STICKY RENTS AND THE CPI FOR OWNER-OCCUPIED HOUSING *

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Abstract

This paper examines the implications of sticky rents on the measurement of owner-occupied housing in the Consumer Price Index (CPI). I argue that market and not average rents are the most theoretically justified measurement of owners' equivalent rent (OER), and that the current measurement of rental inflation using average rents is methodologically incorrect. A new data source is used to construct a market rent measure to compare to the existing CPI measure of owner-occupied housing inflation for the Baltimore/Washington D.C. CMSA. The results show that market rents reflect housing market turning points sooner, and show a larger post-housing bubble decline in rents. In addition, market rents are shown to forecast overall inflation better than average rents. The results suggest that switching to market rents may allow the Federal Reserve to be more responsive to housing bubbles.

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1 Introduction

Shelter makes up 32% of the consumer price index (CPI), with the owner-occupied housing (OOH) portion comprising 24% and rent of primary residence making up 6%[1]. This means housing is the single largest component in the CPI. Reflecting this importance, the current Bureau of Labor Statistics (BLS) methodology has come under some criticism as a large U.S. house price bubble and crash occured alongside slow and steady growth in the CPI for OOH. From the peak in April 2006 to the first bottom in May 2009, the Case-Shiller house price index fell 32%. In comparison, the CPI for owner-occupied housing increased 9%. While this divergence is in large part due to the BLS using rents instead of house prices in the CPI, this paper argues that some of the difference can also be explained by a methodological weakness of the current BLS approach to measuring rents.

The purpose of this research is not to analyze whether rental equivalence is desirable, but to argue that given the theoretical justification for this approach, the CPI should be measured using current market rents instead of the average rents. Market rents reflect current market conditions, and are based on prices that a marginal buyer or seller in the market would face. This is how prices are measured for all non-housing items in the CPI. In contrast, average rents are based on average household rent expenditures. The two measurements can diverge primarily because rents are typically set by long-term leases, such that the current price that a unit would rent for (which would be used in market rent measures) may not be the same as the current rent paid by that unit's tenant (which is used in average rent). Average rents are often set months or even years in the past while market rents reflect current prices.

[1] Percentages are for the the CPI-U as of December 2010. A remaining 0.78% of shelter is lodging away from home.

This paper proposes an alternative and conceptually preferrable measurement method that follows the approached used in many popular house price indexes. The effects of choosing this alternative method over the status quo are analyzed using a new dataset of 276,158 single family housing rental listings from 2000 to 2012. This data comes from a regional Multiple Listing Service (MLS), which are databases used by Realtors to find and list properties, and are a common source of home sales data in real estate economics. Specifically, a market rent inflation series is estimated and compared to the actual BLS CPI for OOH in the Baltimore/Washington D.C. CMSA.

The market rent series shows the popping and bottom of the housing bubble more quickly than the CPI series. This includes the deacceleration of year-on-year price changes showing up two months earlier in the market rent series. An even more stark difference is seen in the timing of the bottom of the bubble, with the largest decline in prices showing up fourteen months earlier in the market rent than in the CPI. Finally, the market rent series better reflects the Case-Shiller House Price Index for the region.

However, contrary to expectations market rent does not reflect higher prices during the bubble period. Furthermore, as expected market rent still lags far behind house prices suggesting measurement methodology does not account for the majority of the divergence between house prices and rents.

Finally, following the literature on inflation measurement, the forecasting ability of market rent and current OER measures are compared. The evidence suggests market rent is better able to forecast overall inflation, which provides further evidence that this measure may be more useful for forward looking monetary policy.

The CPI is one of the most important measures of inflation and is followed closely by the Federal Reserve, businesses, and governments. Reflecting this, potential biases and measurement problems with the CPI have long been a topic of research interest.

This study's contribution is to extend this literature. The evidence suggests that the mismeasurement discussed in this paper causes real underlying OOH price changes to show up slowly in measured inflation. Correcting this may therefore allow the Federal Reserve to be more responsive to house price bubbles and bursts; responding to critics' concerns without altering its existing goals and targets.

Section 2 provides an overview of the current BLS method of using rental equivalence to estimate the CPI for OOH, illustrating that they are currently using average rents to measure OOH inflation. Then Section 3 argues that market rents are more consistent with the primary theoretical justifications for rental imputation. Section 4 explains why this choice of market versus average rents may be significant: the micro-ridigity and macro-rigidity of rents. Section 5 describes an empirical methdology and 6 introduces a new dataset that will be used to measure market rents. Section 7 compares the market rent estimate for the Baltimore/Washington D.C. to the CPI measure of housing inflation for the same geographic area, and Secion 8 compares the forecasting ability of these measures. Section 9 concludes.

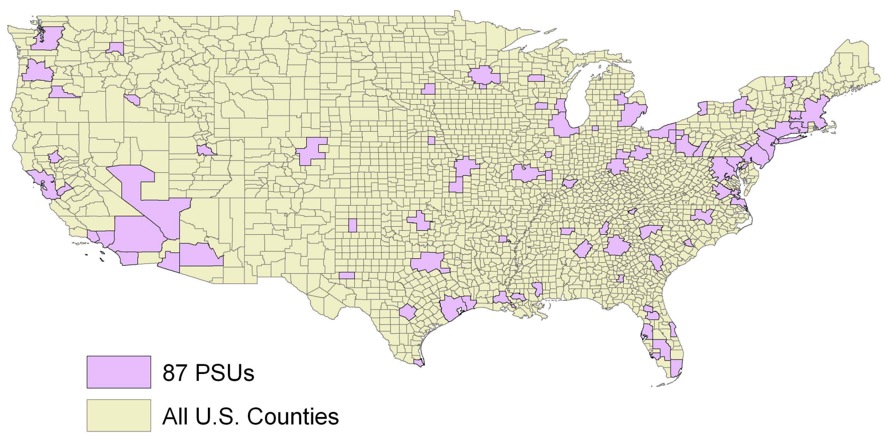
2 The Current BLS Approach

The data source for residential rents is the CPI housing unit sample, a survey conducted specifically for this purpose.[2] Like other CPI components, the largest sampling geography is the 87 primary sampling units (PSUs) shown in Figure 1 below. These PSUs are used to generate the price indices for 38 CPI Index Areas. Thirty-one of the PSUs are "self-representing," meaning an individual PSU represents an individual Index Area. The other 56 PSUs are "non-self-representing", which collectively represent the remainig 7 index areas. For example, one Index Area represents 38 small

[2] This section will draw from the extensive overview of CPI for housing methodology in Poole, Ptacek, and Verbrugge (2005), and the BLS Handbook of Methods (2012)

Northeast metropolitan areas, including Buffalo, Hartford, Syracuse, Burlington, and others. Eight of these metros were randomly selected to represent all of them, and each of these eight areas is a non-self-representing PSU (BLS Handbook of Methods).

Figure 1: 87 Primary Sampling Units



Every PSU is divided into six strata that each represent approximately 1/6 of the total PSU housing expenditure. Within strata, neighborhoods called "segments" are designated which are composed of groups of adjacent census blocks. Each segment must contain 50 housing units for larger PSUs or 30 housing units for smaller PSUs and contain on average 150 housing units. Each segment is placed in one of the six strata.

Within each strata, a sample of segments is chosen with the odds of being chosen proportional to total housing expenditures in that segment.[3] Each segment is then assigned to panels that determine when in the year the houses they contain will be interviewed. Each panel is interviewed every six months, and a different panel is interviewed every month. Panel 1, for example, is surveyed in January and July each year while panel 2 is priced in February and August and so forth. The segments are

[3]Housing expenditures used are total rents for rental units, and total owners' equivalent rent for OOH.

selected into the panels so that each panel, and therefore each month's measurement, is representative.[4]

Each month the BLS estimates a price relative that is used to move the previous month's consumer price index forward. For OER, there are two parts that determine the price relatives for a given area: the weights assigned to each segment and the rents for those segments. For each segment, weighting is based on the aggregate housing rents and aggregate owners' implicit rents from the 1990 Census. The owners' implicit rents are estimated using owner reported housing values as described in the previous section.

The price relatives (PR) for each PSU are estimated as follows:

$$PR_{p,t,t-6} = \frac{\sum_{i \varepsilon p} W_s \cdot R_{i,s,t}}{\sum_{i \varepsilon p} W_s \cdot R_{i,s,t-6}} \tag{1}$$

Where $PR_{p,t,t-6}$ is the price relative for period t to t-6 in area p, and W_s is the weight for houses in segment s.

