U.S. House Price Dynamics and Behavioral Finance

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There has been considerable debate in recent years regarding the role of behavioral factors in determining housing prices. The question of whether psychology matters in the housing market has been settled long ago: the answer is yes. Rather, economists are now debating in what ways psychology impacts market behavior and how large an effect this impact has on housing prices.

One oft-cited example of a clear behavioral bubble in housing is the sharp boom-bust in the Vancouver housing market during the early 1980s (see figure 1). In the 18 months between January 1980 and July 1981, real house prices grew 87 percent. In the subsequent 18 months, real prices fell by nearly 44 percent, plateauing at a level only 6 percent above where prices were three years earlier before the boom began. While news and rumors about Britain's returning Hong Kong to China may have swayed sentiment in the Vancouver market, where many wealthy Hong Kong residents own second homes, it is very difficult to use fundamental factors in explaining the sudden boom-bust pattern witnessed in the early 1980s.

In this paper we examine the relative roles played by economic fundamentals and market psychology in explaining U.S. house price dynamics using two different boom periods, one in the 1980s and the other one in the early-to-mid-2000s. We begin by considering what proportion of the variation in the house price-rent ratio within metropolitan areas can be explained by fundamentals using a single-period version of the user cost model with static expectations of price growth, as in Himmelberg, Mayer, and Sinai (2005). We then consider how much additional variation can be explained by a handful of behavioral finance theories

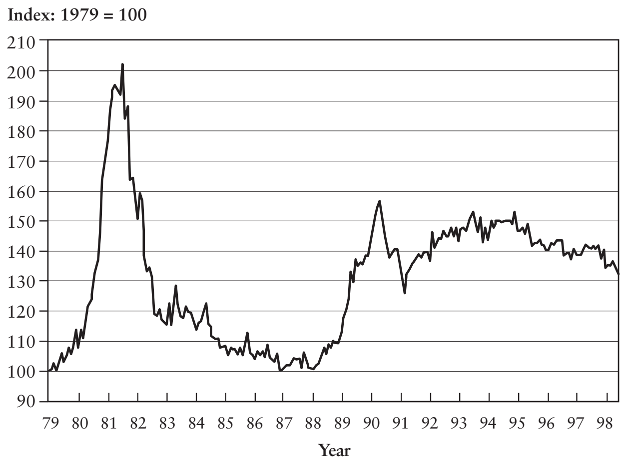

Figure 1
Vancouver Condominium Monthly Real Price Index
Source: Bulan, Mayer, and Somerville (2006).

and conjectures, such as backward-looking expectations of house price growth and inflation illusion. By examining the house price booms of the 1980s and 2000s separately, we can see if the relative weights given to fundamental and to behavioral explanations vary over time.

Our results suggest that both rational and seemingly behavioral factors in the 1980s and in the 2000s explain movements in the price-rent ratio across U.S. metropolitan housing areas over the last 25 years. We find that user cost of capital, which reflects rational asset pricing fundamentals, is one of the most important factors, especially during the 1995–2006 boom. Lending market efficiency also appears to be capitalized into house prices, with higher prices associated with lower origination costs and a greater use of subprime mortgages.

The other important determinant of price-rent ratios is the lagged five-year house price appreciation rate. This result suggests that backward-looking expectations likely play a behavioral role in explaining house price booms, although it is difficult to disentangle backward-looking expectations when using a "rational" model in which households update their beliefs about future house price growth with more recent data. In addition, the results show little evidence in favor of behavioral explanations based on the one-year lagged house price growth rate or the inflation rate.

We begin with a review of the literature on equilibrium models of house price determination and then examine how behavioral economics and inefficiencies in the lending market may also play a role. Section 2 lays out our simple reduced-form empirical framework. We then describe the data in section 3, which is followed by a description of our empirical findings in section 4. We conclude with a brief discussion of the factors that might influence the direction of future house prices and suggest avenues for future research.

1. Background and Related Literature

There is great dispersion in house price appreciation rates and volatility across different U.S. housing markets over the last three decades. Some southern and midwestern markets like Atlanta, Charlotte, Cleveland, and Houston have shown little long-term appreciation and relatively low volatility in prices (see figure 2a). By contrast, many primarily coastal markets like Boston, Los Angeles, and San Francisco have shown higher long-term rates of house price appreciation and also greater peak-to-trough volatility (see figure 2b). Finally, some markets like Las Vegas, Miami, and Phoenix exhibited recent price spikes despite having experienced little real growth in house prices over previous decades (see figure 2c).

One difficulty in decomposing this wide variation in local house price movements across metropolitan areas into so-called fundamental and behavioral factors is the lack of a widely accepted rational dynamic model of house prices that combines local fundamentals—such as changes in economic conditions, risk, and supply constraints—and aggregate fundamentals such as time-series variation in interest rates and inflation. Without such a model as a baseline, it is hard to determine the relative contributions of fundamentals and psychology in generating movements in U.S. house prices.

Recent papers have made some progress in relating fundamentals to house price dynamics. Brunnermeier and Julliard (2008) develop a dynamic rational expectations model of house prices but do not incorporate local factors. Glaeser and Gyourko (2007) calibrate a dynamic

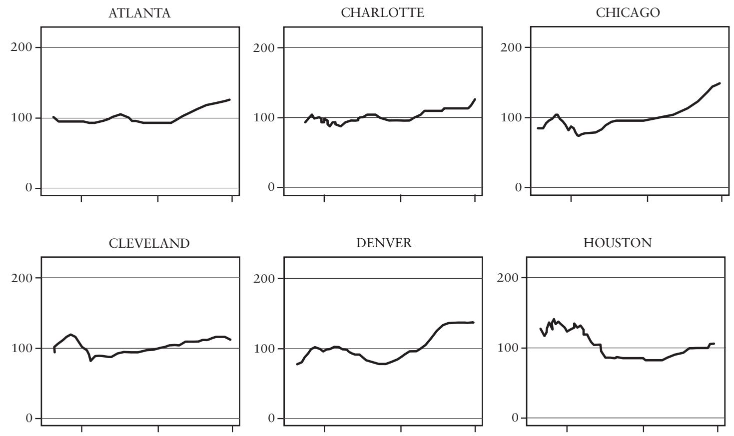

Figure 2a: Steady Markets
Current as of 2007: Q1
Source: Mayer (2007) using OFHEO and BLS Real Home Price Index
Index: 100 = sample average

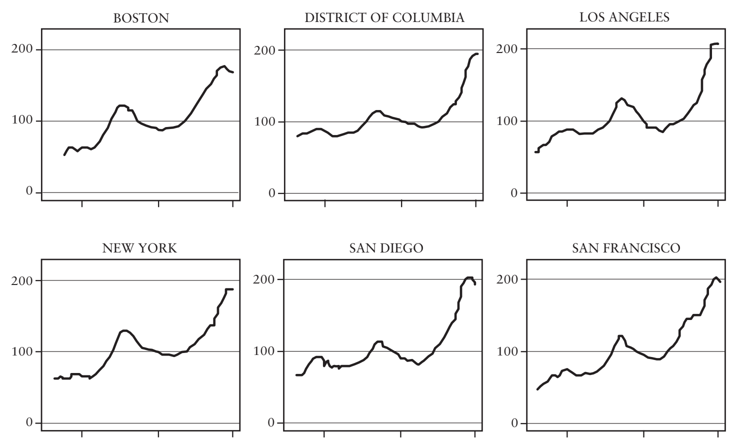

Figure 2b: Cyclical Markets
Current as of 2007: Q1
Source: Mayer (2007) using OFHEO and BLS Real Home Price Index
Index: 100 = sample average

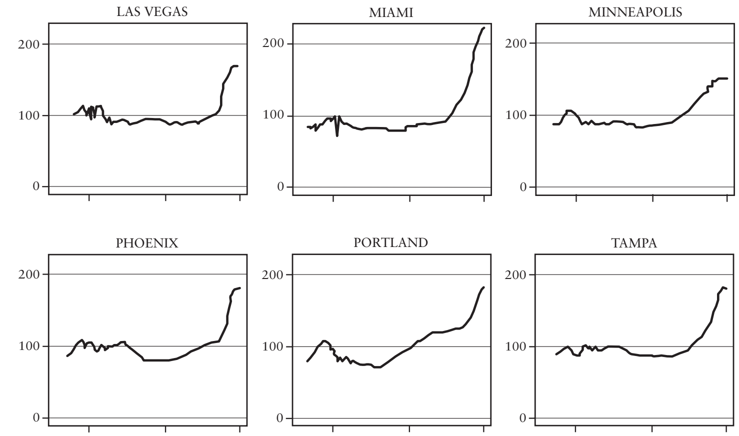

Figure 2c: Recent Boom Markets
Current as of 2007: Q1
Source: Mayer (2007) using OFHEO and BLS Real Home Price Index
Index: 100 = sample average

model of housing in a spatial equilibrium which does a very good job explaining the impact of local shocks on house prices. However, Glaeser and Gyourko are not able to incorporate shocks due to interest rates (or incomes), factors which the authors concede may explain some of the serial correlation in their data.

Himmelberg, Mayer, and Sinai (2005) use the standard user cost model (Hendershott and Slemrod 1983; Poterba 1984) to examine whether U.S. house prices relative to rents in 46 metropolitan areas were high in 2004. The authors constructed the user cost using long-term mortgage interest rates and static long-run real appreciation rates, arguing that most households view the purchase of a house based not on a one-year comparison of buying versus renting, but based on a longer-run holding period. Despite its ability to combine local and aggregate factors, the user cost model contains some simplifying assumptions that abstract from important real-world issues. In particular, the standard user cost model does not characterize how households form their expectations of future price or rent appreciation.

