UNIVERSITY OF MICHIGAN

Bubble Trouble

A Microeconomic Analysis of the Housing Bubble

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Abstract: This paper considers the housing bubble by analyzing visible signs of its causes and effects within a large ongoing panel study. It analyzes marginal entrants and emigrants from the housing market to determine how the characteristics of the market changed between 2001 and 2005. The paper proposes a logit regression based on individual characteristics for predicting the tenure change decision, and concludes from the results that there were no structural breaks in the buyer decision process. It then engages in descriptive analysis and finds that previous explanations of the housing bubble have ignored the effects of a supply constraint on high cost houses in accelerating the increase of average house prices.

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I. Introduction

I.A Motivations

Between January 2001 and June 2006, housing prices rose by 53%, a larger increase than in the entire decade between January 1991 and June 2001.[1] This unprecedented increase in prices was the result of an asset bubble, which peaked in June 2006.[2] Since then, housing prices have fallen substantially, dropping 28.5% from their peak to their December 2008 level with no bottom in sight.[3]

The reason the increase in house prices was treated as a bubble is the assertion that the appreciation was not borne out by the "fundamentals" of the housing market. In particular, because there was no population growth or income growth in the years of the bubble and overall rents did not increase, the claim is that house prices did not rise because of an expected increase in demand for housing.[4] The housing bubble's cause is frequently attributed to the Federal Reserve Board's decision to lower interest rates in the wake of the 2001 recession, and the further downward pressure placed on interest rates by the surfeit of savings pumped into the economy by Asian governments seeking to buy United States treasury securities.[5] Since the demand could not be driven by stable economic factors, its existence was attributed to the matched increase of expanded lending to borrowers unable to repay.

Case, Shiller (1989) discusses local housing market booms and busts, and point out that macroeconomic variables cannot be the single cause of housing bubbles. Too

[1] Monthly Interest Rate Survey House Price Data
[2] Ibid.
[3] Census Housing Price Data
[4] Baker
[5] Ibid.

frequently, these bubbles are localized within a single well-defined geographic area. There must be more fundamental microeconomic factors at work in pushing the bubble. Case, Shiller (1989) then suggests that these booms and their subsequent busts are heavily based on expectations. The expectation of rising house prices skews buyer perceptions toward treating them as an asset instead of a consumption good. Buyers then devote more of their budget to the consumption of housing. This expansion becomes a self fulfilling prophecy, further driving up housing prices, reinforcing expectations and once more increasing housing prices.

Although expectations may have driven appreciation in the late bubble period (2005-6), there must have been some initial reason for buyers and speculators to believe that housing prices would rise above trend. At some point before the height of the housing bubble, some factors other than expectations must have driven up housing prices. On a trivial level, there needed to be a shock to the supply of or demand for houses to initialize the increase in spending. One fact with interesting implications is that ownership expanded from 65% to 69% of the population from 1995 to 2006.[6] Since income and population growth could not explain this increase, it could follow that the market for houses saw changes in the constitution or size of the group demanding housing. Alternately, the owners may have become more persistent, shrinking the size of the market. The questions become who were the new owners and why did they start owning in this period? This paper will focus on microeconomic variables to argue that there may be a more complex series of questions.

[6] Orszag

To determine how demand and supply changed during the housing bubble, this paper will consider the marginal owner: those who changed their tenure choice decision during the bubble period. These are the new buyers and those who switched to renting during the housing bubble. An analysis of these groups between periods will provide insight into how the composition of owners changed over time across demographic and economic variables. Using new buyers only will avoid the need to disambiguate the endogeneity of many other economic factors with respect to home ownership. Clearly, changing preferences among owners buying a new home would also provide bubble pressure, but those effects are outside the scope of this paper. Determining how the incentives to enter and exit the housing market changed will be invaluable in describing the factors influencing the rise of housing prices.

There are two possible ways of explaining the initial increase in prices from a microeconomic perspective. The first is that the demand in the housing market rose significantly. For this to occur, either the group of people with the ability and desire to purchase housing must have increased in number, or the individual preferences of homebuyers must have changed to reflect a willingness to pay more for housing.

An increase in the group of people interested in buying homes could have occurred in two ways. First, there could have been a demographic shift in the United States that increased the number of individuals matching probable buyer criteria. Even though average incomes did not increase and the population did not grow sufficiently to explain the increase in housing prices, changes in the distribution of income or demographic variables toward more individuals meeting the probably buyer criteria may explain some or all of the new found motivation to purchase houses.

Alternately, the group of potential buyers could have been expanded by granting more individuals easy access to credit and mortgage loans necessary to buy a house. This explanation for the housing bubble will be referred to as the credit expansion theory, in reference to its supposition that banks capitalized on low interest rates and the desire for mortgage backed securities by extending mortgage loans to groups that would not have previously qualified. According to this theory, groups who could not have purchased homes in previous years took advantage of banks' desperation to find new avenues for returns and financed their own reckless home buying.

Finally, it might be the case that individual preferences for housing changed. In particular, a strong, increasing demand for bigger houses than had previously existed would drive up the average prices of both the limited supply of larger houses and by crowding out some buyers, the entire market. The relevant difference from the pre-bubble would be an increase in the average size of purchased houses or an increase in the premium buyers are willing to pay for larger homes.

The demand side, however, is not the only determinant of housing prices. Supply could also have affected their movement. The number of housing starts, however, rose substantially in the years of the housing bubble (Chart 1) and the increase in housing starts actually predates the bubble, suggesting that insufficient new stock could not have triggered the bubble.[7] However, new stock is not the only source of supply in the housing market; existing homes are also sold. Although pre-2006 existing home sales data are unavailable from the National Association of Realtors, the 2006 data show that existing home sales constitute a sizeable percentage of all home

[7] http://research.stlouisfed.org/fred2/data/HOUST1F

sales.[8] 6,478,000 existing homes were sold in that year, while 17,683,000 new single family homes were started. Since 2006 is the absolute height of housing construction (Chart 1), it is safe to infer that the ratio of new to existing homes sold was smaller in the years immediately predating the bubble, meaning that changes in the pattern of existing home sales could have had a substantial impact on the supply of houses. The increased ownership rate would then be explained by the decrease in exits from owning coupled with a stable number of buyers. Additionally, the most desirable locations and houses would already be held by existing owners, meaning that new housing starts in less desirable areas would not have loosened pressure on prices in those areas, since they would be imperfect substitutes. Even small decreases in the selling rates of owners in expensive areas could have driven up housing prices in those areas significantly, due to already tight markets.

Very likely, a variety of these factors combined to drive up housing prices in the early bubble period and the proper combination can be tested for with microeconomic data. Although definite conclusions will necessarily be difficult to achieve, it is still worthwhile to see for which causes evidence is available. Determining the answer to this question may provide some clues about the determinants of the early housing bubble.

In this paper, I will propose predictive models for both entering and exiting the housing market, in order to determine which microeconomic factors are most important to the individual buyers and sellers in determining their course of action. I find that the marginal tenure choice regressions retain their general predictive power across periods

[8] http://www.realtor.org/research/research/ehsdata

and that changes in individual variable effects provide extremely limited evidence for bubble related irrationality. I then take the results of these models and use them to inform my consideration of possible reasons for demand and supply side changes in the housing market. In particular, I evaluate whether the size or composition of the potential buyer group changed across periods. I find only one substantive change within this group occurring along any of the variables that the regression finds significant or among the variables that the literature suggests affect the tenure choice decision. This is an increase in average buyer wealth for the 2005 sample period. I do find some evidence that the composition of the seller group has changed; owners of higher value houses sold in lower numbers than they had in earlier periods. I use these conclusions to explore changes in how characteristics of a house, including location, size and previous value affected its future appreciation. I conclude that the supply element of housing prices has been an overlooked portion appreciation during the bubble period.

I.B Literature Review

I.B.1 Tenure Choice

Henderson, Iaonnides (1983) treats housing as both a consumption durable and an investment good, highlighting the interesting dichotomy inherent within the asset. Using this insight, they derive a rental externality that makes owning more attractive than renting, given equal costs. While owner-occupiers pay for all of their own improvements and harvest all of the long-term benefits, landlords do not gain utility from the utilization costs they must pay for in repairs to their tenant's dwellings. To compensate for this, landlords must charge higher rents than the implied rent for owner occupancy. They find that in a two period model, theory predicts that higher-wealth

individuals should be renters and not owners, a result at odds with empirical data. They conclude that other considerations such as the aforementioned rental externality, tax treatment of renting vs. owning and capital market imperfections account for the decision of high-wealth individuals to own.

Goodman (1988) constructs a model of housing demand based on permanent income. He notes that while permanent income is important for housing demand models, it is less key for considering the tenure choice decision. He also notes that size preferences are an important constituent of tenure choice; those with preferences for small dwelling spaces tend to rent, while those with preferences for larger dwelling spaces will buy. The lumpiness of housing capital stock presents problems for the estimation of demand: households cannot always consume the exact amount of housing that they would prefer. Goodman also finds that while rental markets are nationally constructed, housing markets tend to have much stronger local influences. His tenure choice analysis finds rent-price ratios, rent-value ratios, age, race and marital status to all be significant predictors of tenure choice, while household size is not.

Jones (1989) argues that current net wealth, and not permanent income, is the relevant metric for a tenure switch. He roots this argument in Artle, Varaiya's (1978) finding that households tend to intrinsically prefer owning, even though economic theory predicts that, *ceteris parabis*, consumers should be indifferent between the two modes of housing. Jones points out that down payment constraints tend to prevent high human capital but low liquid wealth households from being able to switch into buying when they might wish to do so. However, he concedes that using non-human wealth may be undesirable due to its endogeneity with the tenure choice decision. By using

only young households, Jones lessens the potential biases and finds in his regression results that wealth does have significant effects on tenure choice.

Flavin, Yamashita (2002) discusses the importance of life cycle effects in mortgage and home value holdings. They suggest that young households are highly leveraged in housing relative to their net worth, and so are more likely to quickly pay down their mortgage quickly. Older households with a higher level of net worth relative to their home value and mortgage holdings are less likely to worry about such concerns. Normally, this would be because they have paid off their mortgage. In the bubble period, however, a willingness to take out new mortgages and borrow against home equity may change the risk profile of buyers entirely.

I.B.2 Further Model Considerations

Hendershott, Bosworth, Jaffee (1980) discusses tenure choice changes in an earlier period, 1960-1979, when the percentage of the US population owning a house expanded from 62% to 65%. Although this period of expansion was much longer than the housing bubble, it does provide insights about changing buyer behavior. Demographic data showed an increase in single-person young households owning relative to the multiple-person older households that are more likely to own. Jaffe, Rosen (1979) found that, in 1970, only one quarter of households with head under age twenty-five owned, while half of those with a head between age twenty-five and thirty-four did so, with the number of households owning rising to three-quarters for older heads. The expansion in ownership was even more puzzling because of the doubling in mortgage payments caused by increasing home quality and rising mortgage interest rates over this period. Hendershott et al. finds that the ratio between the user cost of

housing and the cost of renting had a major effect on encouraging the movement of individuals from owning to renting between 1960 and 1979. Their analysis also notes that many households will not respond to changes in homeownership costs or income for a number of years, suggesting the importance of including lagged variables in any analysis of tenure choice.

