

Acknowledgements

To Professor Mario Crucini, without whose help this thesis would not exist, and who always knew the right combination between being strict and being encouraging,

To Professors Malcolm Getz and Ben Eden, for their agreement to oversee my thesis with such short notice,

To Laffer Associates, for kindly allowing me access to their extensive database of tax estimates and statistics,

To Ken Peterson and Nancy Epling, for their insightful comments and willingness to help at crucial moments,

To the rest of the (hopeful) Honors Econ Seminar Students of 2008 and, in particular, to Jeff Moredock, without whose company I would have gone berserk by myself in the library.

Contents

| | |
|--|----|
| Introduction | 3 |
| Theory | 8 |
| Method | 15 |
| 3.1 Theoretical Framework | 15 |
| 3.2 Empirical Model | 20 |
| 3.3 Secondary Model Specifications | 22 |
| Data Summary | 23 |
| 4.1 Characterization and Source of Key Variables | 23 |
| 4.2 Summary Statistics | 25 |
| 4.3 Issues Related to Data | 25 |
| Results and Analysis | 27 |
| 5.1 Baseline Linear Regressions | 27 |
| 5.2 Fixed Effects Regressions | 28 |
| Discussion and Future Research | 31 |
| Works Cited | 33 |

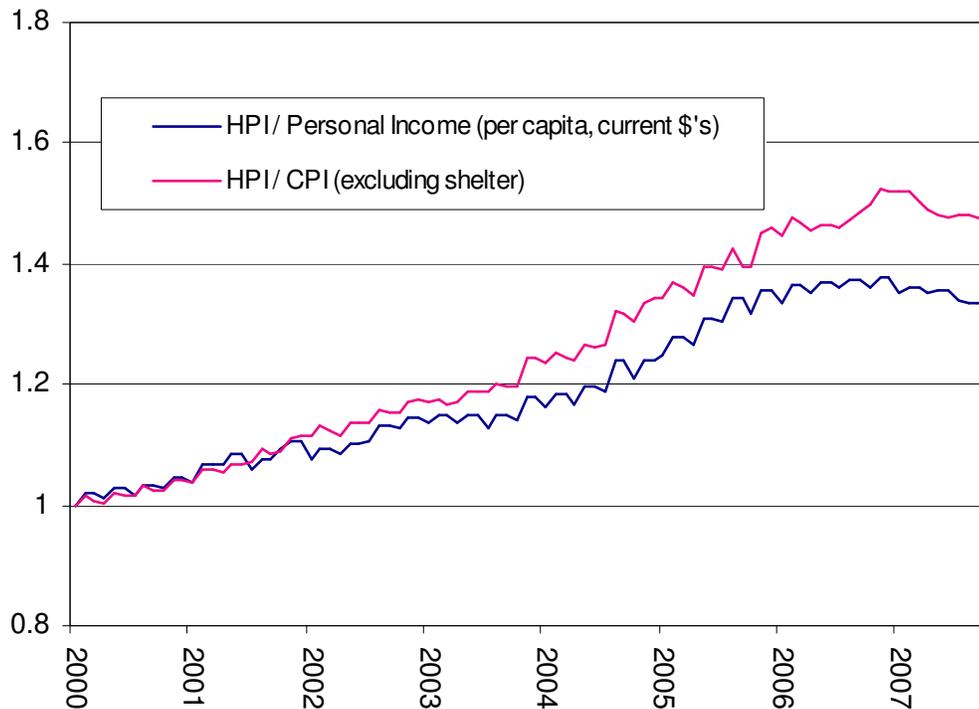
"Only buy something that you'd be perfectly happy to hold if the market shut down for 10 years."

-Warren Buffett

1 Introduction

Like large cap, high dividend yielding stocks, which have historically gained most of their value from dividends rather than capital appreciation, the commanding majority of real estate's value as an investment has been composed of rent income—more precisely, rents either paid to the owner by tenants or, alternatively, the cash outlays owners forego by purchasing a home and avoiding rent payments of their own. Thus, it seems reasonable to assume that, like any other asset, the value of real estate should ultimately be determined by the net present value of its future cash flows—in this case, rent minus maintenance expenditures. In recent year, however, the price to rent ratio has fallen drastically.

Surprisingly, rents have not increased at nearly the same pace real estate prices have. Indeed, a study by *Fortune Magazine* found inflation adjusted rents are virtually the same now as they were in 1970. In particular, however, residential transaction values have outpaced rent growth and CPI growth in the past decade: between Q1, 2000 and Q3, 2007, nominal prices soared 76%. Relative to CPI (excluding the shelter component) and median per capita disposable income (current dollars), this figure represents 47% and 33% comparable gains, respectively. This sudden and unusual set of nominal gains has led some economists to postulate real estate is in a speculative bubble comparable to the tech stock frenzy seen in the late 1990's. Accordingly, many economists have adopted the view that we are “due” for a negative adjustment in housing prices.



The systemic threats associated with a broad decline in residential real estate value vary in character and magnitude depending on which economist you are speaking to, but generally consist of the following: (1) broad decreases in consumption, (2) default and foreclosure rate increases, (3) decrease in value of collateral associated with \$8 trillion residential mortgage debt market, (4) inability to draw equity from home or refinance.

