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The Price to Rent Ratio: A Macroprudential Application

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Abstract

We examine the potential for the price-to-rent ratio to be used as a macroprudential tool. The comparable sales and replacement cost appraisal methods are not designed to identify speculative housing markets. However, in addition to the standard appraisal, appraisers could estimate the current market rent for a property. The resulting price-to-rent ratio would provide a useful signal for speculative pressures. We illustrate this by estimating price-to-rent ratios for home purchases using the American Housing Survey. We show that the distribution of price-to-rent ratios shifted up dramatically during the housing boom. We illustrate how the price-to-rent ratio could be incorporated into a lending policy so as to generate countercyclical loan-to-value ratios.

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Intro …

Can Appraisals Warn of Speculative Housing Markets?

An appraisal is an important element of underwriting a mortgage for a house purchase. The role of the appraisal is to provide the lender (and the buyer) with an independent assessment of the collateral value of the house and property. To guard against any credit losses from a default and foreclosure, lenders will typically loan only up to a percentage of the appraised value. This requires the borrower to contribute equity in the form of a down payment equal to the difference between the purchase price and the loan amount. The borrower's equity is in a first loss position providing credit protection to the lender. So long as the borrower has positive equity, the borrower also has a financial interest in maintaining the property.[1]

The housing bust starting in 2007 resulted in house prices nationally decline by 30 percent. The steep declines in house prices across many local housing markets left many borrowers with no equity in their homes. Those households that also experienced a job loss during the ensuing recession were at high risk of defaulting and losing their house through foreclosure. One explanation for the steep declines in house prices is that during the preceding boom period house prices became disconnected from local market fundamentals. The process of house prices reverting back toward fundamental values, therefore, involved a significant downward price correction. The income losses from the severe recession also adversely impacted the demand for housing. In addition, the high house prices during the boom encouraged builders to increase the pace at which they were building new houses. This added housing supply exacerbated further this downward correction in prices.[2]

Did the boom and subsequent bust in house prices reflect, to some degree, reflect a failure of the appraisal process? Should appraisals have provided a guard against house prices becoming materially disconnected from market fundamentals? To examine this, we need to look at the different appraisal methods and see whether they are robust to the types of non-fundamental influences on house prices that occur during a boom.

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[1] For a detailed discussion see Haughwout, Sutherland and Tracy (2013).

[2] See Haughwout, Peach, Sporn and Tracy (2013) for a discussion of how the durability of housing affects price adjustments to demand changes.

The most common appraisal method is the comparable sales approach.[3] Here, the appraiser selects a set of homes that have recently sold in the same local housing market and that the appraiser judges to be roughly comparable to the house being appraised. The appraiser then makes value adjustments to reflect any quality differences with these earlier sales. The resulting appraisal value reflects what the appraiser would expect this house to sell for in current market conditions. Fundamentally, this is a relative value assessment exercise. The comparable sales approach should guard the lender against a situation where the borrower overpaid relative to what previous households have paid for similar properties. However, the comparable sales appraisal method does not guard against the current market conditions being influenced by speculative behavior—and consequently all of the comparable sales having taken place at prices above fundamental market values.

A second appraisal method is the replacement cost approach. Here the appraiser evaluates what it would cost to duplicate the current house by purchasing land and building a similar house. Adjustments are made to take into account the age of the house and the associated depreciation that would be expected relative to a new house. The largest component of the replacement cost is the land. Haughwout et al (2013) construct land price indices for several metropolitan housing markets during the boom period.[4] They show that the speculative pressures that drove up house prices were reflected to even a greater degree in land prices. So, again, if an appraiser is using the current market value of land to generate a replacement cost appraisal, any speculative behavior that would have impacted comparable sales will also impact the estimated replacement cost through its influence on land prices. Consequently, neither the comparable sales nor the replacement cost appraisal methods are suited by design to pinning appraisal values to market fundamentals.

The third appraisal method is a cash flow approach. Here the appraiser estimates what the house would rent for and projects these rental values as well as associated costs to the owner into the future. These cash flows are discounted to arrive at a valuation. A complexity in using this approach is that many houses that are for sale may not have equivalent counterparts that are available for rent. That is, comparable rentals may not be available to use as a guide to assess the appropriate market rent. The appraiser, then, will need a way of inferring from existing rentals in the local market what this house would rent for in the current market. This is the same problem that the

[3] See for example Appraisal Institute (2013).

[4] Haughwout et al (2008) find the same pattern for New York City land prices relative to house prices.

U.S. Bureau of Labor Statistics faces in computing the owners-equivalent rent that is incorporated into the consumer price index.[5]

Consider a simplified cash flow approach where the appraiser is asked to estimate only the current annual rent for the house. Would this rental assessment be more grounded in current market fundamentals than the other two appraisal methods? If house prices are buoyed by speculative behavior, will this also be reflected in rents? An important point, is that a renter is paying only for the value of the current housing services provided by the house. Today's rents should not reflect the expectation of the future value of these housing services. Therefore, factors that affect the future demand and supply of housing—including speculative sentiments—should not be reflected in current rents.[6] As such, rents should reflect current fundamental conditions in the local market that impact the demand and supply for rental housing. Since the rental market is a spot market, and not an asset market, rents are more firmly tied to current market fundamentals than prices.