This paper takes as an inspiration Case, Shiller's (1989) insight regarding the generally regional nature of housing bubbles. If macroeconomic factors alone are not sufficient to explain regional housing bubbles, then microeconomic factors that can affect the demand for housing should be considered for national housing bubbles as well. Although Case, Shiller (1989) finds expectations to be the strongest determinant of major price appreciation, this does not answer the question of where the initial housing price appreciation that created the expectations of continued appreciation comes from. It is important to notice how expectations will play an asymmetrical role in driving housing prices: a short position is much more difficult to take in the relatively illiquid housing market than in many other asset markets.

Ayal, Hempel (1979) creates a model of micro housing market demand through simulation based on interviews with home buyers and realtors. They specifically divide their potential buyers into nine groups based on categorized income, age and household size. They also note that in a previous paper (1973), the pair had found the number of rooms to be a good indicator of housing price. While their paper claims to use microeconomic variables to determine the housing simulation, they employ econometric models based on macroeconomic variables such as interest rates, the

construction cost index, the index of buyer sentiment and unemployment rates. The model heavily emphasizes the role of buyer contact and interaction with a realtor.

Hardman, Iaonnides (1999) point out that the high costs of moving mean only a relatively small portion of houses are on the market at any one time. Since the market price for all houses is set by the Walrasian process in any period, this small number of houses on the market can determine the value of the remainder of the regional housing stock. Hardman and Iaonnides also point out that despite strict life cycle predictions and empirical research predicting the peak of housing consumption to come at mid-life, Venti, Wise (1984) have found that older consumers tend not to reduce their stocks of housing as quickly as would be expected by these models. Change in the rate older consumers reduced their consumption of housing could be a powerful supply side variable.

Greenlees, Zieschang (1984) grapples with the problem caused by very likely errors-in-variables due to misreporting of household income and price data to survey researchers. Their paper rejects the null hypothesis that the difference among coefficients in housing demand between metropolitan level and household level models is purely a result of these errors in variables. The model used to test the demand for housing in their model relies only on income, the price of housing services and the general price level of other goods. A major element of the divergence between the two models appears to be a problem with the application of metropolitan level price indices to individual households. This paper does employ an inflation adjustment to normalize the price level across years; however, Greenlees, Zieschang's (1984) shows that micro-level demand is not biased by price level consideration.

Archer, Gatzlaff, Ling (1995) discusses the role of location within a metropolitan area in determining housing price appreciation. Municipal boundaries and distance from the center of the city are particularly important. They argue that although the effect of location is small, it is not insignificant and should not be ignored in formulating models. This suggests that when considering reasons for house appreciation, it will be important to consider where in a metropolitan region housing prices actually appreciated. The sorts of buyers and sellers that drove this appreciation may differ from average buyers and sellers across the market in a variety of important ways.

I.B.3 The Effects of Housing Bubbles

Hendershott et al's analysis from 1980 provides several interesting insights into the drivers of the recent housing bubble. They note that mortgage lending funds and housing starts are complements. Increases in the availability of mortgage funds at lending institutions will frequently drive increases in housing starts. This outcome suggests that supply of houses will lag demand significantly if the demand is induced by increased mortgage lending: the houses will only have been started by the time potential owners are ready to buy. Additionally, the average quality and average price of the housing start is a function of mortgage availability and user costs.

Case, Shiller (2003) treats the possibility of a bubble in the housing market as early as 2003. They note that one characteristic of the bubble is an assumption by owners that the appreciating value of housing will do the saving for them, and the subsequent reduction of saving in other assets. Evidence for this would be apparent in reductions of non-main home equity wealth by owners. They also suggest that first-time buyers may feel pressured to buy if a housing bubble is in effect because they fear

being priced out of the market if they wait. In general, they predict that housing bubbles will actually drive a major increase in demand as housing becomes viewed as an increasingly good investment. They argue that the fundamental determinants of housing prices in a macroeconomic model are income per capita, population, employment, housing starts and mortgage interest rates. Case, Shiller's (2003) analysis suggests that in most states, changes in housing prices (and so changes in housing demand) are driven entirely by changes in per capita income. They find that houses do appear overvalued and blame the willingness of people to treat their housing as an investment instead of as a consumer durable. Again, the willingness to treat housing this way creates asymmetries, since individuals who think housing is overvalued frequently lack the wherewithal to sell it short.

Hwang Smith, Smith (2006) argues that the housing price appreciation in ten major metropolitan areas was a logical response to expectations of increased cash flow from property. Since they define a bubble as the appreciation of prices above expected cash flows, their method denied the existence of any bubble at all as late as 2006. They argue that housing prices may have been too low in the past, that improvements in the quality of houses makes the proper fundamental values different to measure and that the heterogeneity of housing price and location also precludes simple measures of where houses are overvalued. They also argue that the major increase in the rent-price ratio cited as evidence for the housing bubble is inadmissible due to the differences between rental and ownership properties.

II. Methods

II.A Data

II.A.1 Data Source and Suitability

The microeconomic data in this paper are taken from the Panel Study for Income Dynamics, a survey of households conducted every 2-3 years by the University of Michigan's Survey Research Center. The sample is estimated to have covered over 7400 families in its 2005 edition.[9] Throughout this paper, I will refer to periods by the year of the data release. However, because of the lag time between the interviews being completed and the release of the data, most data are actually from the year before. All macroeconomic events (particularly the 2001 recession) are treated as occurring in the period that encompasses the nearest interview year after the period.

Since this sample strives to provide a longitudinal study of American families with a specific focus on income and assets, the information it provides lends itself to a study of the microeconomic factors that influenced the housing bubble. Because of the panel nature of the study, lags of variables such as income and wealth are also available for analysis.

Given the suitability of the variables within the PSID to the answering of this question, the only remaining necessary condition for employing this dataset is ensuring that the sample did not by some chance miss the housing bubble entirely, since this outcome would obviously skew the data. The best measure of whether the sample members encountered the housing bubble will be the average house value for owners in each of the three years that will be surveyed. As Table 1 below shows, housing

[9] www.psidonline.isr.umich.edu

prices rise by about $34000 between 2001 and 2003 and then increase by over $60000 between 2003 and 2005. Such radical appreciation in housing prices over the four year period covered by the data leaves little doubt that the PSID sample fully captured the housing bubble's effect.

Year	Average House Value[10]
2001	161894.6 (183504.6)
2003	195686.3 (1484745)
2005	258474 (331142.4)

Table 1: Average House Price in PSID Sample

II.A.2 Data Editing

All money values which are compared between years have been adjusted for inflation, using the Bureau of Labor Statistics Consumer Price Index. Because home buyers are consumers of a specific good and must make their home buying decision relative to the costs of other goods they wish to consume, this is the proper inflation adjustment index to use.

The PSID uses numbers above the top range of the variable as codes to denote when a respondent either does not know the answer to a question or refuses to answer. Depending on the importance of the response, respondents who fail to provide an answer for certain important categories such as wealth, income, age or house value may be omitted from the sample because they are of no value in performing analysis and processing space is limited. For less essential categories, these numbers are reset to missing values to prevent them from skewing descriptive statistics.

[10] Truncated at 97th percentile due to extreme values

Occasionally, variables contain a few extreme observations that lie several standard deviations from the mean. In cases where a few observations are causing substantial changes in the mean, values may be truncated, usually at between the 95th and 99th percentiles. I have noted all truncations of values in this paper and the percentile at which the truncation has occurred. Whenever possible, I have avoided these truncations in order to provide the most accurate representation of the sample possible.

II.B Model

II.B.1 Buy Model

This paper will develop a model for predicting the likelihood of a family purchasing a house when it does not own one at the time, based on the characteristics of the head. As mentioned, this will capture if and how the demand for housing expanded. The model cannot differentiate between the decision to buy a house and the ability to receive a mortgage, but this does not affect its validity. Although the demand for houses could be considered only a demand from the buyers, the profitable securitization of mortgages created a demand from mortgage lenders for the issuance of new mortgages, which requires buyers who could not finance much of their home purchase with the realized equity from the sale of a previous home. Since mortgage lenders are an intermediary necessary for the creation of many new buyers, the broadest coverage of possible expansions of the housing market comes from not providing a differentiation, at least initially, between the ability to receive a mortgage and the willingness to buy a home.

The model uses a logit regression on a "buyXY" series of dummy variables, which are coded as 1 if the individual did not own a home in the sample year before, and did own a home in the sample year ending XY. The buyXY variable is 0 otherwise. The logit is used because the model involves a categorical variable as its dependent variable and the regression sample consists of all non-owners.[11] The periods used are 1999-2001, 2001-2003, and 2003-2005. The first period is a period of macroeconomic prosperity while the second period captures the brief recession in 2001. Separating the macroeconomic conditions and the mood they created from the rest of the analysis allows me to glean valuable information regarding how the recession and subsequent recovery affected the housing bubble. Variables that trend in a direction from 2001 to 2005 will be more likely to be causes of the bubble than those that change between 2001 and 2003 before reverting to their 2001 values in 2005. Since Case, Shiller (2003) had already predicted a bubble by 2003, observation of both the 2003 and 2005 sample years will provide important insights into how the bubble grew and changed.

II.B.2 Justification of Variables

This model contains age because several papers suggested the existence of strong life cycle effects in the tenure switch decision. Taking these effects into account may provide some insight into who is buying. Additionally, an age-income interaction variable is included to test if income level at a given age has the strongest effects on buying behavior.

[11] Wooldridge 2003 (Econometrics Textbook)

The model uses the PSID's total family income variable, a sum of all other reported incomes, as the measure of a household's income. The income is considered both for the year of buying and the previous year in the sample, as suggested by Hendershott et al (1980), in order to control for possibility that it is 2-3 years from the time a person attains a sufficient income level to purchase a home and the time that they actually buy this home. This can be considered the time taken to accumulate a down payment, to ensure that the higher income job is secure or as the actual search time spent looking for the right house. It may be possible that it is not the absolute income but rather a shock to a buyer's income which makes them feel wealthier and more likely to buy a home. This would be the case if there are not threshold effects regarding the income level when the average buyer decides to buy a home. Therefore, I have included a Δ income variable to take these possible income shocks into account. By combining results from multiple variables, this variable will introduce a fair amount of measurement error, which will be taken into account in the analysis of results.

Both a new marriage and the number of children can be predicted to increase the likelihood of buying a home. These factors require a larger living space for the family and so a larger percentage of income devoted to housing. The sum of money they are willing to spend creates more choices in the ownership space, and the family may choose to switch its tenure choice for any of the reasons theory suggests. Additionally, an increase in the number of children (or a marriage with the anticipation of children in the near future) may push families to move to areas where owning is the sole method of consuming housing. Number of children in both the buy period and the period before are included to see changing ages or numbers of children have effects as well.

Rent paid in the sample year before purchase is included in the regression because it can serve as a proxy for preference for more expensive housing. Additionally, Hendershott et al's (1980) analysis shows how high rental costs are a frequent precursor of buying. Although much of the effect of rent is dependent on income, for any given income, people will be paying different amounts of rent. Those paying the highest amount of rent will be most likely to switch to owning, since changes that cause them to devote more income to housing will create more choices in the ownership space. An income rent interaction variable will be included to control for the existence of a possible cost-income threshold for renting.