The index $I_{p,t}$ is estimated by moving the index $I_{p,t-1}$ forward using the sixth root of $PR_{p,t,t-6}$, which approximates the one month change:

$$I_{p,t} = I_{p,t-1} \cdot \sqrt[6]{PR_{p.t.t-6}} \tag{2}$$

[4]Each segment is intended to produce five housing units for the sample. For the 1998 housing sample, 50,000 units were desired, so 10,000 segments were chosen. However, due to the low number of renters in some areas, the initial sample was approximately 25,000. To increase the sample size, an augmentation was done to increase the number of houses sampled in segments with 3 or fewer houses. This yielded an additional 10,000 houses. In 2010, the number of housing unit survey responses used in the estimation of the CPI was 57,015, which implies a sample of over 28,000 units (Crawford, Mauro, and Church, 2011).

3 Theoretical Justification for Rental Equivalence

It is not immediately obvious that rents should be used to measure inflation in owner-occupied housing services. Therefore, it is not immediately obvious whether market or average rents should be used. To understand which kind of measurement the BLS should be pursuing, it is necessary to first establish a justification for rental equivalence. In other words, how rents should be measured cannot be answered without first discussing why rents are measured in the first place.

Ultimately, all CPI measurement issues must be considered in light of the stated measurement goal of the CPI, which has explicitly been a cost-of-living index (COLI) since it was recommended by the Boskin Commission in 1995 and shortly after accepted by the BLS (Greenlees, 2006). [5] A COLI attempts to measure the changes in the cost of acheiving a particular level of satisfaction for a given consumer. The relevant satisfaction is assumed by cost of living theory to be a function of the consumer's utility function (Gillingham, 1983). Specifically, the BLS Handbook of Methods defines a COLI for the current month as answering the following question:

> What is the cost, at this month's market prices, of achieving the standard of living actually attained in the base period?

The cost of living measurement goal explains when and why inflation for durable goods should be measured differently than for non-durable goods. Usually consumer price indices, including the CPI, only consider expenditures on goods as all occurring in the period that the good is purchased. This is known as the acquisitions approach. The problem with an acquisitions approach for durable goods is that they represents a stock of services, whereas a cost of living theory assumes that welfare is determined

[5] Even before the BLS explicitly accepted cost of living theory as a measurement goal, it was considered a guide in dealing with operational problems (Greenlees, 2006). The BLS position here is consistent with a broad range of literature that agrees with this point including the Boskin Commission (Gillingham, 1983; Schultze and Mackie, 2002; Boskin Commission, 1996).

by the flow of services that a consumer receives from the durable good (Gillingham, 1983). Therefore, it is the price of that flow of services, and not the price of the stock, that should be measured in a COLI.

This conclusion implies that all durable goods in the CPI should be measured by the cost of their flow of services, not the price to acquire the asset. However, the the faster a good depreciates, i.e. the shorter its useful life, the more closely the acquisition approach will approximate value of the flow of consumption services. Clothing, for instance, is technically a durable good since the consumer may derive a flow of services from it for more than a year.[6] However, the relatively fast depreciation of clothing means it will likely not yield a useful life of more than a few years on average, and so inflation measured using the acquisition approach will not greatly differ from an ideal user cost approach. The separate treatment of housing is due to the fact that its useful life averages tens of years, and so the depreciation is much slower, and the divergence between acquisition cost and cost of the flow of services is potentially much larger.[7]

In recognition of this fact, the BLS focuses on measuring the cost of consuming housing services. However, the market price of owner-occupied housing services is not directly observable, therefore indirect measurement techniques must be used. There are two primary ways to measure housing services that are considered by price statisticians,and the BLS in particular: user cost and owners' equivalent rent (OER).

[6] The System of National Accounts defines a durable as "a good that may be used for purposes of consumption repeatedly or continuously over a period of a year or more", which Deiwert (2003) interprets more broadly as "it can deliver useful services to a consumer through repeated use over an extended period of time". The Stigler Commission acknowledges that since most goods are not consumed at the moment of purchase, durable is "an elusive concept" (Price Statistics Review Committee, 1961). They focus on commodities whose useful life is long enough that there is a relativey healthy used market.

[7] Some, including the Boskin Commission have argued that longer lived durables like automobiles should be considered as having significant enough useful life to justify departing from the acqusition approach, either by adopting a user cost or rental equivalence. Whether or not this is true is not clear, but is beyond the scope of this paper.

Over time OER has become the preferred measurement by statistical agencies and economists due to a number of issues, including some theoretical issues, but more importantly due to the complexity of actually measuring the components of user cost (Poole, Ptacek, Verbrugge, 2005).

The theoretical equality between OER and the user cost of housing has historically been an important justification for using OER. That is, the user cost represents the theoretically appropriate measurement, and OER should be equivalent to it. However, the empirical failure of this equality to hold has lead economists to increasingly recognized the so-called "opportunity cost" justification for rental equivalence as being more theoretically imporant (Pool, Ptacek, Verbrugge, 2005; Diewert and Nakamura, 2009; Diewert, Nakamura, and Nakamura, 2009). This takes several conceptual forms, but the underlying concept is that the rental price of a house represents the opportunity cost of owning it, i.e. owners could rent the house out and forego this rent to live there. Poole, Ptacek, and Verbrugge (2005) frame the opportunity cost approach as asking:

> How much richer would the homeowner be if he or she did not consume the housing services provided by a dwelling?

To answer this, it is argued, one should look at the rents that homeowners could have earned had they rented their homes instead of consuming the housing services.

The counterfactual choice that the opportunity cost considers makes it clear that what should be considered is market rents and not average rents. If a homeowner were to rent her housing services the price she could get is the current market price for those services. The average price consists of current market prices from past periods which are irrelevant to someone who wishes to sell housing services in the current market. The average price is a choice which is unavailable in the current period.

In addtion, there is some empirical evidence that homeowners also consider market rents and not average rents to be the value of their opportunity costs. Hoffman and Kurz (2004) look at estimates of implicit rent made by homeowners in a national survey from Germany. This survey asks homeowners:

> And if you lived in this flat or house as a tenant: what do you estimate would be the monthly rent without heating costs?

Note that the framing of the question biases the results in favor of an average rent. In contrast, a framing that would more accurately reflect the BLS's stated goal of the CPI would explicitly mention current prices. Despite this, the measure of implicit rent estimated by homeowners tracks market rents in the German CPI more closely than average rents. Figure 2 below, from Hoffman and Kurz (2004), shows that average rents diverge from rental equivalents reported by homeowners, whereas rents in new contracts, which reflect market rents, track them more closely.

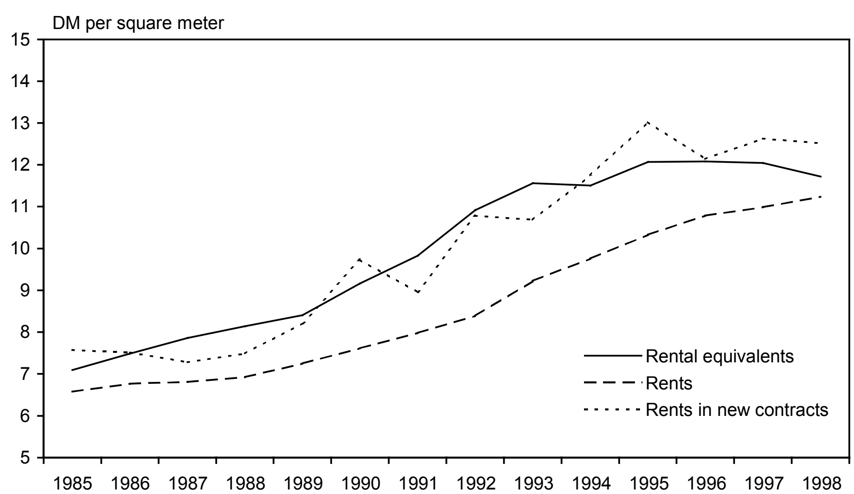


Figure 2: Rent Measure Comparison
Source: Hoffman and Kurz (2004)

While the average rents and imlicit rents are both smoother, the average rents have large deviations from new contract rents. From 1985 to 1992, rental equivalents rose 54%, and new contract rents rose 42%. In contrast, rents on average rose a significantly smaller 28%.[8]

In addition, in one of the few papers to explicitly consider the issue of market versus average rents, Shimizu, Deiwert, Nishimura, and Watanabe (2012) conclude that:

> Conceptually, the imputed rent is a rent level that a house owner can receive when leasing the house in the rental house market today. Therefore, the imputed rent always matches the market price.