Threat 1 is derived from the Milton Friedman's Permanent Income Hypothesis, which essentially states people's consumption is not simply a function of their disposable income but, rather, what they perceive their total lifetime income will be. Thus, an individual's consumption will depend not only on their current wage income and their perceived future wages, but also on the expected appreciation of their valuable and income generating assets. Such assets can include anything from investments in

timberland to artwork and fine jewelry, but typically include bonds, equities, and residential real estate. Indeed, for a typical American, the home they reside in constitutes the *majority* of such assets. Accordingly, if we believe Milton Friedman's permanent income hypothesis, we must conclude a material decline in home prices offers a realistic threat to the consumption component of gross domestic product.

In fact, several academic studies have demonstrated a correlation between consumption and increases in wealth. In particular, Kundan Kishor (2007) found Americans' consumption was more responsive to fluctuations in housing wealth (real estate values) than increases in financial market wealth (equities, bonds, etc.). More precisely, Kishor concluded consumption to be more than *twice* as sensitive to increases in household wealth than to financial market wealth—for every one dollar increase in household wealth, consumers typically increased spending by seven cents, but an equal increase in financial market wealth corresponded to a comparatively small consumption increase of only three cents. Kishor ultimately resolves this peculiar relationship with the explanation that people perceive real estate appreciation as representing a more “permanent” increase in their wealth than financial market gains, which are apparently considered largely transitory.

Threat 2 is a bit circular but, nonetheless, relevant. The argument goes that the shock of default and foreclosure rate increases will severely depress housing values. As inventories rise steadily and values fall rapidly, homeowners' perceptions of their homes' values will fall as well and they will be more likely to quit struggling to make their mortgage payments and simply default—especially if they perceive themselves to be “underwater” (that is, having negative equity in their home as a result of a nominal price

decrease). This trend could potentially snowball, resulting in further price depression. Consequentially, the housing market would be shocked with supply and residential construction would grind to a halt. As the economy's growth lags with the housing investment component's fall (and corresponding layoffs), so too will other components begin slowing until, ultimately, a recession occurs. If this series of events were to occur, elevated unemployment rates and real wage depression would further increase consumers' difficulties in making their mortgage payments (particularly those with variable rate mortgages resetting). And so the cycle would continue...

Threat 3 holds that residential housing price depression would further damage the already battered residential mortgage backed securities (RMBS) market. According to a 2006 study conducted by the Federal Reserve Bank of St. Louis, the value of collateral backing the U.S.' RMBS market amounts to over \$8 trillion. As severe delinquency rates have increased, so too have foreclosures. Foreclosure—the forceful seizure and sale of one's assets for failing to make loan payments—is generally held to be a worst-case scenario in RMBS market valuation stress tests. If housing prices decline materially, so too will the assets underlying RMBSs—thus worsening the worst-case scenario faced by lenders (Wheelock 2006). Further deterioration in the ability of lenders to syndicate mortgage debt will likely lead to increases in real mortgage rates, which would increase the real imputed cost¹ of homeownership and put additional downward pressure on the nominal value of homes.

Threat 4 is simply that housing price declines will limit homeowners' options to refinance or draw equity against their home. Specifically, the rising home values of the past few years and increasingly sophisticated (read “imaginative and ruinously

¹ Imputed rent defined and discussed at greater length later in the paper.

aggressive”) nontraditional mortgage loans of the past few years have left homeowners with extremely small equity stakes in their homes. In particular, the popularity of interest-only loans with variable-rates (most commonly: “2/20s”) and adjustable-rate mortgages that permit negative amortization (“option ARMS”) “raise additional concern about default risk because such loans expose borrowers to more interest-rate risk and house-price risk than traditional fixed-rate, amortizing loans” (Wheelock 2006). If home prices were to decrease materially, homeowners’ equity would suffer a corresponding decrease; in this case, their ability to accommodate adverse interest-rate movements against them through refinancing would be severely limited.

2 Theory and Literature Review

So, if residential real estate depreciation seems potentially deleterious to our overall economic outlook, what is the likelihood of such a broad based decline in value? Historical evidence suggests the likelihood is slim. Indeed, the Federal Reserve concluded there hasn't been a nominal decline in overall real estate values at the national level since the Great Depression. Unfortunately, this conclusion is difficult to prove because there was no broad based measure of housing prices until the Office of Federal Housing Enterprise and Oversight (OFHEO) began tracking them in 1975. Examining historical OFHEO reports on the Housing Price Index (HPI) confirms that there hasn't been a nominal annual decrease in housing prices since the index's inception.

However, at the state level, several "booms" similar to our current market's price appreciation (booms here defined as +7% annualized state HPI / state per cap income growth for three or more quarters) and busts (defined as +10% declines in nominal HPI over a period of four or more quarters) occurred between 1980 and 1999. In total, there have been 20 price booms similar to today's price movements and, of these, 50% (10/20) have been immediately followed by busts. On average, the decline—from peak to trough—following a boom was 15.4% (Wheelock 2006). Consequentially, it seems prudent to explore the forces that have historically moved housing price markets and determine the sustainability of our current price escalation.