A race variable identifying black members of the sample has been included due to the history of housing and mortgage discrimination against blacks in the United States.[12] Since loosening mortgage lending would be a major cause of the influx of new buyers into the market, one would expect the effect of being black to fall in the bubble period and perhaps even become slightly positive.

Finally, a debt variable is included to track fiscal responsibility. A massive influx of new buyers into the market would mean many who are less creditworthy than the previous cohorts of new buyers and therefore many more of them would be carrying higher amounts of debt.

II.B.3 Sell Model

The sell model is constructed in the same way as the buy model. As mentioned in the introduction, this paper will test whether the housing bubble has a larger supply

[12] Anderson, Jones (2002)

constraint element to it than previously suggested. Analyzing how the desire to sell changed during the bubble period is integral to determining whether a supply constraint really did occur. Once again, the expectation raised by the existence of a bubble is higher irrationality, suggesting falling predictive power of both the model as a whole and each of the individual regressors. The sell model will also be a logit regression, this time on the sellXX variable which is constructed in the reverse fashion from the buyXX variable. If the head owned a house in the first year of one of 1999-2001, 2001-2003 or 20003-2005 and did not own a house in the second year of that period, he or she is coded as a 1 for this variable. Otherwise, he or she is coded as 0. The regression sample this time contains all individuals who owned a home in the first years of the period.

II.B.4 Justification of Variables

The case for age in this model is weaker than in the buy model, since if nothing else, individuals must be older in order to have purchased the house that they will be selling. Still, age can be expected to have some effect on stability and equity within a home or the desire to sell due to falling demand for housing, as predicted in Venti, Wise (1984).

The sell model contains the same set of income variables as the buy model does, but the predicted effects of the variable are reversed. Again, income is included both for the year in which the family owned a home and the year the family did not. The inclusion of both sets of incomes captures the ability of the family to live on savings while hoping that their low income recovers, denial regarding circumstances or once again simply the transaction time it takes to sell a home. When mortgages are taken

out, the repayment is predicated on the maintenance of a certain level of income. Large, negative income shocks would make owners incapable of maintaining the payment on the mortgage and possibly force a premature exit from owning. Therefore, the Δ income variable is once again included

The number of children should have a somewhat ambiguous relationship with the decision to sell. Most strongly, as the number of children in the family unit decreases, the sell variable should be affected by the decision of empty nesters to sell their homes and switch to the cheaper renting options. However, an increase in the number of children, if it financially overtaxes the family, may cause them to have less money to spend on housing than previously expected, forcing them to sell. Just as marriage could be expected to drive families to own, an end to marriage, whether it is divorce or widowing, can be expected to drive families to exit owning. Not only does the loss of an income lessen the amount of money available to spend on housing, but the smaller number of people in the family unit lessens the preferred amount of housing for the family unit.

Although unemployment seems like an obvious choice, any substantial effects would be captured by the drop in income, and the proportion of unemployed individuals in the sample is so low that results would almost certainly be insignificant. Race is included because blacks may have trouble receiving refinancing or tapping into the lines of credit available to other homeowners if they run into financial difficulty. Debt is included because skyrocketing debts (such as those caused by an illness in the family) may eventually force the owners to sell.

II.B.5 Specification Analysis

In constructing models, it is important to determine whether they are properly specified. The first test of specification I employed was the Box-Tidwell test for determining non-linear specification in logit regressions. As with all specification tests, it does not yield the proper form, but does suggest when further thought needs to be put into relationships. Since the purpose is to evaluate the changing effectiveness of a model, only the 2001 Buy and Sell models were tested and the results were applied to each of the models used.

For the Buy model, the Box-Tidwell test shows that number of children and amount of debt do not have a strictly linear relationship with the dependent variable. Number of children, as previously suggested, may cause a strain on income above a certain point and force families out of being able to own, so a squared term is included. Amount of debt has a very small coefficient and will be rescaled in thousands for the actual regression. Including debt squared suggests that at high levels of debt, the probability of buying a house falls off even more quickly than a linear relationship would suggest, and this is the specification adopted. In the Sell model, none of the tested variables were significant so there was no modification to the functional form.

Next, I implemented the Davidson-McKinnon test to determine when log specification was proper for any variables.[13] I sequentially tested each of the variables considered as candidates for log specification: income, rent and debt. In each case, if the log model was significant relative to the non-log model, the log of the variable was included in all future iterations of the DM test. Although the model may be sensitive to

[13] Wooldridge

the choice of starting variable, this method yields more accurate results than independently testing each of the variables against the base model, since it tests against the most updated model. In cases where both models are significant, the unspecified model was kept to maximize the ease of manipulating the coefficients.

For the buy model, income in the current period and rent yielded better results when specified in logs. In the sell model, there was no specification that yielded unequivocally better results than the base model, but there was never a case where the base model was unequivocally better than the proposed change. Because of concerns of collinearity with the interaction variable, current year income will be expressed in logs.

II.C Descriptive Analysis

The main method for these tests will be an analysis of change over time for variables such as income, wealth, house size and mortgage size. In this analysis, I will mostly be employing a differences in differences approach, considering how the changes in variables over time differ between different groups of buyers, sellers and owners. I will also apply linear regressions to determine how the data generating process for important variables such as house value and mortgage principal changed during the housing bubble.

III. Tenure Switch Prediction Model

III.A. Buy Model

The purpose of the regression is to determine if a structural break from the previous process for tenure switch prediction occurred in the bubble period. If this is the case, the regressions predictive power should change. There is some evidence from

other analyses of the PSID data that the relationship between permanent income and housing value began to weaken in 2005.[14] Specifically, since the existence of a bubble connotes irrationality about the purchase of the asset, a model with theory influenced factors should have less predictive power in the bubble period. This should manifest both in the falling overall fit of the model and in the falling significance of its major predictors.

Buyers can be expected to be individuals just starting their lives, generally younger than the sample, and richer on average than the non-buying portion of the sample. In general, the profile of a buyer suggests an individual in his or her thirty's, recently married with one or more children.

Table 2 provides the marginal effects and standard errors for the each of the regressors on the probability of switching to owning in each of the three sample periods, as well as overall regression statistics. The model's overall strength remains fairly consistent over time, varying only slightly from year to year. Its percentage of correct predictions is weakest during the housing bubble, but only by a slight margin. The pseudo R^2 is actually higher during the period of increasing housing prices than before. These results suggest that it would be premature to conclude that the market for housing became irrational in the early bubble period: the econometric model fits as well as in the pre-bubble period. Changes in the values of individual predictors will show whether any structural breaks occurred.

[14] Stafford

Variable	2001 (SE)	2003 (SE)	2005 (SE)
Age	.0042*[15] (0008)	.0027* (.0008)	.0009 (.0007)
Kids (Lagged)	-.0242* (.0088)	-.0080 (.0093)	-.0123 (.0092)
Kids	.1027* (.0162)	.0137 (.0150)	.0287* (.0146)
Kids Squared	-.0203* (.0042)	-.0003 (.0033)	-.0030 (.0033)
Marriage	.1198* (.0257)	.0725* (.0258)	.1205* (.0298)
Income (Lagged) ($000)	.0049* (.0010)	.0035* (.0009)	.0017 (.0008)
Income (In Logs)	.0698* (.0156)	.1239* (.0180)	.1043* (.0137)
∆ Income ($000)	.0043* (.0009)	.0032 (.0009)	.0013 (.0007)
Lagged Rent (Log)	.0010 (.0036)	-.0086* (.0032)	-.0060* (.0030)
Race	-.0404* (.0138)	-.0364* (.0142)	-.0782* (.0135)
Debt ($0,000)	-.0062 (.0032)	-.0064 (.0038)	-.0032 (.0029)
Debt Squared	6.17x10^-8 (.0000)	6.43x10^-8 (.0000)	3.22x10^-8 (.0000)
Age/Income Interaction	-7.45x10^-8* (.0000)	-7.01x10^-8* (.0000)	-3.28x10^-8* (.0000)
Rent/Income Interaction	-7.4x10^-10* (.0000)	2.13x10^-11 (.0000)	-1.20x10^-11 (.0000)
Overall Regression Statistics			
Likelihood Ratio	370.62	394.43	372.68
P(Buy) (predict)	.1589	.1615	.1481
Pseudo R^2	.1193	.1280	.1256
N	3162	3063	3066

Table 2: Marginal Effects and Standard Errors for Buy Regressions

The effect of age does trend downward, with significant decreases between 2001 and 2003 and between 2003 and 2005. By 2005, age has ceased to be significant at all. Similarly, although the marginal effect of the Age/Income interaction does not lend itself to meaningful interpretation, it does drop by 50% between 2003 and 2005. This trend

[15] Asterisk indicates significance at the 5% level.

suggests that for any given income level, the effect of age in the house buying decision is halved and vice versa. The interpretation of these changes in age's effect on the home buying decision is that as the housing bubble began and intensified, the normal life cycle effects that would have pushed non-owners to owning weakened. It is unclear, however, whether this result suggests that more buyers came from outside the life cycle, or whether less individuals passing through the buy stage of the life cycle bought.

Income does not follow trends that would be expected if the housing bubble were the result of loosening lending standards and the decreasing rationality of home buyers. It is a significant variable in explaining the decision to buy a house in all three periods. Unlike the results predicted by the hypothesis of irrationality, income's effect rises significantly between 2001 and 2003 and does not change significantly between 2003 and 2005. A 1% increase in income would make an individual almost twice as likely to buy in the bubble periods as in the pre-bubble period. The effect of lagged income is only significant in the first two periods, and does decrease significantly from 2003 to 2005. This decreasing effect of lagged income combined with the rising effect of current income suggests that buyers or lenders traded off long-term stability for individuals with higher current incomes. By the bubble period, only income in the current period is a useful predictor. It would be hasty to conclude from the evidence of lagged income's falling significance that the housing market was expanded to individual's with less persistent wealth; the 2001 recession may explain the falling value of lagged income in both periods. Between 2001 and 2003, many potential buyers might have feared losing their jobs, so only those with high present incomes would have purchased homes, regardless of previous income. Between 2003 and 2005, many buyers might have seen

their incomes rebound and expected their new, non-recessionary level of income to be stable. If there were no strong pattern about who was affected by income loss in the recession, lagged income's predictive power would be diluted by random variations. At the same time, it is important to consider that the falling effect of lagged wealth does support the credit expansion hypothesis as well. Descriptive analysis in Section IV will consider how the lagged income of buyers diverged from the lagged income of potential buyers and the sample as a whole, to see if it was the case that the 2003 and 2005 buyer groups had less persistent income.

Although in all three cases marriage has a significant positive effect on the probability of purchasing a house, in 2003 that effect is almost 50% lower than in either of the other periods. This change also seems more plausibly explained by worries from the 2001 recession than by the effects of irrationality from the housing bubble. If the housing bubble were causing irrationality, the effect of marriage in determining buying behavior should be lower in 2005 as well, especially relative to other variables, instead of very strong. Instead, the effects of the recession should be interpreted as transferring the explanatory power of new marriage to income, due to concerns over future financial stability and the possibilities of higher unemployment for one of the two married earners.