Theoretical papers have argued that liquidity constraints might also explain the seemingly excessive sensitivity of house prices to income shocks (Stein 1995; Ortalo-Magné and Rady 1999, 2006). Lamont and Stein (1999), Engelhardt (1994, 1996), and Genesove and Mayer (1997) present empirical evidence in favor of the liquidity constraints hypothesis. Yet liquidity constraints are unlikely to explain why volatility differs across U.S. housing markets.

Some authors have argued that psychological factors rather than fundamental issues play the key role in determining house price dynamics. The earliest academic papers on the role of psychology on real estate prices focused on unexplained serial correlation in real estate prices (see Case and Shiller 1989). Of course, serial correlation itself is not necessarily evidence of irrational markets if the underlying growth in rental prices is also serially correlated. Yet data on rents are very hard to obtain, confounding tests of market efficiency. Meese and Wallace (1994) obtained detailed rental data from advertisements and estimated an asset pricing model for houses in the San Francisco area. The authors concluded that the price run-up in the late 1980s was not fully justified by fundamentals. Both papers concluded that pricing inefficiencies are due to high transaction costs that limit arbitrage opportunities for rational investors.[1]

Psychology, too, may affect how households set their expectations of future price appreciation. Case and Shiller (1988) surveyed recent home buyers in four American cities about their expectations of future house price growth. Recent buyers in Los Angeles, a market with strong house price appreciation in the 1980s, reported that they expected much higher long-term house price appreciation than households in a control market, Milwaukee, where house prices were flat in the 1980s. In a subsequent survey (Case and Shiller 2003), recent buyers in Milwaukee raised their reported expected appreciation in line with the national housing boom. By 2006, recent home buyers in both Milwaukee and Los Angeles had lowered their reported expected price appreciation for the next year, although they did not make many downward adjustments in their 10-year expected appreciation rate (Shiller 2007). Shiller cites the survey evidence and other case studies to support his contention that the boom cannot be explained in terms of fundamentals such as rents or construction costs, and he concludes that: "The psychological expectations coordination problem appears to be a major factor in explaining the extreme momentum of home price increases. Investors who think that home prices will continue to go up because they perceive prices as going up generally around the world may not change this expectation easily since they will have trouble coordinating on a time to make the change" (118).

A second psychological theory proposed by Brunnermeier and Julliard (2008) argues that households cannot fully disentangle real and nominal changes in interest rates and rents. As a result, when expected inflation falls, homeowners take into account low nominal interest rates when making housing purchase decisions without recognizing that future appreciation rates of prices and rents will fall commensurately. They argue that falling inflation leads to otherwise unjustified price spikes and speculative booms, and can help explain the run-up in U.S. and global housing prices in the 2000s. As evidence, Brunnermeier and Julliard show that expected inflation is correlated with the residuals of a dynamic rational expectations model of house prices.

Probably the most direct evidence on the importance of psychology in real estate markets focuses specifically on loss aversion in housing downturns (Genesove and Mayer 2001; Engelhardt 2003). Yet explaining the current housing boom or even excess volatility in downturns through loss aversion may be difficult. Since loss-averse sellers set higher asking prices when house prices are falling, this particular psychological factor actually leads to lower volatility over the cycle, making the puzzle of possibly excess cyclical volatility an even more difficult problem to explain.

Finally, another set of papers focuses on rational dispersion in long-run price appreciation rather than on short-run dynamics. Van Nieuwerburg and Weil (2007) calibrate a model that uses productivity differences to explain long-run price dispersion across cities. More relevant for our exercise, Gyourko, Mayer, and Sinai (2006) present evidence suggesting that increasing numbers of households and income growth in the right tail of the income distribution, combined with supply constraints in some highly desirable cities, has led to a 50-year trend of faster house price growth in certain "superstar cities." According to this paper's model, households might rationally expect future prices to rise faster in superstar cities like Boston, New York, and San Francisco than in other cities in the United States.

2. Empirical Model

Our empirical analysis examines which factors, fundamental and behavioral, are correlated with house price dynamics within U.S. metropolitan areas. As a baseline, we begin with a rational model of asset price equilibrium and see how much of the empirical volatility in the price-rent ratio such a model can explain. To that baseline, we add proxies for other rational and behavioral factors to see which are correlated with the unexplained residual.

To form the rational market baseline, we assume that housing markets are perfectly competitive and that in equilibrium, risk-adjusted returns for homeowners and landlords should be equated across investments. This yields the usual user cost formula (such as Hendershott and Slemrod 1983; Poterba 1984) where spot rents in a housing market are set such that:

$$(1)\quad R_{it} = P_{it}\left((1-\tau_{it})r_t + m - E\left[\%\Delta P\right]_{it}\right).$$

R_{it} is the rent for one unit of housing services for one year in city i at time t, P_{it} is the corresponding price for prepurchasing the entire future flow of R_i, $(1 - \tau_{it})r_t$ is the after-tax, equivalent-risk opportunity cost of capital, m is a measure of carrying costs (such as maintenance) per dollar of house, and $E[\%\Delta P]_{it}$ is the expectation of future house price appreciation in city i at time t.

To match our empirical work, below we rearrange equation (1) to obtain the price-rent ratio, P/R. Labeling the terms in large parentheses as describing user cost, UC, P/R is:

$$(2)\quad \frac{P_{it}}{R_{it}} = \frac{1}{UC\left(\tau_{it}, r_t, m, E\left[\%\Delta P\right]_{it}\right)}.$$

Examining the price-rent ratio provides a better measure of asset market conditions than does price alone. House prices are determined both by supply and demand for housing services as well as the overall asset market, making it difficult to empirically identify changes in prices due to the asset changes alone.[2] By conditioning on-the-spot rent for housing, the price-rent ratio leaves only asset market factors to explain how current and expected future rental values are capitalized into current prices. In the user cost framework in equation (2), home buyers pay a higher price multiple compared to rents when the after-tax opportunity cost of capital is lower. So, for example, when interest rates fall, purchasers of housing assets will pay a higher price for a given dividend flow (either rental income or the imputed rent from living in the house). Of course, the price-rent ratio also expands when expected future price growth is higher (for example, when more of the return comes in the form of a capital gain).

Re-characterizing the user cost model in the price-rent framework also highlights the highly nonlinear relationship between changes in the price-ratio and user costs. Himmelberg, Mayer, and Sinai (2005) and Campbell et al. (2007) point out that when user costs are low, convexity implies that relatively small absolute changes in user costs (caused by shocks to long-term interest rates, for example) can cause very large percentage changes in the price-rent ratio.

The user cost model described in equation (2) provides some empirical guidance, but it is incomplete. For example, the user cost framework does not address how expectations of capital gains are formed. In Poterba's original framework, home buyers are assumed to have perfect foresight. However, Case and Shiller (1988, 2003) provide survey evidence that homeowners have price growth expectations that are inconsistent with perfect foresight. Himmelberg, Mayer, and Sinai (2005) assume that homeowners have static expectations that house prices will grow at their long-run average rate. But another possibility is that home buyers form their expectations based on recent history.

In addition, the measure of the opportunity cost of capital, r_t, does not fall out of the user cost model. Himmelberg, Mayer, and Sinai (2005) uses risk-free interest rates plus a time-invariant risk premium. However, the risk premium required by lenders or equity investors may vary over time, leading them to accept more risk at a given yield. For example, Allen and Gale (1999) and Pavlov and Wachter (2006) discuss conditions in which competition may lead lenders to misprice risk. In the data, lenders allowed homeowners to take on more debt as a percentage of the house value (for instance, allowing a higher loan-to-value ratio) and made loans to much riskier borrowers (such as borrowers who have lower FICO credit scores or who cannot document their current income). In addition, during the 1980s, low capital reserves maintained by government-insured savings and loan institutions also led lenders to accept more nonpriced risk. In these cases, the decline in the true risk-adjusted cost of capital would be greater than what would be reflected in the Himmelberg, Mayer, and Sinai measure.[3] Along another dimension, Brunnermeier and Julliard (2008) hypothesize that households consider nominal interest rates rather than real interest rates when making borrowing decisions.

One way to test for the relevance of these various factors would be to incorporate them into the user cost framework and see which measure(s) of user cost best fit the data. However, a variety of theoretical and practical considerations preclude pursuing this approach. For one, the user cost model presumes a rational asset market equilibrium. Embedding parameters in a framework that potentially derives from an underlying model where expected returns do not equate across investments would be inconsistent and difficult to interpret. In addition, if the expected capital gain is high enough, the user cost can be negative, implying that expected price appreciation outstrips the cost of capital. If that were the case, the return on home buying would be infinite and the user cost would be undefined.

Our empirical approach is to regress the log of the price-rent ratio on the log of the inverse user cost, as defined in Himmelberg, Mayer, and Sinai (2005), and include proxies for low risk premia in the capital markets, inflation illusion, and backward-looking expectations of price growth:[4]

$$\text{(3)}\quad \ln\left(\frac{P_{it}}{R_{it}}\right) = \alpha + \beta \ln\left(\frac{1}{UC\left(\tau_{it}, r_{it}, m, E\left[\%\Delta P\right]_{it}\right)}\right) + \delta C_{it} + \gamma B_{it} + \varphi \Pi_t + \kappa_i + \varepsilon_{it}.$$

C_{it} is a vector of proxies for the easy availability of capital, including the average loan-to-value ratio, the fraction of mortgage originations that have adjustable interest rates, average points and fees, and the fraction of mortgage originations that are subprime. B_{it} is a vector of backward-looking measures of house price appreciation: the average house price growth in a metropolitan statistical area (MSA) i over the prior year and over the previous five years. To test for the presence of inflation illusion, Π_t is a measure of inflation. A set of MSA indicator variables, κ_i, is also included.