| State | Boom period | Average growth in HCI/PCY (%) | HPI peak | Subsequent decline in nominal HPI (%) |
|-------|-----------------|----------------------------------|----------|--|
| AK | 1981:Q2-1982:Q3 | 8.7 | 1984:Q3 | 43.7 |
| AK | 1990:Q3-1991:Q4 | 11.3 | N/A | N/A |
| CA | 1988:Q2-1990:Q1 | 11.9 | 1990:Q3 | 14.4 |
| CO | 1994:Q1-1994:Q3 | 7.7 | N/A | N/A |
| CT | 1985:Q2-1987:Q4 | 12.5 | 1988:Q2 | 20.7 |
| DE | 1986:Q4-1987:Q2 | 7.8 | 1993:Q2 | 3.1 |
| HI | 1988:Q3-1992:Q2 | 11.3 | 1994:Q3 | 17.8 |
| MA | 1984:Q1-1987:Q2 | 11.7 | 1989:Q4 | 12.2 |
| ME | 1985:Q4-1987:Q2 | 7.9 | 1989:Q4 | 11.6 |
| MI | 1987:Q1-1987:Q3 | 8.1 | N/A | N/A |
| MT | 1983:Q4-1984:Q2 | 9.4 | 1984:Q1 | 13.1 |
| MT | 1994:Q1-1994:Q4 | 9.7 | N/A | N/A |
| NH | 1985:Q2-1987:Q2 | 12 | 1989:Q4 | 22.1 |
| NJ | 1985:Q3-1987:Q4 | 12.2 | 1988:Q3 | 7.8 |
| NY | 1985:Q1-1987:Q3 | 10.3 | 1989:Q4 | 4.7 |
| OR | 1990:Q2-1991:Q1 | 8.5 | N/A | N/A |
| PA | 1987:Q1-1988:Q2 | 8.1 | N/A | N/A |
| RI | 1985:Q4-1988:Q1 | 15.7 | 1989:Q4 | 14.1 |
| UT | 1993:Q3-1994:Q4 | 9.9 | N/A | N/A |
| WA | 1989:Q4-1990:Q4 | 12.5 | N/A | N/A |

Some people have asserted the boom in real estate prices is not necessarily indicative of a “housing bubble.” Notably, Professor Todd Sinai of the Wharton School, Charles Himmelberg of the Federal Reserve Bank New York, and Professor Paul Milstein of Columbia Business School (2005) assert we must not limit our valuation of the housing market to simple ratios, such as price to rent or per capital income. Instead, they propose evaluating how reasonable housing prices are based on imputed rent (the “total cost” of owning a home—which is a function of costs associated with foregoing investing in alternative assets, property taxes, maintenance expenses, and ownership risk premiums, as well as the tax benefits and potential capital gains associated with ownership). Their 2004 study ultimately concluded that housing prices seemed well

grounded in economic fundamentals. They note that none of the 46 metro areas they studied were above their respective imputed-rent-to-income ratios and only 9 were above their historical averages. Further, they find imputed-rent-to-actual-rent ratios were well below their historical highs (only 7 were even within 20 percent and 12 were more than 40 percent below their historical highs). Finally, they find cities with high price-to-rent ratios tend to remain high and those with low ratios tend to remain low. This finding leads them to conclude that the growth of cities is accompanied by (and sometimes driven by) “benefits of increasing density and agglomeration” that create permanent land shortages, thus enabling these (aptly named) “superstar cities”—i.e. Boston, New York, San Francisco, Los Angeles, etc.—to exceed national growth averages for “very long periods of time” (Himmelberg *et al.* 2004).

Some have found little comfort in these findings, however. In a 2006 study, Robert Shiller rejects Himmelberg *et al.*’s findings because they only include data from as early as 1980. Shiller points out real rents have declined steadily to about 50% of their level in 1913, the year the CPI was created. At the same time, however, real housing prices have risen approximately 70 percent, thus reducing rent-to-price ratios to levels well below long run historical norms. Additionally, Shiller rejects the conclusion that long-term prices in “superstar cities” can appreciate indefinitely, citing the average annual return of only .2% per year between 1628 and 1973 of the exclusive Herengracht canal region of Amsterdam.

Ultimately, Shiller does not conclude the U.S. housing market will necessarily crash, but he does point out that the current boom is unique in U.S. history. The only comparable boom occurred between 1942 and 1947, when real home prices increased by

60%, followed by a leveling off and “soft landing.” This figure, however, serves as a poor precedent to base expectations upon, as it followed the economic tumult of World War II and basically just restored real housing prices to their pre-Great Depression levels, rather than elevating them to unprecedented highs (Shiller 2006).

Other economists have argued that widespread speculation in the housing market is economically infeasible as purchasing a home involves substantial transaction costs in the form of lawyer, broker, conveyancing, and survey fees. Additionally, speculators would incur prohibitively high research fees due to the heterogeneous nature of the housing market that necessitates on site visits and inspections by specialists. Such “obstacles” have led some economists to conclude all but the most extreme expected gains will be substantially reduced—if not entirely eliminated (see Smith *et al.* 1998).

Ultimately, however, this argument is fallacious. The fact that demand for homes is primarily dominated by first-time buyers and owner-occupiers who wish to move for reasons other than speculation provides the perfect opportunity to speculate. For such individuals, the costs associated with buying a home cannot be avoided and must thus be treated as sunk costs. Consequentially, such individuals or households are free to take advantage of expected fluctuations in real home prices without incurring any additional costs (Levin and Wright, 1997).

In particular, households who wish to buy for reasons other than speculation are free to speculate in three main ways. First, potential buyers may speculate by timing their purchase. For first-time buyers, this may include deferring purchase because of a perceived future opportunity to buy at a lower real price. In contrast, a current homeowner who wishes to only own one home may purchase a second home prior to

closing on their own home if they perceive higher real future prices that will allow them to sell their previous home at a higher price.

Secondly, an owner-occupier who is moving may wish to carry two homes at once (as above) if they perceive the growth rate in home prices to exceed the rate of interest charged on bridge loans. In contrast, they will seek to minimize the period they carry two homes if they perceive lower future prices as they would incur both capital losses and interest expenses during such a period. Likewise, first-time buyers may move forward or defer their purchases based on relative interest and expected growth rates.