The number of children in the family unit is hugely significant in 2001, with each additional child increasing the chance of buying by 10%, but barely important in the other two periods. Relatedly, the damping effect of children squared is only significant in 2001. Every child up to five provides an increased probability of buying a new home. This may be some evidence for increasing irrationality in the bubble period, but stronger

evidence for the irrationality would come from the number of children term continuing to have an effect, while the number of children squared term's significance fell off. This outcome would mean an expansion of the owner group to families with more children. The falling significance of children does suggest that much as in Hendershott's description of the 1960-1979 increase in house prices, an uptick in the number of single, childless buyers may be an explanation for rising house prices.

Most difficult to reconcile with the story of vastly expanded lending driving demand is race's effect on buying a house. Race is significant and negative in all three periods, but it has the largest damping effect in the 2005 period, twice that of its effect in 2003. Being black made a person significantly less likely to buy a house in the 2005 period than in either other period. This result should debunk claims that the Community Reinvestment Act is to blame for the sudden increase in house prices, but should also raise doubts regarding the general explanation of loosening lending standards driving the bubble. Former Federal Reserve Governor Edward Gramlich claimed that banks frequently found these CRA mortgages quite profitable.[16] If the negative effect of being black on home buying is actually increasing in the bubble period, this is evidence against traditionally marginalized groups being brought into housing.

Rent actually has a slightly negative effect on buying, but this should not be considered an indictment of the idea of a cost-income threshold. The highest paying renters will be residents of expensive urban areas, where buying is also far more expensive. Since these renters are not disaggregated from the model, they will be paying rents that anywhere else in the nation would put them on the buy side of the

[16] Stafford

cost-income threshold. However, in expensive urban areas, many of these high cost renters may still have incomes very far away from qualifying them for owning. This group will drag down the effect of a high rent on buying a house. The rent-income interaction variable is only significant in 2001, and approaches zero very quickly by 2005. This suggests that the any possible cost-income threshold evaporated in the recession and bubble periods. This may also reflect the imbalance of rent-price ratios developing in these periods.[17]

Overall, the buy model provides only ambiguous evidence for the hypothesis of changing constituents of demand driving the increase in housing prices. Race and income provide evidence of the contrary effect, that the ability to buy houses was not expanded to new groups. Age's falling effect suggests a structural break, but it is just as likely that life cycle effects were overwhelmed by the importance of income in later periods.

III.B Sell Model

In contrast to the uniform notion of what a home buyer looks like, individuals exiting ownership should be seen as having two possible sets of characteristics. One group will be those suffering from significant financial hardships and selling against their will. They should be expected to be younger and poorer with a high debt burden. The other group is individuals who are transitioning to a fixed income and changing to a living situation that better fits their new financial situation. For families with such an individual as their head, the expectation is that they would be older, richer and carrying a lower debt. In order to better understand the meaning of the coefficients, it will be

[17] US Federal Reserve Board (2004)

useful to see how the proportion of each of these groups among sellers changes. A simple if crude method of doing this is to consider the percentages of the sell group below 55 (individuals probably exiting ownership for financial reasons) and above 65 (individuals exiting ownership for life-cycle reasons.

Year	% <55	% >65
2001	83.3	14.3
2003	80.0	16.1
2005	91.3	5.8

Table 3: Age proportions among seller

The sell model has a much lower overall rate of predictive success than the buy model, while also having a much higher pseudo R^2. This pairing of results suggests that although the model does a good job of predicting when someone will sell, there is a large proportion of cases where individuals who would be predicted to sell by the model do not do so. Again, both measures of predictive power are fairly consistent across periods. Once more, analysis of individual parameter estimates will be necessary.

Age's negative effect is significantly higher in 2005 than in 2003, matching the descriptive fact that a far smaller number of retirees sold their homes than in earlier periods. In conjunction with the falling significance of the age-income interaction variable, this is strong evidence for the decreasing effect of the life-cycle on the sell decision during the bubble.

Variable	2001 (SE)	2003 (SE)	2005 (SE)
Age	-.0043* (.0003)	-.0037* (.0004)	-.0049* (.0005)
Kids (Lagged)	.0079* (.0040)	.0044 (.0034)	.0145* (.0039)
Kids	-.0203* (.0043)	-.0145* (.0037)	-.0237* (.0044)
Marriage Ends	.1665* (.0238)	.1176* (.0197)	.1840* (.0263)
Income (Lagged) ($000)	-.0013* (.0003)	-.0002 (.0003)	-.0000 (.0003)
Income (Log)	-.0413* (.0068)	-.0460* (.0051)	-.0415* (.0082)
Race	.0073 (.0073)	.0150* (.0068)	.0120 (.0066)
Debt	-4.32x10^-7 (.0000)	-1.67x10^-7 (.0000)	-7.15x10^-8 (.0000)
Age-Income Interaction	2.25x10^-8* (.0000)	-1.56x10^-9 (.0000)	-8.68x10^-9 (.0000)
Overall Regression Statistics			
Likelihood Ratio	1214.08	1123.67	1365.01
P(sell)(predict)	.0605	.0505	.0560
Pseudo R^2	.3355	.3278	.3390
N	5008	4965	5122

Table 4: Marginal Effects and Standard Errors of Buy Models

The effect of income in the later year is statistically indistinguishable between the three periods. Again, this result is somewhat problematic for the supply side hypothesis of housing appreciation, since that theory would suggest a falling importance for income in the decision to sell a house. Lagged income, however, does show a major drop both in significance and in the value of the coefficient between 2001 and the other two periods. Again, the recession's effect may be present here as individuals both in the recession and following the recession were less concerned about lagged income that no longer described their situation well. Alternately, this could mean that the sellers were more likely to be individuals with no expectation that their income would return to its previous level. Although retirees are one such group, their decreasing proportion in the

sell group suggests that they cannot be the reason for the change in the coefficients. Instead, the sellers would have been structurally unemployed heads or those suffering from major costs: in either case, a group of individuals for whom holding on to the house was no longer financially viable.

By far the largest influence on the decision to sell is the end of a marriage, either because of divorce or death. This is entirely expected, but its effect does increase dramatically between 2003 and 2005. This cannot be explained by dividing the sample by the way the marriage ended, as the split between divorce and widowing remains fairly unchanged through time. One possibility is that the higher payments necessitated by rising house prices made it more difficult for single earners to pay for the homes, forcing more sales than would have occurred in previous years. However, as later analysis will show, mortgage payments actually fell during the bubble period, despite the larger mortgages. Another possibility is that relatively younger people are much more likely to become divorced than relatively older ones, and the falling proportion of older individuals in the sample meant that a far larger proportion of sales in the sample were happening because of divorce.

The effect of children in the family unit on selling is negative for the current period but positive in the lagged period. This result is slightly unexpected: there is no reason to expect individuals with a high number of children in one period to be more likely to sell in the next period. One explanation is an empty nest effect. The difference in children is being captured by including the children variable for two periods, so a high number of children in the lagged period and a low number in the current period will increase the chances of selling over simply a low number in both periods. Individuals

with many children may want to sell their homes once the children leave to help finance college tuition expenses, pay down debts, or simply because with a smaller family, they prefer less housing space than they are currently consuming. The gap between these two numbers is largest in 2005, suggesting a stronger empty nest effect in this year than in other years, which opposes a supply constraint hypothesis.

Race's effect is only significant in 2003, but it is positive, as it is in the other two periods. The recession's effects seem to have hit blacks harder, since they have far less wealth on average than the sample as a whole. The percentage of blacks is constant across the sample and among homeowners, so it is not changes in this that shift the significance. Interestingly, as Table 5 shows, the non-home equity wealth of blacks actually falls between 2003 and 2005, despite the expectation that fewer sales would be coupled with more wealth. An alternate conclusion to be drawn is that blacks had a more difficult time with receiving refinancing requests and were given less forbearance by lenders before being foreclose upon.

Year	Non-Home Equity Wealth	% Owning
2003	17201 (51323)	24.6 (42.5)
2005	13708 (91059)	23.6 (43.1)

Table 5: Mean wealth and % ownership for blacks in 2003 and 2005

Overall, the sell model provides evidence for a pattern of less rationality in selling between 2001 and 2003, based on the decreasing effect of marriage ending and age, followed by a return to the 2001 patterns in 2005. This would be consistent with the housing bubble being driven to some extent by supply constraints. Fewer sellers in 2003 would have led to rising house prices in 2005, which in turn would have led to more sellers in 2005 causing falling house prices by 2007. Sell data do in fact match

this trend. Since the 2003 recession could be expected to lower incomes and push more people to exit ownership, sell rates should peak then. Instead, they are lower than those in 2001 and much lower than in 2005. This pattern suggests that some individuals who should have sold in 2003 did not.

Year	% of Sample Selling
2001	6.91 (25.37)
2003	6.63 (24.89)
2005	8.35 (27.67)

Table 6: Percent of Sample Selling by Year

IV. Individual Characteristics

The regressions predictive strength is not high enough for either buyers or sellers to safely use their predictions to describe the characteristics of "expected buyers" or "expected sellers". Such a definition would exclude too many actual buyers and sellers and include too many non-buyers and non-sellers. The regressions have, however, suggested a variety of different factors that did affect home buying behavior. Additionally, they have failed to rule out either a demand or supply based model of home price appreciation and have provided evidence that changes in both these factors had an effect on housing prices. The following section will evaluate the demographics, income and wealth of new buyers and sellers to determine whether there were changes in these factors that could have explained the housing bubble.

Demographic shifts may have affected the composition of the home buying cohorts. Growth in the number of people buying houses could have come from an increase in the proportion of the sample within the existing home buying group, or a

change in the home buying group's composition to include a broader segment of the sample. If the demographic composition of the buyers changes, this may lead to changes in preferences about what sort of houses are bought regardless of whether the demand for housing has increased. Changes in the proportion of the sample with the classical seller characteristics may reveal supply shifts as well. The demographic characteristics surveyed are the ones yielded as important by the regression: age, marital status and number of children.

IV.A Age

It is possible that many people buy at around a certain age, because of general life cycle effects. If there were a particularly large cohort passing through this period of life (as the Baby Boomers would have been in the 1970's) during the housing bubble, it would explain the increase in prices. The mean age for buyers in all three periods is 38 years old with a standard deviation of 12. Therefore, if the 26-50 portion of the sample increased between 2001 and 2005, it would help explain the increase in housing prices. It might also be expected that if the proportion of buyers under 35 increased, this would be evidence for the younger group that generally buys less switching their behavior. As in Hendershott et al. (1980), this could be expected to drive up house prices.

Year	% in Sample	% of Potential Buyers	% Buyers <35
2001	60.84	73.74	46.66
2003	58.27	74.39	45.18
2005	57.19	74.46	47.38

Table 7: Proportions within 26-50 age group

Table 7 shows that a change in the composition of age cohorts buying houses cannot be the cause of the increase in the demand for houses either. Although the mean age for house buying remains unchanged, the percent of people in the sample

who are members of that age cohort actually falls off through the sample, reflecting its aging. However, the shrinking cohort constitutes a fairly similar proportion of the potential buyers in the sample throughout each of the sample years, so no other group could be expected to start buying in larger numbers. This is further confirmed by the stable number of buyers under 35 in each of the three periods. Changes in age based life cycle effects cannot be the cause of a demand side increase in housing prices.