It bears mentioning that in most specifications we choose not to include year dummies, instead using the variation over time in *UC*, *C*, *B*, and Π to help identify their effects on the price-rent ratio. This specification allows us to incorporate two factors inherent in behavioral finance theories. First, inflation illusion can only be considered without national time dummies. Second, Shiller (2007) argues that part of the social epidemics that give rise to U.S. housing cycles are due to national and even international influences that are commonly felt across regions. However, we include the year effects in a small number of specifications where the sample period is short enough that we believe within-MSA variation is more crucial for empirical identification, and where it would be difficult to separately identify national macroeconomic factors.

If the user cost model holds and is correctly specified when we use a real opportunity cost of capital and static long-run expectations of house price growth, we would expect $\hat{\beta}$ to equal 1. If, in addition, this user cost model were the primary determinant of asset pricing in the housing market, we would expect it to have a high R-squared. To the degree that easy credit, inflation illusion, or backward-looking price expectations affect asset pricing in the housing market above and beyond what is already incorporated into this implementation of the user cost model, the estimates of δ, γ, and ϕ should be statistically significantly different from zero, and including C_{it}, B_{it}, and Π_t should increase the explanatory power of the regression.

While the specification in equation (3) is in a reduced form, we believe it will provide additional evidence on which factors are correlated with the price-rent ratio in the housing market and the relative importance of rational (fundamental) and behavioral components. However, we caution that without a structural dynamic model, our results may be sensitive to misspecification of the functional form, especially if some of the included behavioral factors are correlated with measurement error. Alternatively, a lack of statistical significance might not be taken as evidence that a behavioral factor is unimportant, as it may be due to a misspecified model. However, given the absence of models that combine backward-looking expectations, inflation illusion, and fundamentals such as taxes and forward-looking expectations, our approach should provide a starting point to explore how fundamental and psychological factors influence changes in the price-rent ratio across U.S. metropolitan areas.

3. Data

The most important variable in our paper is the price index for single family homes.[5] We use the Office of Federal Housing Enterprise Oversight (OFHEO) repeat sales index in all regressions, as opposed to the two other widely cited alternatives, the median sale price of existing homes from the National Association of Realtors and the Standard & Poor's/Case-Shiller repeat sales price index. The biggest advantage of the OFHEO index is that it is reliable for 287 MSAs and divisions, with most of the MSAs covered since 1975–1979. Yet the index also has two major limitations. First, it includes not only sales transactions, but also appraisals from mortgage refinancings that may be less reliable, especially when prices begin to fall. Second, the sample includes only transactions with mortgages sold to Fannie Mae or Freddie Mac, which have an upper limit of $417,000 in 2007 and lower loan limits in previous years (so-called conforming loans). However, other house price indexes also have flaws. The median price index is less useful for our analysis, both because it is available for a shorter time period and, more importantly, because it is quite sensitive to the mix of houses that sell over the real estate cycle. The Standard & Poor's/Case-Shiller index is arguably more reliable for the MSAs and time periods that it covers because it is based on the universe of all transactions (but not appraisals) and is not subject to a cap on the maximum mortgage amount. Unfortunately, the Standard & Poor's/Case-Shiller index does not have enough history over time to include the 1980s and parts of the 1990s in many MSAs and has a much more limited coverage of MSAs. When possible, we have compared the results of our analysis using the OFHEO data with those using the Standard & Poor's/Case-Shiller data, and found no substantive differences.

Reliable data on rental prices are more limited. We are unable to obtain rental costs for single-family homes, so we instead use rents on comparable quality apartments from Reis, Inc. The Reis data are available from 1980 to present in 43 metropolitan areas in the United States. Reis surveys owners for asking rents on rental units with common characteristics. These are the most comprehensive and reliable U.S. rental data available on a historical basis.

An important complication from using the house price indexes from OFHEO and rents based on apartments instead of single-family homes is that we are unable to compute a price-rent ratio that is comparable across markets. The price index is normalized so that one cannot make cross-metropolitan area comparisons, plus we do not know how the quality of the average rental unit compares to average house quality for different metropolitan areas. We address this problem in several steps. First, we compute a rent index for each MSA by dividing the actual rent in each year by the rent in a base year for that MSA. Next, we divide the price index for each MSA by the rent index for each MSA, and finally we set that ratio equal to 1 in a base year/quarter (1998:Q1). This allows us to compute the relative price-rent ratio across years within an MSA, but does not allow us to compare the price-rent ratio level across MSAs. These price-rent ratios are comparable subject to a multiplicative scaling factor for each MSA because we only observe the estimated price-rent ratio.[6]

Our other major challenge is measuring households' expected growth rate of housing prices. For our base measure of static long-term expected future growth rates, we use the average real growth rate of house prices for 1950–2000 computed by Gyourko, Mayer, and Sinai (2006) from the U.S. Census. All other calculations based on historical appreciation rates come from lagged appreciation of the OFHEO price indexes.

Other variables come from standard sources. We calculate long-term expected inflation by splicing two series together. From 1998 to present, we compute long-term expected inflation as the difference between the yield on the 30-year U.S. Treasury Inflation-Protected Security (TIPS) and the yield on a 30-year U.S. Treasury security. Prior to the beginning of the TIPS market in 1998, we use the 10-year expected inflation rate from the Livingston Survey of economic forecasters as published by the Federal Reserve Bank of Philadelphia. Interest rates are obtained from constant maturity one-year and 10-year U.S. Treasury securities and mortgage rates from the Federal Reserve Board for 30-year fixed rate mortgages. Per-capita income and inflation (based on the Consumer Price Index less shelter) are obtained from the Bureau of Labor Statistics.

Computing the tax subsidy to owner-occupied housing is a bit more complicated and described in more detail in Himmelberg, Mayer, and Sinai (2005). We use average property tax rates from Emrath (2002) and income tax rates which we collect from the TAXSIM model of the National Bureau of Economic Research. However, data from the Internal Revenue Service show that 65 percent of tax-filing households do not itemize their tax deductions and, if they are homeowners, do not benefit from the tax deductibility of mortgage interest and property taxes. To account at least roughly for the higher cost of owning for the nonitemizers, we reduce the tax subsidy in our calculations by 50 percent.

We also assume constant depreciation rates (2 percent) and risk premia (2 percent) for all MSAs in our sample and for all years. These assumptions, while simplistic, could bias our calculated user costs in either direction. We might overestimate the spread in user costs between high-priced and low-priced MSAs by ignoring the fact that the value of structures is generally smaller-than-average relative to the land value in the highest land-cost markets such as New York and San Francisco. Thus depreciation might be less important than we assume when we calculate the user cost in low user cost/high appreciation rate cities (Davis and Palumbo 2007). At the same time, the effect of lower-than-average depreciation rates in creating an upward bias in our calculated user cost for the highest priced cities like San Francisco might be offset by the possibility that the house price risk is also above average in these high-priced cities, creating a bias in the other direction. Some research has argued that housing in high-priced cities is riskier because the standard deviation of house prices is much higher (Case and Shiller 2003; Hwang and Quigley 2006), while other research argues that homeowners can partially hedge this rent and price risk (Sinai and Souleles 2005). Without further guidance from the literature on this issue, our calculations do not allow for variation in risk across markets.

Finally, we obtain lending covariates from two principal sources. Yearly data on the use of adjustable-rate mortgages (ARMs), the loan-to-

value (LTV) ratio, and average fees/points paid on mortgages comes from the Federal Housing Finance Board and is based on the Monthly Interest Rate Survey (MIRS) of rates and terms from conventional mortgages for 32 metropolitan areas and all 50 states. While the MIRS sample has unique data at the metropolitan area level, it is based on a less than fully comprehensive sample of conventional mortgages that does not include Alt-A and subprime mortgages. In addition, the LTV data are only for primary mortgages and do not include piggyback loans. Thus the MIRS data almost surely understate the usage of ARMs and effective LTV ratios, both of which are more prevalent among subprime loans than the conventional mortgage population. The MIRS data run from 1978 to 2005 for MSAs and through 2006 for states. We use the MSA data from 1984–2005 and substitute state values for MSA values for 2006. However, the MIRS cities do not completely overlap with the Reis markets. We report regression results alternatively using two data samples, listed in appendix table 1. The complete sample includes all 43 metropolitan areas with rent data from Reis. When we include the lending covariates, we restrict the sample to 26 cities that are in the Reis and the MIRS data. Results are generally similar across the two sample groups when we include the same covariates.

Our data on subprime mortgages are reported at the state level and are based on lender-reported mortgage data based on requirements from the Home Mortgage Discrimination Act (HMDA). While these data are commonly used and reported in research reports and in the press, they have a significant flaw. The definition of "subprime loans" is based on a primary categorization of the lender. So-called subprime lenders sometimes originate conventional or high-quality ("prime") mortgages and some conventional lenders issue appreciable numbers of subprime mortgages. It is impossible to know the overall direction of this bias. We use subprime data from the Mortgage Bankers Association for 2002 to 2005 and from *Inside Mortgage Finance* for 2000 to 2001. These data are not available prior to 2000, when subprime mortgages were much less widely available.

