Exploring Irrational Expectations:

Macroeconomic Factors in the Housing Boom

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Abstract

Using a panel database of quarterly data from 1976-4 through 2008-2 for each of the 50 states and the District of Columbia, I show that home prices in the US build up significant inertia over time. Price changes in one quarter tend to be serially correlated with successive quarters. This effect has become even more pronounced in recent decades as home buyers and owner-occupiers have acted as speculators through the use of recent financial innovations, thus fueling momentum in residential real estate markets through the enhanced use of leverage.

Moreover, the evidence indicates that inertia in home prices has become a national phenomenon. Contagion, propagated via the national news media, has prolonged the run-up in housing prices. As a result, regional home price correlations have increased markedly over the past three decades, such that the advantages to the diversification of residential real estate, as measured via portfolio analysis, have steadily decreased.

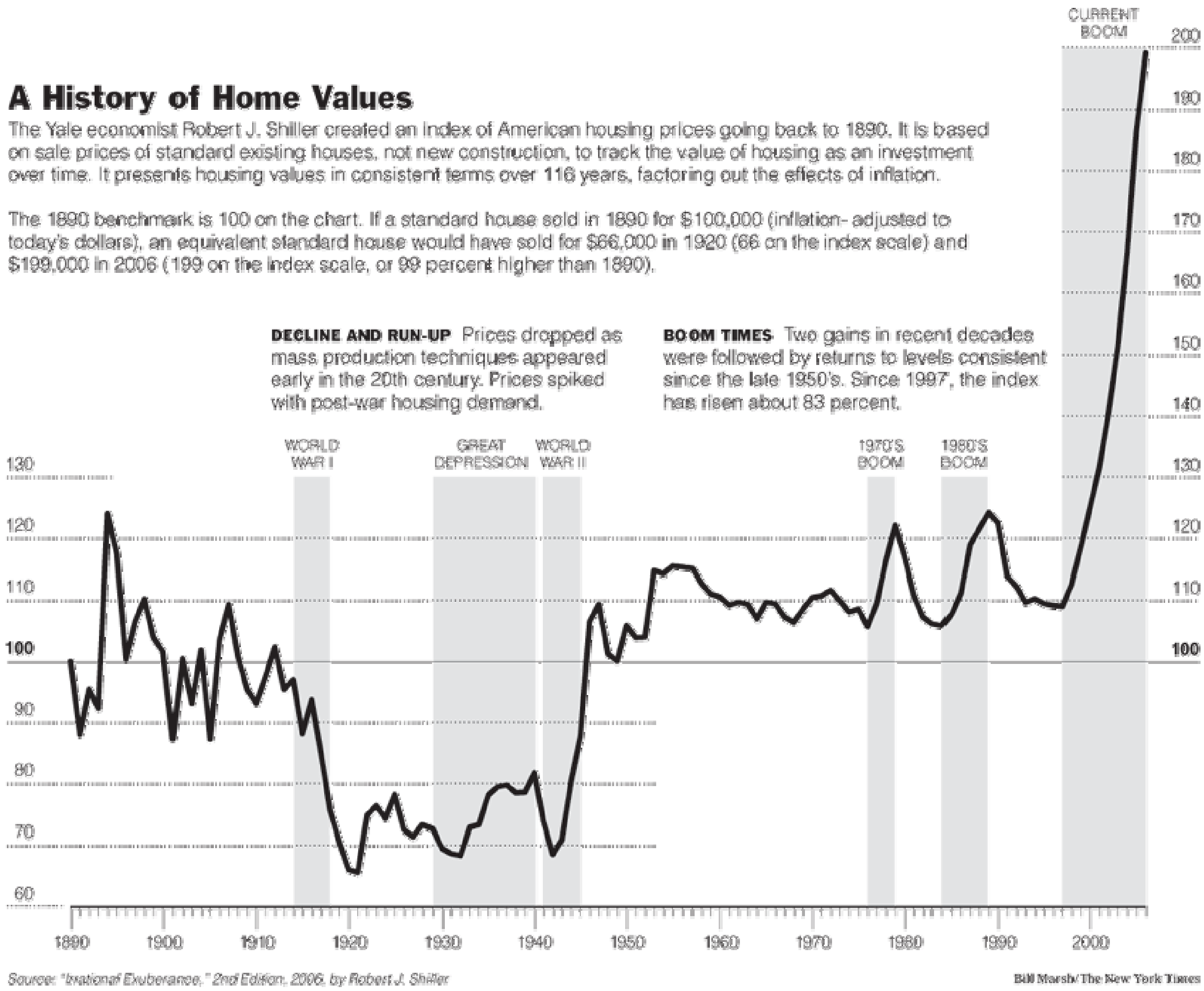
Consequently, investors and banks must re-evaluate the risks of home loan portfolios in light of this inertia and increasing correlation among assets inherent in the current housing market. Over the next few years, this same inertia is likely to drive national home prices down by another 15-30% before any meaningful uptick in home prices occurs.

Introduction

This paper focuses on the effects of local economic variables on the variation in home prices in an attempt to isolate the causes of the recent housing boom. It will also provide the investor and home-buyer some perspective on the diversification of housing assets in the United States and how the landscape has changed over the past three decades.

The recent bubble in residential real estate is remarkable in that it represents a significant deviation from the long-term mean. National price fluctuations above 30% had occurred only twice over the past 110 years before the late 1990s. It now looks as if the boom and subsequent bust will have created two more (Shiller 2005). Even with financial advances such as the long-term amortized mortgage, real home values have traded within a 60 percentage point range since reliable records became available over a century ago. From 1912 to 1920, national home prices dropped over 35%, while from 1942 to 1947 they skyrocketed over 60%. An "equivalent standard house" worth $100,000 in 1890 could have been sold for $66,000 in 1920 or $124,000 in 1989 (in 1890 dollars). But consider that, after never having topped $125,000, an equivalent standard house was worth $199,000 by the year 2006, a gain of over 80% in a single decade. (Shiller 2005)

Figure 1 – A History of Home Values



What accounts for this recent marked break in the trend? Over the past 10 years, traditional economic indicators failed to give us a complete explanation. For example, lending standards tightened from 2001 to 2003, yet real home prices gained 13.6% during the same period. Homeownership rates increased by 1.3 percentage points between 2001 and 2006, despite a 33.6% increase in real home prices. And, while real rent and real building costs increased by less than 5%, real home prices managed to rack up an extraordinary 58.3% return.

Such apparent inconsistencies and incongruities are all the more important when these assets make up such a large portion of our financial system. Tsatsaronis and Zhu (2004) sum up the importance of deciphering home price trends perfectly:

> "A house is the largest single asset of most households, and assets whose value is linked to residential real estate represent an important component of the aggregate portfolio of financial intermediaries. The behavior of house prices, therefore, influences not only business cycle dynamics, through their effect on aggregate expenditure, but also the performance of the financial system, through their effect on the profitability and soundness of financial institutions. Understanding this behavior is thus of key interest to central banks charged with maintaining price and financial stability."

As the current recession deepens, the cause of our recent financial calamity in the US deserves a more thorough understanding.

Theory and Literature Review

Several factors distinguish the recent housing boom from others. First and foremost, the most recent boom had national scope. Many previous housing booms have occurred locally or been confined to a certain geographic area, but from 1997 through 2006 all census regions experienced a robust increase in real home values that ranged anywhere from 25% to 120% appreciation. In addition, real construction costs and the real cost of rent stagnated while home prices boomed. Rent and construction costs were once the major predictive variables for real home values (see Grebler, Blank and Winnick 1956), but that influence has disappeared over the past decade.