Table 3 showed that the distribution of seller ages began to skew downward in 2005 as the number of heads over sixty-five dropped by two-thirds. However, sellers as a proportion of the sample rose quite a bit in the same period. Before there can be a valid claim of a supply constraint, it is important to determine whether the number of sellers in the over-65 group fell or whether they were simply overwhelmed by the influx of new sellers seeking to cash out of their appreciating homes. The simplest method of determining this is to see whether the proportion of those 65 and older selling fell.

Year	% Selling	House Value[18]	House Value, All Sellers
2001	9.11	123216.7 (257177.5)	102768.8 (122529.7)
2003	9.01	156949.5 (140668.3)	130674.4 (124274.2)
2005	3.89	162897.7 (183804.8)	142256.6 (154949.2)

Table 8: Proportion of and mean house value of over 65 sellers

The descriptive analysis shows that even as the proportion of sellers in the sample increased drastically, the number of over 65 heads selling fell by over 50%. These statistics suggest a supply constraint on the sorts of houses that older heads would own. As Table 8 shows, the houses owned by the 65 and over sellers are on

[18] For the sample year before

average $20000 more expensive than those owned by all sellers (and so even more expensive than the houses of the remaining non-over 65 sellers). This outcome provides some evidence for a supply constraint: not all houses are created equal, and the over-65 sellers would be one of the main sources of supply for more expensive, desirable housing. Their failure to sell in consistent numbers would have limited the number of more expensive houses on the market, causing them to appreciate more quickly. The 2001 house values for the 2003 cohort roughly match the average 2001 home value, whereas the 2003 house values for the 2005 cohort of sellers are much lower than the average house values for 2003. The simplest explanation is that the over-65 heads who did sell were the generally the poorest ones with the lowest value homes. Therefore, the supply constraint on more expensive houses may be even more extreme than the data suggest.

IV.B Family Variables

If the proportion of the sample getting married increased, then the pool of likely buyers would as well and demand would rise. Alternatively, if the proportion of the buyers in the sample getting married changes radically in either direction, it will be evidence that the composition of the whole sample has changed and that comparisons with earlier periods are invalid.

Year	% Newly Married	% Newly Married Buyers
2001	6.28	20.88
2003	6.40	20.86
2005	6.16	22.00

Table 9: Proportion of sample and buyers getting married

As Table 9 shows, the proportion of the sample getting married remains stable over the entire period surveyed, providing no evidence for increasing demand. The

proportion of newly married buyers within the sample also remains fairly stable, increasing by just more than 1%, suggesting that the composition of the home buying group remains mostly unchanged as well.

A fertility boom may have similarly driven more people into owning. If the average number of children per household rises significantly between the sample periods, it would suggest an increase in the demand for larger living spaces and an increase in potential buyers, the result of which would be a rising demand for houses, particularly the larger, more expensive ones. This effect may also be localized among potential buyers.

Year	Children in FU	Children in FU, Potential Buyers
2001	.99 (1.22)	1.06 (1.28)
2003	.91 (1.18)	1.00 (1.26)
2005	.87 (1.15)	.93 (1.22)

Table 10: Mean Children in Sample and for Potential Buyers

Reflecting the general aging of the American population, the number of children in the average family falls in all 3 periods. This is not just a result of the population's aging. As analysis has shown, the mean age of buyers remains constant, but the number of children in the potential buyer families also decreases. The demand for more housing cannot be based on rising numbers of children.

Previously, the sell regression showed an empty nest effect where a decrease in the number of children was stronger than the effect of number of children alone. If the proportion of owners experiencing an empty nest fell or the proportion of empty-nesters deciding to sell decreased, then there would be evidence for a supply constraint on

housing prices, especially since the empty nesters would be the sellers expected to hold the highest value houses.

Year	% Empty Nesters Selling	% Sellers who are Empty Nesters	House Value[19], Empty Nesters
2001	16.68 (37.28)	29.56 (45.66)	117613 (110697.2)
2003	14.85 (35.56)	30.50 (46.08)	141098.1 (166730.6)
2005	10.83 (31.07)	26.09 (43.95)	176062.4 (210185.5)

Table 11: Proportion and house value statistics for empty nesters

The difference is not statistically significant but the proportion of empty nesters selling does drop by over 33% between 2001 and 2005. However, the proportion of sellers who are empty nesters does not drop by such a large amount. In 2005, the drop off in empty nesters as a proportion of the sample may reflect the increasing number of sellers as much as the decreasing number of empty nesters selling, especially because the regression shows the empty nest effect is at its strongest in 2005. On average, empty nesters owned more expensive houses than other sellers and than the sample mean (recalling that the house values for the 2005 sample are from 2003 and so on), suggesting that the dropping proportions could have lowered the number of expensive houses on the market.

IV.C Income

Another factor in the regression that could a demand side drive bubble is income. The most natural explanation would be a rise in real national income, which Baker (2006) notes did not happen. However, as this paper has stressed, changes in the

[19] House value is for previous sample year

actual and potential buyer pool may occur independently of changes in the sample and could provide an explanation of rising home prices.

Major increases in the income of either the sample or buyers would provide strong evidence for a non-bubble explanation of housing price appreciation. If the average buyer income does not decrease then it will be difficult to accept the credit expansion theory of the housing bubble. If buyer income remains fairly stagnant, then there will be evidence that irrationality was present, since house prices rose without a commensurate increase in income, but the explanation will not be income's effect. Seller income is also important to consider; major changes will be evidence for a shifting income composition in the sample and a supply constraint on some group of houses.

Year	Sample Income	Buyer Income	Seller Income
2001	58161.79 (72544.34)	60523.69 (75349.56)	35886.2 (39083.24)
2003	54475.47 (75579.21)	56588.01 (43191.92)	36095.94 (49397.61)
2005	54999.35 (90324.81)	58009.4 (72987.23)	35365.37 (32217.98)

Table 12: Incomes for selected groups

Income does not change significantly across the various periods. Overall, the sample is slightly poorer, confirming within the sample the fact that the US population did not grow richer in the 2000's. Although the buyers are also poorer in 2005 than in 2001, they are actually slightly better off relative to the sample population, providing further evidence against the credit expansion hypothesis. The sellers see no change in their average income over time, suggesting that the decision to exit the housing market is more closely tied to a specific real threshold at which owning is no longer feasible than to general macroeconomic conditions. However, this again provides some

evidence for a potential supply constraint: more owners would have fallen below this threshold in 2003 than in the other two years, but the sell rates are the lowest in that year, an unexpected pairing of results.

The increased concentration of individuals within the sell threshold can be tested by inspecting the income distribution of the sell group. Similarly, a large concentration of potential buyers at the main income levels for buyers could drive up house prices. Finally, house prices could be driven up if many high income buyers entered the potential buyer pool. A quick inspection of the histogram distribution of each year (Chart 2) suggests that a range from $45,000 to $75,000 will yield good results for the buyers, and a cohort from $25,000 to $45,000 will provide the proper range for sellers. High income buyers will be those with incomes above $75000.

Year	% Potential Buyers	% Potential Sellers	% High Income Potential Buyers
2001	19.4 (39.5)	22.0 (41.4)	43.7 (49.6)
2003	10.8 (31.0)	23.4 (42.3)	42.3 (49.4)
2005	20.1 (40.1)	23.5 (42.4)	41.2 (49.2)

Table 13: Percentages of potential buyer and seller pool in average and high income

As Table 13 shows, the income proportions of buyers and sellers remain fairly stable. In both cases, any changes are almost certainly a reflection of the slightly lower average income level. Although current year income has a great deal of predictive power in the house buying model, it provides little insight into where the new demand for houses came from.

The regression showed that lagged income had a falling effect in both the buy and sell prediction models. For persistent income to become less important and the

bubble irrationality story to be supported, buyer lagged income will have to fall. For the supply constraint theory to be supported, seller lagged incomes should fall, demonstrating a decreasing number of well off sellers.

Year	Buyers	Sellers
2001	44694.88 (46206.95)	62803.98 (58327.02)
2003	45966.3 (38440.42)	70749 (87873.08)
2005	43479.34 (48437.13)	56406.34 (57787.19)

Table 14: Lagged income for buyers and sellers

For the bubble buyers, the effect of lagged income remains fairly stable. This outcome suggests that in general, buyers follow a fairly consistent life path, and this income path was not changed by the housing bubble. The results for sellers most strongly match the general macroeconomic conditions. This, coupled with the earlier result that seller mean income remained constant across periods, suggests that sellers are likely to be pushed into their decision based on crossing some personal threshold for selling, and not on persistence of income. This also explains the falling effect of lagged income in the regression, as it fluctuated wildly between periods. The major decrease in income for the 2005 cohort of sellers supports the developing hypothesis that these sellers were poorer on average than sellers in the other two cohorts.

Overall, income did not seem to have effects either positive or negative on home buying behavior. The demand for houses was not increased by an expansion of the income levels capable of buying a home nor by an increase in the proportion of the sample at the income groups that previously predicted the home buying transition. Similarly, selling behavior seems tied to the attainment of a certain income level, the proportion of which did not change across years. Evidence from lagged income,

however, does suggest a supply constraint as wealthier owners sold in lower numbers than usual.

IV.D Wealth

Although tenure choice models classically focus on income, Jones (1989) has suggested that current wealth is the proper variable to consider for the decision. An expansion of mortgage credit and decreasing down payment requirements that ignored the low assets backing some buyer's income could explain why the income dynamics did not reveal anything different about the new buyers. Similarly, since different groups of people exit the housing market at different stages in their life cycle, an analysis of changes in seller wealth may provide some insights into the shifting composition of sellers that was not present in the demographic or income analysis.

Year	Sample Wealth[20]	Buyer Wealth	Year on Year Change
2001	116771.6 (288340.4)	42818.7 (144286.2)	--
2003	109952.7 (273092.3)	52209.95 (159074.3)	8391.25
2005	99510.78 (250967)	75519.08 (224590.9)	23309.13

Table 15: Mean wealth and year to year change for buyers

Table 15 provides data confronting the claim that the refusal by mortgage lenders to verify borrower assets made any difference in expanding the pool of individuals who purchased housing in 2005. Instead, the non-home equity wealth of buyers in 2005 has gone up by over $23,000 from 2003. Meanwhile, the overall wealth of the sample has been falling from year to year, declining over $17,000 between 2001 and 2005. The falling overall non-home equity wealth in the sample coupled with the high non-home

[20] Truncated at 2 standard deviations above the pre-truncation mean

equity wealth for the buyers suggests several possible explanations. First, homeowners may have been shifting more of their wealth into housing as the bubble caused prices to increase, matching Case, Shiller's (2003) hypothesis. Therefore, the drop in non-home equity wealth is not evidence for a poorer America, but rather for a population that has changed its preferences for wealth allocation. Table 19, however, will show that mean owner non-home equity wealth actually rose. It could also be the case that growing wealth inequality mostly affected poorer individuals who previously would have decided to buy and caused them to drop out of the housing market. Table 17 shows the lack of confirmation for this hypothesis. Alternately, it is possible that first time homebuyers became wealthier for other reasons unrelated to general wealth dynamics in the United States.