Rents, therefore, offer the best avenue for appraisers to be able to assess if house prices are departing from fundamental values. What is needed, then, is a method to translate a rental estimate into the equivalent house price assuming normal market conditions. The relationship between house prices and rents is explored in the next section.

The Price-to-Rent Relationship

Households have the option to obtain housing services either through renting or owning. At the margin, the household should be indifferent between these two options. That is, in equilibrium the cost of renting should equate to the annual "flow" cost of owning. In the simple case of a single time period and no cost of selling a house, this is given by the following relationship.[7]

$$R_{jt} = u_{jt} P_{jt} \ , \tag{1}$$

[5] For discussions of the evolution of the BLS methods see Moulton (1997), Crone et al (2001, 2004, 2010) and McCarthy et al (2015).

[6] See Leamer (2002) for a more extensive discussion.

[7] For a discussion of the contrast between this single period static approach and a multi-period dynamic approach to the price-to rent relationship see Campbell et al (2009).

where R_{jt} is the annual rent in housing market *j* in time period *t*, P_{jt} is the house price and u_{jt} is the user cost of owning. From this, we can express the price-to-rent ratio as the reciprocal of the user cost of owning.

$$\frac{P_{jt}}{R_{jt}} = \frac{1}{u_{jt}} \tag{2}$$

Understanding how local house prices relate to local rents centers on the determinants of the user cost of owning. This user cost reflects various direct and opportunity costs of owning a house. These include the after-tax mortgage interest and foregone interest on the down payment, the after-tax property taxes, the cost of insurance, maintenance expenses and depreciation, the expected capital gains and a risk premium. We can express the user cost of owning as follows.

$$u_{jt} = \left[\theta_t r_t^{RF} + (1-\theta)_t r_t^{M} + \omega_{jt}\right](1-\tau_{jt}) + i_{jt} + \delta_j - g_{jt}^{H} + \gamma_{jt} \;, \tag{3}$$

where θ_t is the down payment percentage, r_t^{RF} is the risk-free interest rate, r_t^{M} is the mortgage rate, ω_{jt} is the property tax rate (expressed as a percentage of the house price), τ_{jt} is the borrower's marginal (combined federal and state) income tax rate, i_{jt} is the cost of insuring the house (expressed as a percentage of the house price), δ_j is the maintenance expenditures (expressed as a percent of the house price) and the economic depreciation rate, g_{jt}^{H} is the expected annual house price appreciation and γ_{jt} is the risk premium associated with housing.

This formulation for the user cost of owning assumes that any capital gains from housing fall under the excluded amount and therefore are not taxed. We further assume that the mortgage balance does not exceed \$1 million, so that the full amount of mortgage interest is deductible. Local property taxes are also deductible.[8]

An important question is how expected inflation impacts the user cost and therefore the price-to-rent ratio. Expected inflation enters into the two nominal interest rates and the expected nominal house price appreciation. We can make this explicit by rewriting these three elements of the user cost assuming full pass-through of inflation as follows.

$$\begin{aligned} r_t^{RF} &= \pi_t^e + \tilde{r}_t^{RF} \\ r_t^M &= \pi_t^e + \tilde{r}_t^M \\ g_t &= \pi_t^e + \tilde{g}_t \end{aligned} \tag{4}$$

where π_t^e is the expected inflation rate, $\tilde{r}_r^{RF}$ is the real risk-free rate and similarly for the real mortgage and real house price appreciation. If we assume that the borrower's marginal tax rate is not affected by the expected inflation rate, then substituting into the user cost and rearranging gives the following.

$$u_{jt} = \left[\theta_t \tilde{r}_t^{RF} + (1-\theta)_t \tilde{r}_t^M + \omega_{jt}\right](1-\tau_{jt}) + i_{jt} + \delta_j - \tilde{g}_{jt} + \gamma_{jt} - \pi^e \tau_{jt} \tag{5}$$

As previously shown by Poterba (1984, 1991), higher expected inflation reduces the user cost due to the tax deductibility of interest. Consequently, the price-to-rent ratio is not invariant to changes in expected inflation. This impact is mitigated as the borrower's marginal tax rate is reduced.

[8] Variations in local property taxes may reflect differences in the provision of services which are valued by residents. So long as owners and renters value these services, this should not impact the price-to-rent ratio. See Himmelberg et al (2005).