Behavioral factors may have been a prominent factor in the recent boom. Psychological factors were first examined by Karl Case and Robert Shiller in "The Efficiency of the Market for Single Family Homes" (1989) and later in "The Behavior of Home Buyers in Boom and Postboom Markets" (1989). Weak tests for efficiency on single family homes in four metropolitan areas found positive serial correlation in real housing prices. In other words, Case and Shiller regressed lagged home price appreciation against current home price appreciation, controlling for factors such as cost of rent, population, income, and construction costs. They found that the regression coefficient was both positive and significant. A change in the real price index for the previous year successfully predicted a rise in real prices for the successive year by the magnitude of approximately 25-50% of the previous year's gains or losses. Additionally, they found that excess returns build inertia in real estate markets. (Case and Shiller 1990) In "The Behavior of Home Buyers in Boom and Postboom Markets" (1989), Case and Shiller explain this inefficiency by citing high transaction costs associated with real estate markets, which causes potential arbitrage opportunities to become too costly.

They also recognized the role that expectations play in home price booms. In a survey of recent home-buyers in the boom market of Los Angeles in 1988, Case and Shiller asked, "How much of a change do you expect there to be in the value of your home over the next 12 months?" Respondents mean expected 12 month increase in nominal home value was 15.3%, and the median 11%. In the control city of Milwaukee, the mean expected increase was 6.1% and the median 5%, leading Case and Shiller to conclude that the boom in Los Angeles could be chalked up to inflated and irrational expectations. (Shiller 2007) The pair has examined the same phenomenon more recently, and found that while the mean and median in Los Angeles were 9.4% and 10%, respectively, the mean in Milwaukee was 8.6% and the median 5%. Given that Milwaukee had not experienced a significant boom, Shiller believes that the most recent boom in home prices was a contagious phenomenon in which home price expectations gained national momentum. In 2007, after Los Angeles had experienced a nominal price decline of 3.3%, the answers to the same survey indicated a mean and median of -0.7% and 0%, respectively. Shiller concludes that home buyers' expectations change naturally to conform to the current trend. (Shiller 2007)

Shiller makes the case for inflated expectations in his book *Irrational Exuberance* (2006). He concludes that a feedback loop forms and "new era stories" develop as bubbles progress. According to Shiller, "the new era story warns people that they have to join the capitalist world and buy their homestead now, before it is priced out of reach by hordes of wealthy new investors. " New era stories are logical and exciting, and it is often hard to see the flawed statistical stretches these theories create. Contagion ensures that both the news media and word of mouth increase the popularity of the phenomenon. Contagion and “new era” stories may be visibly manifested by successive positive serial correlation in prices. Economists tend to ignore the “social epidemic model” because it is hard to prove and thus is not immediately verifiable or easily explained, but comes about as a result of a number of interrelated factors. (Shiller 2007)

Precisely because such an explanation involves so many interrelated factors, however, can we immediately accept the research of Case and Shiller at face value? Power (2008), drawing on the research of Levin and Wright (1997), argues that for determined purchasers, transaction costs are unavoidable and may be considered sunk. In this case, buyers may speculate freely through the purchase of a home in a specific market, timing their purchase within a reasonable range, and buying more expensive homes, through the use of loans as leverage, in order to capture a larger share of the price increase. In this light, it is unreasonable to assume that high transaction costs eliminate profitable opportunities and create market inefficiencies. Individuals may speculate, driving home prices up and creating a positive feedback loop, leading to the inevitable bubble. Determined “investors”, far from exhibiting mean-reverting behavior, feed into the “new era” hype.

Psychological factors cannot be the only factor driving home prices. Real rent and construction costs have historically predicted real home price variation fairly well, but neither has appreciated significantly over the past decade. Local area economic factors, such as unemployment, personal income, and population size inevitably affect housing prices. As unemployment increases, a larger percentage of the labor force has lost income, decreasing housing demand or forcing the substitution of smaller homes for larger ones. As population increases, demand for living space and new construction increases, driving up home prices and possibly construction costs, if certain constraints exist within a geographic region. And as real personal income grows, individuals may choose to “trade up” to larger homes or purchase a home instead of renting.

Case and Shiller (1990) test employment, construction costs, income, population, and previous home prices for four metropolitan areas as explanations for the variation of current housing prices. They find that recent returns in real estate predict future home prices significantly. Construction cost and employment were insignificant and income only marginally significant. Population was often significant in their tests, most likely due to the population density of the study, which measured price changes in urban areas. An exogenous increase in population, given a relatively fixed supply of land, increases demand for housing, driving up the value of land and thus the overall value of the residential real estate property. Of the significant variables mentioned here, all were positively related to home prices. However, there is very little research exploring macroeconomic variables that affect home price variance other than the 20-year-old Case/Shiller study mentioned, and fewer still that examine the psychological impact.

Another factor to consider is the role complex financial instruments played over the past decade. The advent of securitization was likely a key factor in the rise of home prices and expansion of credit availability over the past 12 years. Money flowed ceaselessly into Mortgage-Backed Securities (MBS) and Collateralized Debt Obligations (CDO), freeing up capital on banks’ balance sheets to extend loans to progressively less credit-worthy customers.

This paper also attempts to explain the findings of Modern Portfolio Theory in relation to housing prices and to examine the national scope of the recent boom through the distribution of state correlations and typical investor risk analysis. Investors, using Harry Markowitz’s famed Modern Portfolio Theory analysis, could determine the advantage of a high-yielding, diversified housing investment in their portfolio through readily available software. Goetzmann (1993) examines the effect of “The Single Family Home in the Investment Portfolio”. He concludes that holding a well-diversified portfolio over one-year halves the risk of investment in just a single home, thereby providing rationale to investor sentiment concerning MBS and CDO assets. These vehicles were backed by thousands of mortgages from diverse geographic regions of the country, much like Goetzmann’s constructed portfolio. By investing in these assets, investors received higher returns at ‘lower’ perceived levels of risk, a logical investment by any standard.

Empirical Framework

This paper attempts to identify and quantify the impact of aggregated local factors on real home prices. In addition, I use Modern Portfolio Theory to identify national housing trends and investor risk perception and behavior with regards to securitization.

Theoretical Framework

My home price model assumes that home prices at the state level are impacted by four distinct macroeconomic factors: the labor force, which I use as a proxy for the adult population, the unemployment rate, real personal income, and previous quarter’s home price appreciation. The labor force is assumed to be a reasonable proxy for the adult population, as unemployment in the United States during this period is relatively low, and home price variation will be better explained by those in the labor force as a result of their access to income. It is assumed that only one quarter’s lag in home price appreciation is necessary to capture psychological effects and avoid unduly complicating the procedure, although results using a 10 quarter decay of the lagged variable are reported as well. Additional quarters can reduce the size and accuracy of the data set and complicate the implementation of the instrumented lagged variable, distorting the results and producing weaker and increasingly irrelevant estimators. This issue is explained in further detail with regard to equation (5) below.

Home Price Model

My home price model captures both state-by-state and time-series variation among the 50 states and the District of Columbia over periods of 127 and 42 or 43 quarters. Statewide data, as opposed to data organized by Metropolitan Statistical Areas (MSAs) are more readily available and better capture the full geographical breadth of US home price appreciation.

The home price model regresses the *change in the labor force* ($x_{s,t}$)*, change in unemployment rate* ($\rho_{s,t}$)*, change in real personal income* ($\alpha_{s,t}$)*,* and the *change in lagged home prices (instrumented -* $\hat{y}_{s,t-1}$*)* against the *change in (current) real home prices* ($y_{s,t}$)*,* controlling for *state fixed effects* (f_s)*.* It is expressed as a statistical regression model as follows:

(1) $$y_{s,t} = \beta_0 + \beta_1 x_{s,t} + \beta_2 \rho_{s,t} + \beta_3 \alpha_{s,t} + \beta_4 \hat{y}_{s,t-1} + f_s + e_{s,t}$$

Where: y_{st} represents the change in real home prices, deflated by the Consumer Price Index less Rent of Shelter; $x_{s,t}$ is change in labor force in the from the previous quarter; $\rho_{s,t}$ represents the change in the unemployment rate; $\alpha_{s,t}$ represents the change in real personal income deflated by the Consumer Price Index less Rent of Shelter; and $y_{s,t-1}$ represents the change in real home prices for the previous quarter.