Finally, purchasers may speculate by “trading up.” If potential buyers expect material future price increases, they may choose to concentrate more of their wealth in real estate by purchasing a larger or higher-quality home (Levin and Wright, 1997).

Many economists believe such speculation is futile. Per the Efficient Market Hypothesis (EMH), they assert markets are “informationally efficient” and therefore already reflect all known information (defined as any information relevant to an asset's value). Accordingly, investors are unable to consistently outperform the market by using any information that is already public, except through luck. Numerous studies of speculative strategies—based on both fundamental and technical analysis—have been conducted on the stock market. To the delight of EMH proponents, most studies have demonstrated poor and inconsistent long run returns to speculating relative to holding an equally weighted market portfolio. Notably, actively managed dynamic strategies have been shown to either fail to beat the market or incur prohibitively high expenses (related to trading, research, and slippage, among others fees) to be profitable (Malkiel 1999).

In contrast, others have found behavioral and psychological forces—such as herding and risk aversion—affect market prices and create potential opportunities to achieve outsized gains (Shefrin 2000, Shleifer 2000). Attempts to model the impact these speculative forces have on the market in a vast array of literature. Of particular note, is Blanchard and Watson’s (1982) model, which is generally considered to be the first plausible attempt to demonstrate a speculative bubble may be able to diverge from its “fundamental price” and remain in such a state for an extended period of time in spite of assumed rationality for all market agents.

To date, most research on the above mentioned forces has been concentrated on highly liquid international markets—in particular, stocks, commodities, and bond price fluctuations are the subject of a vast literature attempting to either defend or disprove the EMH. However, comparably little research on how past price movements may or may not effect the real estate market. This may be due to the longstanding belief that the housing markets are systemically immune to pricing bubbles. Indeed, in 2004 Alan Greenspan responded to concerns regarding drastically rising home prices may be indicative of a speculative bubble with the following:

‘Housing price bubbles presuppose an ability of market participants to trade properties as they speculate about the future. But upon sale of a house, homeowners must move and live elsewhere. This necessity, as well as large transaction costs, are significant impediments to speculative trading and an important restraint on the development of price bubbles’ (Greenspan 2004).

As noted above, however, the assumption that speculation in the real estate markets is not possible is fallacious at best, and economically disastrous at worst. Supposedly, one would only need to observe the +50% real estate market crashes in some parts of Asia during the Asian Financial Crisis, or at the wild swings in Ireland’s real estate values over

the past three decades, to see that home prices do not move up forever in a perfectly predictable (and handsomely profitable) line—they are subject to many of the same behavioral and psychological forces that drive broad stock indices prices to “irrationally exuberant” valuations.

Of the people who have attempted to apply speculative feedback models to real estate prices, Karl E. Case and Robert Shiller have gained the most acclaim for their research suggesting the real estate market is not efficient. Among other accomplishments, they found evidence of positive serial correlation in real housing prices. Their study showed the change in a log real price index tended to be followed by a gain the following year of between 25% and 50% of the prior year’s gain. Further, they found a number of variables (ratio of construction costs to home prices, real per capita income growth, and increases in adult population) are positively related to price changes in the following year. Additionally, they find that gains in excess of those predicted by fundamentals tend to build inertia (Case and Shiller 1990).

This paper will thus attempt to explain the recent surge in U.S. home prices by utilizing Blanchard and Wilson’s “rational bubble” model. The model is oft modified and applied to other asset classes; however, this paper is unique in that the model is rarely applied to real estate. Further, similar existing studies suffer from smaller time horizons and generally use annual, rather than quarterly data. Ideally, this study will determine the likelihood and average rate at which real estate price bubbles return to prices supported by their fundamental values.

3 Empirical Framework

"Common sense is not so common."

-Voltaire

This paper attempts to identify the perceived likelihood of real estate prices closing gaps between their speculative and fundamental valuations. To accomplish this, a theoretical framework for speculative bubbles is used developed for the real estate market and used to produce an empirical regression. Once the regression results are estimated, a measure of the constant likelihood speculative bubbles retrace to fundamental values in a given period is calculated.

3.1 Theoretical Framework

3.1.1 Assumptions

A fundamental assumption of my model is that future price expectations are driven primarily by perceived fluctuations in demand. This assumption is routed in the fact that net housing construction/destruction in a given period is miniscule compared to the stock of existing homes. The high degree of existing housing relative to new construction is consequence of its highly durable nature. Accordingly, supply is assumed to be totally inelastic in the short run.

3.1.2 Stochastic Bubbles—the Blanchard-Watson Model

Stochastic bubbles are defined as those that may either survive or collapse in each period. The model implies that there are two possible regimes providing market returns—one where the bubble collapses, and one where the bubble survives. Assuming a period-to-period arbitrage condition, it is possible to define restrictions on the two regimes. That is, for the bubble to survive, it must sufficiently compensate the investor for the risk associated with a potential regression to fundamental value.

