. 7479.

Crone, Theodore M., Leonard I. Nakamura, and Richard Voith. 2001. "Measuring American Rents: A Revisionist History." Federal Reserve Bank of Philadelphia Working Paper no. 01-8.

DiPasquale, Denise, and William C. Wheaton. 1994. "Housing Market Dynamics and the Future of Housing Prices." Journal of Urban Economics 35, no. 1 (January): 1-27.

Dougherty, Ann, and Robert Van Order. 1982. "Inflation, Housing Costs, and the Consumer Price Index." American Economic Review 72, no. 1 (March): 154-64.

Epstein, Gene. 2000. "Inflation's Upward Creep Would Look Even Worse if BLS Counted What's Really Happening to Housing." Barron's, March 20, p. 40.

Gallin, Joshua, and Randal Verbrugge. 2007. "Improving the CPI's Age-Bias Adjustment: Leverage, Disaggregation and Model Average." BLS Working Papers, #411, U.S Department of Labor, Bureau of Labor Statistics, Office of Prices and Living Conditions, October.

Gillingham, Robert. 1983. "Measuring the Cost of Shelter for Homeowners: Theoretical and Empirical Considerations." Review of Economics and Statistics 65, no. 2 (May): 254-65.

Mankiw, N. Gregory, and David N. Weil. 1989. "The Baby Boom, the Baby Bust, and the Housing Market." Regional Science and Urban Economics 19, no. 2 (May): 235-58.

Moulton, Brent R. 1997. "Issues in Measuring Price Changes for Rent of Shelter." Paper presented at the conference "Service Sector Productivity and the Productivity Paradox." Ottawa: Centre for the Study of Living Standards.

Poole, Robert, Frank Ptacek, and Randal Verbrugge. 2005. "Treatment of Owner-Occupied Housing in the CPI." Bureau of Labor Statistics, U.S. Department of Labor.

Poterba, James M. 1984. "Tax Subsidies to Owner-Occupied Housing: An Asset-Market Approach." Quarterly Journal of Economics 99, no. 4: 729-752.

Ptacek, Frank, and Robert M. Baskin. 1996. "Revision of the CPI Housing Sample and Estimators." Monthly Labor Review 119, no. 12 (December): 31-9.

U.S. Census Bureau. 1999. "Current Construction Reports— Characteristics of New Housing: 1998, C25/98-A." Washington, D.C.: U.S. Department of Commerce.

———. 2000. "Current Construction Reports—Housing Completions: December 1999, C22/99-12." Washington, D.C.: U.S. Department of Commerce.

U.S. Department of Labor. 1996. "How the Consumer Price Index Measures Homeowners' Costs." Fact Sheet no. BLS 96-6. Washington, D.C.: Bureau of Labor Statistics.

———. 1999. "Consumer Price Indexes for Rent and Rental Equivalence." Fact Sheet no. BLS 99-4. Washington, D.C.: Bureau of Labor Statistics.

Verbrugge, Randal. 2006. "The Puzzling Divergence of Rents and User Costs, 1980-2004." Unpublished paper, Bureau of Labor Statistics, May.

ENDNOTES

[1] The CPI in this case is the CPI-U or consumer price index for all urban consumers, which excludes farm dwellings. The weights of OER and tenant rent in the CPI are based on the Consumer Expenditure Survey. To determine the OER weight, the survey asks homeowners to estimate what their homes would rent for, excluding utilities and furnishings. Weights for OER and tenant rent in the PCE deflator, while large, are lower than the corresponding weights in the CPI due to the broader concept of consumption covered by the PCE deflator.

[2] Also included within the shelter component of the CPI are lodging away from home and tenants' and household insurance. While not discussed in this paper, Table 1 shows the classification and weight of the corresponding items in the PCE deflator. Note that lodging away from home in the CPI is not conceptually comparable to hotels and motels in the PCE deflator even though the price index used in both cases is the same. Lodging away from home in the CPI includes second homes as well as hotels and motels. In contrast, in the PCE deflator the rental value of second homes is reflected in space rent.

[3] Shelter is an important component in alternative measures of core inflation as well. For the median CPI, Bryan and Cecchetti (1994) show that shelter is at the median in about 48 percent of their sample, which is well above its weight in the CPI measure. For the trimmed mean CPI, shelter is trimmed in less than 13 percent of the time within their sample period, which is below its weight in the CPI.

[4] "Here's the scandal: The BLS would have us believe that inflation in this all-important sector has actually slowed over the past year, even though all real world evidence tells us it could only have accelerated" (Epstein 2000).

[5] This section draws heavily on several BLS publications, including U.S. Department of Labor (1996, 1999), Ptacek and Baskin (1996), and Poole, Ptacek, and Verbrugge (2005).

[6] The cost of utilities not included in contract rents is reflected in the fuels and utilities subcomponent of the overall housing category of the CPI. The BEA specifically strips out the influence of utilities from the BLS tenant rent measure when constructing the price index for tenant rent within the PCE deflator.

[7] These characteristics include the number of bedrooms, bathrooms and other rooms in the unit; utilities and facilities provided; and the type of energy used for heating and cooling.

[8] Galin and Verbrugge (2007) discuss the age-bias adjustment in detail and present alternative methods of estimating it.