I weight the data in order to correctly measure the magnitude of the coefficients (e.g., California should constitute a larger weight in the model than Alaska). The weights constitute each state's share of housing units in each quarter. I use the Census Bureau's Historical Census of Housing data from the 1970, 1980, 1990, and 2000 censuses in the category of "All Occupied Housing Units" for each state. From these data, I construct a linear interpolation of the number of housing units in each state by quarter from 1976 to 2008, such that the weight for a given state from 1980 to 1990 is given as follows:

(2) $$w_{s,t} = \frac{H_{s,1990} - H_{s,1980}}{40}(d_t) + H_{s,1980}$$

Where $w_{s,t}$ represents the weight of a given state, *s,* in quarter, *t*; $H_{s,1990}$ and $H_{s,1980}$ represent the number of housing units in state *s* in 1990 and 1980, respectively; d_t represents the number of the quarters that have passed since the 4th quarter of the last year of the preceding decade (e.g., 1979-4). Data after the year 2000 are a continued linear interpolation of the trend calculated from 1990 to 2000 data. The weighting factor $w_{s,t}$ is then applied to the variables $y_{s,t}$ and $\hat{y}_{s,t-1}$ in order to correctly measure the magnitude of the home price regression model.

I include a fixed-effects term f_s in the regression to control for state-specific effects within the model. To implement this, a binary dummy variable, D, is created for each state with the exception of Alabama (AL). The effect of the omitted variable is estimated by the coefficient β_0 in the regression equation. Thus f_s is defined as follows:

$$(3) \qquad f_s = \sum_{i=AK}^{WY} f_i D_i$$

Where D_{AK} takes the value of 1 if the state *i* is Alaska (AK) and 0 for any other state in the set. Each f_i is estimated this way for every state in the set with the exception of Alabama (AL).

The lagged regressor $y_{s,t-1}$ wouldn't normally present a problem within the regression model. This particular model, however, exhibits both a lagged regressor and autocorrelated error terms. The error terms in the home price model are autocorrelated in part because only 1-Quarter lagged home prices were used. The error term would thus include the influence of the exogenous lagged variables beyond 1-quarter of lagged home price data. If the model is indeed correct and lagged home prices predict future home price variation, then the error terms are assumed to be autocorrelated. It is possible that a history of home price changes dating from up to 10 quarters lagged may be necessary to capture the true psychological effect. Here we assume that 1 quarter's lag captures a significant percentage of the psychological effect measured. Later, I calculate instrumented lagged variables in the same fashion for 10 quarters of lagged data to determine the inertia present in real estate markets.

In the case of autocorrelated error terms with a lagged regressor, Peter Kennedy summarizes the issue at hand; "This asymptotic bias results because the lagged dependent variable is contemporaneously correlated with the autocorrelated disturbance; the *t*th period's disturbance is determined in part by the (*t* - 1)th period's disturbance and it in turn was one of the determinants of the lagged (i.e., (*t* - 1)th period's) dependent variable." (Kennedy 1998) In order to correct for this, I calculate a 2-Stage Least Squares model, in which the instrumental variable $\hat{y}_{s,t-1}$ is used as the lagged regressor, such that:

(4) $$\hat{y}_{s,t-1} = \beta_0 + \beta_1 x_{s,t-1} + \beta_2 \rho_{s,t-1} + \beta_3 \alpha_{s,t-1} + v_{s,t}$$

Where $v_{s,t}$ represents the error term in the first stage regression. The lagged regressor is thus estimated as a function of the lagged values of the variables in the home price model – in other words, it is an "instrumented" variable. These variables are exogenous and thus uncorrelated with the error term $\epsilon_{s,t}$. The lagged terms are correlated with the lagged regressor $y_{s,t-1}$, as we can see when we lag the entire home price model (i.e., if $y_{s,t}$ is correlated with $x_{s,t}$, then $y_{s,t-1}$ must be correlated with $x_{s,t-1}$). The instrumental variable $\hat{y}_{s,t-1}$ is calculated, allowing the coefficients of the home price model to be estimated in the second stage in Equation (1). For the purposes of demonstrating the "drift", or decay of the lagged instrumented variable, $\hat{y}_{s,t-2}$ through $\hat{y}_{s,t-10}$ are calculated using the same methodology and added to the home price regression.

Modern Portfolio Theory

My Modern Portfolio Theory (MPT) analysis uses home price data from 50 states and the District of Columbia and creates an equally weighted portfolio of 51 homes in each of the states and territories, such that:

(5) $$w_{AL} = \cdots = w_{WY} = w_p$$

Where w_p is the weight of each individual asset in the portfolio, *p*.

The return of the diversified portfolio, *p*, can be expressed as an average of the weighted returns of the underlying assets, such that:

$$(6) \qquad r_p = ((r_{AL1} + \cdots + r_{ALt})/t) * w_p * \ldots * ((r_{WY1} + \cdots + r_{WYt})/t) * w_p$$

Where *t* is the total number of periods involved in the analysis. In the instance of this analysis, *t* is expressed as follows:

$$(7) \qquad t = 1, \ldots, T = 40 \textbf{ OR } t = 1, \ldots, T = 43 \textbf{ OR } t = 1, \ldots, T = 128$$

And where r_{ALt} represents the real (deflated by CPI less rent of shelter) return of a home in Alabama (AL) in quarter *t*.

The variance (σ_p^2) of the diversified portfolio, *p*, can be expressed as follows:

$$(8) \qquad \sigma_p^2 = w_p^2 * (\sigma_{AL}^2 + \cdots + \sigma_{WY}^2 + 2 * (\rho_{AL(AR)} * \sigma_{AL} * \sigma_{AR} + \cdots + \rho_{WV(WY)} * \sigma_{WV} * \sigma_{WY}))$$

Where $\rho_{X(Y)}$ is the correlation coefficient for each individual two state pair (X,Y); σ_X^2 and σ_X represent the variance and standard deviation for each individual state in the set. Average variance (and standard deviation) for the set over a given time period is expressed as follows:

$$(9) \qquad \sigma_{avg}^2 = \sigma_{AL}^2 * w_p * \ldots * \sigma_{WY}^2 * w_p$$

Data Summary

Data were taken from a number of sources. Home price model data are panel data across 51 states for periods of 127 and 43 or 42 quarters.

Home Price Model

OFHEO vs. Case-Shiller

Rather than use the now widely-cited S&P/Case-Shiller Index, I use the Office of Federal Housing Enterprise Oversight's (OFHEO) Housing Price Index (HPI), adjusting the data using the Bureau of Labor