Overall, the underlying theory, empirical evidence, and the general, albeit limited, conclusions of research in this literature clearly suggest that the opportunity cost justification for OER implies the CPI should measure the changes in market and not average prices.

4 Micro Rigidity and Macro Rigidity

For non-durable goods, the price a household pays for the consumption in a given period is typicallly set in that period. As a result, the average price, as measured by a survey of household spending, should be close to market prices of the actual goods and services consumed in that period, as measured by changes in average current prices. In contrast, housing rents are typically set in long-term leases and the amount that households pay every month change infrequently, and respond slowly to changes in market prices as contracts expire and are renegotiated. This nominal price rigidity of housing rents can create a large divergence between the two measurement methods. The following section will provide an overview of sticky rents, and the related phenomenon of tenure discounts.

Evidence on the extent of nominal rigidity in U.S. rents can be found in Genesove

[8] Data for these calculations provided by Claudia Kurz-Kim.

(2003), who documents rental rigidity in the U.S. from 1974-1981, and Verbrugge and Gallin (2012), who characterize rental rigidity using BLS micro data from 1998-2011.

Table 1: Average Lease Length

Lease Length	Percent
No Lease	15.5%
Less than one year	36.1%
Annual	44.4%
Greater than one year	4.0%

Source: POMS; Crone, Nakamura, Voith (2011)

Genesove creates an annual panel of AHS data from 1974 to 1981 which is unique because in all other periods the national AHS survey occurs only every other year. Annual change in rent is measured by looking at percent change in rent for each unit from one year of AHS data to the next. In all years there is strong evidence of nominal rigidity, with the percent of units with zero change in rent in a given year ranging from 23% to 34%, and averaging 29% across all seven years. He also reports on nominal rigidity in BLS micro data from 1988 through 1992, which shows that 37% of units surveyed had zero change in rent over 18 month periods. Verbrugge and Gallin find a larger amount of rigidity for 1998-2011, with 54% of units experiencing no change after 12 months. At 18 months they find 41% experience no change, which is higher than but close to what Genesove found for 1988 through 1992 with the same BLS micro-data. Collectively this evidence indicates that nominal rigidity has increased over the previous 37 years.

In addition to shorter-run rigidity, Verbrugge and Gallin document that for a significant portion of units there was no change in rent at longer intervals as well. As Table 2 shows, nominal rigidity remains even after two years for 34% of units in their data.

Given the compelling evidence of nominal rigidity in rents, the natural question

Table 2: Probability of Rent Change

Duration	Percent Decrease	No Change	Percent Increase
6-month	9%	69%	22%
12-month	11%	54%	36%
18-month	14%	41%	45%
24-month	15%	34%	51%

Source: Verbrugge and Gallin, (2012)

is why it occurs. In the literature on nominal rigidity in other goods, menu costs are a common explanation for sticky prices. However, landlords have no literal menus to change. Furthermore, while menu costs typically apply to a single seller of a homogeneous good that sets one price for many customers, housing is a heterogeneous good where prices are usually negotiated by bargaining between the two parties (Genesove, 2003). Therefore, the typical explanation for rent stickiness does not apply, and a different explanation must be found.

In addition to the obvious factor of long-term leases, other explanations found in the literature include grid pricing, when rents tend to change in intervals of $50, $100, or other discrete intervals greater than $1 (Verbrugge and Gallin, 2012; Genesove, 2003), and tenure discounts.

There are a variety of potential causes for tenure discounts, but the shared feature is that tenants receive rents below market value as their tenure length increases. Genesove (2003) hypothesizes that the convention of using previous period's rent saves the cost of information acquisition, bargaining time, and emotional stress of renegotiation for landlord and tenant. A similar transaction cost based explanation for tenure discounts focuses on the transaction cost of outside options. This occurs if, as tenure length increases, the cost of choosing an outside option increases for the tenant or the landlord. There is evidence that new tenant costs on the part of the landlord are substantial with one estimate of turnover costs related to painting, decorating, and lost rents of around $1,174 (Barker, 2003). Alternatively, a surplus for landlord and tenant to split via tenure discounts may arise from matches between "good" tenants and "good" landlords (Hubert, 1995).

Whatever the cause, there are several studies providing empirical evidence for tenure discounts. Genesove (2003) shows that 36% of units with continuous tenants experience nominal rigidity, compared to 14% for units with new tenants. In addition, he found that the median growth rates were higher for units with new tenants than for units with continuing tenants. In earlier work using the same data, he showed that third year tenants had rents that were an additional 5% lower (Genesove, 1999). Therefore, by the end of the third year, tenants had rents that were 9% below market rate. As shown in table 3, Verbrugge and Gallin (2012) found that 12-month rent changes, both positive and negative, are more common when a new tenant moves in.

Table 3: Probability of Twelve-Month Rent Change by Tenure

	Percent Decrease	No Change	Percent Increase
Continuing Tenant	10.1%	52.5%	37.4%
New Tenant	19.7%	27.6%	52.8%

Source: Verbrugge and Gallin (2012)

Regardless of the causes, nominal rigidity of rents and tenure discounts are a widespread phenomenon. Importantly, nominal rigidity appears especially likely to affect the subsample of rents that receive the most weight in the CPI housing sample in the OER estimation: single family homes. Almost half of detached homes in Genesove's sample report nominal rigidity compared to 13% in apartment buildings with more than 50 units.

However, while micro-rigidity in housing rents clearly exists, the relevant issue for inflation measurement is whether and to what extent micro-rigidity translates to macro-rigidity. Micro-rigidity means that at the individual unit level prices are slow to adjust to changes in market prices, whereas macro-rigidity refers to the aggregate measure of prices adjusting slowly to changes in underlying market prices. While a simple model of micro-rigidity based on Calvo price setting suggests that this would be the case, Caballero and Engel (2007) showed that aggregate price levels may be more flexible than is implied by nominal rigidity at the micro level.

Shimizu, Nishimura, and Watanabe (2010) (hereafter "SNW") apply the model of Caballero and Engel to housing rents and investigate the extent to which micro-rigidity translates into macro-rigidity using a panel dataset of rents from 1986 to 2006 in Japan.

SNW provide empirical evidence that the mitigating effects of endogenous rent changes in Japan do not prevent a significant divergences between average and market rent for Japan. Using their lease level dataset, they use a hedonic model of rents to estimate market rents and show what the overall CPI for Tokyo, Japan would have looked under alternative levels of nominal rent rigidity. As shown in 3 below, inflation using market rents is initially higher than the official CPI and then lower. The higher period corresponds to a housing bubble in Japan, and the lower power corresponds to a housing bust.

Overall, they found that if Japan had flexible rents, which corresponds to the market rent measure, measured inflation would have increased by 1% faster during the house price bubble period in Japan, decreased by 2% faster during the house price bust, and showed deflation starting a year earlier. In contrast, during the relatively stable mild deflationary period at the end, there was far less divergence between the two measures.

Figure 3: Actual Tokyo CPI Compared To CPI With Market Rent Measure
Source: Shimizu, Nishimura, Watanabe (2010)

5 Measuring Market Rents

The simplest way to measure changes in market rents would be to use the price relative approach currently used in the CPI, except only using observations where leases and tenants in a unit are new in that month. However, generating a price relative requires there to be an observation in consecutive periods. If using the BLS panel approach, this would mean finding units that not only have a new lease in the current period but also a new lease six months ago and taking the sixth root of the price relative. Since the majority of leases are 12 months in length, this would mean finding a large dataset of tenants, throwing out most observations, and using a possibly non-random subsample.

Instead, econometric methods can be used to estimate constant quality measures of rental inflation. The general approach to econometric models of rent inflation has been to extend approaches used to measure house price inflation to rents (SNW, 2010; Ambrose, Coulson,Yoshida, 2012). The two most common models used are hedonic regression and repeat sales.

Broadly speaking, the hedonic approach models the log of house prices as a function of housing characteristics, a vector of dummies indicating the period of sale, and an error term. The housing characteristics control for quality differences and the time dummies are used to create a price index. However, hedonic indexes have several shortcomings. However, due to the shortcomings of hedonic models[9], repeat sales models are often used. The popular Case-Shiller indexes utilize a repeat sales methodology as does the Conventional Mortgage Home Price Index (CMHPI) produced by the Office of Federal Housing Enterprise Oversight (OFHEO) (Calhoun, 1996). This method, first described by Herman Wyngarden in 1927 and later rediscovered from obscurity by Carl Case in 1986 (Shiller, 1987), only uses information on sales that have transacted more than once during the timeperiod of the index. The primary advantage of this over hedonic models is that it forgoes specifying a relationship between housing characeristics and price. Instead, characteristics of the house are either assumed to have not changed between sales, or, when data are available, only homes that have not changed over time are used in the index. Therefore, for these homes, the changes in prices are pure appreciation that is not dependent on quality or other characteristics of the home.