Summary statistics are reported in table 1 for all variables used in our analysis. We begin our analysis in 1984 to allow the inclusion of the lagged five-year appreciation rate as an independent variable. We report both the aggregate standard deviation as well as the average within-MSA

Table 1
Summary Statistics of Variables

	# Obs	Years	Mean	Median	Std. Dev.	Avg. w/in MSA Std. Dev.	Min	Max
Mortgage Interest Rate Survey Subsample								
Price/rent index (P/R)	520	1984–2006	1.06	1.02	0.17	0.18	0.68	2.04
User cost (UC)	520	1984–2006	0.06	0.06	0.01	0.01	0.02	0.08
Ln(P/R)	520	1984–2006	0.05	0.02	0.15	0.15	−0.38	0.72
Ln(1/UC)	520	1984–2006	2.91	2.87	0.20	0.15	2.54	3.69
Lagged five-year growth rate	520	1984–2006	0.05	0.04	0.04	0.03	−0.05	0.20
Lagged one-year growth rate	520	1984–2006	0.06	0.05	0.05	0.05	−0.08	0.27
Inflation rate	520	1984–2006	0.03	0.03	0.01	0.02	0.00	0.06
Loan-to-value ratio (LTV)	520	1984–2006	0.77	0.77	0.04	0.03	0.61	0.86
% Adjustable-rate mortgages (%ARMs)	520	1984–2006	0.27	0.24	0.16	0.12	0.04	0.77
Points and fees (% of mortgage amount)	520	1984–2006	1.15	0.95	0.73	0.81	0.07	3.44
% of loans that are subprime	130	2000–2005	0.11	0.10	0.05	0.04	0.03	0.29

	# Obs	Years	Mean	Median	Std. Dev.	Avg. w/in MSA Std. Dev.	Min	Max
Full Sample								
Price/rent index (P/R)	989	1984–2006	1.08	1.03	0.20	0.18	0.68	2.28
User cost (UC)	989	1984–2006	0.06	0.06	0.01	0.01	0.02	0.10
Ln(P/R)	989	1984–2006	0.06	0.03	0.17	0.15	−0.38	0.82
Ln(1/UC)	989	1984–2006	2.92	2.89	0.24	0.15	2.34	3.86
Lagged five-year growth rate	989	1984–2006	0.05	0.04	0.04	0.03	−0.05	0.20
Lagged one-year growth rate	989	1984–2006	0.06	0.05	0.06	0.05	−0.10	0.33
Inflation rate	989	1984–2006	0.03	0.03	0.02	0.02	0.00	0.06
Loan-to-value ratio (LTV)	520	1984–2006	0.77	0.77	0.04	0.03	0.61	0.86
% Adjustable-rate mortgages (%ARMs)	520	1984–2006	0.27	0.24	0.16	0.12	0.04	0.77
Points and fees (% of mortgage amount)	520	1984–2006	1.29	1.07	0.83	0.81	0.07	3.88
% of loans that are subprime (% Subprime)	258	2000–2005	0.12	0.11	0.05	0.04	0.03	0.29

Source: Authors' calculations.

standard deviation, as the latter better reflects our empirical identification. We should also note that the mean values of the price-rent ratio and ln(P/R) are not meaningful since both are measured as indexes.

There are several instructive facts in the data. While many commentators have reported the seemingly large variation in the ln(P/R) ratio, ln(1/user cost) exhibits the same within-MSA standard deviation. Thus the MSA price-rent ratio is not a priori more volatile than might be expected from a simple user cost model. Second, the lagged five-year nominal growth rate exhibits quite substantial variation, rising as much as 20 percent in the highest-appreciation rate MSA and falling as much as 5 percent, with a within-MSA standard deviation of 3 percent.

4. Empirical Results

We start by establishing a baseline for how much of the variation in the price-rent ratio can be explained by the user cost model with real interest rates and static expectations of capital gains based on long-run real house price growth. The first column of table 2 reports the results from estimating equation (3) over the 1984–2006 period with only ln(1/user cost) on the right-side. The estimated coefficient on user cost is 0.48 (with a standard error of 0.03), well below (and statistically different from) the value of 1.0 that would be expected if the standard user cost model held. Given this estimate, a 10 percent decline in user cost from

Table 2
Variation in the Price-Rent Ratio, 1984–2006

	Whole Sample		
	1984–2006	1984–1994	1995–2006
Ln(1/user cost)	0.48 (0.03)	0.12 (0.03)	1.26 (0.06)
R^2	0.28	0.55	0.57
# Obs	989	473	516
MSA fixed effects	YES	YES	YES

Source: Authors' calculations.

the sample average would lead to a 5.3 percent increase in house prices, holding rent constant.[7] The R-squared is 0.28, so just over one-quarter of the variation in the price-rent ratio is explained by user cost and a set of MSA fixed effects.

Next we split the sample into two periods, 1984–1994 and 1995–2006. We do so to follow-up on the observation in Himmelberg, Mayer, and Sinai (2005) that the user cost model fit particularly poorly in the 1980s. The sample split shows that the user cost model performs badly in the earlier time period (with a coefficient of 0.12 on user cost), but there is excess sensitivity in the later period (with a coefficient of 1.27). Thus between 1984 and 1994, changes in user cost had little effect on the price-rent ratio, while the effect was 10 times stronger in the late 1990s and early 2000s. This result is consistent with the view that the run-up in U.S. house prices in the 1980s was *not* supported by fundamentals, while the price growth in the 2000s was better supported. Indeed, it is apparent a priori that this should be the case: user costs were high in the 1980s since real interest rates were high, yet house prices experienced rampant growth. By contrast, in the 2000s movements in the price-rent ratio trended with a strong decline in real interest rates. In both periods the R-squared is just over 0.55, suggesting that considerable variation in the price-rent ratio remains to be explained.

Capital Availability as an Explanation for Housing Booms

In table 3, we add proxies (C_{it}) for changes in loan terms or mortgage market efficiency over time—including the fraction of loans that are adjustable-rate mortgages, average points and fees (a proxy for the improved efficiency of the lending market), and the average LTV ratio in an MSA for a given year—because lenders take on more risk when they underwrite with more leverage. Since we do not have these variables for all the cities with price data, we estimate the model on the subset for which we have complete data, which we label as the "MIRS subsample." The first column of table 3 replicates the regression from the first column of table 2 using the MIRS subsample and finds almost identical results, albeit with larger standard errors due to the smaller number of observations.

Adding the fraction of ARMs or average points and fees has the expected effect. In column (2) the ARM share is positively correlated

Table 3
Changes in Loan Terms and Mortgage Market Efficiency Over Time

	Mortgage Interest Rate Survey Subsample						
	1984–2006	1984–2006	1984–2006	1984–2006	1984–2006	1984–1994	1995–2006
Ln(1/user cost)	0.50	0.56	0.30	0.51	0.37	−0.13	0.88
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.05)	(0.07)
%ARMs		0.13			0.19	−0.04	0.23
		(0.05)			(0.05)	(0.04)	(0.06)
Points & fees			−0.06		−0.07	−0.07	−0.21
			(0.01)		(0.01)	(0.01)	(0.03)
Loan-to-value ratio				−0.98	−1.11	−0.99	−0.56
				(0.20)	(0.18)	(0.25)	(0.25)
R^2	0.20	0.21	0.28	0.24	0.35	0.72	0.66
# Obs	520	520	520	520	520	234	286
MSA fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations.

with the price-rent multiple, suggesting that when ARMs are more prevalent, the price-rent ratio is higher. Similarly, when average points and fees are lower, the price-rent ratio is higher, reflecting the fact that the effective cost of capital is lower when points and fees are reduced. Adding these two variables changes the estimated coefficient on user cost, indicating that in part these are picking up some measurement error in the proxy for the cost of capital used in the user cost formula. In column (4) the estimated coefficient on the average LTV ratio is negative, the opposite sign to what would be predicted if relaxing liquidity constraints leads to a higher price-rent ratio. However, the LTV ratio as measured by the Federal Home Loan Banks falls in house price booms, so its sign is not surprising. Also, the variable may be measured incorrectly due to missing second mortgages and the lack of high LTV subprime mortgages. The inclusion of these lending variables generally lowers the coefficient on user cost, suggesting that mismeasurement of the true cost of lending in the user cost model might bias our estimation.

When we divide the sample period between the boom-bust in the 1980s and the boom in the 2000s, again there are significant differences in the relationship between the capital markets and the price-rent ratio. The estimated coefficient on user cost over the 1984–2006 period when all three credit market variables are included is 0.37 (with a standard error of 0.06). But that masks a coefficient of -0.13 during 1984–1994 and 0.88 for 1995–2006. Some of the credit market variables also have different estimated coefficients during the two periods, with the coefficient on the percent ARM variable approximately zero and thus insignificant during the early period, but positive and significant in the 2000s, while the coefficient on the points and fees variable triples in magnitude during the latter period. Indeed, with the exception of the LTV ratio, credit market conditions seem to have a magnified effect on the price-rent ratio in the 1995–2006 boom and provide little help explaining the 1980s boom-bust in U.S. housing prices.