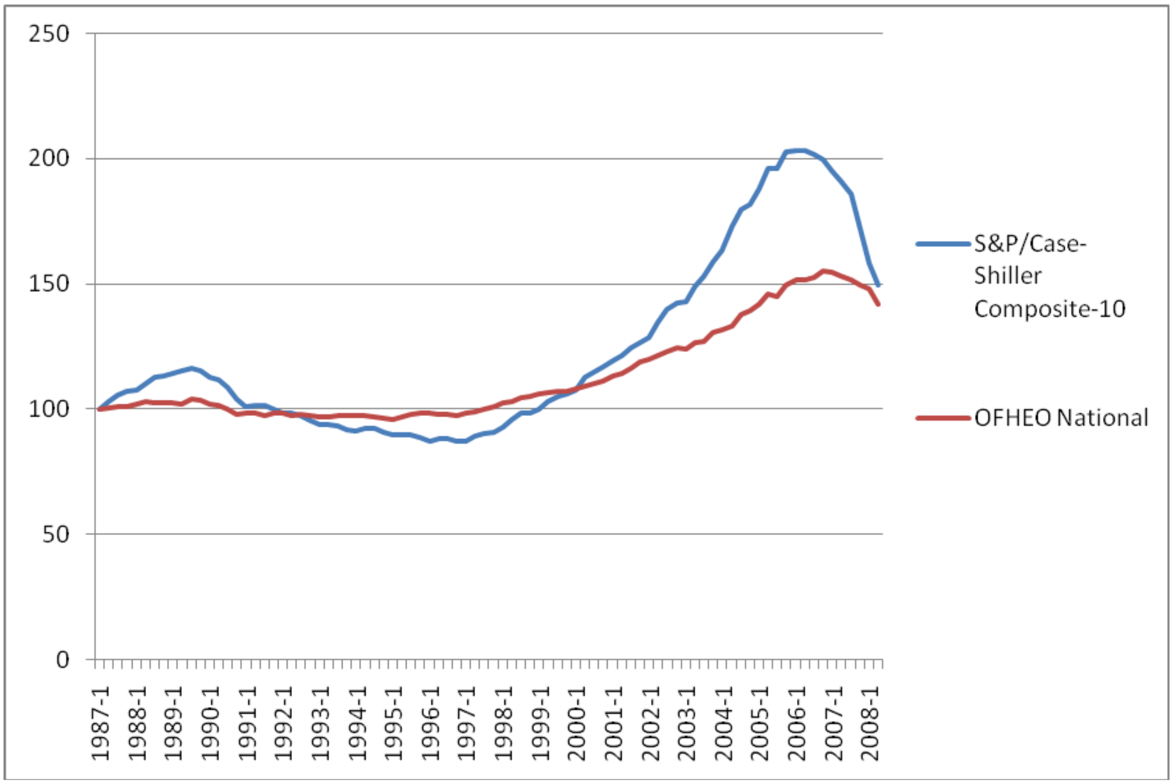
Statistics' (BLS) Consumer Price Index (CPI) less Rent of Shelter to calculate real quarterly home price appreciation at both the local and national levels.

I chose this over S&P/Case-Shiller because it is more representative of national home prices, begins in 1975 – 12 years before the S&P/Case-Shiller Index – and it breaks the national data down by state while Case-Shiller reports for just 20-metropolitan areas. Additionally, Case-Shiller's index covered only 14 metropolitan areas in 1987, and used a 10-metropolitan area composite index to calculate national home prices until the current 20-metropolitan area composite was first calculated in 2000. Consequently, OFHEO allows greater historical insight and geographical coverage than Case-Shiller. Calculating data from as many disparate geographical areas over as long a period as possible is crucial to gaining a better understanding of the nationwide impact of the recent housing bubble. With Case-Shiller we have, at best, 14 metropolitan areas representing approximately 20% of the total US housing stock for only 20 years. With OFHEO, on the other hand, we have data for 50 states and the District of Columbia for over 30 years. Although Case-Shiller's national index coverage is around 70%, local data are the focus of my model. And as the industry benchmark, OFHEO offers the greatest insight into psychological effects propagated by rising home prices. The index is calculated using a repeat sales technique on conventional, conforming mortgage transactions purchased and reported by Fannie Mae and Freddie Mac. The index collects data from single-family home sale-pairs and refinancings for repeat transactions, and thus is known as a "constant quality" index. Case-Shiller uses a similar repeat-valuation framework, but excludes refinancing and uses solely "purchase-only" data. The index draws data from county assessor and recorder offices, and includes all loans (e.g., subprime and other non-conforming), some of which are excluded under OFHEO.

OFHEO is not without its faults. The index does not include "non-conforming" loans such as subprime mortgages or jumbo loans, which became increasingly important as the boom progressed and came to constitute nearly 15% of all mortgages in the market at the height of the boom. Also, the exclusion of jumbo loans may ignore speculation that occurred when homeowners bought larger homes to take advantage of greater leverage in future home price increases. Homeowners would have had to sell smaller loans with conforming mortgages to complete these transactions. To the extent that these homes approached the conforming loan limit, these actions could depress home prices on conforming loans and fail to capture the "trading up" effect. OFHEO also fails to adjust for quality improvements within the home, assuming "constant" quality across sale-pairs and thus assuming that any price change is a reflection solely of a change in the market for homes. In reality, such changes could be explained by home repairs and renovations. For example, if a homeowner builds a new kitchen which adds $30,000 to the value of the home, the index assumes the kitchen remains unchanged and attributes the $30,000 increase in selling price, all else remaining equal, to the market for homes (i.e., a decrease in supply or increase in demand). Additionally, when a Homeowner refinances, the appraisal may be inaccurate or lag the market. (Power 2008)

Figure 2 compares real home prices measured by the S&P/Case-Shiller Composite-10 Index with the OFHEO National Index. Besides differences in methodology and loan type, the differences can be explained mainly through coverage. The S&P/Case-Shiller Composite-10 depicts a larger bubble, as may be expected given the focus on metropolitan housing values.

Figure 2 - OFHEO vs. Case-Shiller



Other Key Variables

The Local Area Unemployment Statistics (LAUS) program within the BLS reports unemployment and labor force statistics monthly on the statewide level and estimates are based on the CPS (Current Population Survey) methodology. The CPS is taken monthly using a sample population of 60,000 households over a calendar week. Respondents participate voluntarily and all results are confidential. The cooperation rate is generally around 96% of those contacted. Labor force estimates are reported for those persons 16 years of age or older. The unemployed, defined by the survey, are those who had no employment for a specified week, were available and willing to work, and had attempted to find a job during the specified period. The Civilian Labor Force is defined as those classified either employed or unemployed, while the Unemployment Rate represents those unemployed as a proportion of the Civilian Labor Force. To create quarterly results, labor force and unemployment appreciation values are calculated by using data from the final month of each quarter (i.e., 1=March, 2=June, 3=September, 4=December).

I used the Bureau of Economic Analysis' (BEA) State Quarterly Income Statistics to compute quarterly changes in real income. This definition encompasses wage disbursements, supplements, proprietor's income, rent, transfer receipts, dividends, and interest received. After computing quarterly nominal personal income appreciation, the data were deflated using the CPI excluding Rent of Shelter to calculate changes in real quarterly income.

The quarterly data are divided into four periods – one encompassing the entire length of the data set and three of which are about a decade in length – and are estimated in 1st differences.

Home Price Model Data Summary Statistics (1976-4 to 2008-2)						
Variable	Obs.	Mean	Std. Dev.	Min.	Max.	Units
N=51, T=127						
Real OFHEO	6477	0.0081394	0.0666328	-0.4180374	1.2457361	Δ (Real OFHEO)
Labor Force	6477	0.0037336	0.0053903	-0.0494482	0.0730754	Δ (Labor Force)
Unemp. Rate	6477	-0.0004520	0.0662555	-0.4324324	1.2200000	Δ(Unemp. Rate)
Real Income	6477	0.0070422	0.0307299	-0.6536572	2.0622180	Δ (Real Income)
Lagged OFHEO	6477	0.0088317	0.0075443	-0.1529418	0.2298622	Δ (Lagged OFHEO)

Home Price Model Data Summary Statistics (1976-4 to 1987-1)						
Variable	Obs.	Mean	Std. Dev.	Min.	Max.	Units
N=51, T= 42						
Real OFHEO	2142	0.0077604	0.0825931	-0.4180374	1.2457361	Δ (Real OFHEO)
Labor Force	2142	0.0052156	0.0060833	-0.0302776	0.0481502	Δ (Labor Force)
Unemp. Rate	2142	-0.0000261	0.0734311	-0.3823529	0.8387097	Δ (Unemp. Rate)
Real Income	2142	0.0078315	0.0185869	-0.1646418	0.1930700	Δ (Real Income)
Lagged OFHEO	2142	0.0076623	0.0121143	-0.0772632	0.0632194	Δ (Lagged OFHEO)

Home Price Model Data Summary Statistics (1987-2 to 1997-4)						
Variable	Obs.	Mean	Std. Dev.	Min.	Max.	Units
N=51, T=43						
Real OFHEO	2193	0.0002686	0.0435187	-0.2013870	0.1454304	Δ (Real OFHEO)
Labor Force	2193	0.0035548	0.0054342	-0.0371228	0.0730754	Δ (Labor Force)
Unemp. Rate	2193	-0.0062840	0.0579872	-0.3114754	0.8750000	Δ (Unemp. Rate)
Real Income	2193	0.0062971	0.0123430	-0.1056570	0.2371923	Δ (Real Income)
Lagged OFHEO	2193	-0.0000333	0.0080999	-0.0715867	0.0728247	Δ (Lagged OFHEO)