The most salient unrelated reason is the real estate market itself. If these buyers had held equity in real estate other than their primary home, this would appear in the PSID's calculation of their total non-main home equity wealth. Since the housing bubble was marked by increased real estate speculation, a plausible reason for the increased wealth is the rising value of investment real estate.

Year	Other Real Estate-Buyers	Year on Year Change	Other Real Estate-All	Year on Year Change	Difference
2001	8424.39 (48714.55)	--	90432.51 (162823.6)	--	
2003	9033.15 (43748.69)	608.76	70144.6 (125139.5)	-20287.91	20896.67
2005	22613.93 (103157.3)	13580.78	123751.8 (233257)	53607.2	-40026.4

Table 16: Non-main home real estate and changes, buyers and all

The increase in real estate wealth for new buyers explains more than half of the disparity in wealth between the 2003 and 2005 cohorts. Although this is a substantial

portion of the wealth, the 2005 buyers still remain much better off than those in previous years, with over $10000 more in non-home equity wealth at their disposal that remains unexplained. Additionally, real estate provides no explanation for the diverging wealth between buyers and the rest of the population, since average gains from real estate were much higher for the general population than for buyers. One possibility is that many owners managed to turn their home value gains into new real estate through refinancing, so gains in real estate were cancelled out by increases in mortgage debt.

As mentioned, the increase in home buyer wealth may hide diverging wealth within the sample as a whole, as some extremely wealthy buyers mask a swelling bottom tier. Determining this would require setting a benchmark for low wealth and analyzing how the proportion of buyers below it has changed over the sample years. One reasonable standard is to consider those people who were already in debt (e.g. zero or negative wealth) when they purchased their house. This is the group of people with the least protection against negative income shocks or sudden increases in costs, making them the riskiest group receiving home loans. A higher proportion of the population with such low wealth in 2005 would provide evidence for a two-peaked distribution of buyer wealth.

Year	% of Sample	Mean Wealth	% with Mortgage
2001	20.88 (40.68)	-14394.86 (28888.16)	72.66 (44.75)
2003	18.85 (39.14)	-14307.01 (17742.41)	75.57 (43.13)
2005	18.46 (38.83)	-15549.81 (18949.12)	70.00 (46.01

Table 17: Statistics regarding insolvent home buyers

The histograms in Chart 3 show that a smaller percentage of buyers had zero or negative wealth in 2005 than in 2001, and that in general, a smaller proportion of buyers had low wealth in 2005. Table 17 confirms that the proportion of low wealth buyers has fallen. Although the drop is not significant, it should show that there is no evidence for the alternative hypothesis that more low wealth buyers were let into the housing market in 2005. It is also not the case that the low wealth buyers became substantially poorer or that a larger percentage of them received mortgages in 2005 than in other sample years. Also interesting is that almost one fifth of all buyers in each of the three years considered had negative assets and a consistent proportion of those received mortgages. This result means that home loans to low asset individuals were not a new practice during the housing bubble.

An increase in the proportion of wealthy buyers in the sample could also have led to a top down increase in the price of houses. More high wealth buyers would have demanded expensive houses from a short-term stable supply. The high wealth buyers who were outbid the most expensive houses would have been willing to overpay for less expensive houses, driving those who would normally have purchased those houses into less expensive houses, for which they too would have been willing to overpay. This explanation for house price appreciation will be worked out in greater depth in Section V. Such a cascade would require a higher proportion of high wealth buyers in 2005 than in 2001. High wealth buyers in all three periods are defined as those buyers with more wealth than the mean buyer in 2001.

Year	% High Wealth Buyers	Mean Wealth of Potential Buyers
2001	11.53 (31.93)	33964.65 (264937.5)
2003	11.48 (31.89)	28817.977 (194016.8)
2005	8.95 (28.56)	32187.19 (194904.5)

Table 17a: High Wealth Buyers

The proportion of high wealth buyers in the sample drops slightly, though not significantly, in 2005, matching the decreasing wealth of the overall sample better than the rising wealth of buyers. Since the mean wealth of buyers has increased, the average buyer in the high wealth group must be wealthier in 2005 than in 2001. In general, the distribution of wealth remained about the same across periods, with 75% of it occurring in the $0-$57000 range. The distributions in Chart 3 show, however, that the wealthiest 9% of buyers in 2005 were, individually, much wealthier than the wealthiest 12% in 2001 and 2003. It is also not the case that the increase in buyer wealth reflects a wealthier potential buyer pool creating more competition for homes at the midrange level. The mean wealth of potential buyers drops slightly in 2003 and returns only to parity with 2001 in 2005.

Investigating the wealth of sellers can show whether sellers are selling their homes to defray debts, or whether they are cashing out of their homes to gain wealth. The wealth of sellers should be much lower than the wealth of those who continue to own during the same period. If the disparity in wealth of the two groups falls during the bubble period, it will be evidence that people are cashing out of their rapidly appreciating homes, whereas if the disparity in wealth rises, it will suggest that only those people who are in truly dire straits are willing to sell their homes.

Year	Owner Wealth	Seller Wealth	Difference	Lagged Seller Wealth
2001	205825 (303667.4)	36567.51 (194015.1)	169257.5	185052.4 (471908.5)
2003	206229.1 (300844.4)	42928.42 (225065.3)	163300.7	164462.1 (445395.8)
2005	247977.1 (356631.7)	51784.57 (267915.4)	196192.5	142778.7 (378334.8)

Table 18: Wealth for Owners and Sellers

Owner non-main home equity wealth grows faster than the corresponding seller wealth between 2001 and 2005, but seller wealth still increases with every year. What this reflects is the increasing value of home prices. However, there is a large gap between the increase in the value of the sellers' homes from Table 8, and the increase in seller wealth. This difference suggests that the financial hit necessary to cause an individual to sell was worse in each subsequent period, costing them a larger proportion of their accrued home wealth. Alternately, it could mean that the average seller was shorter tenured in the later periods and had less accrued equity. Looking at the lagged wealth shows another interesting trend. Over time, despite consistent increases in overall owner wealth, those people who would eventually sell became a poorer group. In every period, these people were much poorer than the average owner, but this divergence became more pronounced over time, as the average wealth of sellers falls. This compounds the suggestion that only the most marginal owners sold between 2003 and 2005.

The changing wealth of home buyers and sellers does provide some interesting outcomes for consideration. The much higher wealth of the 2005 buyers should firmly discredit the expansion of credit to less qualified buyers as a reason for the original appreciation of house prices. The wealth patterns instead suggest the concentration of

wealth at the top among buyers. Similarly, the patterns of wealth among sellers further reinforce the notion that the owners of the most expensive homes refused to sell. The combined result of these two observations would be a rising demand and falling supply for the most expensive houses. The next section will treat this insight and search for evidence of this phenomenon.

V. Housing Market Characteristics

An in-depth analysis of the demographic and financial variables of home buyers and sellers has provided some evidence that the major movements in the prices of homes came from the top of the home price distribution. It will be useful to determine whether the shift actually happened, and whether it was the result of changing preferences regarding some specific location, size or quality variable. A change in preferences, coupled with the already noticed supply constraints, can provide a strong, plausible explanation of the mechanics that started the housing bubble. Additionally, no discussion of the housing market can be complete without an analysis of how the mortgage market changed the individual decision of how much housing to consume.

V.A Geographical Clustering

As Case, Shiller (1989) mentions, shifts in supply and demand cannot be expected to affect all areas equally. In particular, consideration of changing house prices based on urban and regional geography can provide some evidence regarding whether house prices appreciated evenly or if location-related factors had a strong influence on increasing house prices.

The Beale-Ross Urban-Rural Continuum provides an excellent breakdown of density based on United States Census metropolitan region classifications. Lower numbers reflect greater proximity to a larger metropolitan area. If supply constraints had any effect on increasing housing prices, home values should appreciate more rapidly in areas with less available space to develop: here, increasing demand will not necessarily be met by increased housing starts.[21] Coupled with the already visible trend of high end homeowners cutting back on sales, this may provide some of the impetus for the increase in housing prices. Particularly in counties with the 1 classification, new housing starts will not be an option for increasing housing supply, so if supply constraints do exist, they should be most apparent there.

[21] The Beale-Ross code values mean:
1: (central counties of metro area with 1M or more people)
2:(fringe counties of metro area with 1M or more people)
3: (counties of metro area with 250K to 1M people)
4:(counties in metro areas with less than 250K people)
5:(Urban population of 20K or more, adjacent to metro area)
6:(Urban population of 20K or more, not adjacent to metro area)
7:(Urban population of 20K or more, adjacent to metro area)
8:(Urban population of less than 20K, not adjacent to metro area)
9:(Completely rural population, adjacent to metro area)
10:(Completely rural population, not adjacent to metro area)

Beale-Ross Number	House[22] Value 2001	House Value 2003	House Value 2005	2001-2003[23] Difference	2001-2005 Difference
1	171887.57 (128879.03)	196168.17 (153224.97)	260140.49 (225503.36)	24280.6 (14.1%)	63972.32 (32.6%)
2	199688.75 (122537.38)	231333.94 (153155.31)	291655.57 (217149.54)	31645.19 (15.8%)	60321.63 (26.1%)
3	124889.49 (97143.59)	142543.99 (124019.44)	183947.03 (193945.89)	17654.5 (14.1%)	41403.04 (29.0%)
4	131293.05 (93653.74)	145781.68 (114111.19)	178963.6 (153511.15)	14488.63 (11.0%)	33181.92 (22.8%)
5	134518.01 (102647.55)	149196.19 (118882.33)	180242.63 (169502.99)	14678.18 (10.9%)	31046.44 (20.8%)
6	97627.84 (85608.51)	117437.46 (114087.88)	145861.02 (168623.04)	19809.62 (20.3%)	28423.56 (24.2%)
7	102735.44 (96192.37)	114275.35 (119181.37)	144229.51 (198488.26)	11539.91 (11.2%)	29954.16 (26.2%)
8	100800.32 (108868.55)	108724.88 (137388.05)	154781.93 (223773.85)	7924.56 (7.9%)	46057.05 (42.4%)
9	128301.89 (86729.90)	149500.63 (147053.81)	158866.15 (175473.78)	21198.74 (16.5%)	9365.52 (6.3%)
10	88727.375 (103041.21)	97428.333 (116302.79)	129600.55 (177593.8)	8700.96 (9.8%)	32172.22 (33.0%)
Total	142613.42 (115499.46)	162260.04 (142264.9)	210143.03 (210508.24)	19646.62 (13.8%)	47882.99 (29.5%)

Table 19: Average House Values by Beale Classification

The rise in housing prices is much higher in absolute terms in the two most densely populated zones than in any of the others. In percentage terms, the most densely populated urban zone sees prices appreciate at an above average rate as well. As Chart 4 shows, the increase between 2003 and 2005 is much larger than the increase between 2001 and 2003 for these zones in both percentage and absolute terms, and much higher than the mean absolute increase for all house values. Since these areas had the highest home prices to begin with, this matches the previous conjecture that housing prices appreciated most for the most expensive houses. The regression results in Table 24 will show that the premium to living in one of these two

[22] All house values truncated at 97th percentile

[23] % Change in parentheses

areas remained constant between 2003 and 2005, so the increase must have come from another factor. This factor is the decreasing willingness of high-value homeowners in these regions to sell their homes.