My model begins with a simple expectational difference equation that defines the basic period-to-period arbitrage condition for any asset:

$$(1) \quad P_t = (k + (E_t(P_{t+1}))/ (1+i_t),$$

where: P_t is the present market price; k is the value of owner-occupation or rent for one period; $E_t(P_{t+1})$ is the current expected market price at the end of period t , and i_t is the risk free interest rate for the current period. The fundamental value of an asset based on this model is thus:

$$(2) \quad P_t^* = \sum_{k=0}^{\infty} (1+r)^{-(k+1)} \cdot E_t(D_{t+k})$$

All prices not conforming to this model all defined by Blanchard and Watson (1982) to be “bubbly.” The excess to the fundamental price is called the bubble component and defined in magnitude by the equation:

$$(3) \quad B_t = P_t - P_t^*$$

Based on the assumption above that all prices (bubbly or otherwise) must conform to the period-to-period arbitrage condition; a second expectational difference equation is used to define the expected bubble:

$$(4) \quad E_t(B_{t+1}) = (1+r) \cdot B_t$$

Blanchard and Watson (1982) assume a 2 outcome scenario to solve this stochastic equation. In the 2 outcome model, there are only two states: the bubble survives (S), or the bubble collapses (C). Applying this assumption to the equation above makes it clear that the expected value of the bubble will be a function of the possibility of staying in state S (assumed to be a constant q for each period), the risk free rate, and the current bubble value:

$$(5) \quad E_t(B_{t+1}|S) = \frac{(1+r)}{q} \cdot B_t$$

To define the bubble component further, I first need to derive a proxy for calculating the fundamental value. There is no universally accepted model for any asset's intrinsic value, but similar studies on stocks typically equate long-run income components with logarithmic dividends. Schaller and van Norden (2007) assume log dividends follow a random walk with drift:

$$(6) \quad d_t = \alpha + d_{t-1} + \epsilon_t$$

Under this assumption, Cutler, Poterba, and Summers (1991) derive the fundamental price of the current dividends as:

$$(7) \quad P_t = \rho \cdot D_t$$

where:

$$(8) \quad \rho = \frac{1 + r}{e^{(\alpha + (\sigma^2 / 2))} - 1}$$

Cutler, Poterba, and Summers (1991) estimate ρ using the mean of the price dividend ratio. Real estate is a bit trickier, however. There is no useful and cheaply available measure of average rents for each state, and the CPI shelter index tends to systemically understate the value of house services because rental units are, on average, smaller and of lower quality than owner-occupied units (Case and Shiller 1990). Accordingly, I will use a function of interest rates and 4 person family median personal income (y_t) as a proxy for housing service prices. This model rests upon the assumption that housing is a non-inferior good. I include the interest rate because I expect consumption of housing services to move inversely with interest rates, which inflate (or decrease) mortgage payments and effectively impact real buying power of all goods (indeed, Poterba (1984) shows housing consumption rises relative to consumption of all other goods when interest

rates decrease because of a substitution effect). I adopt Cutler, Poterba, and Summers' (1990) model for income value (rent) but do not use a log:

$$(9) \quad k_t = \alpha + f(y_{t-1}, i_{t-1}^*) + \epsilon_t$$

where:

$$(10) \quad i_t^* = (1 + (1 - \omega_t)(i_t^m)) / (1 + \pi_t^e) - 1,$$

where: ω_t is median marginal tax rate; i_t^m is the 30 year conventional mortgage rate, and π_t^e is expected inflation (assumed to equal the past year's inflation).

To estimate $f(y_t, i_t^*)$, I calculate the average nominal mortgage payment as a percent of nominal y_t using i_t^* , which equals roughly 14.26% (τ). I can thus calculate the expected amount of consumption on housing in each period and use a present discount value of mortgage payments at that consumption level to estimate the current fundamental market price:

$$(11) \quad P_t^* = \sum_{t=1}^{30} (1 + i_1^*)^{-t} \cdot \tau \cdot y_1$$

Thus, B_t can finally be calculated as the difference between the present value of rents model and the actual median market home price.

3.2 Empirical Model

3.2.1 Basic Linear Model

After deciding on the characterization of the bubble and fundamental components, I can design a simple linear equation relating their attributes and the median home price. The bubble component simply placed in the model and a simple linear relationship of functional form $f_k(\cdot)$ is assumed for equation

$$p_{t,p} = \beta_0 + \beta_1 B_{t-1,p} (1 + i_t) + \beta_2 y_{t,p} + \beta_3 i_t^* + \mu_{t,p} \quad (1)$$

It is clear from comparing this model to equation (5) that β_1 should equal $1 - q$.

3.2.2 Linear Model with Liner Time Trend

To help adjust for trending in the data I will also run a second regression with the addition of a linear time trend variable δ .

$$p_{t,p} = \beta_0 + \beta_1 B_{t-1,p} (1 + i_t) + \beta_2 y_{t,p} + \beta_3 i_t^* + \beta_4 \delta_t + \mu_{t,p} \quad (2)$$

The value of δ is the year plus $(.25) * (\text{quarter} - 1)$.

3.2.3 Linear Model with Liner Time Trend

Up to this point, most of the analysis has focused on primarily on monetary business cycle and speculation based variables. To improve the models performance, it may be useful to add a piece of empirical data.

I would like to adjust the model to take into account changes made to the Community Reinvestment Act (CRA) in 1995². Some people have accused the government of instigating the subprime crisis by forcing lenders to make bad loans in order to maintain CRA compliance. Economists are not yet in agreement on this matter. However, many studies have found evidence the CRA was—for better or worse—successful in promoting lending to lower- and mid-income regions (see Avery *et al.*, 2005).