Home Price Model Data Summary Statistics (1998-1 to 2008-2)						
Variable	Obs.	Mean	Std. Dev.	Min.	Max.	Units
N=51, T=42						
Real OFHEO	2142	0.0165765	0.0673372	-0.0921982	0.1223412	Δ (Real OFHEO)
Labor Force	2142	0.0024348	0.0040898	-0.0494482	0.0381862	Δ (Labor Force)
Unemp. Rate	2142	0.0050929	0.0661628	-0.4324324	1.2200000	Δ (Unemp. Rate)
Real Income	2142	0.0070157	0.0485151	-0.6536572	2.0622180	Δ (Real Income)
Lagged OFHEO	2142	0.0190772	0.0057859	-0.0811504	0.1751473	Δ (Lagged OFHEO)

Shortcomings in the Data

It is possible that the coefficient for Labor Force from the 1976-4 to 1987-1 regression is biased. From 1976-4 to 1987-1, the female participation rate in the labor force increased from 47.6% to 55.6%. Therefore, the increase in the labor force was partially due to women, especially considering the male participation rate dropped over this period. This increase would overstate the increase in population for the time period, meaning the coefficient may be insignificant or biased downward. If the women were single, the labor force may be a better variable than population, as it would partially measure this effect (assuming a significant portion of single working women are involved in the residential real estate market). If the women were married, the variable would simply be biased downward – newly employed wives in families who already have a working husband are unlikely to affect the demand for housing.

Results and Analysis

Almost all of the variables in both the full and decade-by-decade analysis of the housing price model were significant, although R-squared values were quite low, ranging from just above 0.01 to 0.19. Thus changes in adult population, the unemployment rate, personal income, and lagged home prices explain only a small portion of the variance in real home prices in the home price model. Modern Portfolio Theory analysis revealed significant rising geographical correlations over each of the past three decades, decreasing the benefit of diversification offered by a portfolio of housing assets.

Home Price Model

The following table summarizes the results for the home price model, which regressed changes in real home prices against changes in the Labor Force, Unemployment Rate, Real Personal Income, and single-quarter lagged home prices. All variables were significant at the 5% level except Lagged Home Prices (significant at the 10% level) in the third 'decade' and Real Income (insignificant) in the first 'decade'. The term "SE" stands for "Standard Error".

Home Price Model - Regression Results					
1976-4 to 2008-2	(1)	(2)	**1976-4 to 1987-1**	(1)	(2)
Labor Force	0.6104215***	0.7877139***	Labor Force	0.7721339**	1.14381***
SE	(0.1748491)	(0.1795213)		(0.3510627)	(0.364614)
Unemp. Rate	-0.0725698***	-0.0714699***	Unemp. Rate	-0.114666***	-0.1076501***
SE	(0.0142252)	(0.0139128)		(0.0293137)	(0.0287842)
Real Income	0.1437502***	0.1534502***	Real Income	0.1491979	0.1471646
SE	(0.028232)	(0.0277714)		(0.0999998)	(0.097924)
Lagged OFHEO	0.5524403***	0.607384***	Lagged OFHEO	0.3625931**	0.3428244*
SE	(0.1290638)	(0.1275932)		(0.1822691)	(0.1790604)
β_0	-0.0000638		β_0	-0.0002164	
SE	(0.0013565)			(0.002441)	
R-squared	0.0195	0.0715	R-squared	0.0239	0.0947
(1) = w/o fixed-effects	N=51, T=127			N=51, T=42	
(2) = w/ fixed-effects					

1987-2 to 1997-4	(1)	(2)	1998-1 to 2008-2	(1)	(2)
Labor Force	0.8039141***	1.051754***	Labor Force	0.8840119**	0.7639593**
SE	(0.1933792)	(0.202372)		(0.3838414)	(0.3835502)
Unemp. Rate	-0.0432451**	-0.04093**	Unemp. Rate	-0.0866053***	-0.0837596**
SE	(0.0170781)	(0.0169707)		(0.0243451)	(0.0225225)
Real Income	0.3623942***	0.4088686***	Real Income	0.1077432***	0.1086586***
SE	(0.0763229)	(0.0755911)		(0.0342296)	(0.0324544)
Lagged OFHEO	0.3944078***	0.5432429***	Lagged OFHEO	0.542143*	0.5429231**
SE	(0.1264633)	(0.1294919)		(0.2864962)	(0.2735766)
β_0	-0.0051298***		β_0	0.0037667	
SE	(0.0012116)			(0.0056164)	
R-squared	0.0409	0.0963	R-squared	0.0182	0.1896
(1) = w/o fixed-effects	N=51, T=43			N=51, T=42	
(2) = w/ fixed-effects					

State-level analysis reveals the increasing importance of psychological factors in the residential housing market. Although the R-squared values are discouragingly low, the variables in the analysis explain more variance in real home prices recently than they did just 20 years ago. Additionally, all variables except two yielded significant results, and all carried the expected sign. It is interesting to note that the lagged component has a positive sign in every time period studied. The lagged coefficient over the entire period is approximately 0.6, meaning that over the past 32 years, an increase in home prices of 1% in one quarter would, on average, predict a 0.6% increase in home prices the following quarter. Moreover, the value of this coefficient rises over time from 0.34 to 0.54. The coefficient for the lagged indicator is large and positive, confirming Case and Shiller's (1989) argument that home prices have the potential to build significant inertia over extended periods of time. Their conclusion is further supported by the coefficient on the lagged indicator in the first 'decade' (0.34), which falls within the 0.25 to 0.50 range. While the lagged coefficient grew from the first to the third decade, the magnitude of each of the three remaining variables was reduced, even as the R-squared value of the overall regression increased. This may indicate that *the inertia of home prices has become more important than macroeconomic factors normally indicative of home price variation*.

The table below describes the "decay" of the lagged instrumental variables, which provides additional support for this conclusion. Lagged real home prices, instrumented by lagged changes in the labor force, unemployment rate, and real personal income were estimated for 1 through 10 quarters of lagged data. A value of 0.27 for the full data set's one-quarter lagged variable, for example, indicates that a 4% increase in real home prices one quarter ago predicts about a 1% increase in real home prices in the current quarter. The regression results are run controlling for changes in the labor force, unemployment rate, and real personal income, only this analysis adds additional instrumented lagged variables to determine the "decay".

Mapping Psychological Effects – Lagged Decay				
# Quarters Lagged (variable)	Full (1976-2008)	1976-1987	1987-1997	1998-2008
1	0.2705949	0.1378414	0.9203004	0.2408118
2	0.2048457	0.1458639	-0.2864859	0.7227365
3	0.3215451	0.5991691	0.2497134	0.4395963
4	0.0812397	0.4600566	-0.1808253	-0.1753892
5	0.1548974	0.0844401	0.1823811	-0.6366257
6	0.0957628	0.051952	-0.0109367	-0.153509
7	-0.1958519	-0.5666814	0.0022677	0.0271717
8	-0.2378902	-0.4204671	-0.1428629	0.411225
9	-0.0654676	-0.0052397	0.3585472	-0.0993481
10	0.0744501	0.4565745	-0.3618473	-0.2436438
10-Q R-Squared	0.3217	0.0228	0.3958	0.6201

The one-quarter lagged variable remains positive within the full model and throughout the "decade" periods, confirming the home price model's initial results that quarter-to-quarter inertia exists in residential real estate markets. These estimates are noticeably smaller, except in the case of the second "decade" period, where the estimate is noticeably larger. This larger estimate for the period