[9] The variable also includes, in a small number of cases, the cost of renter's insurance.

[10] In our preliminary analysis, we included the squared value of the log level of housing costs as an explanatory variable to test for nonlinearity, but it was statistically insignificant with a negative sign, and thus was not included in our final regression.

[11] Crone, Nakamura, and Voith (2001) also develop an alternative tenant rent series using AHS data. Although the period of their study mostly precedes ours, the first three panels of our study overlap with theirs. Their alternative series suggests a higher rate of tenant rent inflation than is reported in the CPI.

[12] Note that we are estimating the level of OER with the estimated level of user cost, not the rate of change of OER based on the rate of change of the estimated user cost. Verbrugge (2006) demonstrated that the rates of change of rents and of user costs often sharply diverge. This is likely due to the fact that rent-user cost equality is a long-run equilibrium condition.

[13] To compute aggregate housing expenditures within a PSU and within a segment, the BLS must also estimate the level of OER for all owner-occupied units. The BLS approach is to estimate a level of OER from a nonlinear regression of actual rents within a Census block on the estimated value of owner-occupied homes with the Census block.

[14] The marginal tax rate is determined by estimating the owner's taxable income based on the AHS-reported gross income, assuming that the owner files a joint return and has two children.

[15] The density functions in Chart 5 are smoothed versions of the empirical distribution, using a normal kernel with a bandwidth parameter of 100 for renters and 300 for owners.

[16] Theoretically, another option in measuring the implicit rent of owner-occupied housing is to calculate its user cost (for example, see Dougherty and Van Order [1982]). At the time that the BLS adopted the rental equivalence approach, it suggested that this approach could measure user cost more efficiently (see Gillingham [1983]). More recently, Verbrugge (2006) examined the relationship between user costs and rents, and found that despite the theoretical relationship between the two, user costs and rents behave very differently.

[17] In 1995, the BLS made some technical changes to the split-sample approach: it changed the formula that was used to compute the percentage change of OER (the Sauerbeck formula) to eliminate "chain drift." This change is estimated to have reduced the OER inflation rate by about 0.4 percentage points. In addition, the BLS began basing changes in OER (and in tenant rent) on six-month rent changes only, rather than the previously-used weighted average of one-month and six-month rent changes. For further details, see Armknecht, Moulton, and Stewart (1995).

[18] "Research performed by the BLS using 1980 and 1990 census data indicates that geographic location is the most important variable…in determining rent change. Once geography is taken into account, only rent level is significant in predicting rent change" (Ptacek and Baskin 1996).

[19] The one time during the matched-sample period when the two rent inflation rates were roughly equal was during 1996-98. This pattern reflected the influence of the technical changes discussed in note [21]. Also, both of the rent inflation rates displayed less monthly volatility after the mid-1990s, reflecting the use of only six-month rent changes on sampled units to calculate rent inflation rates.

Table 1

Housing in the CPI[1] and PCE Deflator[2], 2006

Consumer Price Index	% of Total		Personal Consumption Expenditure Deflator
Shelter	32.776	15.083	Housing
Owners' equivalent rent of primary residence	23.83	11.081	Owner-occupied non-farm dwelling
Rent of primary residence	5.93	3.011	Tenant-occupied non-farm dwelling
Lodging away from home	2.648	0.638	Hotels and motels
Tenants' and household insurance	0.369	0.068	Household insurance