Sensitivity of Price-to-Rent Ratios

The value of the user cost framework is that it allows us to estimate what the price-to-rent ratio would be under different choices for the parameters. We can vary the parameters to trace out the range of possible values for the price-to-rent ratio. The goal is to identify an upper value for the price-to-rent ratio that we would not expect to see in a local housing market unless households are anticipating significantly higher than normal house price returns. If the actual purchase price to the estimated annual rent for a property exceeded this upper value, then this would be a signal that local housing market is "frothy."

As a baseline case, assume that the risk-free rate is given by the 10-year treasury rate and is set at 3 percent; that the mortgage rate is 4.5 percent; the required down payment is 20 percent; the local property tax rate is 1 percent; the borrower's marginal tax rate is 25 percent; insurance is 0.5 percent; depreciation plus maintenance expenditure is 2.5 percent[9]; expected house price appreciation is 3.8 percent (2 percent expected inflation and 1.8 percent real[10]); and the risk premium is 2 percent[11]. Substituting these parameter choices into the user cost of owning implies a price-to-rent ratio of 16.9.

The sensitivity of the implied price-to-rent ratio to different parameter choices is illustrated in Table 1. The first row repeats the baseline case from above. Each subsequent row changes one parameter leaving the others at their baseline values. In each of the alternative cases, we leave the expected house price appreciation as in the baseline. The aim is to see what the range of price-to-rent values we can obtain for a given expected appreciation rate. Holding constant the expected house price appreciation and varying the other parameters of the user cost of owning produces price-to-rent ratios that vary in a range from 16 to 21.

The Behavior of Price-to-Rent Ratios Over the Cycle

The price-to-rent ratios shown in Table 1 were all calibrated assuming a level of expected house price appreciation consistent with the pre-boom data. What we now want to examine is what

[9] See Harding, Rosenthal and Sirmans (2007).
[10] This was the real rate of house price appreciation from 1980-2004 for a set of 46 metro areas. See Himmelberg, Mayer and Sinai (2005).
[11] See Himmelberg, Mayer and Sinai (2005).

happened to estimated price-to-rent ratios during the boom. Himmelberg et al (2005) examine estimates of price-to-rent ratios across metropolitan areas during the housing boom using aggregate house price and rent indices. This approach will reveal the average price-to-rent ratio for the housing stock, but not the price-to-rent ratios for the houses that are selling in the market. The price-to-rent ratios for the houses that are selling can be significantly higher than the average for the metropolitan area. To assess any speculative behavior in a local housing market, what we care about is the marginal and not the average price-to-rent ratio.

Hedonic model of rents

We use the American Housing Survey (AHS) data which since 1985 has been collected every two years. The AHS is a panel survey of residences and covers both owned and rental properties. For owned properties, the survey asks when the household purchased the house. This allows us to identify houses that were purchased since the last survey. In cases of recent purchases, the owner is asked to provide the purchase price for the house value. For houses that are rented, the annual rent is provided. The survey also ascertains if the rent includes or excludes basic utilities. For any utilities that are included in the rent, the cost of these utilities is recorded. This allows us to express all rents on a comparable basis exclusive of utilities.

The AHS is designed to provide an assessment of the state of the housing stock. As such, the survey includes a wealth of information on the attributes of the house and overall quality assessments. There are also a few questions that gauge the neighborhood amenities. Table 2 provides descriptive statistics for a list of these house attributes that are asked both for rental and owned houses. These housing attributes allow us to estimate a hedonic model for rents.[12] Let $\tilde{R}_{ijt}$ denote the real annual rent for property *i* in local housing market *j* in year *t*. Let X_{ijt} denote the set of attributes for this property.

$$Log(\tilde{R}_{ijt}) = X_{ijt}\beta_t + \alpha_j T + \varepsilon_{ijt} \ , \tag{6}$$

[12] See Thibodeau (1995) for a more extensive discussion of hedonic rent regression methodology.

where β_t captures the values of different housing attributes and $\alpha_j T$ is a set of metro area specific year effects.

The estimated hedonic specification can then be used to impute the annual rent for any house that sold between surveys. The predicted rent would reflect the attributes of the house, the neighborhood and the local rental market conditions as reflected in the metro area specific year effects.

$$\hat{\hat{R}}_{ijt} = \exp(X_{ijt}\hat{\beta}_t + \hat{\alpha}_{jt} + \tfrac{1}{2}\hat{\sigma}^2) \;, \qquad (7)$$

where we assume that the residuals from the hedonic regression follow a normal distribution to calculate the adjustment factor to account for transforming the prediction from logs to levels.

When imputing rent for an owner-occupied house, we want to reflect the market rent for a new occupant. Landlords may offer discounts to retain existing tenants for a number of reasons including avoiding broker fees, the cost of the expected vacancy and if they feel the tenants are taking good care of the unit.[13] If we fail to control for the duration that the existing tenant has rented the house, then we would be incorporating the average discount into our imputed rent. To avoid this, we will include a series of indicator variables for different durations that the exiting tenant has been renting the house.