Next we attempt to examine the impact of the growth in subprime lending. In table 4, we examine the extent to which subprime lending is correlated with excess growth in the price-rent ratio. Since data on subprime shares are available only for the 2000–2005 period, we restrict our attention to those six years. The first column of table 4 shows that

Table 4
The Growth in Subprime Mortgages versus the Price-Rent Ratio, 2000–2005

	Subprime Subsample				
	2000–2005	2000–2005	2000–2005	2000–2005	2000–2005
Ln(1/user cost)	0.96 (0.04)	0.82 (0.06)	0.81 (0.08)	0.65 (0.08)	0.90 (0.22)
%Subprime Mortgages		0.43 (0.12)		0.63 (0.15)	1.54 (0.22)
%Adjustable-rate mortgages			0.12 (0.05)	−0.02 (0.06)	0.06 (0.07)
Points & fees			0.01 (0.05)	−0.02 (0.04)	0.01 (0.04)
Loan-to-value ratio			−0.81 (0.23)	−0.75 (0.21)	−0.23 (0.21)
R^2	0.89	0.90	0.90	0.92	0.94
# Obs	130	130	130	130	130
Year fixed effects	No	No	No	No	Yes
MSA fixed effects	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations.

the user cost model plus MSA dummies fit quite well during that period, with an estimated coefficient on user cost of 0.95 and an R-squared of 0.89. In column 2, we add the share of mortgages originated that were subprime loans. We find that greater fractions of subprime mortgages are correlated with higher price-rent ratios, but that the magnitude of the effect is fairly moderate. The estimated coefficient of 0.42 implies that a one standard deviation increase in the subprime mortgage share (5 percentage points compared to a mean of 11 percent) yields just over a 2 percent increase in house prices, holding rents constant. As column 4 shows, this result is robust to including the other measures of the cost of credit, increasing in magnitude by half when these costs are added. However, when we include the subprime share, the other lending variables appear to matter much less in explaining the price-rent ratio, as can be seen by

comparing columns 3 and 4. Since subprime mortgages often involve adjustable-rate features and high LTV ratios, it is not surprising that the inclusion of a control for subprime lending reduces the magnitude of the coefficients on these other lending variables.

One might be somewhat skeptical of using changes in the subprime share of mortgages over time to help identify the relationship between the subprime share of mortgages and the price-rent ratio. Since both the price-rent ratio and subprime share were trending upwards between 2000 and 2005, one cannot be sure if the price-rent ratio rose because of lenders taking on more risk through the extension of subprime loans or if the correlation is spurious. In the last column of table 4, we add year fixed effects to address this issue. The year effects control for any national trends in the price-rent ratio and subprime share of mortgages. Thus the estimated coefficient on the subprime portion is identified by whether a given MSA's price-rent ratio grows faster than the national average when the share of subprime mortgages in that MSA grows faster than the national average. Similarly, the user cost coefficient is identified by whether MSAs with user costs that decline more than the national average in a given year have price-rent ratios that increase more than the average for that year.

In this specification, percent changes in user cost, with an estimated coefficient of 0.90 (standard error of 0.22), have an almost one-for-one effect on the price-rent ratio. The increase in the size of the user cost coefficient in this specification relative to that in the previous column suggests that aggregate time-series factors may actually obscure the relationship between user cost and the price-rent ratio during this period, possibly due to omitted time-varying risk effects or other macroeconomic time-series variables. The estimated effect of the subprime share actually rises by a fourfold increase when we restrict our focus to variation within a given MSA over time. The resulting coefficient of 1.54 (standard error of 0.22) implies that a 5 percentage point increase in the subprime share is correlated with a 10 percent excess increase in the price-rent ratio. The other credit market variables are no longer statistically significant. These results suggest that subprime lending is related to excess growth in price-rent ratios in recent years and are similar in spirit to the findings in prior research (see Pavlov and Wachter forthcoming).

Behavioral Explanations for Housing Booms: Backward-Looking Expectations

Collectively, the user cost of capital and credit market variables explain a great deal of the within-MSA variation in the price-rent ratio from 2000 to 2005: 92 percent without including year dummies and 94 percent with this inclusion. In addition, the estimated coefficient on user cost is very close to one, suggesting that the housing market was priced rationally given the state of the capital markets. But this result leads one to ask: was the capital that flowed to the housing market motivated by some behavioral response, as suggested by Shiller (2007), even if purchasers priced the housing asset correctly?

Discussing the behavioral motivations for excessive lending or insufficient risk aversion on the part of lenders is beyond the scope of this paper, but at least we can examine whether an increase in subprime mortgage lending followed growth in housing prices. In table 5, we regress the subprime share on recent house price growth rates: the average house price appreciation rate between six years and one year prior to the current year and the house price growth rate between two and one years prior to the

Table 5
The Growth in Subprime Mortgages versus the Growth in Housing Prices, 2000–2005

	Subprime Subsample					
	2000–2005	2000–2005	2000–2005	2000–2005	2000–2005	2000–2005
Lagged five-year growth rate from years -6 to -1	1.24 (0.11)		1.29 (0.11)	0.67 (0.06)		0.71 (0.06)
Lagged one-year growth rate from years -2 to -1		0.16 (0.09)	−0.10 (0.07)		0.04 (0.04)	−0.07 (0.03)
R^2	0.50	0.21	0.50	0.92	0.87	0.92
# Obs	258	258	258	258	258	258
Year fixed effects	No	No	No	Yes	Yes	Yes
MSA fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations

current year.[8] Since the regressions contain MSA fixed effects, the identification comes from within-MSA changes in subprime lending relative to the MSA sample period average. The first three columns of table 5 show that higher past five-year lagged appreciation rates are associated with a much higher share of subprime loans. The coefficient on the lagged five-year growth rate in column 3 shows that a 1 percentage point increase in house prices leads to a 1.29 percentage point greater subprime share of mortgages. However, the most recent year's appreciation rate in house prices has little predictive power for the growth of subprime loans; if anything, conditional on the five-year lagged growth rate in house prices, subprime lending is slightly lower in markets that experienced high housing price growth over the prior year.

When we include year dummies in the last three columns of table 5, we see that increases in lagged five-year house price growth are still associated with bigger-than-average increases in the subprime share of mortgages. However, the magnitude of the effect is about 60 percent as big as without the year fixed effects, with an estimated coefficient on the five-year average prior house price growth ranging from 0.67 to 0.71 with very low standard errors. These results suggest that lenders may have lent more aggressively in markets with high rates of medium-term (five-year) house price growth. The fact that the last year's price growth in the housing market is unrelated to the share of subprime mortgages is evidence against the view that increases in house prices spur rapid expansions of subprime lending, thus causing house prices to quickly spike.

Another way in which behavioral factors can affect the housing market is through the formation of expectations about house price growth by home buyers and sellers, as suggested by Case and Shiller (1988, 1989, 2003), Shiller (2007), and others. We consider two simple backward-looking rules for forming expectations: future house price growth is expected to be the average of the last five years' appreciation in housing prices and future house price growth is expected to be the same as last year's increase. While these are particularly naïve rules of thumb, we have no theory that would give more precise guidance.[9]

As reported in the first column of table 6 and predicted by the behavioral conjectures, the lagged five-year average of house price growth is positively associated with increases in the price-rent ratio. The individual coefficient on the lagged five-year growth rate is highly statistically signif-

Table 6
Inflation Expectations and Expected House Price Appreciation, 1984–2006

	Mortgage Interest Rate Survey Subsample						Subprime Subsample		
	1984–2006	1984–2006	1984–2006	1984–2006	1984–1994	1995–2006	2000–2005	2000–2005	2000–2005
Ln(1/user cost)	0.33 (0.05)	0.38 (0.06)	0.33 (0.05)	0.43 (0.05)	–0.00 (0.05)	0.76 (0.06)	0.63 (0.06)	0.57 (0.06)	0.97 (0.17)
Lagged five-year growth rate	2.17 (0.13)		2.20 (0.14)	1.99 (0.13)	1.57 (0.12)	2.08 (0.19)	2.35 (0.23)	2.16 (0.24)	1.80 (0.28)
Lagged one-year growth rate		0.36 (0.12)	–0.07 (0.10)	–0.01 (0.10)	–0.14 (0.07)	–0.03 (0.13)	0.21 (0.10)	0.15 (0.10)	0.19 (0.09)
Inflation rate				2.12 (0.31)	0.57 (0.33)	2.49 (0.31)	–0.19 (0.20)	–0.34 (0.21)	
%ARMs	0.09 (0.04)	0.17 (0.05)	0.10 (0.04)	0.08 (0.04)	–0.03 (0.03)	0.02 (0.05)	0.11 (0.04)	0.05 (0.04)	0.07 (0.05)
Points and fees	–0.05 (0.01)	–0.06 (0.01)	–0.05 (0.01)	–0.05 (0.01)	–0.02 (0.01)	–0.08 (0.02)	0.01 (0.03)	–0.01 (0.03)	–0.01 (0.03)
%Subprime								0.33 (0.12)	0.64 (0.22)
R^2	0.55	0.31	0.55	0.59	0.85	0.82	0.95	0.96	0.96
# Obs	520	520	520	520	234	286	130	130	130
Year fixed effects	No	No	No	No	No	No	No	No	Yes
MSA fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations

icant and increases the explanatory power of the regression appreciably.[10] When the lagged five-year average house price growth rate is above the MSA average, the price-rent ratio for that MSA is also above its average. In particular, the estimated coefficient in column 1 suggests that a one standard deviation change in the lagged growth rate of 3 percentage points is associated with more than a 6 percent increase in the price-rent ratio.