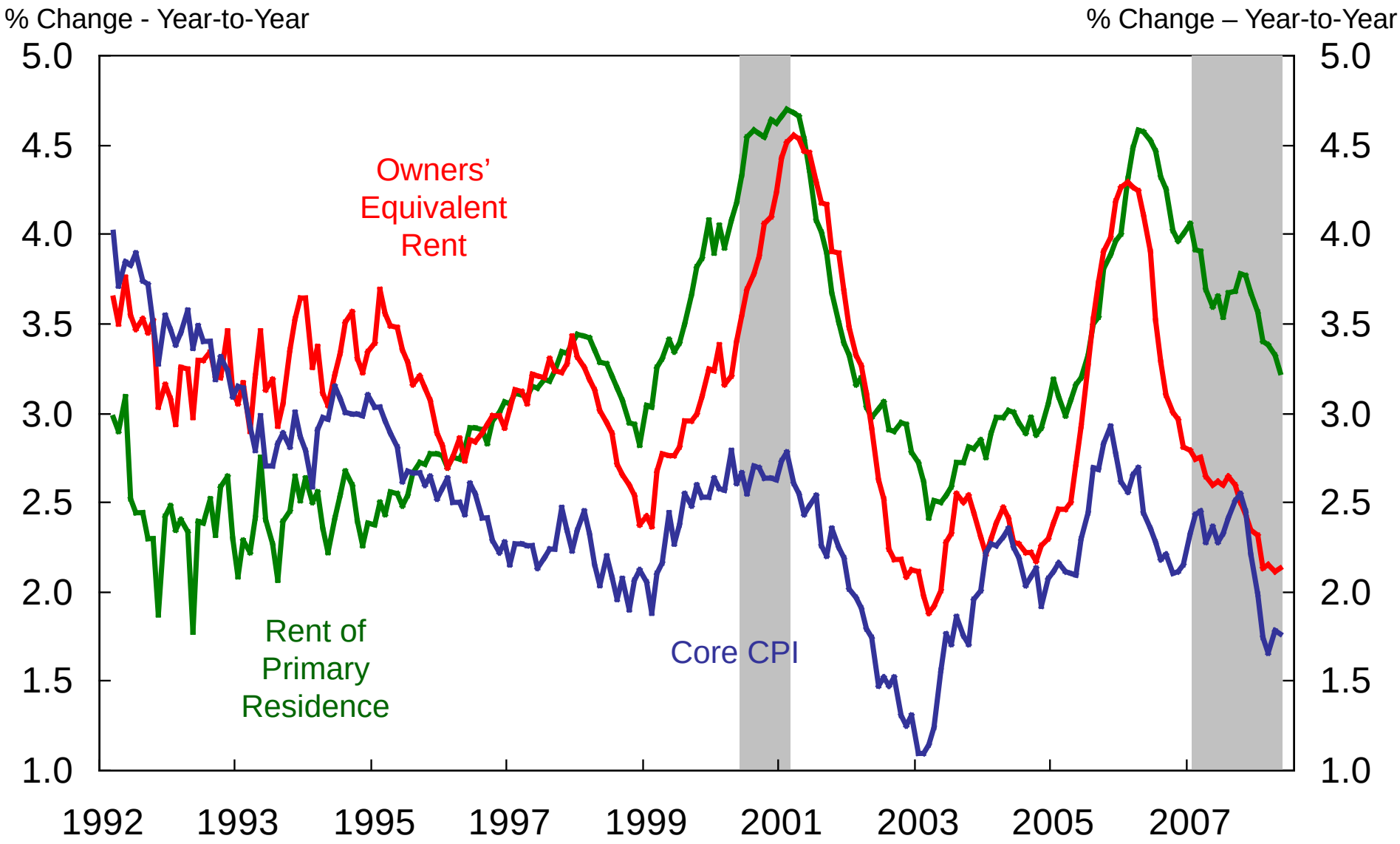
1. The CPI-U, or CPI for all urban consumer. New weights were introduced beginning with the January 2006 CPI Data.