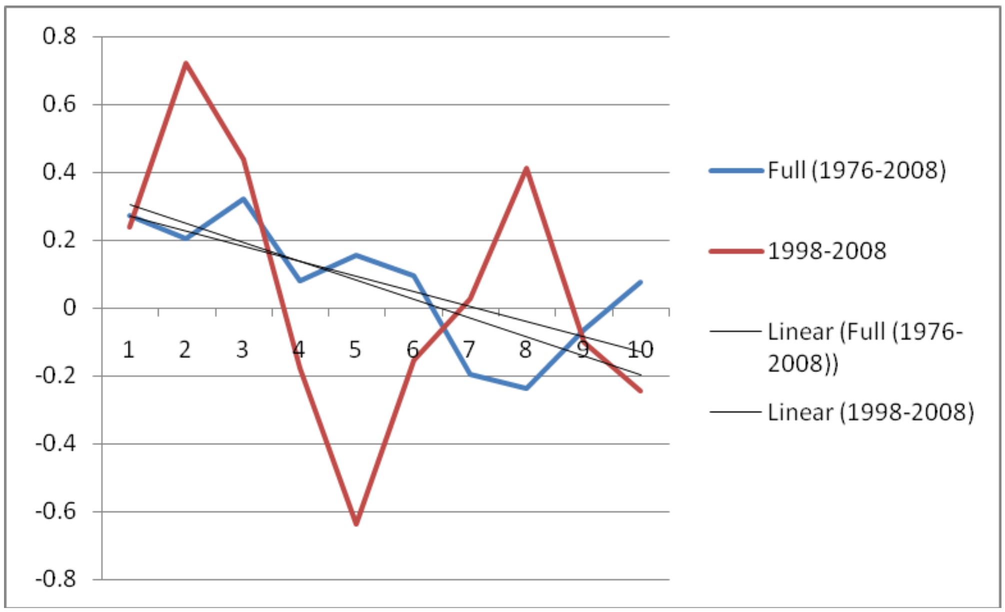
1987-1997 places more of an emphasis on the one-quarter lagged regressor, as the coefficients of the remaining regressors are either small or such that their effects neatly cancel out. It is possible to generalize from these results that inertia in real estate markets tends to build based on 3-6 quarters of home price appreciation or depreciation, with the exception of the second “decade” period.

Throughout each period’s decay, and especially in the full period’s results, there exists a notable downward trend as the lagged regressors’ effects vary around and trend toward zero (see graph below). Generalizing from the full period’s results, it can be said that significant momentum is built in real estate markets from approximately three quarters of previous home price appreciation or depreciation. For the full period, an increase in home prices by 1% in each of the past three quarters would predict about a 0.8% increase in the price of homes in the current quarter. It can also be said that over a longer time horizon, prices revert to the mean as inertia gives way to common sense. This effect is demonstrated by the negative values of the coefficients for most of the variables beyond 6-quarters of lag. These quarters tend to be weighted negatively in regards to home-buyers expectations of future price appreciation. For the full period, a 1% increase in each of the quarters 7, 8, and 9 quarters past would predict about a 0.5% decrease in home prices for the current quarter.

I concluded that the inertia of home prices has become more important than macroeconomic factors normally indicative of home price variation. This hypothesis is further supported by the R-Squared values of the “decay”, which increase markedly from the first to the third “decade” periods. From 1976 through 1987, changes in home prices in all 10 previous quarters explained little (2.28%) of the variation in current home prices. From 1998-2008, however, inertia was a significant factor - the lagged home price variables in this period explained over 62% of the variation in current home prices. This trend highlights the increasing significance of psychological effects and inertia in residential real estate markets.

Overall, the graph of the decay for the full period and the period 1998-2008 show remarkably similar linear trends (see graph below). The volatility of the lagged components and the increasing R-Squared values for each period could be an indication of the heightened influence of the news media in spreading the effects of contagion in residential real estate markets.

Figure 3 – Lagged Decay



Interestingly, after using 3-quarters of lagged data, adding additional lagged quarters to the regression analysis does little to enhance the explanatory power of the model. In conducting a separate analysis, I found most of the explanatory power is derived from the first three quarters alone. Adding additional lagged variables does little to increase the overall R-Squared values, indicating that these variables explain little of the variation in real home prices. From 1976 to 1987, a little over 1/3 of the R-squared value generated from using ten lagged variables occurs within the first three quarters. From 1987 to 1997, over 90% of the R-squared value generated from ten lagged variables occurs in the first three quarters. From 1998 to 2008, a little under 90% of the R-squared value from ten lagged variables occurs within the first three quarters. And throughout the entire period, this same number is just under 80% within the first three quarters. In this light, one can easily see contagion as a prime factor in the recent housing boom. While the period 1976-1987 had a combined first three quarters lagged factor (coefficient from 1-quarter lagged + coefficient from 2-quarters lagged + coefficient from 3-quarters lagged) of about 0.881 (0.137+0.145+0.599), the factor for the following decade was 0.883 and the for the most recent decade 1.401. When analyzing the data with the perspective of explained variance detailed above, it becomes evident that psychological effects are playing an increasingly important role in residential real estate markets.

Portfolio Consequences of the Housing Bubble

One consequence of the housing boom and the attention devoted is an environment in which price movements have become increasingly correlated over time between states.

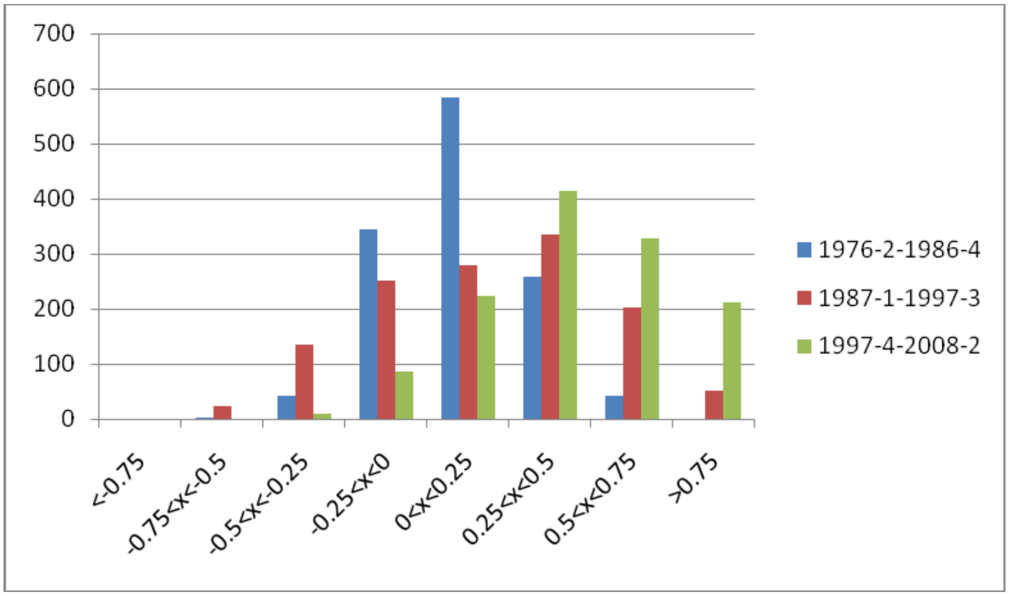
The following table describes correlations between states on a decade-by-decade and state-by-state basis. Full decades were analyzed in order to include sufficient data points to lend the analysis significant explanatory power (40-43 data points per "decade"). That is, instead of studying 2-year periods, which would have yielded only 8 quarterly data points (i.e., fairly unreliable correlation coefficients), periods of 40-43 quarters ('decades') were calculated every two years (i.e., a moving window), as shown below. The decades 1976-2-1986-4, 1987-1-1997-3, and 1997-4-2008-2 were maintained in order to parallel the decades used in the regression models and thereby draw more accurate conclusions.

"State-by-State Pairs" indicates that for each state pair during a time period given (e.g., Alabama and Alaska from 1976-3 to 2008-2), a correlation coefficient was calculated (0.118). This particular coefficient is between 0 and 0.25, meaning there would be a value of 1 in the box under "0<x<0.25" for the time period "1976-3-2008-2". This is completed 1,275 times for each possible state pair combination in the 51 state set. The table below represents a histogram of the number state pair correlations within each given range.