A second issue to consider in using the coefficient estimates from the log rent regression to estimate rents for owner-occupied houses is whether rental and owned houses experience similar or different rates of depreciation (net of maintenance expenditures). If the depreciations rates differ, then the rental depreciation rate should not be used to age adjust owner-occupied housing when calculating a quality adjusted rent. One might think that rental housing may be under maintained relative to owned housing, and Shilling (1991) finds this to be the case for data on properties in

[13] Tenants also face search costs and moving costs. The discount can result from bargaining between the landlord and tenant over the surplus to continuing their relationship. See Genesove (2003) and Guasch and Marshall (1987).

Louisiana from 1985 to 1989. However, Malpezzi et al (1987) find the opposite result using AHS metro area surveys for 1976 to 1978. To check this, we estimate the same hedonic specification for our sample of purchased properties using the log purchase price as the dependent variable. We find that over the first 30 years the rental depreciation rate exceeds the owner-occupied depreciation rate by only 6 basis points.

The aim of the hedonic rent regression is to simulate what an appraiser would do in calculating a market rent for a house. An important aspect of this process is to find as best as possible comparable houses to the property in question that rented. While the AHS data have a large number of physical attributes and respondent ratings to make this comparison, we wanted to restrict out estimation sample to those rental units that are roughly comparable to the owner-occupied houses that transact in our data.

We use a propensity score approach where the predicted log rent is taken as an overall summary of the quantity/quality of housing services. Specifically, we estimate a log rent regression described below using the full sample of rental properties in the AHS. We use this estimated regression to predict the log rent for each owner-occupied house that transacts in our data. We then take each rental property in the data and check to see if we can find a owner-occupied house that sold in the same metro area and year with a predicted log rent within 10 percent. If a match is found, that rental property is retained in the estimation sample. We then take each owner-occupied house that transacts and check to see if there is a rental property in the same metro area and year that has a predicted log rent within 10 percent. If a match is found, that owner-occupied property is retained in the estimation sample. This matching process resulted in the deletion of XXX rental properties and YYY owner-occupied properties. We then re-estimate the log rent regression using the matched sample of rental properties.

Estimation Results

The estimated hedonic rent regression results for specification (7) are provided in Table 3. The AHS has a large number of housing characteristics that we can control for in the hedonic rent specification. The number of bedrooms and bathrooms have a large impact on the annual rent.[14] Controlling for the number of bedrooms and bathrooms, the size of the house and the size of the lot have only small impacts on the annual rent. A garage adds 5.5 percent to the annual rent, while a basement does not significantly affect the rent. The presence of central air conditioning adds 11.5 percent to the rent. We find that a linear spline in the age of the house with a spline point at 30 years fits the data well. The estimated spline suggests roughly a 0.4 percent per year decline in the annual rent over the first 30 years.[15]

In addition to controlling for the attributes of the house, we want to control for as best as possible the quality of the house. A purpose of the AHS is to assess the quality of the U.S. housing stock. As a consequence, there are a large number of house quality items that the survey taker records. The survey taker summarizes the assessment of the house quality into three categories: adequate, moderately inadequate and severely inadequate. In addition, residents rate their satisfaction with the house. The data indicate that holding constant the residents ratings, rents are lower by 4 percent for moderately inadequate housing units. Residents rate their satisfaction of the house on a scale of 1 to 10 with higher ratings corresponding to higher satisfaction. We collapse these rating into five categories with the worst two ratings as the left-out category. Holding constant the survey taker's overall adequacy rating, houses with respondent ratings of 7-10 have rent premiums of 3 to 4 percent. Residents also rate their satisfaction with the neighborhood on a similar 1 to 10 rating. Again we set the top two ratings as the left-out category. Neighborhoods receiving a rating of 1 to 4 have rents that are on average around 9 percent lower than neighborhoods receiving the top two ratings. There may be residual quality differences that we are not capturing through the survey taker and respondent ratings. We would expect that higher income households would sort into higher quality houses and neighborhoods. We can use household income as a proxy for any residual housing and neighborhood quality. The coefficient on log household income is 7.4 percent.

The data indicate that rents decline by roughly 2 percent per year that the renters have been in the unit. When we predict rents for the owner-occupied houses that transact, we set the rental duration to a new rental. We calculate the market rent for our owner-occupied houses that transact

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[14] Alternatively, one can control from the total number of rooms and either the number of bedrooms or bathrooms.

[15] If this decline in real rents with the age of the house reflects economic depreciation, then this estimate of 0.6 percent is less than earlier estimates of the economic depreciation rate. See Harding et al (2007).

assuming a new rental contract. Including the MSA-specific time effects, the hedonic model explains 68 percent of the observed variation in annual rents.