2. Weights are equal to 2006 shares of nominal personal consumption expenditures.

Source: Bureau of Labor Statistics, Bureau of Economic Analysis

Chart 1

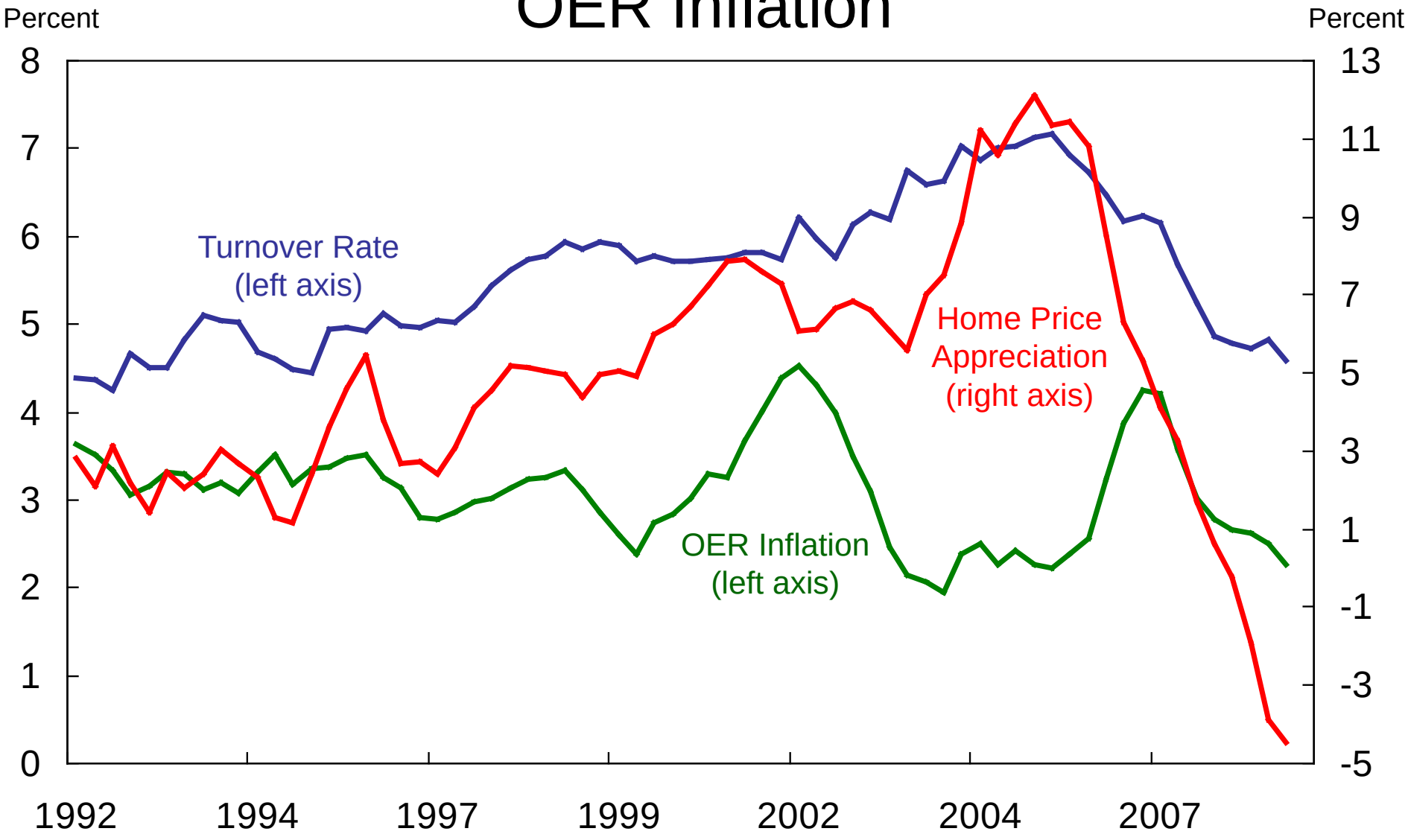
Rent Inflation in the CPI



Source: Bureau of Labor Statistics

Chart 2

Housing Turnover, Home Price Appreciation and OER Inflation



Source: Department of Commerce, Office of Federal Housing Enterprise Oversight and Bureau of Labor Statistics

Table 2

Coefficients from Rent-Change Regression

	Coefficient	Std. Error	T-Stat
Log of Housing Cost	-4.138	0.094	-43.94
Multifamily Building Dummy	-0.560	0.096	-5.87
Midwest Dummy	-1.046	0.149	-7.01
South Dummy	-0.735	0.133	-5.53
West Dummy	0.465	0.135	3.44
Suburban Dummy	0.196	0.095	2.07
Rural Dummy	-1.280	0.132	-9.67
Change in Sq Feet*	0.017	0.020	0.87
Change in Neighborhood Rating**	-0.006	0.019	-0.32
R^2	0.051		
Root Mean Squared Error	8.933		

*100 square feet = one unit
**Positive numbers represent an improvement in neighborhood rating.
Note: Fixed time effects (not reported) included in the regression. All calculations made with 10% trimming.
Source: American Housing Survey and authors' calculations

Table 3

Construction of CPI Tenant Rent + Utilities Inflation

(Used in Chart 3)

	c.1	*c.2*		*c.3*	*c.4*	*c.5*	*c.6*		*c.7*
	CPI Data *Annualized Change*			**AHS Data**					
	Tenant Rent	**Utilities**		**Avg. Utility Expenditure as % of Housing Cost**	**Avg. of Column *3* over 2-year Intervals**	**Weighted Avg. of % of Units Paying for Utilities Separately from Rent**	**Avg. of Column *5* over 2-year Intervals**		**CPI Inflation for Rent + Utilities***
1989-1991	3.884	3.409		14.696	14.369	88.838	89.233		3.822
1991-1993	2.422	2.594		14.043	14.405	89.629	89.795		2.444
1993-1995	2.440	0.947		14.767	14.385	89.961	90.191		2.243
1995-1997	2.782	2.828		14.002	13.293	90.422	88.768		2.787
1997-1999	3.194	-0.739		12.583	12.044	87.113	87.464		2.773
1999-2001	4.043	7.962		11.505	11.714	87.815	88.094		4.453
2001-2003	3.422	1.449		11.924	11.622	88.373	88.320		3.217
2003-2005	2.831	7.637		11.320	11.504	88.266	88.002		3.324
2005-2007	3.922	5.873		11.688	13.085	87.737	87.705		4.149