By contrast, the prior year's house price growth rate has little effect on the price-rent ratio (column 2) and what effect it does have is subsumed by the five-year average lagged growth rate (column 3). Neither lagged growth rate affects the estimated coefficient on the user cost of capital, which remains between 0.33 and 0.38, very close to the estimate in the fifth column of table 3. This result is inconsistent with the most behaviorally influenced conjecture, which holds that households set expected house growth rates based on very recent changes in house prices.[11]

Of course, backward-looking expectations are not necessarily based on behavioral factors: instead, households might rationally incorporate lagged five-year price growth when predicting future house price growth, especially if there is serial correlation in underlying demand growth.[12] Indeed, all one can say with certainty is that house price growth expectations appear to be dynamic since, to the degree that households across different MSAs hold different static expectations about future price growth, these varying price growth expectations are absorbed by the MSA fixed effect. Thus the large and statistically significant coefficient on past house price growth indicates that changes in expected capital gains are correlated with the price-rent ratio.[13] Even so, the effect of recent house price growth on current price-rent ratios is certainly suggestive of a behavioral component. More work needs to be done so we can better understand how households set their expectations of future price growth and how those expectations are capitalized into prices.

Inflation Illusion

Finally, we examine the evidence on whether households are subject to inflation illusion, meaning that they confuse nominal interest rates with real ones, as has been suggested by Brunnermeier and Juillard (2008). To see if inflation illusion has an effect on expected future house prices, we add a measure of inflation to the regression. The results showing that higher inflation is correlated with a higher price-rent ratio are reported in the fourth column of table 6. The estimated coefficient of 2.13 (with a standard error of 0.31) suggests that a 1 percentage point higher inflation rate (the mean is 0.03) is correlated with a 2 percent higher price-rent ratio. This is actually the opposite result that one would expect given the results in Brunnermeier and Julliard (2008). Those authors argue that when actual inflation falls, households think that the cost of capital (the mortgage interest rate) is lower even as expected house price appreciation has not changed. If lower inflation made housing appear relatively inexpensive in recent years, the price-rent ratio should have increased, not fallen.[14]

Note that the user cost model predicts that higher *expected* inflation should raise house prices as increases in *expected* inflation raise the value of the nominal mortgage interest deduction. However, with the expected inflation rate already incorporated in the user cost of capital and the relationship between actual and expected inflation unclear, it is quite possible that the positive and significant coefficient on inflation may be due to measurement error in the user cost or in expected inflation. In addition, as discussed above, it is difficult to accurately compute the value of the tax deduction for nominal interest payments since many households do not itemize deductions when filing their taxes.

In table 6, the fifth and sixth columns return to the notion that the 1980s boom in house prices was perhaps more behaviorally driven than the housing boom in the 2000s. Between 1984 and 1994 the user cost of capital had no effect—and credit market conditions had almost no effect—on the price-rent ratio once one controls for lagged house price growth and inflation, and even those variables had a relatively small impact on the price-rent ratio during that period. But in the 1995 through 2006 period, the user cost coefficient increased to 0.76, which is much closer to its theoretical value of 1.00. Lagged house price growth also had a larger effect, with an estimated coefficient of 2.08. To give a sense of magnitudes in column six, a within-MSA one standard deviation decrease in ln(1/user cost) of about 15 percent would lead to an 11.4 percent increase in ln(P/R). By contrast, a within-MSA one standard deviation increase in lagged house price growth (3 percentage points) would lead to a 6 percent increase in the price-rent ratio. So a one standard

deviation change in the user cost has about twice as large an effect on ln(P/R) as a one standard deviation change in lagged five-year house price appreciation.

We finish by revisiting the recent boom years of 2000–2005 and the impact subprime mortgages may have had on this run-up in house prices. The seventh column shows that the coefficients estimated over the 2000–2005 period look very similar to those estimated during 1995–2006, except that the coefficient on the inflation rate switches signs and is no longer statistically significant from zero. In the eighth column we add the subprime share and see, once again, that the subprime share is strongly correlated with higher price-rent multiples. With a coefficient of 0.32, a one standard deviation increase in the within-MSA subprime share (4 percentage points) is associated with a 1.3 percent increase in the price-rent ratio. The last column of table 6 incorporates year dummies using just the variation within a given MSA over time to identify the coefficients. The estimated coefficient on user cost, 0.97, is quite close to unity. The coefficient on the five-year lagged appreciation rate is little changed. This specification suggests that in the latest time period, a one standard deviation change in the user cost of capital has almost three times the impact on ln(P/R) as a one standard deviation change in lagged five-year house price appreciation, and almost six times as much explanatory power as is accounted for by a one standard deviation change in the percent of subprime mortgages.

5. Conclusions

Our results suggest that both fundamental (meaning rational) and seemingly behavioral factors play an important role in explaining changes in the price-rent ratio across U.S. metropolitan areas since 1984. We began by estimating a standard user cost model with long-term interest rates and expected house price appreciation equal to its postwar average. We then included other independent variables to control for measurement error and omissions in the standard user cost model. Finally, we added proxies for behavioral explanations of house price growth, including backward-looking expectations and inflation illusion.

The standard model matched changes across MSAs in house price appreciation after 1994 almost one-for-one, but did a poor job describing the period between 1984 and 1994. Backward-looking expectations, in the form of five-year lagged appreciation rates, were the only factor to have any sizable correlation with movements in the price-rent ratio between 1984 and 1994, but changes in the user cost of capital appeared to have a larger effect on the price-rent ratio in the 1995–2006 period than did the lagged five-year appreciation rate. Mortgage market factors, especially the growing use of subprime mortgages and the decline in lending costs, also help explain an additional portion of the variation in price-rent ratios in the latter part of the 1995–2006 period.

The results present a mixed bag when interpreting the magnitude of rational and behavioral effects in explaining house price movements. Fundamentals seem to be important—but only in the 1995–2006 boom. Coefficients on the two most striking behavioral variables, the inflation rate (inflation illusion) and one-year backward-looking expectations, were the wrong sign in nearly all specifications and these variables displayed little explanatory power. However, medium-term, backward-looking expectations (five-year lagged appreciation rate) are quite important in explaining within-MSA variations in price-rent ratios and are also correlated with the increased use of subprime mortgages. Overall, these results suggest that the house price boom in the 1980s was more of a behavioral bubble than the boom in the 2000s, where fundamentals dominated in importance but backward-looking expectations continued to play a sizable role in influencing market behavior. Still, there is appreciable scope for additional work exploring how households set their expectations and how lenders determine their lending standards. Without a formal model of expectation-setting for households and lenders, it is nearly impossible to determine the extent to which households and lenders are rationally updating their beliefs about future house price appreciation or are getting caught up in a "zeitgeist" that "is at least in part the result of a social epidemic of optimism for real estate" (Shiller 2007, 96–97).

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Notes

1. Smith and Smith (2006) analyzed a sample of single-family rental units, so that prices and rents were closely matched. However, their estimation procedure did not incorporate differential house price appreciation rates across metropolitan areas and their limited sample appears not to be fully representative of the market. The paper concluded that, based on fundamentals, house prices in some California cities were quite low in 2005.

2. See Gallin (2006) who examined the relationship between prices and rents.

3. Also, an increase in mortgage market efficiency that allows mortgages to be more cheaply originated might be capitalized in higher house prices.

4. We include log P/R and log user cost in equation (3) to address an additional problem that is described further in the data section. Our measure of P/R is not comparable across cities and requires that we factor out a multiplicative error term.

5. More detail on the data used in this paper, as well as updated web links to our sources, can be obtained from the website, http://www0.gsb.columbia.edu/realestate/research/housingcost or in most cases from Himmelberg, Mayer, and Sinai (2005).

6. We remove the multiplicative error by taking logs of both sides, regressing ln(P/R) on ln(1/user cost) and MSA fixed effects (to pick up the multiplicative scaling factor), plus other covariates. Thus, we can use only within-MSA variation to identify the various parameters of interest.

7. The average user cost over this sample period is 0.06, from table 1. A 10 percent decline would yield a user cost of 0.054. In that case, 1/UC would rise from 16.6667 to 18.5185, an 11 percent increase. Multiplying that 11 percent by 0.48 gives a 5.33 percent rise in house prices.

8. We measure the growth rate up through the start of the prior year rather than the current year to avoid a contemporaneous measurement of subprime market share and house price growth. We obtain similar results if we measure price appreciation through the current year.

9. In addition, the five-year-average fits the data better than other approaches, such as overweighting more recent years or estimating an autoregressive price growth process, as in Campbell et al. (2007). Ideally, we would have some measure of peoples' actual house price expectations but we are not aware of any source that collects such data for a wide variety of cities.

10. We exclude the LTV ratio since it appears not to reflect the true degree of leverage. Our conclusions are unchanged even if we include it.

11. This result is not surprising. If very short-run price increases had large impacts on expectations, we would see more bubbles of the form seen in Vancouver in the early 1980s, which was characterized by a quick spike and decline in house prices.

12. For example, Gyourko, Mayer, and Sinai (2006) show that the price-rent ratio falls as long-run price growth increases, at least using decadal data.

13. This result is consistent with the last table from Sinai and Souleles (2005) which shows that that markets with higher historical house price growth have higher price-rent ratios and those price-rent ratios expand when past house price growth rises, holding the metropolitan area constant.

14. One potential reason for the differences between our findings and theirs is that we use a panel with variation in prices and rents across metropolitan areas, while Brunnermeier and Julliard (2008) estimate their model using only national aggregate data. On the other hand, Brunnermeier and Julliard have a more complete dynamic model of price determination, albeit one that abstracts from features like tax advantages accruing to owner-occupied housing.