Dynamics of Price to Rent Ratios

A common practice in the literature is to create a time-series of aggregate or metro area price-to-rent ratios by using the ratio of a house price index to a rent index. Restricting our attention to the U.S. housing market, examples include Leamer (2002), Himmelberg et al (2005), Gallin (2008), Campbell et al (2009), Duca et al (2011).[16] There are two problems with this approach. First, even if the rental and house price indices are quality adjusted, they are estimated over different properties. This introduces composition bias. Second, price-to-rent ratios calculated as the ratio of indices are informative only about the change in the price-to-rent and not the level.[17] In addition, using an area price-to-rent ratio—even properly estimated—as a macroprudential tool would be a blunt instrument.[18] That is, it would be preferable to tie a macroprudential lending policy to property-specific price-to-rent ratios. Finally, for macroprudential purposes we are interested in the price-to-rent ratios for homes that are transacting the local housing market, as opposed to the price-to-rent ratios for homes that are not selling.

To overcome these limitations, we will derive property-specific price-to-rent ratios using only owner-occupied properties that sold over our sample period.[19] From the AHS, we can identify owner-occupied houses that sold over the past two years. For these houses, we observe the same housing and neighborhood attributes that we used in the hedonic rent specification in Table 3. This allows us to estimate an annual rent for each of these home sales and to calculate an implied property specific price-to-rent ratio. Table 4a provides summary statistics on these implied price-to-

[16] In contrast, Davis et al (2008) present aggregate rent-to-price ratios calculated as the ratio of the average across properties of the implied rents to the average across the same properties of the house values. This differs from the average of the property-specific price-to-rent ratios.
[17] For more discussion, see Smith and Smith (2006).
[18] By blunt instrument, we mean that in cases where a metro area price-to-rent exceeds a stipulated threshold, properties may be transacting at implied price-to-rent ratios below this threshold. Similarly, in cases where a metro area price-to-rent ratio is below a stipulated threshold, there may be properties that transacting at implied price-to-rent ratios above this threshold.
[19] Our approach is similar to Hill and Syed (2012) analysis of Australian data. Smith and Smith (2006) use a matched sample approach instead of a hedonic approach using 2005 MLS data for 10 U.S. metro areas.

rent ratios over the period from 1988 to 2013.[20] From 1988 to 2001, the median ratio was always under 16. As the housing boom gathered momentum, the median ratio in 2007 exceeded 20, with the 75th percentile at 24.4 and the 95th percentile at 51.9. Table 4b provides summary statistics for Arizona, California, Florida and Nevada (the "sand" states) that were most affected by the housing boom. In 2007, the 75th percentile ratio for these four states was 32.9 and the 95th percentile was 64. Figures 1 and 2 show the time series of the median implied price-to-rent ratios for the full sample, and split between the sand states and other states. [Add comparison to Willen's analysis using sales of rental properties from the MLS data – see if Paul has a paper yet]

Using Price-to-Rent as a Macroprudential Tool

As a result of the housing booms affecting several countries, there is a greater interest in macroprudential tools for housing markets. Cerutti et al (2015) present results from an IMF survey of 119 countries that was conducted between 2013 and 2014. The data collected covered the time period from 2000 to 2014. Of the countries included in the survey, 21 percent had enacted a cap on LTV and 15 percent a cap on debt-to-income (DTI).[21] Adopting a cap on LTV is one approach to limiting the procyclicality of LTV that was evidenced across countries during prior housing booms. A more general macroprudential LTV tool would more continuously reduce LTVs as property markets heated up, and subsequently allow LTVs to rise as markets cooled off. An LTV cap prevents LTVs from increasing above the cap during a boom—instead LTVs would bunch at the cap—but does not necessarily allow LTVs to rise after a boom has subsided.

We can instead use the appraisal process to implement a countercyclical LTV policy. Assume when underwriting a mortgage that appraisers are asked to conduct both a comparable sales analysis and an annual rent analysis. In this case, in addition to the traditional appraised value, an output of the appraisal process would be the appraised value-to-rent ratio. This ratio would provide information to both the buyer as well as to the lender about whether the local housing market is

[20] Our approach differs from Davis et al (2008) who present aggregate rent-to-price ratios calculated as the ratio of the average across properties of the implied rents to the average across the same properties of the house values.

[21] Kuttner and Shim (2013) collect data on 60 countries covering from 1980 to June 2012. Over this period, they report that changes in LTV policies (both tightening and loosening) occurred 94 times, while changes in DTI policies occurred 45 times. Both Cerutti et al (2015) and Kuttner and Shim (2013) find DTI policies to have relatively more impact on household credit growth.

becoming overheated. This alone would be a useful input into the decision making process to purchase the home or to underwrite the mortgage for the home.