The repeat-rent and repeat-sales methods assume that the price of a house i at

[9]One is that they can be biased if the correct functional form is not specified, or if an incomplete or incorrect set of hedonic variables is used. Futhermore, because different researchers tend to use different functional forms, housing characteristics, error specifications, and dependent variable transformations, this method is sometimes regarded as not entirely reproducible (Diewert, 2009). Collecting a complete set of housing characteristic variables can also be difficult, as some data, particularly neighborhood characteristics, is simply unavailable for many attributes that would be expected to have large impacts on the value of a house (Case, Pollokowski, Wachter, 1991).

time t, P_{it}, is the product of a market price index β_t, gaussian random walk H_{it}, and white noise process η_{it}:

$$P_{it} = \beta_t H_{it} \eta_{it} \tag{3}$$

$$ln\left(P_{it}\right) = \beta_t + H_{it} + \eta_{it} \tag{4}$$

Then the percentage change in the price of house i sold in time periods t and s, with $t > s$, is:

$$\begin{aligned} \Delta V_i &= ln\left(P_{it}\right) - ln\left(P_{is}\right) \\ &= \beta_t - \beta_s + H_{it} - H_{is} + \eta_{it} - \eta_{is} \end{aligned} \tag{5}$$

Every observation then consists of two transactions. Let $D_{i\tau}$ represent a dummy variable equal to 1 if house i transacted for a second time in time period τ, and equal to -1 if it transacted for the first time in period τ. Then equation ΔV_i can be rewritten as:

$$\Delta V_i = \sum_{\tau=0}^{T} \left(P_{i\tau}\right) D_{i\tau} \tag{6}$$

Then from the assumptions that $E\left[H_{it} - H_{is}\right] = 0 \ \forall \ t, s$ and $E\left[\eta_{it} - eta_{is}\right] = 0 \ \forall \ t, s$, we can write ΔV_i as:

$$\Delta V_i = \sum_{\tau=0}^{T} \beta_\tau D_{i\tau} \tag{7}$$

This formulation allows the estimation of the repeat-rent price index I_t as:

$$I_t = e^{\beta_t} = \frac{E[R_t]}{E[R_0]} \tag{8}$$

6 MLS Rental Data

The evidence from SNW (2010) suggests that micro-rigidity of rents translates to macro-rigidity, which slows the transmission of a housing bubble into average rent inflation compared to market rent inflation. To test whether a market rent series would outperform the actual CPI in terms of forecasting overall inflation, a new dataset of rents that are geographically concentrated in one BLS sampling area will be used to compute a market rent series to compare to the official BLS CPI for that area.

This exercise will show whether the market rent series reflects inflation faster than the official CPI measurement. One advantage of this data set is that it is based on rents for single-family housing units, which makes it more similar to the owned housing stock for which housing inflation is being proxied.

In addition, this data allows for a statistical test comparing market rents to the actual CPI as an inflation measure. Given the Federal Reserve's need to be forward looking, previous research has compared inflation measures by their ability to forecast future inflation (Crone, Khettry, Mester, and Novak, hereafter CKMN, 2011). The estimated market rent inflation series can be compared to official inflation estimates to see if the new measure better forecasts overall future inflation. In addition to the theoretical arguments for using market rent discussed in previous sections, if market rents are found to better forecast overall inflation, it will be evidence in favor of the BLS adopting this measure.

The dataset for this comes from MRIS, a large Multiple Listing Service (MLS) in the Mid-Atlantic area. MLSs are organizations usually run by one or more local boards of Realtors for the purposes of providing a web portal Realtors can use to list and search for housing for sale. Datasets compiled from MLS transactions have been a rich source of information for real estate economics studies. A recent meta-analysis of 71 housing price studies found that 45% of the studies utilized MLS data (Sirmans, MacDonald, Macpherson, and Zietz, 2006). Some MLSs also collect and make available on their web portals data on rental units, because Realtors will sometimes list rental units for a landlord client. This is the second study to date to utilize MLS rental data.[10]

The MRIS dataset has several quality advantages over other listing data. Importantly, Realtors utilizing the MLS are required to enter a final lease price in addition to a listing price. In addition, because MRIS uses the rental data for their own analysis and marketing reports, they perform quality control measures and contact Realtors who have posted a listing if the data appear suspicious.

The dataset contains 276,158 single family unit listings from 2000 to 2012, 41.1% of which are in Maryland, 54.7% are in Virginia, 2.6% are in Washington D.C., with the small remainder scattered throughout other Mid-Atlantic states.[11] Each listing contains the following information on the unit: address, building type, number of bedrooms, number of bathrooms, year built, and total unit square footage. Each listing also contains the following information on the unit's lease: date listed, original listing price, final leased date, final leased price, lease length, required security deposit amount. The dataset also contains a string variable that indicates what services are included in the price of rent that can be parsed to produce dummy variables indicating

[10]One other example of the MLS rental data used by economists is a short note published by CoreLogic using their proprietary MLS rental dataset which has not yet been made publicly available. See Khater (2012).

[11]There are 90,132 that are for multi-family or other non-single family unit types that are not included in the analysis. These are excluded because different units in the same address cannot be tracked over time. This provides the added benefit of more closely matching the predominantly single-family universe of owner-occupied housing for which OER is being imputed. In addition, there were a small percentage dropped for data cleaning purposes. Dropped observations include: 537 with lease terms over 10 years, 99 with unit size over 10,000 sf, 13 with missing rent or list price data, 788 where rental price was less than 50% or greater than 150% of the list price, and a single unit with a list price of $1. Finally, when there was more than one observation for a unit in a given month, the last listing was kept, which resulted in 552 duplicate observations being dropped. Overall, 1,991 or 0.7% of the single-family units were dropped due being outliers or duplicates.

if a unit's rent includes various amenities, such as heating or parking.

Due to the data's significant coverage of a specific geographic region, a repeat-rent index can be estimated that can be compared to the official BLS estimate of owner-occupied housing inflation for that same area. As discussed in Chapter **??**, the BLS surveys 87 geographic areas known as Primary Sampling Units (PSUs) for its housing survey. The PSUs A312 and A313 consists of 33 counties in DC, WV, MD, and VA. As Table 4 below indicates, there are 159,1798 repeat-rent observations in the 33 counties in these two PSUs. This coverage allows for the creation of a repeat-rent estimate of market rent inflation for the Baltimore/Washington D.C. CMSA that is comprised of these two PSUs.

Compared to typical repeat-sales datasets, there are a large number of repeat-rent observations in the MRIS data. The repeat-sales studies summarized in Table **??** list repeat-sales percentages that make up 3.2% to 14.5% of the data. As the table below shows, repeat-rent observations make up over 60% of the cleaned MRIS data, illustrating that most observations can be used in a repeat-rent analysis. Only 101,503 out of the total of 261,311 cleaned transactions are for individual units that have no repeat-rents which leaves the 159,798 usable observations.

7 Inflation Comparison

The basic repeat-rent estimate from section 5 can be used to estimate a price index for January, 2000 through September, 2012. Figure 4 below displays the estimated index alongside the CPI for owners' equivalent rent of primary residence in Washington-Baltimore, DC-MD-VA-WV CMSA.