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Appendix Table 1

REIS/MIRS MSAs	REIS ONLY MSAs
Austin	Atlanta
Charlotte	Baltimore
Cincinnati	Boston
District of Columbia	Chicago
Fort Lauderdale	Cleveland
Fort Worth	Columbus
Jacksonville	Dallas
Memphis	Denver
Nashville	Detroit
Oakland	Houston
Orange County	Indianapolis
Orlando	Kansas City
Richmond	Los Angeles
Sacramento	Miami
San Antonio	Milwaukee
San Bernadino-Riverside	Minneapolis
San Jose	New York
	Philadelphia
	Phoenix
	Pittsburgh
	Portland
	San Diego
	San Francisco
	Seattle
	St. Louis
	Tampa

Comments[1] on "U.S. House Price Dynamics and Behavioral Finance" by Christopher J. Mayer and Todd Sinai

Andrew Caplin

There are many who tie problems in the subprime mortgage market to topics typically covered under the rubric of behavioral economics. It is widely asserted that naïve borrowers did not understand loan terms, and that regulators should intervene to protect those whose bounded ability is so clearly revealed by the episode. In these comments I note that the inadequacy of consumer understanding is as nothing next to that of the regulators and academic economists. I outline how the behavioral limitations of these two groups have contributed to the subprime crisis, and offer suggestions on how future crises of this kind might be avoided.

Consider an obvious asymmetry between options open to households as opposed to corporations when each entity encounters repayment difficulties. When a debt-financed corporation is at risk of default, all forms of deal are open for cases in which replacing managers and/or scrapping the enterprise would be inefficient. For example, an equity investor may find it worthwhile to "take out" the debtors in exchange for some portion of the continuing value of the operation. A similar renegotiation involving equity may make sense for many homeowners, who can be seen as proprietors of small businesses. There are many cases in which the efficient option would be to leave the current owner in place to avoid a fire sale. After all, where is one to find a better-off pool of replacement managers for properties in areas with significant short-term economic stress? This suggests that opening up equity options in mortgage negotiations would prevent many defaults, without choking off long-term capital to less well-off lenders. Arguments on the social value of markets in housing equity are of longstanding (Caplin, Chan, Freeman, and Tracy

1997; Caplin, Carr, Pollock, and Tong 2007). Personal experience suggests that arguments on social value are insufficient to convince regulators to change their ways.

The first equity sharing mortgage to be considered, the shared appreciation mortgage (SAM), was initially proposed in the 1970s to reduce the very high interest payments caused by the inflationary interest rates. At that time, the Internal Revenue Service (IRS) was called in to rule on whether a specific SAM created joint ownership. In response to a request for a ruling as to the "federal income tax consequences to a mortgagor under a shared appreciation mortgage loan used to finance the purchase of a personal residence," the IRS issued Revenue Ruling 83-51. While it was ruled that regular interest payments during the life of the loan and final payments of contingent interest could be deducted for tax purposes, the ruling was limited to "the fact situations set forth above," which included a detailed description of the mortgage in question. At one and the same time, the IRS moved SAMs onto the "No Advance Rulings" list. This effectively chilled the market, as noted by the California Housing Finance Agency (2002):

> One of the primary attributes of ownership under the federal tax rules is the right to benefit from appreciation in the value of the property. Where that right is shared by the title owner with another party, the Internal Revenue Service has only grudgingly (and in relatively few instances) concluded that the title owner is the owner for federal tax purposes. For example, Revenue Ruling 83–51 concludes that under very restricted circumstances, a shared-appreciation mortgage loan used to finance the purchase of a personal residence results in a debtor-creditor relationship (rather than a joint venture or other joint ownership arrangement). Since the publication of that ruling, the Internal Revenue Service has announced that the shared-appreciation area is one in which they will not issue rulings or determination letters. See, e.g. Revenue Procedures 88-3 (4).

The reason that this policy was of interest to the California Housing Finance Agency is that it indirectly blocked efforts to help with housing affordability on the lower end of the market; in particular, a scheme developed by National Ecumenical Homebuilders (NEH). In ultimately developing an affordability scheme that was acceptable to the IRS, the NEH ran into a second set of obstacles to market development, relating to the securities laws. Evidently efforts to allow sharing of equity for such

socially-minded purposes as increasing the rate of homeownership have, to date, fallen on deaf ears.

Another example of the regulatory morass confronting those seeking to rationally amend mortgage design strikes even closer to home. I participated in a project to offer some form of index-based house price insurance in Syracuse, New York (Caplin et al. 2003). Along the way, we found out that insurance regulations would preclude such an offering. So we proposed developing a mortgage in which the balance due fell with the value of local housing. The existence of such a mortgage would clearly have been very beneficial in terms of the current market problems. Unfortunately we were informed that such a mortgage would be judged in New York State to be a "price-level-adjusted mortgage" (PLAM). These had been banned in New York State some 20 years earlier, a decision that is as hard to change as it is justify. To complete the circle, such mortgages were initially proposed by Franco Modigliani in the 1970s, and the lack of receptivity to this idea is, to my knowledge, the first known important example of the tangle that is the U.S. regulatory system. The PLAM is also the precursor to the SAM, which was initially designed precisely to overcome regulatory resistance to the PLAM!

In the United States, promoting the private sector's interest in these innovative mortgages may be necessary to overcome such regulatory hurdles, a component which was missing in the above cases. Yet such interest has had little impact on the regulatory framework, as evidenced in 2000 by a failed effort to reintroduce SAMs in the United States with Bear Stearns involved as the securitizer. Given the IRS rulings, the supporting consumer brochure stated that: "The application of the federal income tax rules to a SAM is both uncertain and complicated, and the rules will affect each borrower differently. Accordingly, you must talk to your tax advisor about the federal income tax consequences to you of borrowing under a SAM" (National Commerce Bank Services 2000). Not surprisingly, there were few takers, and those who had pioneered the market development of SAMs were soon working elsewhere. Guess where the creative energies of those in the business of securitizing mortgages went next? To those who are currently looking to justify additional regulations with the refrain "look where all this novelty got us," the appropriate response is that the creative effort was misdirected precisely because of poor regulations.

The case of equity sharing is not an isolated example of regulatory and institutional inertia, as revealed by the case of reverse mortgages (Caplin 2002). In 1978 Ken Scholen founded the National Center for Home Equity Conversion in an effort to stimulate development of these markets. The private sector caught on slowly to this idea, and in 1992, armed with qualified applicants and properties, Providential raised $65 million for reverse mortgage finance in an oversubscribed public offering. A short while later the Securities and Exchange Commission announced an investigation into the company's accounting practices, and then ruled that Providential should not assume any future changes in property value when projecting cash flows. You might ask why, but that appears to be beside the point. Realizing that the legal and regulatory challenges were overwhelming, private capital fled the market.

In an effort to move market development forward, Congress authorized the Home Equity Conversion Mortgage (HECM) as a pilot program in 1989 for the Department of Housing and Urban Development (HUD). Yet in its initial report to Congress, HUD itself was very concerned with legal issues at the state level. In its follow-up report, it noted that some progress has been made, but that there was considerable uncertainty concerning enforcement of the HECM as a first mortgage:

> The laws in some states are not clear regarding the lien priority to be granted to loan advances made over an extended number of years under a mortgage that was recorded as a first mortgage. HUD has attempted to ensure that all HECM loan advances will be regarded under state law as mandatory or obligatory advances that, under the laws prevailing in most states, would also have a first lien priority, but there remains some legal risk in some states (HUD 1995, 5–13).

These state-by-state discrepancies are far from the end of the regulatory problem. The Federal Reserve Board considers a reverse mortgage to be an "open-end consumer credit plan under which extensions of credit are secured by a consumer's principal dwelling." In a Kafkaesque twist, the Truth in Lending Act requires the lender to lie by stating that "loss of dwelling may occur in the event of default." In truth, the household only stands to lose the property if it fails to pay taxes, fails to keep the property in good repair, or otherwise endangers the lender's security interest in the property.

What about the tax treatment of reverse mortgages? Borrowers must sign a certificate disclosing that a HECM may have tax consequences, affect their eligibility for assistance under federal and state programs, and impact on the estate and heirs of the borrower. One open question in this regard concerns the potential taxability of the proceeds of the reverse mortgage. A second concern is the possibility of a phantom gain that may occur when an elderly household sells the home for a handsome capital gain, but at a time when the loan has grown to be even larger than the property's sale amount. It has even been conjectured that the IRS will ultimately rule that reverse mortgages are really sales rather than loans, which would have a disastrous impact on the financial positions of the supposed owners. The situation with respect to benefits is almost equally unclear. In the federal Supplemental Security Income (SSI) program, a loan advance cannot affect your SSI benefits if you spend the loan advance in the calendar month in which you receive it. But if your total liquid assets at the end of any month are above very low limits, eligibility is lost. In addition, the money you get from an annuity can reduce your SSI benefits dollar-for-dollar or make you ineligible for Medicaid.

Taking stock, it is almost as if most of the major U.S. institutions have been constructed to preserve an archaically structured housing finance market. The fiscal, legal, and regulatory systems are incomplete, leaving participants uncertain on how to design new instruments. Rather than being prepared for all future contingencies, regulators have implicitly blocked the development of new products by leaving important questions unanswered. The incompleteness of these systems exposes innovative producers and consumers to widespread risk. The Internet would be but a dream had computer technology been subject to such reactionary oversight.