One could take this a step further and create a housing finance macroprudential tool. The tool would be designed as follows. Let's assume for illustration that banks are allowed to loan up to 90 percent of the appraised value of the home. Under the macroprudential policy, we modify this rule to allow the bank to loan up to 90 percent of the lower of the appraised value of the home or 30 times the estimated annual rent.[22] In a normal housing market the appraised value would be less than 30 times the estimated annual rent, so the maximum loan size would be determined in the same manner as current practice. As a local market becomes overheated pushing up the price-to-rent ratios, the 30 times estimated annual rent becomes binding. In this case, the borrower would have to put in additional equity in order to make the purchase. This is illustrated in Figure 3. This rule lowers the origination LTV during a boom as the annual rent multiple binds. As the market cools off, price-to-rent ratios would decline and, consequently, the origination LTVs would be able to increase. This appraisal based macroprudential tool allows for adjustment in origination LTVs on both sides of a housing cycle.

We could enhance this tool further by incorporating the insight from Haughwout et al (2011) on the role of speculative investors in the U.S. housing boom and bust. The authors document a dramatic shift in the flow of purchase mortgages during the boom to investors with multiple first-lien mortgages on their credit file. This reflected both an extensive margin with more households becoming investors, and an intensive margin with existing investors increasing the size of their housing portfolios. These investors were also more sensitive than owner-occupants to house price declines so that the composition of buyers shifts away from investors as the market cools. These findings suggest an additional element to the macroprudential tool which is to reduce the maximum LTV as the number of first-liens on the borrower credit file increases. Figure 4 illustrates this where for every additional first-lien the maximum LTV is reduced by a factor of 0.9. Including the number of first-liens into the macroprudential tool introduces another element which works to reduce origination LTVs as property markets heat up and to raise origination LTVs as they cool.

[22] One could pick any P/R cap. We use 30 since the earlier analysis indicates that it would not generally bind outside of boom periods. We focus on the price-to-rent ratio instead of the appraised value-to-rent ratio. However, a significant fraction of appraised values are very close to the transaction price. See Cho and Megbolugbe (1996) and Ding and Nakamura (2014).

The change in the average origination LTV among new purchase mortgages would reflect not only movement along these curves but also movements between the curves.

How much impact might such a macroprudential tool have on the distribution of origination LTVs? We can use the AHS data to do a simple calculation. For each of the home purchases, we know both the sales price and the mortgage balance. This allows us to calculate the origination LTV. We can use a variant of our macroprudential tool where we hold fixed the observed LTV but impose the cap of 30 times the estimated annual rent. Assuming that the house was purchased for the same price, we can re-estimate what the origination LTV would be if the annual rent cap was binding. [table of chart of comparison of LTVs to be added]

Conclusion [to be added]

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Table 1. Sensitivity of Price-to-Rent Ratio

Parameter Setting	Price-to-Rent
Jan 2000: $r^{RF} = 6.66,\ r^{M} = 8.08$	12.8
Jan 2005: $r^{RF} = 4.22,\ r^{M} = 5.90$ (baseline)	16.3
Jan 2010: $r^{RF} = 3.73,\ r^{M} = 5.10$	18.0
Higher marginal tax rate: $\tau = 35\%$	18.3
Higher property tax rate: $\omega = 1.5\%$	15.4
Lower property tax rate: $\omega = 0.5\%$	17.4
Lower down payment: $\theta = 10\%$	16.0
Lower risk premium: $\gamma = 1\%$	19.5

Notes: Any parameter not listed is set to its value in the baseline (Jan 2005): $r^{RF} = 4.22,\ r^{M} = 5.90,\ \tau = 25\%,\ \omega = 1\%,\ \theta = 20\%,\ \gamma = 2\%$. r^{RF} is set to the 10-year Treasury rate and r^{M} is set to the 30-year fixed-rate mortgage rate.

Table 2. Descriptive statistics

		Square Feet	Rooms	Garage	Basement	Age
1989	Rent	1,359	5.2	0.48	0.34	38.1
	Own	1,866	6.4	0.74	0.46	25.6
2001	Rent	1,356	5.0	0.48	0.30	44.3
	Own	2,108	6.4	0.79	0.42	26.9
2013	Rent	1,611	5.5	0.56	0.37	50.3
	Own	2,215	6.5	0.83	0.49	37.7
Total		1,752	5.8	0.65	0.40	37.1

Table 3. Log Rent Regression

Variable	Coefficient (standard error)
Unit Size (x1,000 sq ft)	0. 0291***
	(0. 0037)
Unit Size Squared	-0.0016***
	(0.0002)
Lot Size (x10,890 sq ft)	0.0000
	(0.0000)
Garage	0.0555***
	(0.0046)
Basement	0.0090
	(0.0067)
Central Air	0.115***
	(0.0054)
Bedrooms	
0	−0.0634
	(0.0346)
2	0.129***
	(0.0074)
3	0.223***
	(0.0079)
4	0.285***
	(0.0101)
5+	0.306***
	(0.0188)
Bathrooms	
0	−0.0355***
	(0.0436)
2	0.101***
	(0.0052)
3	0.184***
	(0.0155)
4	0.286***
	(0.0519)
5+	0.228
	(0.163)
Spline in age	
0-30 years	−0.0044***
	(0.0003)
31+ years	−0.0003
	(0.0001)