The most obvious difference between the two series is the seemingly implausibly fast growth in 2001, at times exceeding 10%. This fast growth appears in both a hedonically estimated index and a simple median rent index, so it does not appear

Table 4: Repeat-Rent Observations in PSUs A312 and A313

County	State	Repeat-Rent Observations	Total OOH Units	County Share of Repeat-Rent	County Share of OOH
District Of Columbia	DC	3,185	110,853	2.0%	5.3%
Anne Arundel	MD	10,156	147,829	6.4%	7.0%
Baltimore	MD	3,270	209,260	2.0%	10.0%
Baltimore City	MD	3,372	117,500	2.1%	5.6%
Calvert	MD	2,491	25,293	1.6%	1.2%
Carroll	MD	569	49,690	0.4%	2.4%
Charles	MD	3,966	40,580	2.5%	1.9%
Frederick	MD	2,333	64,670	1.5%	3.1%
Harford	MD	2,308	72,443	1.4%	3.4%
Howard	MD	3,866	77,803	2.4%	3.7%
Montgomery	MD	17,907	243,751	11.2%	11.6%
Prince Georges	MD	8,065	191,829	5.0%	9.1%
Queen Annes	MD	836	14,574	0.5%	0.7%
Washington	MD	544	37,131	0.3%	1.8%
Alexandria City	VA	4,558	28,403	2.9%	1.4%
Arlington	VA	4,637	42,696	2.9%	2.0%
Clarke	VA	178	4,387	0.1%	0.2%
Culpeper	VA	846	11,654	0.5%	0.6%
Fairfax	VA	40,221	270,928	25.2%	12.9%
Fairfax City	VA	498	5,958	0.3%	0.3%
Falls Church City	VA	450	3,024	0.3%	0.1%
Fauquier	VA	2,109	18,216	1.3%	0.9%
Fredericksburg City	VA	1,403	3,650	0.9%	0.2%
King George	VA	484	6,132	0.3%	0.3%
Loudoun	VA	11,787	81,476	7.4%	3.9%
Manassas City	VA	896	3,326	0.6%	0.2%
Manassas Park City	VA	406	2,816	0.3%	0.1%
Prince William	VA	15,264	94,406	9.6%	4.5%
Spotsylvania	VA	4,654	32,285	2.9%	1.5%
Stafford	VA	6,626	32,278	4.1%	1.5%
Warren	VA	372	10,272	0.2%	0.5%
Berkeley	WV	923	29,982	0.6%	1.4%
Jefferson	WV	618	15,049	0.4%	0.7%
Total		159,798	2,100,144	100%	100%

Table 5: Count of Transactions by Number of Repeat-Rents

Num. Per Unit	Count of Obs.	% of Obs.	Cumulative %
0	101,513	38.9	38.9
1	68,248	26.1	65.0
2	42,453	16.3	81.2
3	25,068	9.6	90.8
4	13,310	5.1	95.9
5	6,414	2.5	98.4
6	2,737	1.1	99.4
7	1,064	0.4	99.8
8	360	0.1	99.9
9	110	0.0	100.0
10	22	0.0	100.0
11	12	0.0	100.0
Total	261,311	100	

to be either a quality adjustment or repeat-rent methodological issue.

Further visual inspection of the two indexes in Figure 4 reveals several things. First, while both series are not seasonally adjusted, the repeat-rent series displays higher seasonality. The series diverge at first, with the repeat-rent series growing faster, then converge by 2007 when the CPI grows more quickly, and finally converge again by 2011. Looking at levels also show that the housing bubble burst appears more clearly in the market rent series. The Case-Shiller for the Washington-Baltimore CMSA declined 33.9% from the peak in May of 2006 to March 2009. Over this period OER increased by 10.7% while the market rent series only increased 1.6%.

Looking at the series in one-month changes, the differences between repeat-rent and the CPI series become more stark. The repeat-rent series is far more volatile, with a standard deviation of .0078 compared to .0026 for the CPI series. Given that the CPI series uses a six-month averaging, its lower volatility is unsurprising. Figure 6 below illustrates the effect of a six-month smoothing on the repeat-rent series. It is closer in volatility to the CPI, with a standard deviation of .0042.

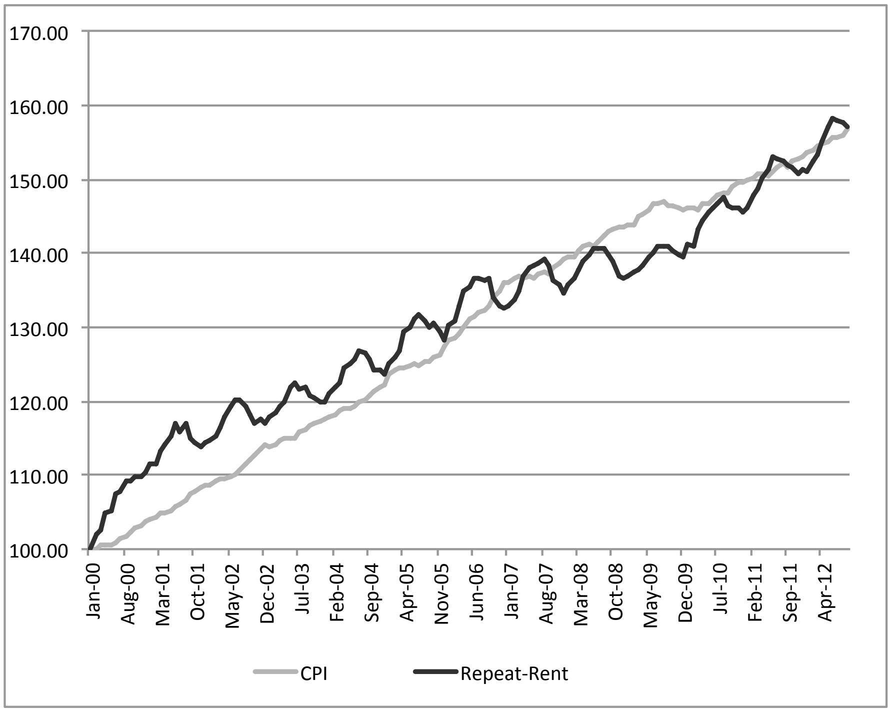


Figure 4: Repeat-Rent Index Compared to CPI for OER

To abstract from the issue of seasonality in each series, year-on-year changes, a common form in which CPI changes are reported, can be examined. As seen in Figure 7 below, the difference in volatility is only slight, with the CPI having a standard deviation of 0.0127, and the repeat-rent series having a standard deviation of 0.0193. In fact, if the first year of idiosyncratic high growth in the repeat-rent is excluded by looking at the 2002 and forward standard deviations, the repeat-rent series is less volatile than the CPI, at 0.0125 versus 0.0128 respectively.

The year-on-year changes illustrate several crucial trends for the DC/Baltimore area. First, as indicated by the levels, the housing bubble did not show up more starkly in the repeat-rent series. In fact, while the CPI increased from an average of 4% inflation to 6% inflation from 2006 through 2007, the repeat-rent series remained steady. However, between 2003 and 2006, the repeat-rent series did have a gradually increasing inflation rate, which nevertheless remained below or near the CPI inflation

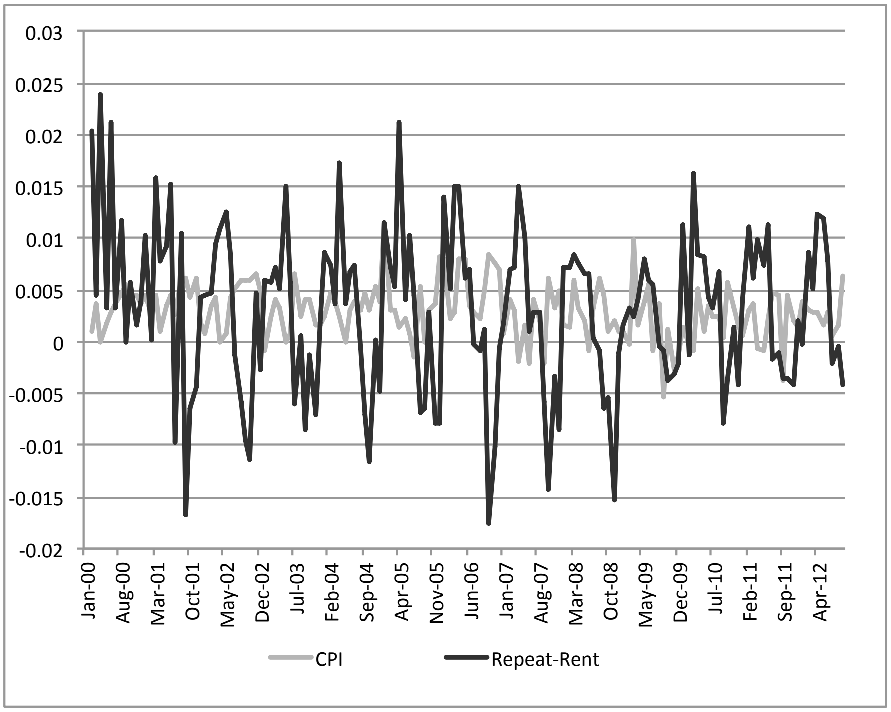


Figure 5: Repeat-Rent Compared to CPI for OER
One-Month Changes

over this period.