By constructing a histogram of the distribution of state-pair correlations every two years, I attempt to discover a trend in geographical home price correlations over the past 30 years. It is my hypothesis that home prices have become increasingly correlated as we have entered the "information age". This is one of Shiller's (2007) contentions as well – increasingly, home-buyers are turning to national forces to determine their opinions in local residential real estate markets.

Number of Correlations – State-by-State Pairs									
	<-0.75	-0.75<x<-0.5	-0.5<x<-0.25	-0.25<x<0	0<x<0.25	0.25<x<0.5	0.5<x<0.75	>0.75	Total
1976-3-2008-2	0	2	16	259	613	345	40	0	1275
	<-0.75	-0.75<x<-0.5	-0.5<x<-0.25	-0.25<x<0	0<x<0.25	0.25<x<0.5	0.5<x<0.75	>0.75	Total
1976-2-1986-4	0	3	43	345	584	258	42	0	1275
1978-3-1988-2	0	4	61	351	546	266	47	0	1275
1980-3-1990-2	0	15	114	426	472	200	45	3	1275
1982-3-1992-2	0	12	131	368	440	239	75	10	1275
1984-3-1994-2	0	36	175	292	336	264	134	38	1275
1987-1-1997-3	0	23	135	251	279	334	202	51	1275
1990-3-2000-2	0	5	38	174	310	413	276	59	1275
1992-3-2002-2	0	14	46	221	286	317	278	113	1275
1994-3-2004-2	0	10	28	128	304	399	267	139	1275
1997-4-2008-2	0	0	9	87	224	415	329	211	1275

Figure 4 - Correlation Distribution – State-by-State Pairs



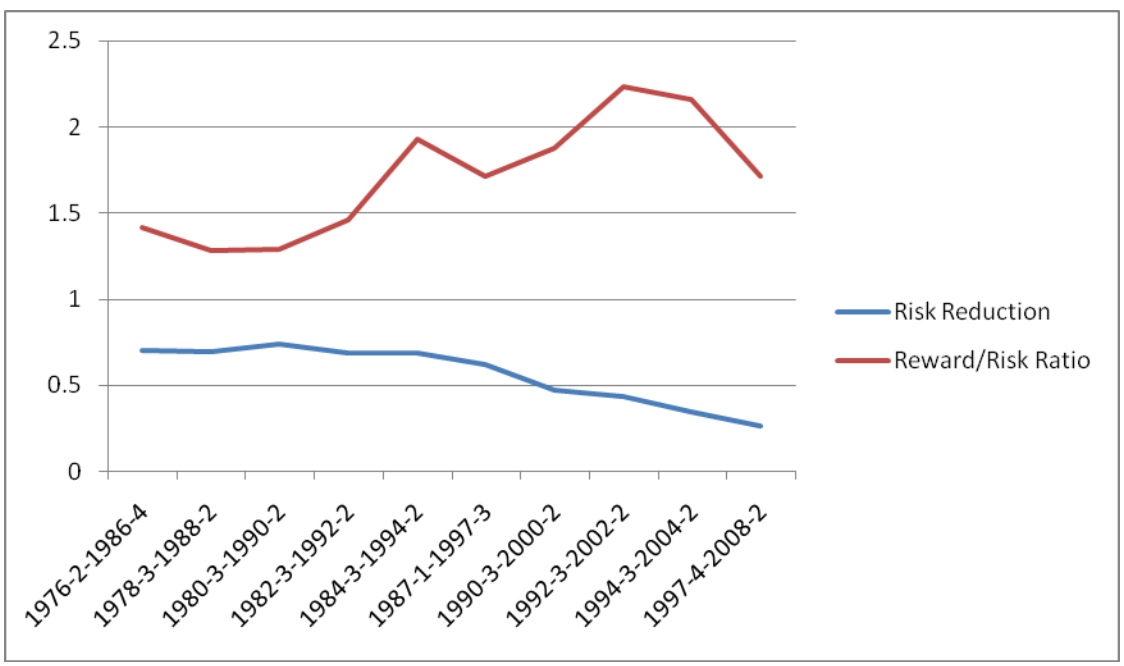
The table and histogram demonstrate that large positive correlations increased as negative correlations faded away, causing home prices nationwide to become increasingly correlated throughout the past 12-15 years. It is clear that as time has progressed, disparate geographic real estate markets have converged, despite the fact that the first four periods studied showed very little difference in correlations, overall.

The following table examines the risk reduced by holding an equally weighted portfolio of homes in each of the 50 states and the District of Columbia, when compared with holding a single home of average risk over the same period. Risk and return are calculated quarterly.

Modern Portfolio Theory Analysis					
	r(P)	σ(P)	σ(Avg)	Risk Reduction	Reward/Risk Ratio
1976-3-2008-2	1.39%	1.01%	2.80%	63.95%	1.38
1976-2-1986-4	1.81%	1.28%	4.30%	70.15%	1.41
1978-3-1988-2	1.51%	1.18%	3.87%	69.47%	1.28
1980-3-1990-2	1.18%	0.92%	3.57%	74.26%	1.28
1982-3-1992-2	1.02%	0.70%	2.28%	69.28%	1.46
1984-3-1994-2	1.01%	0.52%	1.69%	69.11%	1.93
1987-1-1997-3	0.88%	0.51%	1.36%	62.25%	1.71
1990-3-2000-2	0.91%	0.48%	0.92%	47.24%	1.88

1992-3-2002-2	1.10%	0.49%	0.88%	43.87%	2.24
1994-3-2004-2	1.26%	0.58%	0.90%	34.98%	2.16
1997-4-2008-2	1.48%	0.86%	1.18%	26.47%	1.71

Figure 5 – Risk Measures



The percentage of risk reduced by a diversified portfolio falls as home price correlations rise nationwide, indicating that a diversified portfolio of homes over the past decade has "diversified away" much less risk (26.47%) than has historically been the case (63.95%). In other words, it became increasingly difficult to diversify a residential real estate portfolio. Home price correlations and risk-reduction analysis looked worse than ever before, yet investors may have been enticed into purchasing MBS and CDOs because their reward to variability (r(P) /σ(P)) ratio was at an all-time high. In any diversified portfolio, an increase in asset correlations is associated with an increase in risk. Even though the true risk of a diversified portfolio of US residential homes was rising (measured by the rising asset correlations and risk-reduction %), the reward-to-risk ratio was falling. Housing became an extremely attractive investment – if you could get out before the highly correlated prices turned south.

As previously referenced, home prices help determine business cycle dynamics, aggregate expenditure, and the performance of our economy as a whole (Tsatsaronis and Zhu 2004). As home price correlations decreased, not only did the relative risk of holding a diversified portfolio of residential real estate increase, but the risk of holding a portfolio of financial assets also increased. If the value of the housing assets were to decrease dramatically, the balance sheets of financial intermediaries would sour, negatively influencing the performance of the economy as a whole.

Conclusions

Momentum and inertia have become increasingly important indicators of future home price variation. The effects of inertia have increased over the past three decades, while its explanatory power jumped dramatically. Home price correlations have been on the rise as home-buyers look increasingly to national market trends to determine local market price appreciation. Housing, as an asset essential to financial intermediaries, has shown its critical importance to the health of the financial system in the recent crisis. Between 1991 and 2006, for example, bank holdings in residential real estate loans and Mortgage Backed Securities rose from 15% to 20% of total bank assets in the US. (Wheelock 2006) In this section of the report, further implications of the data are discussed in order to fully explain recent macroeconomic trends in the market for residential real estate.