Table 3. Log Rent Regression, continued

Variable	Coefficient (standard error)
House Quality by Survey Taker	
Moderately Inadequate	−0.0427***
	(0.0101)
Severely Inadequate	−0.0024
	(0.0129)
House Rating by Occupant (scale of 1 to 10)	
3-4	0.0252
	(0.0173)
5-6	0.0178
	(0.0119)
7-8	0.0424***
	(0.0067)
9-10	0.0331***
	(0.0054)
Neighborhood Rating by Occupant (scale of 1 to 10)	
1-2	−0.0896***
	(0.0144)
3-4	−0.0904***
	(0.0099)
5-6	−0.0638***
	(0.0064)
7-8	−0.0330***
	(0.0050)
Log Income	−0.0741***
	(0.0025)
Years renting the unit	
1	−0.0164***
	(0.0056)
2	−0.0429***
	(0.0062)
3	−0.0606***
	(0.0073)
4	−0.0731***
	(0.0086)
5	−0.0972***
	(0.0102)
6+	−0.167***
	(0.0063)
Constant	5.097***
	(0.0248)
Observations	21,551
R^2	0.677

Notes: Year*MSA year effects included. A quarter acre is 10,890 square feet.

Table 4a. Summary Statistics for P/R

	Median	Mean	25th	75th	95th
1988	15.41	13.92	9.88	18.09	29.89
1989	14.38	12.19	9.36	18.28	29.11
1990	15.46	12.20	9.40	15.76	36.00
1991	13.69	12.40	8.91	17.47	26.50
1992	12.58	11.29	8.50	14.18	21.80
1993	13.78	12.42	9.14	17.32	27.05
1994	11.76	10.89	8.83	14.68	20.64
1995	13.06	12.11	9.09	15.63	23.14
1996	12.66	11.26	9.04	16.25	22.22
1997	13.09	12.00	9.03	15.78	25.45
1998	15.18	11.85	8.88	17.44	40.74
1999	14.28	12.47	9.32	16.79	32.63
2000	15.71	13.43	10.55	18.15	32.25
2001	15.47	13.26	10.16	18.27	34.45
2002	16.82	13.70	10.40	19.99	37.89
2003	17.35	14.31	10.84	21.60	37.29
2004	18.72	16.40	12.38	22.27	39.12
2005	20.64	17.82	12.48	25.93	45.34
2006	22.73	17.66	13.69	27.68	51.87
2007	20.26	16.51	11.43	24.42	51.91
2008	16.55	14.18	10.56	18.85	28.62
2009	15.50	13.23	9.63	17.85	33.04
2010	14.92	13.89	9.09	17.79	29.09
2011	15.36	13.06	9.41	18.46	34.02
2012	15.57	13.13	9.15	18.06	31.19
2013	14.12	12.47	8.53	18.02	31.59

Table 4b. Summary Statistics for P/R – AZ, CA, FL, NV

	Median	Mean	25th	75th	95th
1988	17.47	12.77	10.71	26.02	34.96
1989	17.28	16.90	9.78	22.65	31.84
1990	13.25	11.89	9.29	14.62	30.30
1991	17.19	16.51	10.44	21.56	31.44
1992	10.82	8.98	7.99	11.97	21.80
1993	14.69	13.43	10.34	18.16	28.42
1994	12.79	10.99	9.40	14.82	21.37
1995	14.29	13.64	9.74	16.78	24.87
1996	12.91	11.06	8.45	15.51	22.34
1997	14.94	13.37	9.64	18.14	31.85
1998	15.55	12.12	8.76	20.85	41.09
1999	17.35	14.92	10.33	20.77	36.66
2000	17.62	14.24	10.82	20.88	32.40
2001	17.30	14.59	10.62	20.30	37.69
2002	19.99	16.83	12.44	23.57	38.61
2003	20.79	17.90	12.69	27.71	41.37
2004	22.83	21.18	15.20	29.16	41.76
2005	27.21	25.02	18.17	33.66	49.50
2006	31.28	27.51	18.52	44.16	59.88
2007	28.41	23.54	16.68	32.87	63.98
2008	23.06	16.92	10.63	21.36	100.32
2009	19.20	15.63	10.88	22.32	48.24
2010	16.97	15.96	10.40	19.76	37.26
2011	17.31	14.17	9.67	21.67	42.22
2012	16.07	15.79	12.29	18.15	43.80
2013	18.48	14.22	9.66	21.34	58.10