Another crucial pattern illustrated in the year-on-year graph is that the repeat-rent series reflects market turning points more quickly. These can be seen by comparing the two series to the Case-Shiller house price index for Washington DC, which is shown in Figure 8 below.[12]

The axis on the right provides the scale for the HPI, and the axis on the left for the CPI and repeat-rent measures. While Case-Shiller tracks closely to the repeat-rent measure, the variation is much larger in the HPI.

The Case-Shiller index begins the deacceleration that marked the start of the end of the housing bubble in May 2005 as it declines from the peak growth rate of 26.8% in the previous month. The CPI begins deacceleration one year and seven months

[12]To extrapolate from the idiosyncratic early growth in the repeat-rent series, only 2003 and forward are shown.

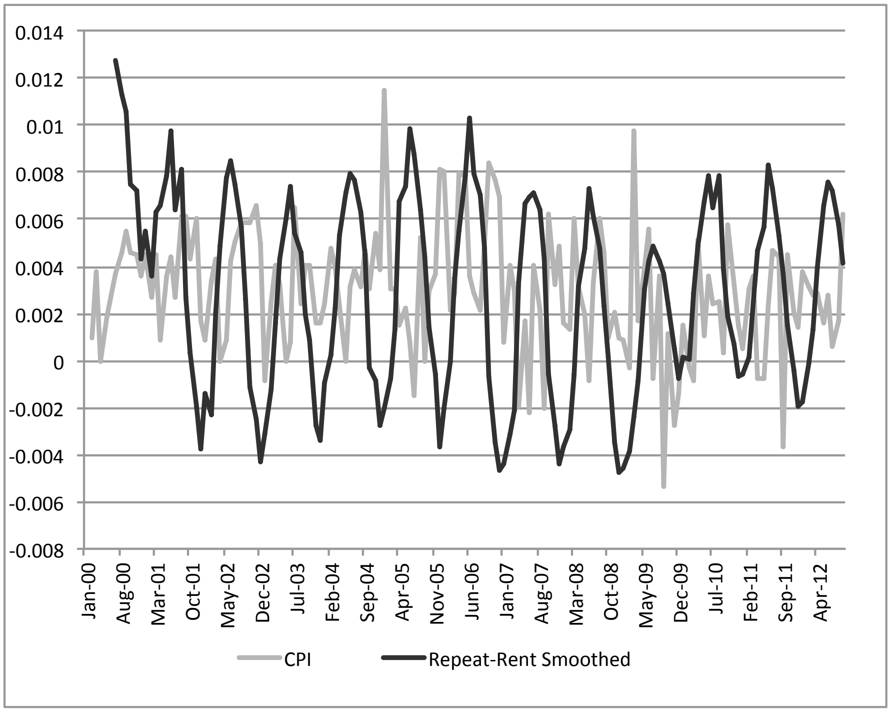


Figure 6: Smoothed Repeat-Rent Compared to CPI for OER
One-Month Changes

later in December 2006, a month after achieving the peak bubble period year-on-year growth rate of 6.9%. The repeat-rent index begins deaccelerating two months earlier than the CPI, beginning the decline in October from the previous month's peak of 5.0%.

The bottom of the housing bust is reflected even more quickly in the repeat-rent series. The second derivative of the HPI changes in January 2009 as prices start declining at a slower pace. The previous month was the largest decline in the housing bust, at -19.6%, and from January on, things began declining at a slower rate. The CPI did not stop deaccelerating until July, 2010. The previous month, it reached the low point of its growth rate at 0.4%, and began growing increasingly quickly after that point. The repeat-rent series began turning around in May of 2009, fourteen months before the CPI. It reached its lowest growth rate the previous month of -0.4%, and conditions began improving thereafter.

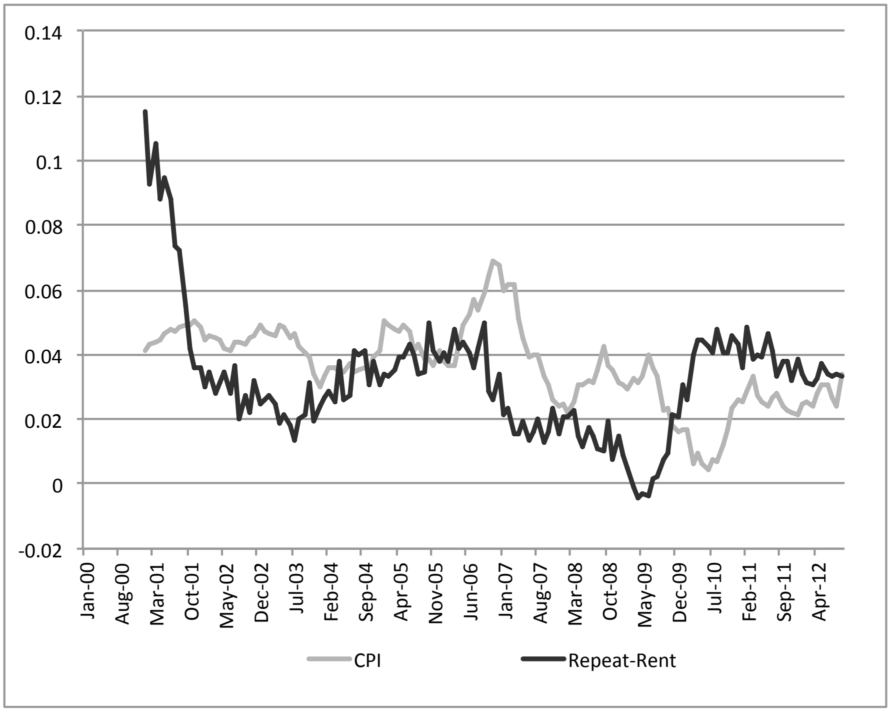


Figure 7: Repeat-Rent Compared to CPI for OER
Twelve-Month Changes

The recovery stall in late 2010 shows up in the repeat-rent series very close to when it shows up in the HPI, but is not reflected in the CPI until around a year later.

8 Forecasting Comparison

While visual inspection provides evidence that the repeat-rent series is able to reflect underlying market changes in a more timely manner, econometric evidence can also be brought to bear. If it can be shown that a particular measure of inflation better predicts total future inflation than total future inflation predicts itself, then this is evidence that the measure is more useful for necessarily forward looking monetary policy. Past research has focused on comparing different measures of core inflation to overall inflation. Blinder and Reis (2005) look at core CPI's ability to forecast overall CPI, whereas CKMN include the additional measures of CPI less energy, the

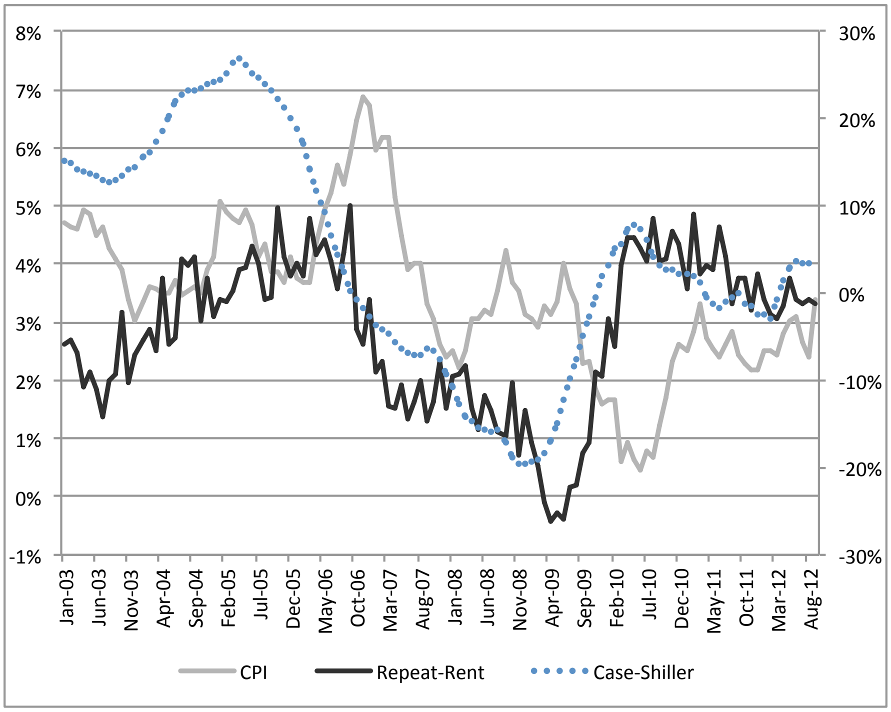


Figure 8: Repeat-Rent Compared to CPI for OER and Case-Shiller for D.C., Year-on-Year Changes

Note: CPI and Repeat-Rent estimates use the left axis, and the Case-Shiller for D.C. uses the right axis.