Beale Code	Value 2001[24]	Value 2003	Value 2005
1	138258.04 (159783.59)	195082.23 (250710.92)	188047.13 (233557.91)
2	152867.92 (125215.97)	191835.7 (219583.32)	190276.68 (208025.19)
3	81875.373 (58462.706)	125570.23 (174953.28)	162245.99 (244029.16)

Table 20: Average Value of Sold Houses

2003 sellers in all three zones shown in Table 20 owned homes that roughly matched the average home price in 2001. However, the 2005 sellers in the more urban zones did not have any gains from the 2001-2003 regional appreciation, particularly in the 2 classification. Not coincidentally, home price appreciation between 2003 and 2005 was highest within this zone. In 3, however, the average 2003 home price of 2005 sellers was actually higher than the average 2003 price for the region, and increased by more between 2001 and 2003 than the average increase for the zone. This suggests that the sellers selling in 2005 had less expensive homes than average, unlike the sellers in previous years. This matches the previous insights from the wealth analysis about steadily decreasing seller wealth. Because the stagnant or falling seller value occurs in the areas where house prices appreciated the most, there is further evidence that the top of the seller market, the oldest and wealthiest owners, chose not to sell between 2003 and 2005, constraining the supply of expensive houses and driving up the cost of housing.

[24] All house values are actually for previous sample year.

Analyzing regional geography can provide some clues regarding the role of supply constraints as well. The South and West saw the highest proportion of population growth over the last few decades, so a demand based theory would predict higher price appreciation there.[25] A theory with a stronger supply component would predict house prices to appreciate more strongly in the Northeast, since it is quite built up and population growth there has been stagnant over the housing bubble period. The regional divisions used are the Census Divisions that divide the country into four regions.[26]

Region	2001 Value	2003 Value	2005 Value	01-03 Difference	03-05 Difference
Northeast	180260.1 (128687.44)	220950.03 (163394.09)	278912.63 (229428.05)	40689.93	57962.6
North Central	126139.17 (95895.14)	139766.98 (115928.03)	166938.34 (170162.17)	13627.81	27171.36
South	114028.42 (107391.64)	129027.66 (128523.34)	174968.42 (205340.2)	14999.24	45940.76
West	201662.45 (127057.81)	227825.87 (154574.36)	301203.68 (218822.85)	26163.42	73377.81

Table 21: Price Appreciation across Regions

Despite the Northeast's low population growth, it saw higher house price appreciation than the far faster growing South in both 2001-2003 and 2003-2005. All four regions exhibit higher price appreciation in the bubble period than in the non-bubble period, but it is apparent that those who lived in the South and West were most susceptible to the bubble's effects, whereas the increase in housing prices in the Northeast appears to be a longer-term trend than the bubble. Therefore, regional geography provides evidence for the demand side aspect of the housing bubble being driven by population inflows into the West and South.

[25] http://www.census.gov/popest/states/NST-pop-chg.html

[26] Alaska and Hawaii constitute a fifth region but are omitted due to low sample size and dissimilarity

V.B Rental Costs

Hendershott et al. (1980) showed that rising rental costs played a large factor in driving more individuals into the housing market during the 1960's and 70's. If a similar effect were visible as the bubble began to inflate, it might explain part of the demand for more expensive homes on the part of buyers. In particular, since later analysis will show that monthly mortgage payments fell, the combination of rising rents and falling mortgage payments could provide a powerful incentive for the decision of higher income renters to switch into buying. Although the price-rent ratio increased dramatically over the period of the housing bubble, this does not mean that rents actually fell, only that housing prices appreciated even more rapidly.[27] An increase in rents over the course of the periods would be a potential cause of the housing bubble. As always, this effect may be localized among the buyer population, pushing them in particular to buy more expensive homes.

Year[28]	Sample Rent	Buyer Rent	Number of Rooms
2001	445.35 (246.03)	438.25 (289.29)	4.95 (3.52)
2003	480.28 (293.75)	585.27 (449.80)	4.53 (1.54)
2005	483.50 (298.99)	572.45 (431.93)	4.50 (1.76)

Table 22: Rents and Rooms for Buyers

Rents increased slightly for the sample between 2001 and 2003 while holding flat between 2003 and 2005, while the rent paid by future buyers rose by a substantial margin between 2001 and 2003. Buyer rents go from being roughly equal to sample rents to being somewhat higher. Recalling that the income and wealth dynamic does not

[27] http://www.frbsf.org/publications/economics/letter/2004/el2004-27.html

[28] This is the buy year of the cohort. The rents and number of rooms are actually for the previous sample year

change between 2001 and 2003 rules out the possibility of wealthier buyers entering the sample. Instead, it must be that either the buyer cohorts in 2003 and 2005 had preferences for more expensive housing or the places where potential buyers tended to live became more expensive. The average number of rooms provides some proxy for the level of housing services consumed and it actually decreases as rent rises. This suggests that the places where the eventual buyers lived saw rents rise during the pre-bubble period. The tenure choice regression results show that rising rents should actually drive down the chance of buying, but again, this is the result of particularly high paying renters living in very expensive to driving down the chances of a high-paying renter buying.

This increase in rents provides a reason for the increasing willingness of new buyers to consume more expensive homes. A $100 rise in monthly rent should yield a willingness to pay of at least $100 more per month in mortgage payments, and likely more, since the mortgage payment money will be viewed as an investment. Over the life of a 30 year mortgage, this would lead to a willingness to take on at least another $36000 in debt, before factoring in elements such as discount rates and natural preferences for owning over renting. With falling interest rates, much of this could have been translated into increasing the principal of the mortgage and buying a more expensive home. Rising buyer rents provide a rational, overlooked reason for the willingness of new buyers to purchase more expensive homes.

V.C House Size/Quality

As the analysis continues, it seems increasingly clear that the majority of house price appreciation came from the factors influencing the prices of the most expensive

houses. The next question is whether buyer preferences also changed during this time. Did buyers desire larger, more expensive homes on average, or was the price increase a result of the supply constraint previously mentioned? A consideration of house size and quality, including a regression analysis of how the determinants of house value change across the three years will be executed in this section to answer this question.

The shift in the distribution of house prices between 2001 and 2005 provides support for the hypothesis that a major driver of the housing bubble was an increasing premium for larger, more expensive houses. The percentiles below and Chart 6 show that the increases in mean home value are mostly driven by increases in the higher percentiles, particularly due to the distribution's fat right tails, rather than by a uniform shift of the distribution.

Year	25	50	75	90	Kurtosis
2001	64150.95	108490.6	179245.3	320754.7	4.588
2003	68181.82	118181.8	204545.5	363636.3	5.281
2005	77586.21	137931	258620.7	493534.5	6.046

Table 23: Selected percentiles of housing prices

The increase in the median home price is much smaller than the increase in the mean. The major increase in home price comes from the 90% and above values, where the rise between 2003 and 2005 is twice the mean increase. This contrasts with the increases between 2001 and 2003, which are much more uniform across the distribution. Expensive homes accrued in value more quickly than less expensive homes, reinforcing the importance of exploring how consumer preferences for factors such as size and quality may have affected the price of houses. A possible test of how bubble related this growth was can arise as housing value data for 2008 becomes

available. It will be possible to test the erosion of value for smaller houses as opposed to bigger ones.

Once again, number of rooms is used as a proxy for house size, since there is no variable available for dwelling square footage. This assumption does not cause too much loss in fine-grainedness over alternatives, because as Goodman (1988) notes, the housing stock is lumpy, even for square footage. If it is the case that buyers have preferences for bigger houses, the number of rooms in the house of the average 2005 buyers should be higher than the average number of rooms in the houses of buyers in earlier years. As already shown, the buyers did not have strong preferences for a larger number of rooms prior to buying, but this may have reflected constraints in available dwellings and high rental costs more than preferences, in which case buying might lead them to buying homes with more rooms.

Year	Owners	Buyers
2001	6.63 (1.89)	6.03 (1.75)
2003	6.65 (1.96)	6.12 (1.91)
2005	6.62 (1.99)	5.97 (1.87)

Table 24: Mean Number of Rooms

Table 24 shows that the average number of rooms in the sample has remained constant across years, providing weak evidence for a change in preferences toward bigger houses. Buyers bought houses with slightly fewer rooms than the mean-owned house, which could reflect either smaller houses or shifting consumer tastes. Therefore, the preferences of buyers relative to the general owner population also appear not to have changed. This result rules out the purchase of larger homes as a factor in the

rapid housing price appreciation (overturning another commonly attributed cause of the housing bubble).

This conclusion alone, however, cannot prove that buyers did not value larger rooms more. In the short run, the supply of houses is fairly inelastic, so the average number of rooms will not change. Even if the demand for larger houses and more rooms increased, the limited number of larger houses and more rooms would prevent the data on average house size from reflecting this change. To determine whether changing preferences for larger or higher quality homes did have an effect on housing prices will require an explanation of how the premium for the most expensive houses would have trickled down into the entire market and a linear regression to test both the effects of house size and the theory explaining its effect.

Although the income profile of new home buyers is the same throughout each of the three years, a change in preferences for larger, more expensive houses would raise the average price of all houses. Individuals have specific preferences for house size and cost based on family size and exogenous preferences for living space and house quality. Rising demand in the short run inelastic market for large houses would squeeze some buyers out of the market for houses of a particular size. Since the buyers would prefer and can afford houses as close to this size as possible, they will be willing to pay more for a slightly smaller house than someone whose natural preference and income level match a house of that size. This effect would be repeated at each tier of houses, forcing the buyers with the weaker preferences for house quality or with less money down into the next tier, where they would inject extra money into the market and raise house prices. An increase in competition over the largest, most expensive house could

have cascaded throughout the entire housing market by this mechanism, raising housing prices across the board. Since the number of lower tier houses will be larger, this appreciation could be expected to be more diffuse at lower price levels, explaining the asymmetrical increase of house prices near the top.

This theory can be tested by a regression on the effect number of rooms has on house value in each of the three periods. It will be important to only use the house value of owners who lived in the same house for both years, in order to ensure that the number of rooms has not changed, or they have not moved to a location where the premium on rooms is different. Since the moving variables in the PSID will only capture individuals who moved over the period of a year, and the samples are separated by two years, using the move variables to ensure the regression sample consists of owners who occupied the same house will not be possible. Instead, the regression is restricted to those heads who lived in the same state and Beale type for both the sample year prior to the regression year and the regression year. This way, even if the owner moves, the characteristics determining the premium to house size will not change.

House size is not the only characteristic that makes houses more expensive: location and quality are also important. Location will be controlled through dummy variables for residency in large urban areas (Beale 1 and 2) and the West, where prices were previously shown to appreciate the most. House quality is a difficult metric to operationalize, since it is subjective. Any specific factors selected will be open to debate and unduly bias possible results. One reasonably neutral method of determining the quality of a house is by assuming that it is already incorporated into the house's price. Therefore, as a measure of house quality, this regression will use the price of the

house from the previous period and interpret the coefficient as the residual value placed on aspects of the house not explained by location and size. If the price of the house in the last period becomes an increasingly important predictor of the price in the regression period, it will show that the qualities that are valued in a house are becoming more valued. To test the theory that the premium was most extreme for the highest quality houses, the square of housing value is also included. Positive values for this variable will strongly support the hypothesis.