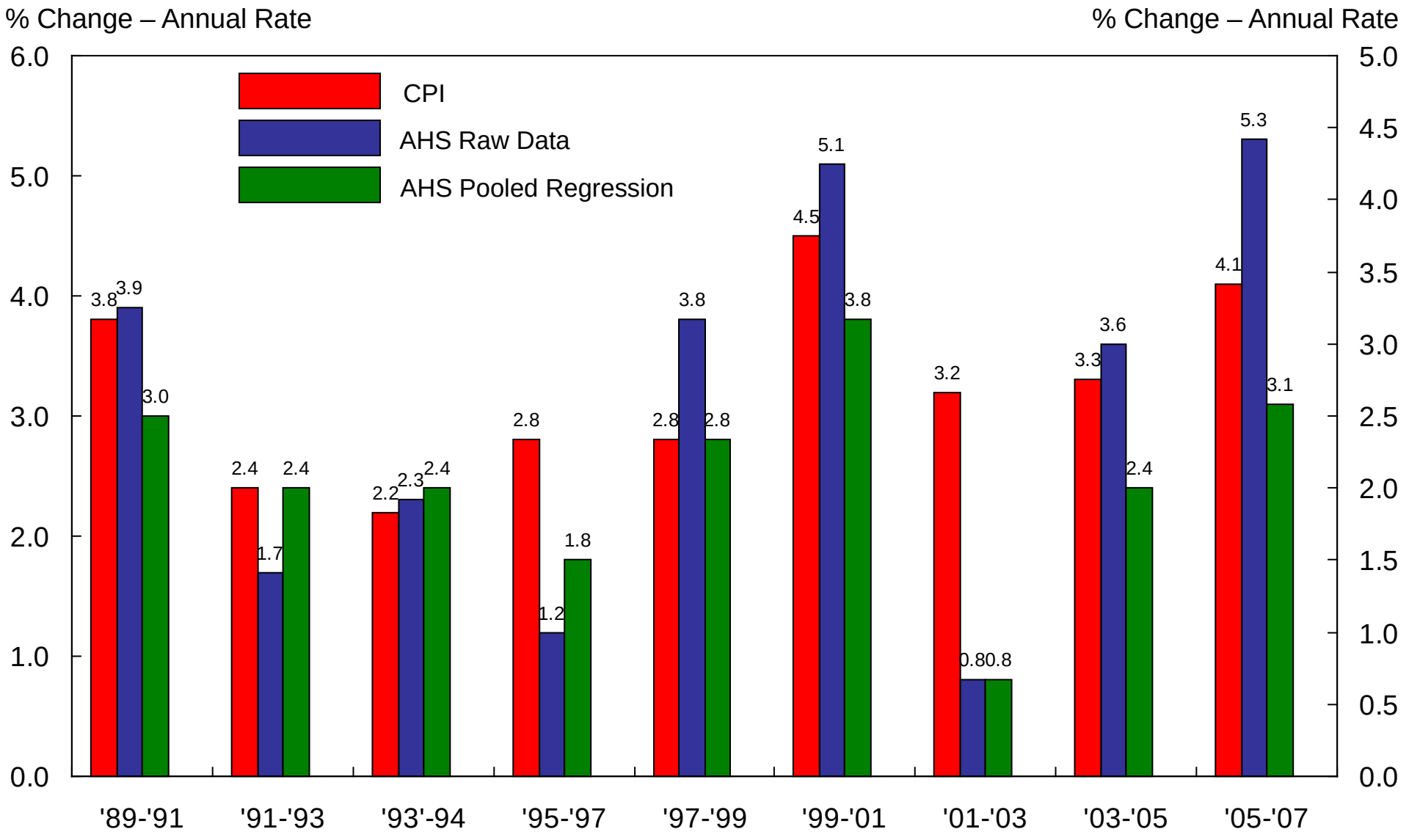
***Formula for CPI Inflation:**

$$\frac{[(c.1 - [c.4 * (1 - c.6)] * c.2) * (1 - c.4)] * (c.2 * c.4)}{[(1 - c.4) * (1 - c.6)] + c.6}$$

Source: American Housing Survey, Consumer Price Index and authors' calculations

Chart 3

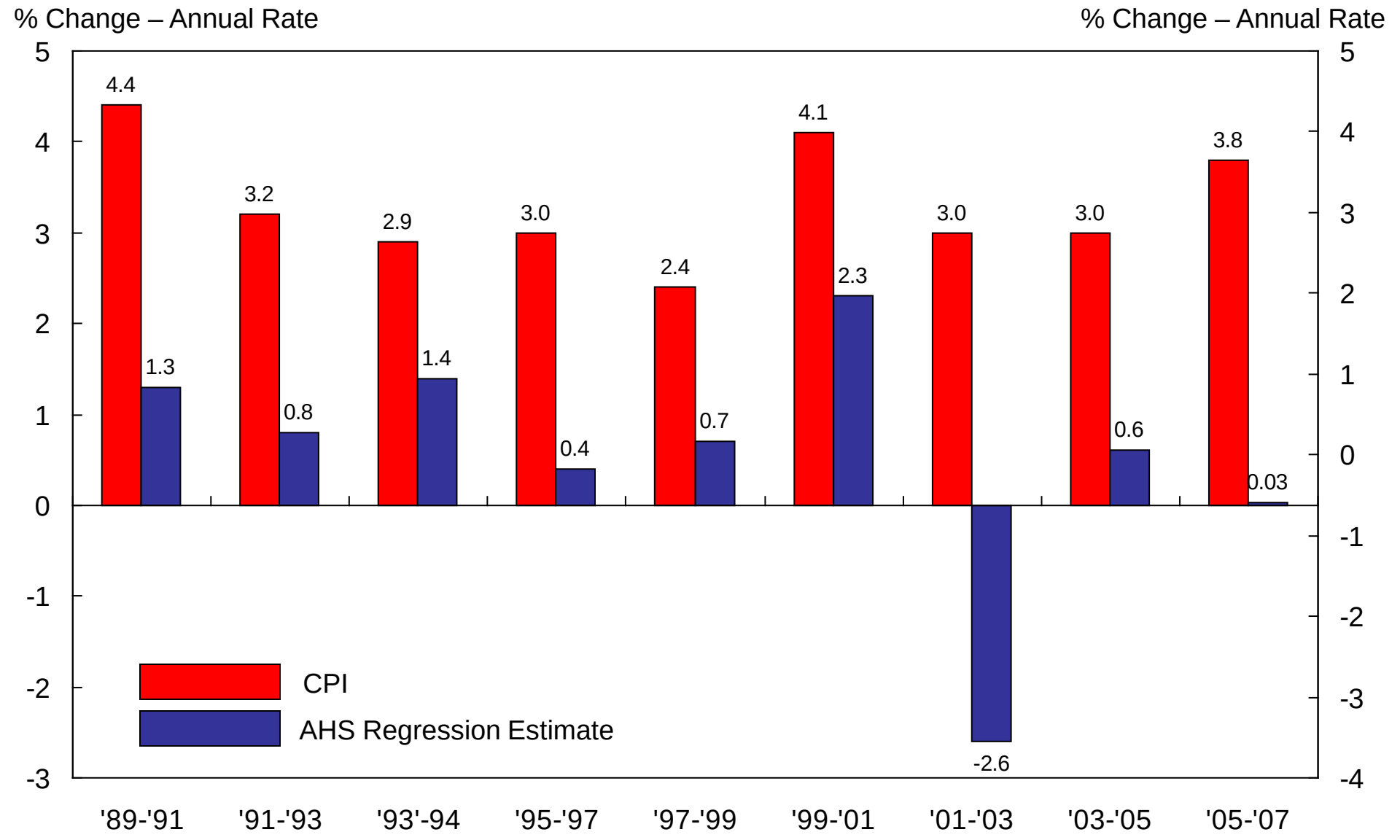
Tenant Rent Inflation: AHS and CPI Measures