Cleveland Fed's weighted median CPI, and also similarly analyze PCE inflaiton. In light of the past literature, there are two potential analysis that can done to determine whether repeat-rent provides a superior measure of OER.

First, it will be determined whether repeat-rent forecasts current OER better than current OER forecasts itself. Additionally, it will be seen which measure better forecasts overall inflation. It could be, for instance, that repeat-rent is a better predictor of the current OER measure, but that the current OER measure better forecasts overall inflation due to the added volatility of repeat-rent.

Several studies support the use of univariate inflation forecasts (CKMN; Ang, Bekaert, and Wei, 2007; Stock and Watson, 2007; and Blinder and Reis, 2005) which greatly simplifies the exercise compared to a multivariate model. Following CKMN and Blinder and Reis (2005), the following univariate model will be employed:

$$\pi_{t,t+h} = \alpha + \beta X_{t-12,t} + \epsilon_t \qquad (9)$$

Where $\pi_{t,t+h}$ is the percentage change in total inflation from t to $t+h$ for the Baltimore/Washington D.C. CMSA, and $X_{t-12,t}$ is the twelve month percentage change from $t-12$ to period t in either the market rent inflation series or the official BLS CPI for owners' equivalent rent for Baltimore/Washington D.C. CMSA.

Following Reis and Blinder (2005) and CKMN, future inflation will be forecast at intervals of h = 6 months, 12 months, 24 months, and 36 months. Rolling regression forecasts will be computed using a window of 60 months for estimation. For example, the earliest forecast period is January 2006. The model for this month was estimated using the 60 months from January 2001 through December 2005. For the next forecasted period, February 2006, the model was reestimated using February 2001 through February 2006. A rolling forecast as used by CKMN has two advantages over the fixed period forecast used in Reis and Blinder (2005): it allows parameters to change over time reflecting underlying structural change, and it reduces the influece of parameter estimation noise (CKNM).

Three measures of overall inflation are used for $\pi_{t,t+h}$. First, owners' equivalent rent of primary residence in the Baltimore/Washington D.C. MSA used, which is the also the the second independent variable. This is used to determine whether market rent can forecast OER better than it can forecast itself. In addition, two measures of overall inflation are used: overall CPI for the U.S. and overall CPI for the Southern Census region, which includes the Baltimore/D.C. MSA.[13]

Figures 10 through 11 show the forecasts and the actual values for the three

[13]Inflation for the Baltimore/D.C. MSA is the most applicable measure of overall inflation, however for this area overall inflation is only measured every other month.

measures of inflation and four forecast horizons. Overall, visual inspection suggests that forecasts using repeat-rent tend to more closely track actual values than forecasts using OER.