To adjust for the potential impact of the CRA, I will insert a dummy variable (*cra*) with value 0 pre-1995, and 1 for 1995 and every year after. The third regression equation is thus:

$$p_{t,p} = \beta_0 + \beta_1 B_{t-1,p} (1 + i_t) + \beta_2 y_{t,p} + \beta_3 i_t^* + \beta_4 \delta_t + \beta_5 cra_t + \mu_{t,p} \quad (3)$$

3.2.4 *Fixed Effects Linear Model*

It is possible that all the above linear models suffer from endogeneity issues related to interstate variation that creates omitted variable bias. I attempted to control for this by doing extensive research on the difference between various states property and capital gains tax rates but other factors (restrictions on partitioning land, for example) may be omitted. To help control for this, a fixed effects regression is run using the state

² The Community Reinvestment Act was originally passed in 1977. Initially, it required the Office of Thrift Supervision (OTS) to monitor the lending activities of all FDIC insured depository institutions to insure they adequately and “equitably” funded the needs of their local communities—in particular, the low- and moderate-income neighborhoods. This consisted mainly of examining the institution’s “record of meeting the credit needs of its entire community” and writing a publicly available report their performance.

In 1995, implementation and enforcement of the CRA was materially changed through legislation. The new CRA provisions standardized the performance review process and assigned each bank a rating (ranging from “Outstanding” to “Substantial Noncompliance”) that would be taken into account when the bank applied to the government for deposit facilities, mergers and acquisitions, etc.

as panel data (note: because interest rates vary only across time and not place, I cannot run a ‘true’ two-factor fixed effects regression, I therefore run a fixed effects model dummy variables for time only):

$$p_{t,p} = \beta_0 + \beta_1 B_{t-1,p} (1 + i_t) + \beta_2 y_{t,p} + \beta_3 i_t^* + \beta_4 [\text{stateDummies}] + \mu_{t,p} \quad (4)$$

3.2.5 Fixed Effects Linear Model with Linear Time Trend

Though I cannot run a ‘true’ two-factor fixed effects model (as noted above), I replicate my attempt to adjust for trending by adding a linear time trend (as in regression (2)):

$$p_{t,p} = \beta_0 + \beta_1 B_{t-1,p} (1 + i_t) + \beta_2 y_{t,p} + \beta_3 i_t^* + \beta_4 \delta_t + \beta_5 [\text{stateDummies}] + \mu_{t,p} \quad (5)$$

3.2.6 Fixed Effects Linear Model with Linear Time Trend and CRA

As in section 3.2.3, a dummy variable is added for when the CRA was reformed in 1995:

$$p_{t,p} = \beta_0 + \beta_1 B_{t-1,p} (1 + i_t) + \beta_2 y_{t,p} + \beta_3 i_t^* + \beta_4 \delta_t + \beta_5 \text{cra}_t + \beta_6 [\text{stateDummies}] + \mu \quad (6)$$

3.3 Secondary Model Specifications: Estimating the Chance of a Burst

As noted in section 3.2.1, the results of the linear regression will allow an estimation of q —the implicit constant likelihood that a bubble will collapse to the fundamental value in a given period.

4 Data Summary

Data was taken from a variety of sources. A brief description of data sources and some summary statistics follow:

4.1 Characterization and Source of Key Variables

4.1.1 *Real Median Home Prices*

I used the Census Bureau's 2000 state median home prices as my base year. Next I used the Office of Federal Housing Enterprise Oversight's (OFHEO) Housing Price Index (HPI) to adjust nominal housing costs back to quarter 1 of 1975 through quarter 4 of 2007. The HPI approximates median nominal housing appreciation using a repeat sales technique similar to that of the Case-Shiller Index but does not adjust for qualitative changes. In short, the HPI collects data on single-family home resales, and captures sale pairs to compute resale differentials. This index was chosen because it is the most widely recognized metric used to describe housing prices and because the index was started in 1975 (eleven years earlier than the Case Shiller). The HPI is released monthly but I used end of quarter values to adjust my data. I also adjusted the HPI using the Consumer Price Index (excluding the shelter component) to calculate my dependent variable: Real HPI in 2000 dollars on a quarterly basis.

Finally, the HPI was chosen because it is the most widely recognized measure of housing prices and, therefore, the most relevant for calculating public expectations and speculation.

4.1.2 Speculative Components

The speculative components were calculated as described in the theoretical and empirical framework section above.

4.1.3 Median 4 Person Family Income

Median family income is released annually by the Census Bureau. I adjust for effective tax rates using data from the Census Bureau, the IRS statistical database, and Laffer Associate estimates. Finally, I adjust the after-tax median family income using headline CPI to a base year of 2000.

4.1.4 Discount Rate

The discount rate was calculated using the equation described in the theoretical framework section above (section 3.1.2, equation (10)).

The 30 year rate on conventional fixed rate mortgages is released on a monthly basis by the Federal Housing Finance Board (FHFB) as an average rate for all conforming mortgages. Only fully amortized mortgage loans used to purchase single-family, non-farm homes are included (excludes refi's and non-amortized and balloon loans).

The median marginal tax rate was calculated by the Tax Policy Center on an annual basis and the inflation rate was calculated as the prior quarter's year-over-year percent change in the CPI.