Note: All American Housing Survey calculations made with 10% trimming.
Source: Bureau of Labor Statistics, American Housing Survey and authors' calculations.

Chart 4

OER Inflation: AHS and CPI Measures



Note: All American Housing Survey calculations made with 10% trimming.
Source: Bureau of Labor Statistics, American Housing Survey and authors' calculations

Table 4

Tenant Rent and OER Inflation: AHS v. CPI

	89-91	91-93	93-95	95-97	97-99	99-01	01-03	03-05	05-07	Average
CPI Tenant Rent	3.8	2.4	2.2	2.8	2.8	4.5	3.2	3.3	4.1	
AHS Raw	3.9	1.7	2.3	1.2	3.8	5.1	0.8	3.6	5.3	
Difference	-3.90	-1.70	-2.30	-1.20	-3.80	-5.10	-0.80	-3.60	-5.30	-3.08
AHS Pooled Regression	3.0	2.4	2.4	1.8	2.8	3.8	0.8	2.4	3.1	
Difference	-3.00	-2.40	-2.40	-1.80	-2.80	-3.80	-0.80	-2.40	-3.10	-2.50
CPI OER	4.4	3.2	2.9	3.0	2.4	4.1	3.0	3.0	3.8	
AHS	1.3	0.8	1.4	0.4	0.7	2.3	-2.6	0.6	0.03	
Difference	-1.30	-0.80	-1.40	-0.40	-0.70	-2.30	2.60	-0.60	-0.03	-0.55

Source: American Housing Survey and Bureau of Labor Statistics

Table 5

Growth of Rent by Rent Quintile

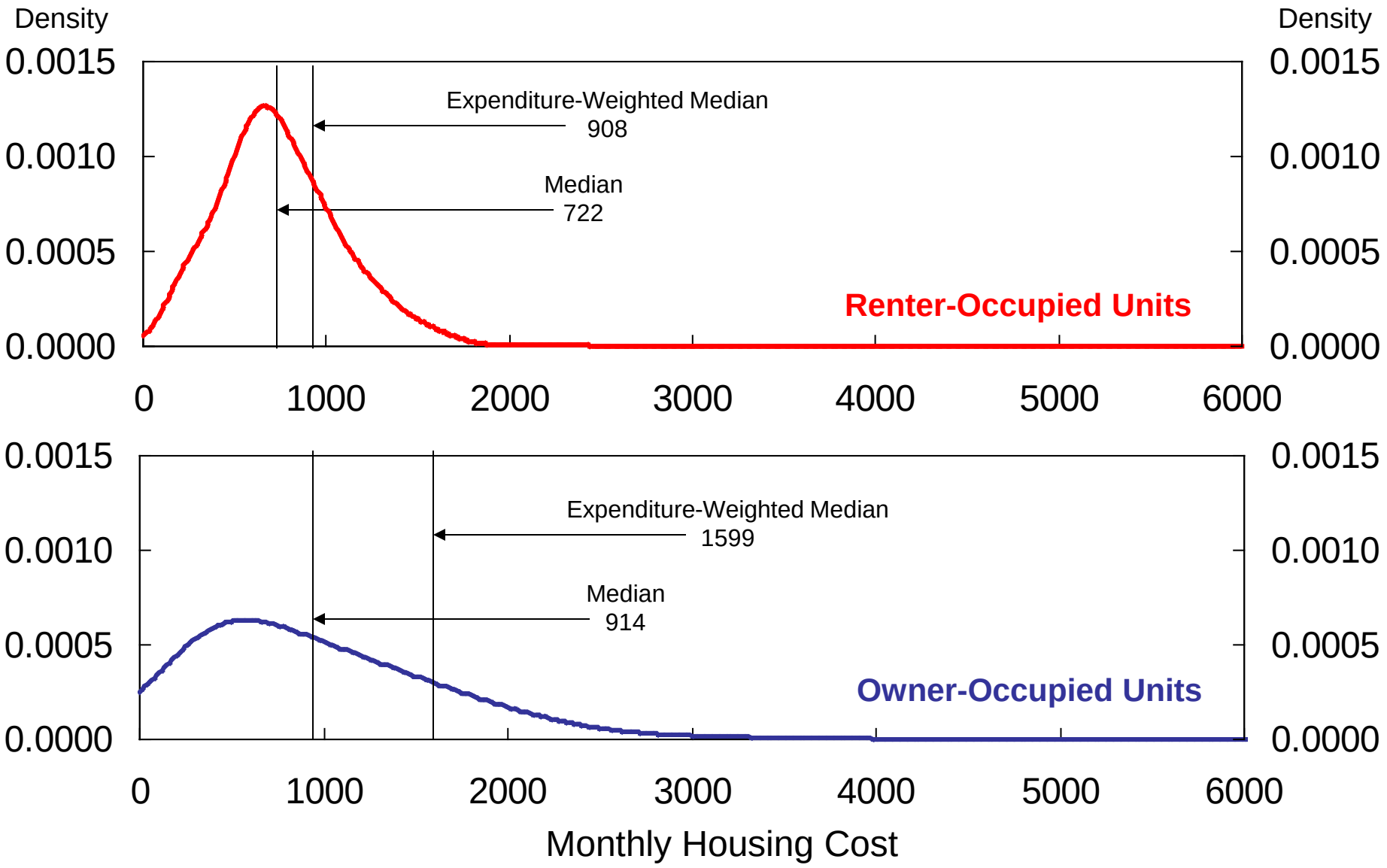
(Annualized Growth Rates)