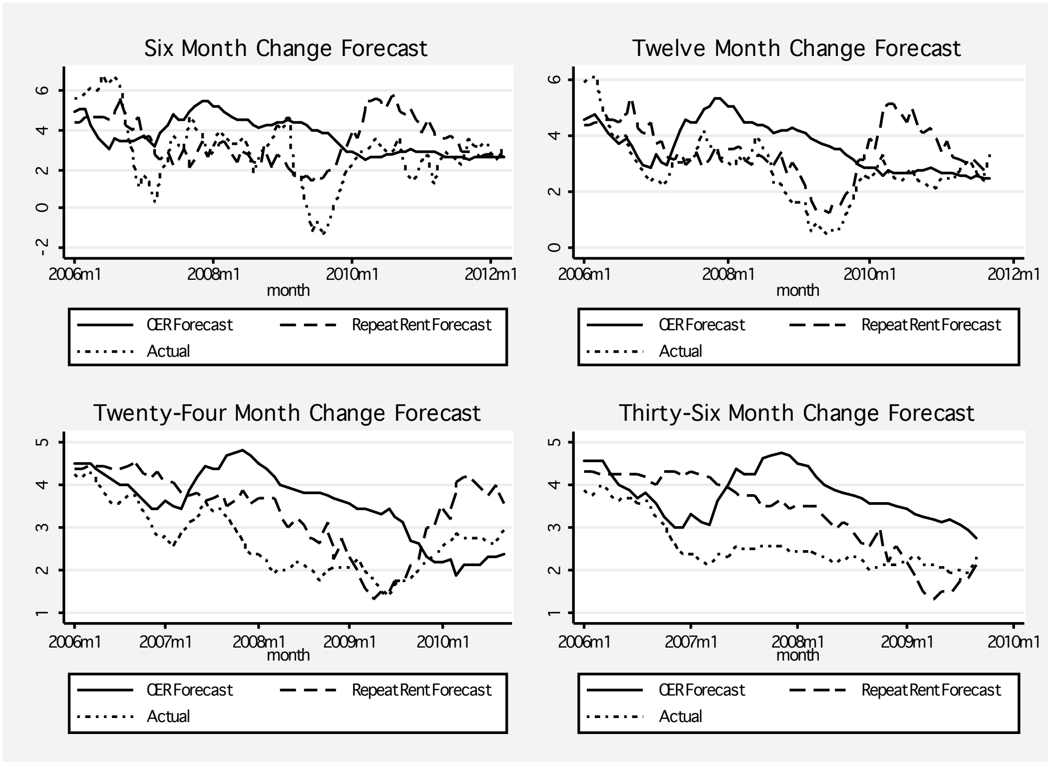


Figure 9: Forecast Comparison
$\pi_{t,t+h}$ = OER, Washington-Baltimore CMSA

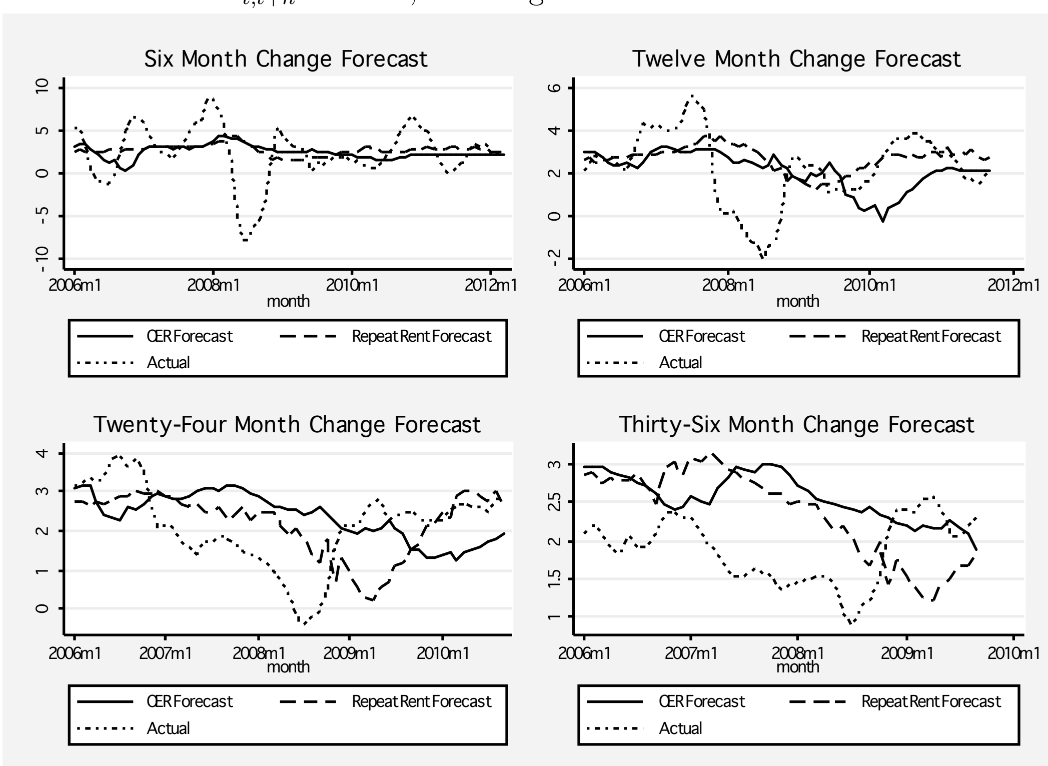


Figure 10: Forecast Comparison
$\pi_{t,t+h}$ = Overall CPI, National

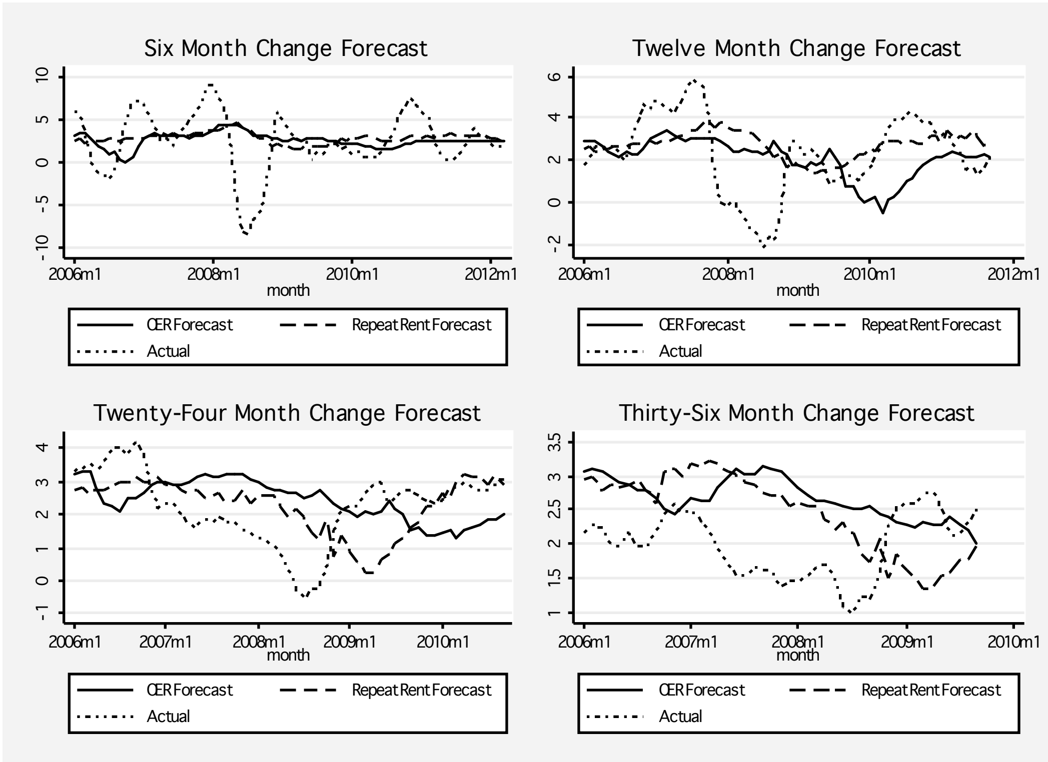


Figure 11: Forecast Comparison
$\pi_{t,t+h}$ = Overall CPI, South Region

A first test of forecasting accuracy is to compute root mean squared errors for each forecast. In addition, to test for differences in forecasting accuracy between the two inflation measures, the Giacomini-White statistic for differences in mean squared errors will be used. This statistic compares a baseline forecasting model with an alternative using the following statistic:

$$\lim_{n\to\infty} \frac{\frac{1}{n}\sum\left(\varepsilon_{b,t}^2 - \varepsilon_{a,t}^2\right)}{\sqrt{\sigma^2/n}} \xrightarrow{d} N\left(0,1\right) \tag{10}$$

Where $\varepsilon_{b,t}$ is the residuals from the baseline model, and $\varepsilon_{a,t}$ is the residual for the alternative model. In this exercise, the CPI measure of OER will be the baseline, and the repeat-rent measure will be the alternative.

Following CKMN, the Newey-West method to correct for autocorrelation is used to estimate the variance using a lag of $h-1$. The result is a two-sided test statistic. If the baseline model forecasts better than the alternative, then the squared errors for the baseline will be smaller than the alternative on average, and the test statistic will be negative. If the alternative outperforms the baseline, then the opposite will be the case. Therefore, positive and significant value for the GW statistic suggests the repeat-rent measure performs better, and a negative and statistically significant value suggests the CPI measure performs better.

As shown in Table 6 below, the repeat-rent measure of inflation generally produces more accurate forecasts using RMSE criteria and GW tests. The RMSE for the repeat-rent measure is always smaller. In ten out of twelve GW tests, the repeat-rent measure statistically significantly outperforms the CPI measure at at least a 10% significance level and in most cases the 0.1% significance level, and in the other two cases the GW statistic is positive, indicating repeat-rent performs better, but is not statistically significant. Importantly, the CPI measure never performs statistically significantly better than repeat-rent.

Overall, the evidence suggests that the repeat-rent measure performs better at forecasting total inflation.

Table 6: Measures of Forecasting Performance

Forecasting OER, Washington-Baltimore CMSA						
h	RMSE: OER	RMSE: RR	Mean ε^2 Diff.	GW	p-value	N
6	1.934	1.650	1.020	6.882	0.000	75
12	1.432	1.170	0.681	4.781	0.000	69
24	1.245	0.872	0.789	10.377	0.000	57
36	1.322	1.001	0.746	9.793	0.000	45
Forecasting Overal CPI, National						
h	RMSE: OER	RMSE: RR	Mean ε^2 Diff.	GW	p-value	N
6	3.376	3.348	0.188	2.527	0.007	75
12	1.852	1.737	0.411	3.997	0.000	69
24	1.300	1.113	0.450	9.833	0.000	57
36	0.932	0.929	0.007	0.437	0.332	45
Forecasting Overall CPI, South Census Area						
h	RMSE: OER	RMSE: RR	Mean ε^2 Diff.	GW	p-value	N
6	3.651	3.632	0.138	1.529	0.065	75
12	2.030	1.910	0.474	3.568	0.000	69
24	1.400	1.182	0.563	11.136	0.000	57
36	0.948	0.939	0.016	0.886	0.190	45

9 Conclusion

The Case-Shiller house price index for the Baltimore/Washington D.C. CMSA declined 33.9% from the housing bubble peak in May of 2006 to the first bottom in March 2009. Over this period the BLS measure of owner-occupied housing inflation increased by 10.7%. In contrast, the market rent measure estimated in this paper only increased 1.6%. This suggests that the use of this alternative measure of owners' equivalent rent would have reduced the divergence between house prices and owner-occuppied rent inflation by 20%.

In addition, the housing bubble peak shows up two months earlier in the market rent series, the bottom in terms of year-on-year growth showed up fourteen months earlier, and the 2010 recovery stall showed up nearly a year earlier. In all cases this brought the turning points closer to their timing in the house price index. In one important example, the fastest drop in year-on-year prices in the HPI came in December, 2008 while the CPI did not reach its bottom until June, 2010. For the market rent series, this bottom came only four months after the HPI in April, 2009.

Following the literature on choosing among alternative measures of inflation (Crone, Khettry, Mester, and Novak, 2011), the ability of the market rents to forecast overall inflation better than the existing BLS measure provides additional evidence in favor of this measure. Beyond these practical considerations, market rent has the added benefit of being a more theoretically correct measure based on the opportunity cost justification for rental equivalence.

Another contribution of this research is to offer a specific potential source of data that the BLS could use to construct market rent measures. Over the past decade, MLSs have become an increasingly utilized resource for those looking to rent out single-family residences. One possible objection to this data source is that the universe of single-family homes that are for rent on an MLS differ systematically from the average single-family rental. However given that inflation focuses on price changes, differences in levels are not by themselves problematic. In addition, the opportunity cost justification for rental equivalence indicates that the relevant prices are those that would be faced by current homeowners deciding to rent out their homes. If this counterfactual is taken seriously, it seems likely that the prices prevailing in the single-family MLS rental market are more relevant than the prices charged by landlords that market the properties on their own. In other words, if MLS single-family rentals have systematically different inflation rates than other single-family rentals, then perhaps the MLS market is the more relevant.

Future research should consider the extent to which MLS data sources can be used to construct nationally representative market rent measure to replace the current BLS measure of OER. Speficially, CoreLogic's single-family rental dataset that is currently under development represents an important potential source of national MLS rental data (Khater, 2012). In addition, given that nominal rent rigidity will differ across the country, it should be examined whether national market rent outperforms the current BLS measure similarly as the findings for the Baltimore/Washington D.C. CMSA. It may be that endogeneous price changes further mitigate the divergence at the national level. Alternatively, it may be that the divergence is greater, and that the national market measure not only reflects the housing burst better but also the housing bubble. In this case a market rent measure would not only allow the Federal Reserve to be more proactive in reacting to the deflationary impacts of a bursting housing bubble, but perhaps also counteract the bubble before it bursts. This would allow the Federal Reserve to respond to critics that suggest more should be done to stop housing bubbles without altering their existing mandate.

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