Table 4.2: Summary of Data

| Descriptive Statistics for Pooled State Data | | | | | |
|---|---------|---------|--------------------|----------|---------|
| | mean | median | standard deviation | minimum | maximum |
| $P_{t,p}$ | 119,501 | 103,325 | 53,965 | 48,464 | 552,887 |
| $B_{t-1,p}(1+i_t)$ | -55,611 | -58,826 | 47,189 | -160,460 | 406,667 |
| $y_{t,p}$ | 44,553 | 43,614 | 6,956 | 22,654 | 73,300 |
| i_t^* | 0.0331 | 0.0353 | 0.0210 | -0.0421 | 0.0765 |
| δ_t | 60 | 60 | 34 | 1 | 119 |
| cra_t | 0 | 0 | 0 | 0 | 1 |

note: Data includes statistics from all 50 states and Washington D.C., regression begins in Q2 1978.

4.3 Issues Related to Data

4.3.1 HPI: Omitted Transactions

The HPI has a handful of shortcomings worth mentioning. First, it only includes homes using conventional mortgages (so homes bought with subprime or jumbo loans are excluded). To the extent that one of the above mentioned mechanisms for speculating in the real estate market is trading up to a more expensive home this presents a problem. The omission of jumbo loans means that this effect may be understated as people use equity to trade up to a bigger home (with a bigger loan). In a highly speculative market, decisions to concentrate additional wealth in real estate could potentially inflate luxury home prices at a faster rate than more modest homes. Indeed, excessive flight to high priced homes poses the risk of putting deflationary pressure on low priced homes as they are put on the market in greater numbers.

Additionally, homes with low turnover rates will not be included in the HPI sample because at least two transactions must have taken place for a home to be included in the indexes calculation. I am uncertain what effect this would have, but I speculate it would not be significant.

4.3.1 HPI: Lagged Effect of Refi's

Some paired sales are in fact based on refinancing appraisals, which tend to lag the market.

4.3.2 HPI: Hedonic Value

The HPI does not adjust for owner improvements (i.e. additions, installing pools, adding hard wood floors or granite countertops, etc.). Consequentially, it may overstate appreciation of homes, *ceteris paribus*, by not taking into account the value such investments.

5 Results and Analysis

As a general comment, the model's results seem quite good. R-squared values ranged from the low .8 range to the low .9 range with all variables except *cra* consistently significant and of the expected sign. All the regressions also demonstrated constant variance when subjected to a Breusch-Pagan/Cook-Weisberg test for heteroskedasticity. Additionally, performing a Hausman test on the fixed effects regressions did not demonstrate systemic differences in the value of the coefficients.

5.1 Baseline Linear Regressions

Table 5.1.1 summarizes the results from the linear models 1-3, which regressed real median home price against the bubble component, median real 4 person family income, the discount rate, the linear time variable, and the dummy variable for the CRA reforms.

All variables were significant to at least the 5% level in each regression—except the CRA dummy, which was not significant and added nothing to the model's explanatory power. This observation conflicts with reports that the CRA may have contributed to the run-up in home prices.

Table 5.1.1: Linear Regressions

| Results for Regression 1-3 | | | |
|---|---------------|---------------------|---------------|
| | Base | w/Linear Time Trend | w/ CRA dummy |
| $B_{t-1,p}(1+i_t)$ | 0.766223*** | 0.847332*** | 0.847352*** |
| t-stat | 0.005969 | 179.31 | 178.72 |
| $y_{t,p}$ | 4.604955*** | 3.672995*** | 3.672882*** |
| t-stat | 0.040167 | 108.64 | 108.41 |
| i_t^* | -27230.6** | -53551*** | -53414*** |
| t-stat | 13408.24 | -5.22 | -5.05 |
| δ_t | - | 1848.305*** | 1846.152*** |
| t-stat | - | 65.74 | 37.09 |
| cra_t | - | - | 44.89337 |
| t-stat | - | - | 0.05 |
| Constant | -42150.5*** | -3678219*** | -3673947*** |
| t-stat | 1894.893 | -66.48 | -37.29 |
| R-Squared | 0.8377 | 0.9053 | 0.9053 |
| Breusch-Pagan (Prob>chi2) | 0.0000 | 0.0000 | 0.0000 |
| Implied q | 1.31 | 1.18 | 1.18 |
| *** = significant at 1% level ** = significant at 5% level * = significant at 10% level | | | |

The simple base model's results are quite good. All variables except the *cra* dummy yielded statistically significant results in every model and with a consistent/expected sign.

Interestingly, the implied q is positive, suggesting years when bubbles increase are usually followed by years of further increases in bubbles. This result supports Case and Shiller's (1990) results, which demonstrated positive serial correlation for short time horizons.

5.2: Linear Regressions with Fixed Effects

Table 5.2.1: Linear Regressions with Fixed Effects

| Results for Regressions 3-6 (A-random effect, B-fixed effects) | | | | | | |
|---|---------------|---------------|--------------------------|--------------------------|-------------------|-------------------|
| | Base-A | Base-B | w/Linear Time Trend-A | w/Linear Time Trend-B | w/ CRA dummy-A | w/ CRA dummy-B |
| $B_{t-1,p}(1+i_t)$ | 0.738538*** | 0.739757*** | 0.800855*** | | 0.80028*** | |
| z-stat | 129.21 | 129.16 | 225.06 | | 223.83 | |
| $y_{t,p}$ | 6.269936*** | 6.309293*** | 3.76022*** | | 3.766896*** | |
| z-stat | 137.13 | 137.27 | 99.44 | | 99.05 | |
| i_t^* | -36279.5*** | -35958.1*** | -64597.5*** | | -66753.9*** | |
| z-stat | -4.31 | -4.28 | -12.53 | | -12.54 | |
| δ_t | - | - | 1763.826*** | | 1795.379*** | |
| z-stat | - | - | 100.12 | | 68.55 | |
| cra_t | - | - | - | | -697.958 | |
| z-stat | - | - | - | | -1.63 | |
| Constant | -117570*** | -119266*** | -3515990*** | | -3578832*** | |
| z-stat | -40.89 | -59.36 | -103.36 | | -69.56 | |
| R-Squared | 0.8154 | 0.8154 | 0.9044 | | 0.9043 | |
| Hausman (Prob>chi2) | 0.000 | - | 0.7424 | - | 0.8494 | - |
| Implied q | 1.354027 | 1.351796 | 1.248665 | | 1.249562 | |
| *** = significant at 1% level ** = significant at 5% level * = significant at 10% level | | | | | | |

The results for the model with dummy variables for state are quite strong as well.