Period	Lowest 5th	4th	3rd	2nd	Highest 1st	Top 10%	Top 5%
1989-1991	5.97	3.90	2.86	1.83	1.47	1.86	1.46
1991-1993	4.71	3.14	2.25	1.47	0.67	0.12	-0.43
1993-1995	5.28	3.28	1.92	1.03	0.98	1.28	1.48
1995-1997	4.60	2.59	0.61	0.25	-1.02	-1.88	-1.67
1997-1999	6.58	3.57	2.16	1.14	4.59	8.59	13.12
1999-2001	7.59	4.70	3.00	2.44	3.81	3.92	0.97
2001-2003	5.13	3.23	0.76	-0.59	-3.65	-6.53	-6.55
2003-2005	8.08	3.72	1.69	0.87	0.08	-1.69	-2.12
2005-2007	6.84	4.79	3.89	2.51	-2.94	-6.44	-7.24

Note: Quintiles are based on monthly housing cost. All calculations made with 10% trimming.
Source: American Housing Survey

Chart 5

Distribution of Units by Monthly Housing Cost: 2007



Note: Empirical distributions smoothed using a normal kernel with bandwidth parameter of 100 for renters and 300 for owners.
Source: American Housing Survey

Table 6

Average Pretax Family Income

(In 2000 Dollars)

	1989	2007	Percent Change, Annual Rate 1989-2007
Lowest Quintile	$ 7,705	$ 7,669	-0.04
Second Quintile	$ 20,319	$ 21,765	0.57
Middle Quintile	$ 33,925	$ 37,041	0.73
Fourth Quintile	$ 52,165	$ 60,877	1.30
Highest Quintile	$ 103,638	$ 140,220	2.55
All Families	$ 43,652	$ 53,573	1.72
Top 10 Percent	$ 130,439	$ 189,607	3.17
Top 5 Percent	$ 158,349	$ 256,105	4.09
Top 1 Percent	$ 220,228	$ 468,593	6.49

Note: Quintiles are based on family income. Nominal incomes have been deflated to 2000 dollars using the PCE deflator.
Source: American Housing Survey and Bureau of Economic Analysis

Table 7

Growth of the Housing Stock: 1989-2007

(Annualized Growth Rates)

	1 Unit	2-4 Units	5 + Units	Mobile	Total
Total	1.47	-0.43	1.03	1.46	1.22
Vacant	3.29	1.06	1.27	1.83	2.31
For Rent	3.61	0.72	2.54	1.71	2.38
For Sale Only	4.69	3.27	1.67	0.33	3.79
Rented/Sold, but not yet Occupied	2.49	-0.55	1.16	3.08	1.88
Occasional Use/URE* & Other	2.87	1.49	-2.52	2.15	1.93
Occupied	1.28	-0.72	0.89	1.52	1.05
Owner	1.54	-1.71	2.44	1.30	1.47
Renter	-0.07	-0.51	0.69	2.36	0.23

*Usual Residence Elsewhere

Source: American Housing Survey

Table 8

Housing Unit Dynamics by Income Quintiles

(Millions of Units)