Figure 1. Median Price/Rent Ratio

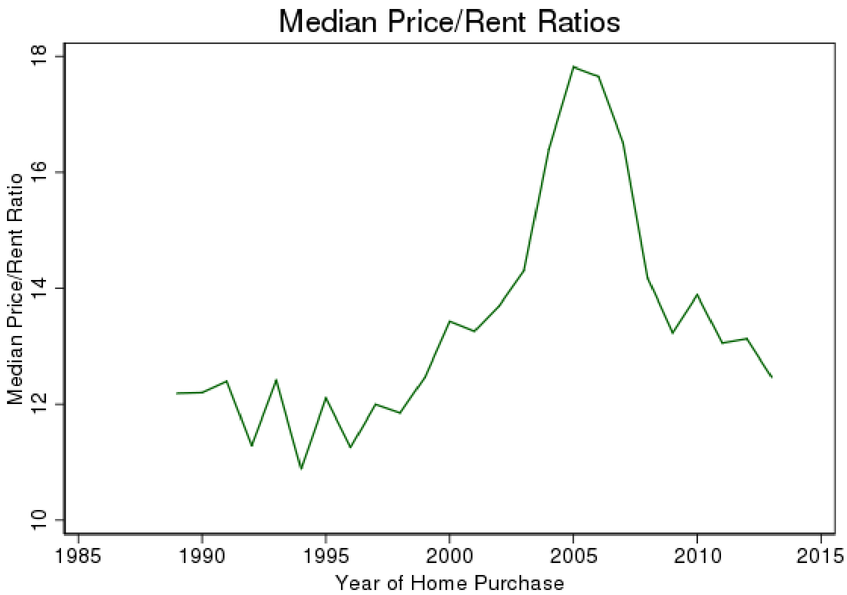

Figure 2. Median Price/Rent Ratio – Arizona, California, Florida and Nevada

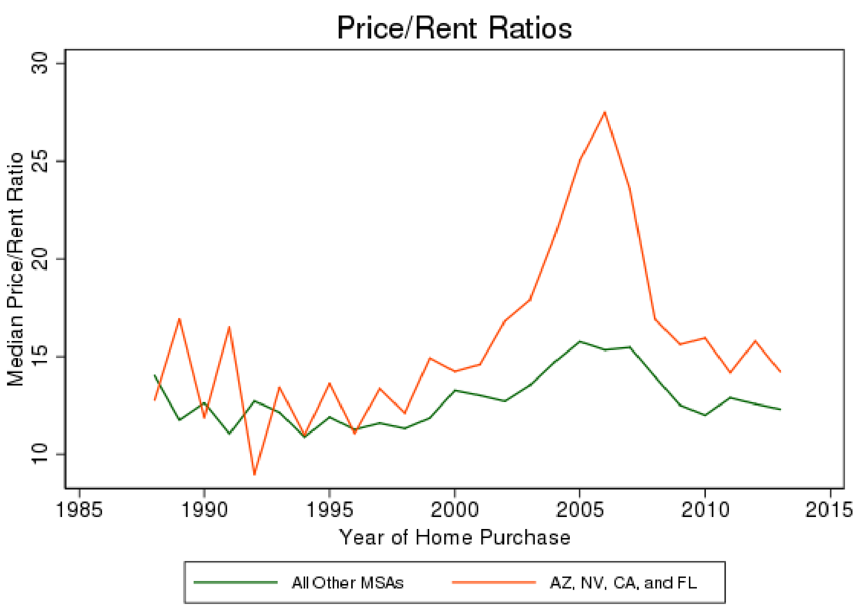

Figure 3. Price-to-Rent as a Macroprudential Tool

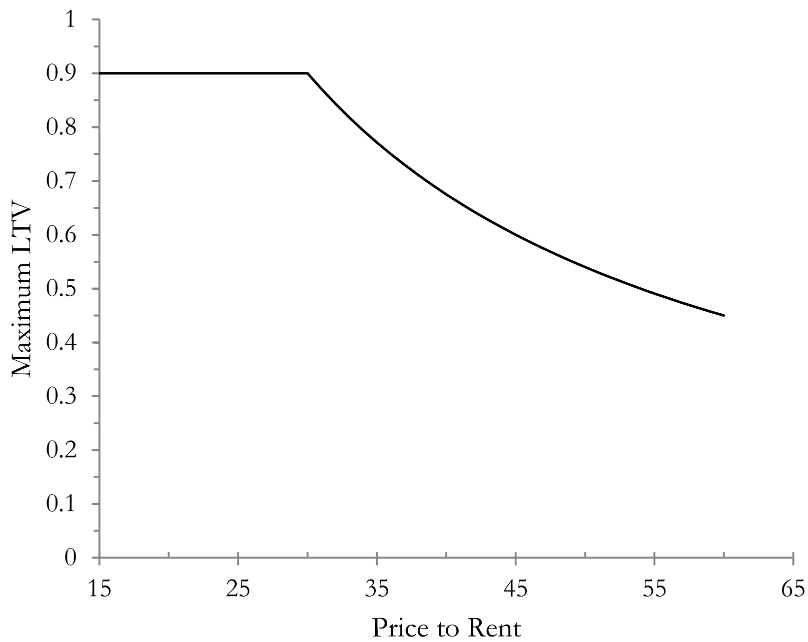

Figure 4. Price-to-Rent and Number of First Liens as Macroprudential Tools