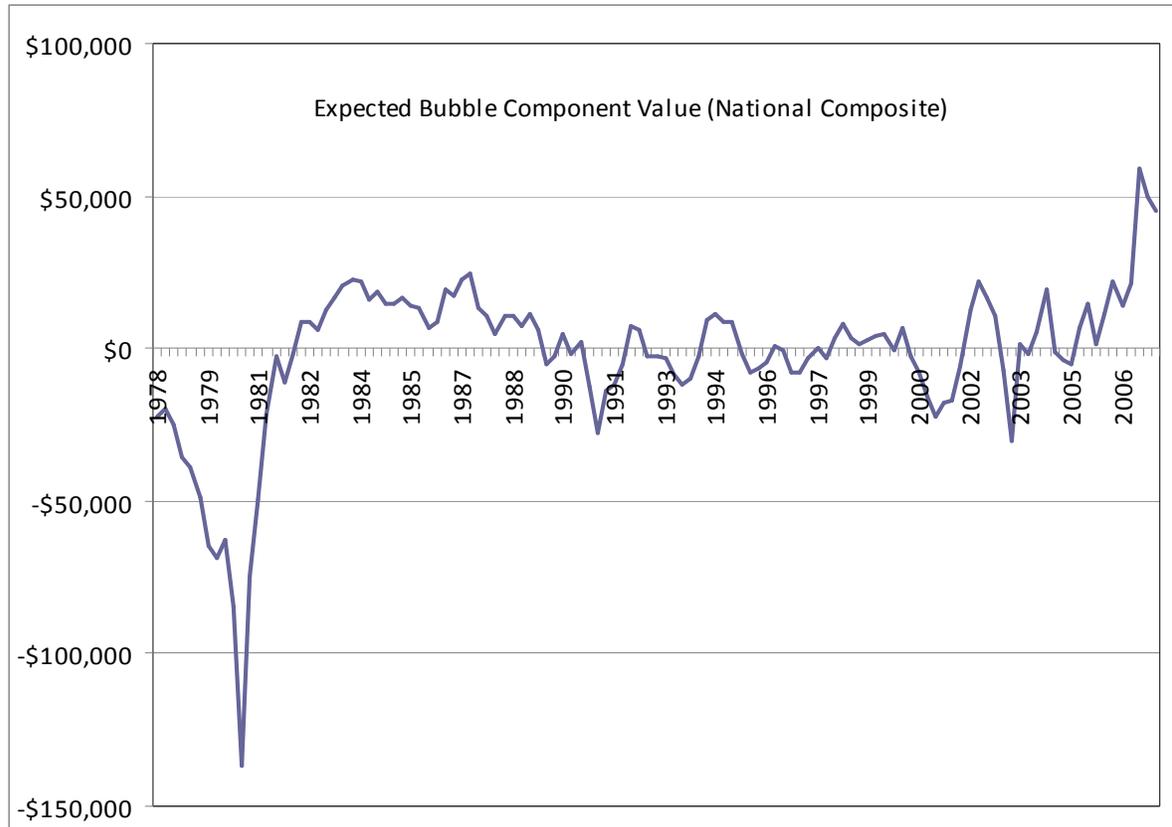
The regressions all succeeded in explaining a minimum of 81% of the variation in real estate prices. With the exception of the CRA dummy variable (which again had no significant impact), all variables are highly significant—to the 1% level—for each regression and of the expected sign.

The implied value of q was again demonstrated to be greater than 1. This indicates that when the price of real estate moves away from its fundamental value, it

will—more often than not—continue extending its divergence the next year if only 2 possible states are assumed to be allowed. More realistically, however, the changes will follow some kind of distribution that will average out to the fundamental price in the long run.

6

Conclusions and Further Studies



The bubble component's current extension should be troubling for U.S. home owners. As is presumably regresses to its long-term value of 0, it is unlikely to receive much support in the form of lower interest rates (as inflation rises, government budget deficits continue to soar, and banks generally are more hesitant to lend money after the subprime debacle hurt their ability to syndicate debt) or increased median 4 family incomes, as the economy slips into a recession or a "soft-patch of growth." An additional threat to housing is that interest rates are already at low levels. Himmelberg, Mayer, and

Sinai (2004), concluded that a linear relationship between housing and interest rates is not the most appropriate a marginal 1% decrease (or increase) has a substantially larger impact on mortgage payments when they are around 6% than when they are around 10%.

Overall, the outlook for residential real estate seems quite glum. Even if fundamentals maintain for the next year or two, the speculative component is likely to retrace some more of its overextension—especially now that the bloom has come off the bubble.

"Speculation is an effort, probably unsuccessful, to turn a little money into a lot. Investment is an effort, which should be successful, to prevent a lot of money from becoming a little."

-Fred Schwed Jr.

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