A preliminary national regression was run in order to tease out certain macroeconomic factors in the recent housing boom. These results suggest that the homeownership rate was *not* a significant or large predictor of home prices over the past decade. This could indicate that the effects of the homeownership rate were trumped by other, more powerful factors, such as the psychological factors discussed above. Real cost of rent also played a limited role in the recent crisis. Although preliminary regression results indicate that real Owner's Equivalent Rent (OER) did have a large, positive and significant impact on real home prices, real OER explains only 7-8% of the 58.3% increase in real home prices over the past decade. These same results assign a *positive*, insignificant, and small coefficient to the mortgage rate when regressed against real national home prices over the past decade. For example, real home prices rose 20.2% *despite* increases in the mortgage rate that occurred from late 2003 through 2006 (see graph below). Credit availability (as proxied by the Federal Reserve Board Senior Loan Officer Opinion Survey on Bank Lending Practices) also played an insignificant role, accounting for only 3% of home price appreciation over the past decade. Finally, construction costs, when incorporated into the same preliminary national regression analysis, yielded a significant, but very small negative coefficient, which may indicate it played more of a reactionary role in the recent housing bubble.

Psychological factors and financial innovation, then, must explain a large portion of the recent boom. The growing impact of inertia on the variation in real home prices can be explained by financially innovative instruments that reinforced the expectation of perpetually rising home prices and allowed home buyers to place increasingly leveraged bets on these expectations. The significance of these effects can be seen in the R-squared values of the lagged decay analysis and the home price model as a whole, and in the value of the lagged-coefficient, which exceeds 0.5 in the overall analysis and in more recent decades. Innovative financial products led home price appreciation, as more and more people were able to refinance their mortgage to get cash out, which led to further increases in home prices as owner-occupiers remained in the market, many as speculators. Financially innovative products offered little risk to the buyer and little perceived risk to the bank or investor, as long as home prices increased. Low perceived risk gave homeowners the incentive to leverage their housing asset at a low teaser rate, which they could then refinance to a conventional rate a few years later (again, as long as home prices increased).

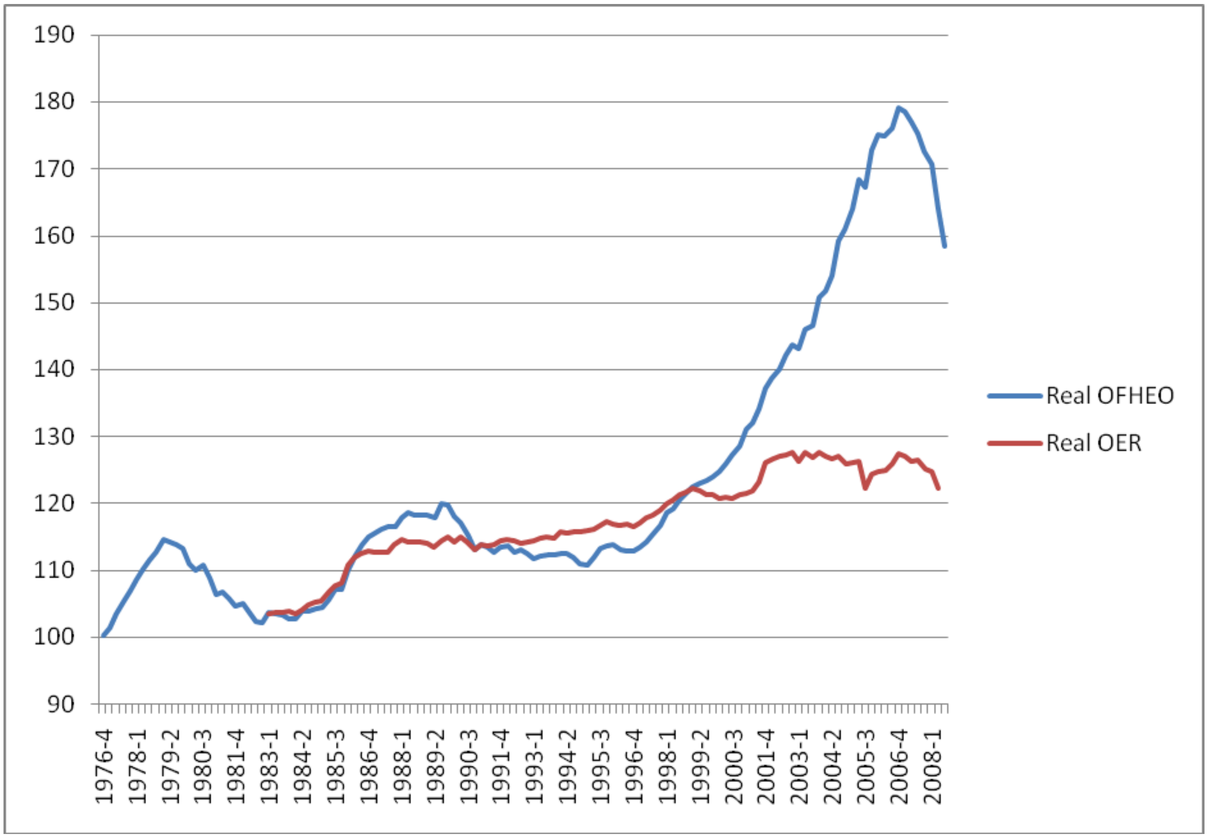
In addition to momentum, the concentration of housing assets on the books of financial intermediaries and investors created risks for the market not reflected in most conventional mathematical models. Many investors concentrated about 20% of their portfolios in real estate related investments, a trend that became popular over the past 8-10 years. Even as the level of risk-reduction of a geographically diversified portfolio of US residential homes fell because of rising correlations, so too did the level of risk (measured by the standard deviation) of both the average home in the portfolio and the portfolio as a whole. In other words, as housing diversification became less effective, the overall level of risk on individual homes and the portfolio decreased. Thus, the reward-to-variability ratio continued to rise, making housing an attractive asset. Similar logic and mathematical analysis led banks and investors alike to hold securitized assets in their portfolios. As these assets came to constitute a larger percentage of each bank's and investor's portfolio, the risks to the financial system as a whole increased, a fact not reflected by any mathematical model.

Implications for the future of real estate investment are worrisome. Given the large number of financial innovations (e.g., Option-ARMs) popularized over the past decade, investors and homeowners have gained more sophisticated tools that allow a larger portion of the population to speculate with increased leverage on future home price appreciation. Investors seeking to capitalize on future appreciation need only take out an ARM on 100% of the home value, refinance before the rate reset, and take in a substantial profit (or loss). Although some of the more exotic instruments are expected to be eliminated as a result of the recent crisis (e.g., Wachovia recently eliminated Option-ARMs), it is clear that at least some portion of the recent decade's financial innovation is here to stay.

Market psychology will likely play a much larger role in future home price fluctuations as a result. Homebuyers prone to contagion and given more sophisticated tools will continue to be enabled to act upon inflated expectations. And as information sharing continues to improve via the internet, real estate transaction costs will continue to decrease and local expectations will likely continue to be informed by national sentiment. With geographical diversification providing less and less of an advantage, real estate investors may look to categories such as creditor profile, home value, or mortgage product as new ways of diversifying risk.

The current outlook for real home prices is just as grim. Home prices in the third quarter of 2008 (the most recent OFHEO HPI release) were well above both Real OER and the historical average for real home prices over any significant long-term period. Mortgage lending has slowed significantly, with more than 2/3 of banks indicating they had tightened their standards for home mortgages in the first two quarters of the Federal Reserve Senior Loan Officer Opinion Survey on Lending Practices, 2008. ARMs that will reset in 2008, 2009, and 2010 threaten to put homeowners in negative equity and flood the market with more foreclosed homes. Recent moves by the Federal Reserve and the Treasury, however, may stem the tide of foreclosures and bank failures through the expenditure of trillions of dollars on securitized assets.

Figure 6 – OFHEO vs. Cost of Rent



From current levels, as measured by OFHEO, home prices may decrease by as much as 25-30% over the next few years. This would equate to a return to 1999 levels when the Purchase/Rent Gap was close to zero. As of 2008-3, real home prices have fallen only 11.5% in real terms. As home prices continue to fall, expectations of further decreases in home prices will likely feed into momentum for a downward market trend, just as expectations fuelled record profits on the upside. This slide may cause real home prices to overshoot their long-term mean, leading to a serious depression in housing prices for many years to come.

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