Total

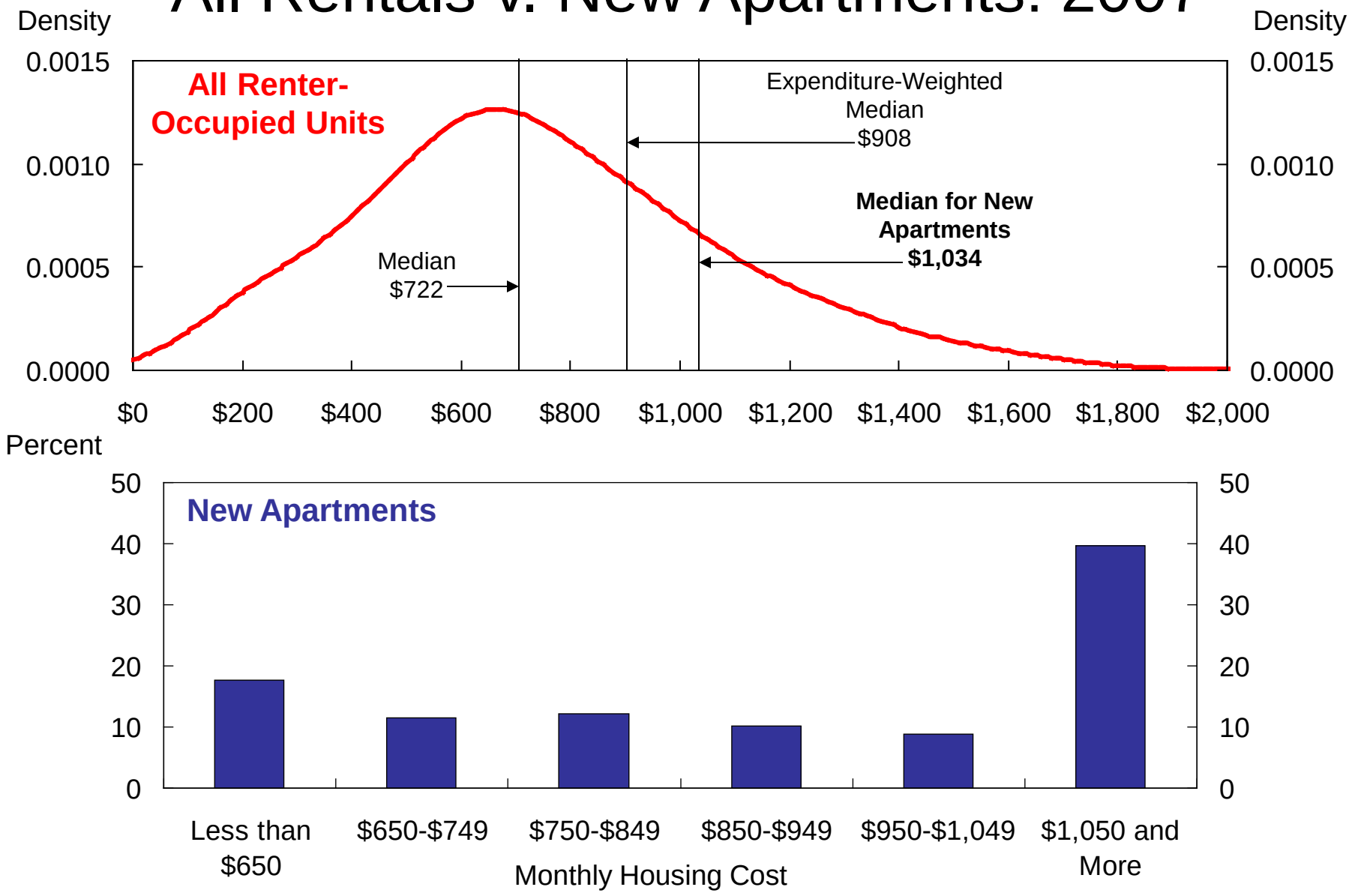
1989 Income Quintile	Change in Units 1989-2007	*Change Due To* Net Filtering	New Construction	Net Conversions
1 - lowest	1.06	1.09	2.68	-2.70
2	4.60	1.89	4.00	-1.29
3	-1.74	-2.28	3.15	-2.61
4	2.58	-1.74	5.36	-1.04
5 - highest	10.45	1.05	9.51	-0.10
Total	16.95	0.01	24.70	-7.74

Notes: Nominal incomes have been deflated to 2000 dollars using the PCE deflator.

Source: American Housing Survey

Chart 6

All Rentals v. New Apartments: 2007



Note: Empirical distributions of "All Renter-Occupied Units" smoothed using a normal kernel with bandwidth parameter of 100.

Source: American Housing Survey, U.S. Census Bureau

Table for Box 2

Hypothetical Example of CPI Methodology

				Sample (Observed)	Universe (Estimated)
Segments	**A**	**B**	**C**	3	20
Type	1	1	2		
Units					
Renters	100	100	150	350	2,500
Owners	150	150	100	400	2,500
Total	*250*	*250*	*250*	*750*	*5,000*
Rent Level (Period 1)					
Tenants' Rent	400	400	200		
OER*	400	400	200		
Housing Expenditures					
Renters	40,000	40,000	30,000	110,000	700,000
Owners	60,000	60,000	20,000	140,000	800,000
Total	*100,000*	*100,000*	*50,000*	*250,000*	*1,500,000*
Probability of Segment's Inclusion in Sample	0.067	0.067	0.033		
Raw Weight of Segment	15	15	30		
Ratio of Total to Sampled Units (HU/SU)	10	10	10		
Renters' Share of Total Housing Costs (RC/TC)	0.4	0.4	0.6		
Owners' Share of Total Housing Costs (OC/TC)	0.6	0.6	0.4		
Rent Change Calculation					
Renters					
Total Rent Period 1	24,000	24,000	36,000	84,000	700,000
Total Rent Period 2	24,960	24,960	36,720	86,640	722,000
Percent Change	*4.00%*	*4.00%*	*2.00%*	*3.14%*	*3.14%*
Owners					
Total Rent Period 1	36,000	36,000	24,000	96,000	800,000
Total Rent Period 2	37,440	37,440	24,480	99,360	828,000
Percent Change	*4.00%*	*4.00%*	*2.00%*	*3.50%*	*3.50%*

*Unobserved; estimate based on property value.