Given how blatantly disconnected it has become from economic rationality, an intriguing question is why the regulatory system (broadly construed) has not been subjected to a "behavioral" analysis. I believe this to be because we have no first-order theory of what motivates regulators. Neglecting regulatory behavior because we have no idea what drives it, when viewed from the social standpoint, represents a very poor allocation of academic attention.

A similar issue of academic priorities shows up in the area of house prices. Academics have managed to predict not only six of the last three recessions, but ten of the last two housing bubbles, which gives a true reflection of the state of our knowledge regarding house prices. There have been few strong findings, and the housing indexes that are relied on are poorly measured and contain errors that may contribute systematically to the pattern of returns that are found in the data (Meese and Wallace 1991). Economic models of house price dynamics remain rudimentary, making it hard even to understand the extent to which observed differences in housing returns across locations were ex ante predictable.

Ironically, I believe that our ignorance concerning house price dynamics has played an integral part in the subprime crisis. Implicitly, those who lent with subprime mortgages were issuing equity in down markets. The crash is in part a sudden recognition that the return properties of these assets are little understood, even by leading academics.

More broadly, I believe that academics understate their importance in contributing to market innovation and to policy. If we could take a big lead in developing the relevant knowledge base, then we could actually play a role in promoting and developing socially beneficial financial instruments. We are currently part of the problem, and it is past time for us to become part of the solution. A significant change in academic priorities is second only to regulatory revamping in terms of the potential to improve real-world outcomes. We are in the best position to help overcome the many chicken and egg problems that underlie the failure of potentially beneficial markets to develop. Our research priorities end up impacting the world, and changes in our behavior have the potential to feed through in a beneficial loop to promoting better real-world outcomes.

Note

1. These comments represent my earliest efforts to suggest appreciation sharing as a necessary part of any solution to the subprime tragedy. Since delivering these comments in September 2007, my co-authors and I have presented the ideas in increasingly refined form that has appeared in various outlets (for example, Caplin, Cunningham, and Engler 2008; Caplin, Cunningham, Engler, and Pollock 2008; Caplin, Cooley, Cunningham, and Engler 2008). More than one year after this initial statement, the good news is that this proposal is being taken increasingly seriously by policymakers. In particular, William Hambrecht has proposed a similar plan that is getting attention (Nocera 2008). The bad news is that the two theses advanced in this comment concerning the behavioral limits of regulators and of academic economists have been confirmed. In the face of rising foreclosures and loan losses, regulators continue to search for short-run fixes rather than building polices that will promote the nation's long-run economic welfare. Academic economists, meanwhile, have added few original notes to the policy debate. Moreover, contra Zingales (2008), local (zip code) house price indexes remain highly unreliable. It is alarming, and in some ways tragic, that real estate and real estate finance remain such understudied areas of economics when the consequences of such relative inattention prove so severe.

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Comments on "U.S. House Price Dynamics and Behavioral Finance" by Christopher J. Mayer and Todd Sinai

Robert J. Shiller

Mayer and Sinai begin their paper with the disarming assertion: "The question of whether psychology matters in the housing market has been settled long ago: the answer is yes." I suppose we could get agreement on this claim among real estate economists, but this is a very weak statement of how most economists view the housing market. While efficient markets theorists have always acknowledged that markets are not *perfectly* efficient, I think that there is still a strong tendency in the profession for many economists to describe the housing market entirely in rational terms. Psychological factors are still difficult for most economists to incorporate into their thinking. I think that this bias towards describing people as almost perfectly rational has led many analysts astray in the past, and continues to do so now. For example, the current "subprime crisis," which has now developed into a global financial crisis of magnitude unseen since the Great Depression, appears to have been a surprise to most people, both within and without the economics profession.

I think that proper recognition of the role psychology plays in markets should have sounded a loud warning about the subprime crisis, and other such crises, in advance. In the second edition of my book *Irrational Exuberance*, published in early 2005, I sounded such a warning. Employing an analysis of the stock and housing markets based on behavioral finance I wrote:

> Significant further rises in these markets could lead, eventually, to even more significant declines. The bad outcome could be that eventual declines would result in a substantial increase in the rate of personal bankruptcies, which could lead to a secondary string of bankruptcies of financial institutions as well. Another long-run consequence could be a decline in consumer and business confidence, and another, possibly worldwide, recession (xiii–xiv).

Very few people seemed to be warning of this possibility in 2004 and 2005, and I think that perhaps the reason is that they were not appreciative enough of the psychological underpinnings of the bubble in the housing market.

That is all the more reason why the Mayer and Sinai paper, which is a very useful overview of evidence about behavioral finance as it relates to housing, is really very important. Yet I find myself differing from their conclusions.

The paper offers some substantial and careful scholarship in analyzing the literature. One point that they make forcefully is that tests for serial correlation in prices are not necessarily tests of market efficiency. The authors assert that "Of course, serial correlation [of price] is not necessarily evidence of irrational markets if underlying rent growth is serially correlated." This is absolutely right. But it would be an error to think that the high level of upward momentum that we have seen in the U.S. housing market from 2000 to 2006, with prices going up in double digits year after year in many cities, could be explained by the serial correlation of rents.

Attributing the serial correlation of house prices to the serial correlation of rental prices is attributing the bubble to something unmeasurable. Rents for single-family homes are indeed inherently hard to measure, since there is no regular rental market for conventional single-family homes. Indeed, the largest company in the United States that is in the business of renting out detached single-family homes, Redbrick Partners, has an inventory of only a couple thousand homes. Since they have avoided managing properties that are widely dispersed geographically, no aggregate measure approximating a national average for renting a single-family can be estimated from their data.

Rental properties are different from single-family homes and offer consumers different psychic benefits. Since there is no substantial rental market that captures all the varieties of single-family homes that are available, there is no arbitrage that would produce a market valuation on the fair market rental price of these homes. Each individual assigns a different psychic rental value for a given house.

If we were to explain the recent serial correlation of home prices by the serial correlation of rents, we would have to confront drastic differences through time in the price-rental ratio. The U.S. 10-City Composite Standard & Poor's/Case-Shiller Home Price Index rose over 10 percent

a year from 1999 to 2006, and now is falling at 4.5 percent a year. For that rise and fall in housing prices to be justified by perfect knowledge of future changes in rents, there would have to be huge forecastable changes in rents. The price-rental ratio would have to be exceptionally low now to offset falling home prices on returns. But price-rental ratios are still at exceptionally high levels.

Todd Sinai and Nicholas Souleles wrote an important 2005 paper entitled "Owner-Occupied Housing as a Hedge against Rent Risk." In it, they found that homeownership rates are higher in places where the rent risk is higher. Sinai and Souleles argue that people have a hedging interest in buying a home: a way of hedging home price rental risk is to purchase a house. The authors invite the reader to conclude that perhaps homeowners are eminently rational in their decisionmaking: buying a house locks in their housing services for their lifetime. But I am not convinced that homeowners are so rational in their behavior. Many homeowners approach retirement with little more assets in their name than their house, and that house saddled with debt. Hence many Americans only own a leveraged undiversified investment that is exposed to the economic risk of their city, and of their own job and employment prospects. Expenditures for housing (mainly owner-occupied and tenant-occupied nonfarm dwellings—space rent) amounted to only 15 percent of total consumption expenditures in 2007:Q3, according to the National Income and Product Accounts. Rent does not appear to be a highly important component of consumption. I believe that if we did a thorough analysis of the lifetime portfolio allocation problem that individuals face, taking into account all of their uncertainties, including human capital uncertainty, and taking into account all of the aspects of their consumption price risks, we would not find it optimal for people to hold these highly leveraged housing investments.

The regression results that Mayer and Sinai show are interesting, but do not provide decisive evidence about the efficiency of the housing market. They have a short sample period, 1984–2006, which has only one complete housing cycle (up from 1984 to a peak around 1990 to another bottom in the mid-1990s) and then half a cycle (from the bottom in the mid-1990s to the peak in 2006). Their R-squared on user cost alone is only 0.28. Adding in other variables, such as the percent of adjustable-rate mortgages (ARMs), the loan-to-value ratio, and the past growth rates of housing prices, raises R-squared, but these variables sound like proxies for the boom.

Mayer and Sinai make some interesting arguments that recent increases in U.S. home prices have been driven by capital availability. But capital availability has been largely driven by the boom and is part and parcel of what constitutes boom psychology. Capital availability is not an exogenous factor unrelated to the boom mentality. The subprime mortgage market grew from practically nothing in 1995 to financing 20 percent of all U.S. mortgages issued in 2005. The ability of subprime mortgage lenders to obtain the capital to do this had something very much to do with the boom psychology. These lenders produced a new standard for subprime mortgages, a 2/28 ARM. But such a new standard would likely not have been so popular if home buyers didn't believe that the boom would continue for so many years that they would be able to make a nice profit on their investment, and that they could easily refinance after two years into a lower-interest-rate mortgage after their prepayment penalty period expired. The failure of the rating agencies to accurately foresee the problems of subprime mortgage securities was also related to their failure to fully understand the boom's fragile psychology.

I find a lot that is interesting in the Mayer and Sinai paper but nothing to change my general opinion about the causes underpinning the recent housing boom. The overriding fact about the recent housing situation is that people—financial professionals and the general public alike—were excessively optimistic about housing investments; this optimism was part of a social epidemic or bubble, and the psychology is rapidly souring at the present time. The idea that the housing market has not been deeply irrational is to a large extent what prevented us from taking actions that would have prevented the enormous financial crisis that began in late 2007 and continues today.

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Should Central Banks Maximize Happiness?