Year	2001	2003	2005
House Value	.9067* (.0148)	.9721* (.0476)	.7163* (.0611)
Value Squared	-2.97x10^-7* (9.39x10^-9)	-3.14x10^-7* (9.50x10^-8)	4.27x10^-7* (9.92x10^-8)
Number of Rooms	5574.68* (619.37)	7393.24* (814.32)	7308.34* (1271.40)
Urban	16075.66* (2246.4)	28130.58* (3141.05)	30286.38* (5043.83)
West	17845.08* (48563.68)	18252.66* (3941.51)	44237.96* (6219.29)
Constant	-12387.85* (4004.85)	-28949.62* (5590.72)	3458.67 (8601.67)
Overall Regression Statistics			
R^2	.6686	.5865	.5141
N	3799	3935	3917

Table 25: Parameter Estimates, Standard Errors and Overall Regression Results for House Value Regression

The results of these regressions show two major things. The first is that the premium for larger houses increased by a statistically significant amount between 2001 and 2003 and not between 2003 and 2005. Owner preferences really did change within the sample. However, this increase cannot explain the major house price appreciation between 2003 and 2005, since the premium to rooms remains constant between the two periods. Therefore, the increasing premium can only explain the moderate appreciation in 2003. The second and perhaps more important outcome is that the

effect of value squared goes from being negative in 2001 and 2003 to positive in 2005. Combined with the general appreciation of houses, this result means that in the earlier periods, house appreciation was mostly lead by increases in the value of the bottom 90% of houses. Between 2003 and 2005, however, house price appreciation came most heavily from more expensive houses. This provides strong support for the theory of house appreciation in the bubble put forward above. The point at which a lag of house value raises the price more in 2005 than in 2003 is $345,209, a high price but one that still encompasses over 10% of all owned houses.

Given these results, there can be little doubt now that the housing bubble was driven by appreciation in the most expensive houses. Already, this paper has put forward a theory of why the most expensive houses appreciated most quickly: the wealthiest sellers, the ones who would have sold the most expensive houses, chose not to sell during the bubble period. This decision is particularly apparent in the areas where house prices appreciated most rapidly, but clearly happened throughout the sample as well.

V.D Mortgage Size

A final factor in determining house prices is the size of mortgages being made available to borrowers. Finding more mortgage recipients or the same number of mortgage recipients receiving bigger loans will bolster the case for the credit expansion hypothesis. However, the expansion of mortgage lending is an uncontroversial fact about the housing bubble: what will be more interesting is to determine whether the increased mortgage lending permitted further appreciation in the most expensive houses. This section will provide a detailed descriptive analysis and a multiple

regression consideration of how mortgage lending affected and was affected by the increasing value of high-end homes.

The simplest statistics to consider are the proportion of buyers receiving a mortgage, and the size of the mortgage those buyers received relative to the value of their houses. A rising number of buyers receiving mortgages could suggest an expansion of credit standards, although the previous analysis has shown no substantive difference in the income and only positive difference in the wealth of housing buyers. This increase in wealth would explain if 2005 buyers received more and bigger mortgages than their counterparts in other years. Also useful will be a consideration of how mortgage-income ratios varied across the sample years.

Year	% Receiving Mortgage	Average Mortgage Size	Mortgage-Income Ratio	Average House Value
2001	71.61 (45.12)	89063.78 (75140.08)	1.69 (1.75)	123696.4 (96330.83)
2003	65.04 (47.72)	107089.8 (82427.59)	2.07 (2.02)	148781.3 (122865.3)
2005	62.15 (48.54)	116548.7 (100062.8)	2.29 (3.19)	184153.5 (184402.1)

Table 26: Mortgage Information, New Buyers

While the average size of mortgages rises considerably between 2001 and 2003, it remains almost flat between 2003 and 2005, during the bulk of house price appreciation. Mortgage size's lead on house value suggests that lending may have played a major role in inflating the bubble, instead of just increasing the ease of speculation. The expansion in loan size matches the decrease in the Federal funds rate, the macroeconomic variable most strongly associated with the rise of the housing bubble.[29] The evidence for mortgage lending expanding is more ambiguous; the

[29] http://www.federalreserve.gov/fomc/fundsrate.htm

number of buyers receiving a mortgage fell steadily from 2001 to 2005. This decrease further confirms the weakness of the credit expansion explanation of the housing bubble. Instead, the data show that banks focused on increasing their loans to the shrinking pool of buyers who fulfilled the two conditions of wanting a mortgage loan and having the proper characteristics to receive it. Mortgage/income ratios rise by almost 50% between 2001 and 2005. Mortgage size, however, did not seem to feed into the frenzy for buying larger houses: the average house value of mortgage recipients rose by less than the sample average, and remains below the average house value of the sample in every period.

One final table can lay the credit expansion hypothesis of the housing bubble to rest. If the decrease in buyers seeking mortgages forced the banks to expand their lending to new groups they had not previously considered, then there might still be an argument for credit expansion at least partially driving the bubble. Low-income individuals receiving larger mortgages could have some explanatory power, in conjunction with other factors.

Year	Income[30]	Wealth	% Black	Age
2001	63490.19	50365.48	30.07	37.23
	(52752.09)	(265255.2)	(45.91)	(11.1)
2003	61097.26	41788.63	29.87	37.09
	(41412.5)	(146881.8)	(45.82)	(10.31)
2005	57684.69	69685.93	23.76	37.19
	(39951.76)	(226824.8)	(42.62)	(11.27)

Table 27: Income and Demographic Statistics of Mortgage Borrowers

Table 27 shows that in 2003, there may have been some evidence for credit expansion, as buyer wealth declined even as mortgage size expanded. The rebound in

[30] Truncated at the 99th percentile due to extreme observations

2005, however, suggests that during the height of the bubble, the large mortgages did match the rising wealth of buyers. The income and age of borrowers remain very close to that of buyers as a whole. Matching the regression results but countering the hypothesis that the government mandated expansion of credit to minority groups drove the housing bubble, blacks decrease as a percentage of the mortgage pool, even though they would be a natural avenue of expansion for banks that had previously denied them credit.

Since the buyers are substantively the same in terms of income, looking at monthly payments will show whether the increase in mortgage size resulted primarily from buyer preferences for larger, higher quality houses. Since average mortgage principal rose, a buyer preference theory would expect monthly payments to rise as well, as buyers devoted a larger percentage of their income to housing and were willing to pay more to receive it. Alternately, steady or falling monthly payments would dovetail nicely with rising rent payments for buyers as a reason for the housing bubble expanding. Since mortgage size mostly increased between 2001 and 2003, the expectation would be that monthly payments and interest rates should hold steady between 2001 and 2003, and then drop in 2005 to signify the beginning of the most intense part of the housing bubble.

Year	Interest Rate	Monthly Payment	Payment-Income Ratio
2001	7.86 (2.05)	917.91 (2314.02)	.023 (.134)
2003	6.55 (1.81)	878.46 (781.73)	.018 (.020)
2005	6.23 (2.13)	854.07 (676.93)	.026 (.102)

Table 28: Interest Rates and Monthly Mortgage Payments

Rising rents matching falling monthly payments surpass changing buyer preferences for larger homes as the major demand side explanation of the housing bubble based on the data in Table 28. Note that the monthly payments fall despite the precipitous rise in average mortgage principal. Even as rising rents made buyers more willing to accept higher monthly payments on their mortgage, falling monthly payments permitted these buyers to purchase even larger homes. Payment to income ratios rise in 2005 after falling heavily in 2001. Again, this suggests that in 2003, buyers found cheap deals on houses and mortgages, whereas in 2005, other factors began to drive the housing bubble. This convergence would have increased the number of buyers willing and able to buy the more expensive homes that drove the appreciation in average housing prices.

To determine which factors pushed buyers to receive bigger mortgages or convinced banks to hand them out, it would be useful to fit a simple linear regression to predict mortgage size in each of the three years. In particular, the relationship between mortgage size and the house size and quality variables is important. Rising coefficients would confirm that buyers sought larger, more expensive homes and received the money to finance them.

The main variables that theory predicts would determine mortgage size are buyer income, buyer wealth, house size, house value, mortgage interest rate, race and location dummies to reflect the differences in house price in different areas. In particular, the dummies used will be one set to 1 for metropolitan households (BR Urban Code=1 or 2) and one set to 1 for residence in the West. These location measures will again control for whether house appreciation in these high value regions

matched only the appreciation in the rest of the nation, or if there were other idiosyncratic factors at work. Flavin, Yamashita (2002) predicts a strong life-cycle effect in mortgage holdings as well, with younger families tending to consume a much larger ratio of housing value to net worth.

Variable	2001 (SE)	2003 (SE)	2005 (SE)
Age	-344.80 (214.54)	-129.21 (217.15)	-600.74* (248.05)
Income	.5808* (.1193)	.2282 (.1773)	.6892* (.1051)
Income^2	9.93x10^-7* (3.27x10^-7)	1.26x10^-6 (7.91x10^-7)	1.07x10^-7 (1.25x10^-7)
Wealth	.0612* (.0169)	-.0386* (.0184)	.0043 (.0161)
Interest Rate	17018.82* (1724.42)	21144.92* (1930.90)	19147.18* (1859.28)
Interest Rate^2	-896.15* (135.12)	-1464.16* (180.97)	-1020.32* (151.22)
House Value	.1664* (.0238)	.2706* (.0222)	.1138* (.0153)
Number of Rooms	7151.49* (1445.95)	6422.20* (1397.62)	6730.24* (1645.65)
Urban	13488.41* (5260.30)	23149.87* (5258.22)	12009.99* (5832.12)
West	27734.15* (6029.77)	21099.16* (6366.41)	29301.06* (7513.73)
Race	9587.53 (5638.75)	-3501.84 (5530.96)	-6212.51 (6518.33)
Intercept	-82361.43* (13279.46)	-69820.13* (13121.66)	-53518.97 (13672.15)
Overall Regression Statistics			
R^2	.5959	.6520	.7354
N	439	465	390

Table 29: Parameter Estimates and Standard Errors for Mortgage Model

The model R^2 rises steadily throughout the three years even as the number of mortgage recipients falls, strongly supporting that this is the proper model for predicting mortgage principal. The rising influence could suggest the increasing effect of particular variables, but the uneven nature of the estimates from year to year belies this. Since

average mortgage size mostly increased between 2001 and 2003, but average house value mostly increased between 2003 and 2005, the differences in estimates will yield some insight into how the mortgage market affected and was affected by housing value.

Age is only significantly negative in 2005, suggesting that the buyers in this year were more strongly constrained by the Flavin, Yamashita (2002) life-cycle effects, holding less mortgage debt instead of a possibly predicted more. The increase in income's effect, although not significant between 2001 and 2005, does match the previous intuition that rising home prices were driven by increasing loans to already qualified borrowers, and not to an expansion in the demand for housing. In 2003, however, income's effect plummets to the point that it is no longer significant. This outcome is opposite the high importance of income in the 2003 tenure choice regression. This suggests that even though the buyers in 2003 were most concerned with income, mortgages for those who could buy were not determined by their relative income, but were there for the asking. Wealth's effect also fluctuates wildly between years. This change can have one of two interpretations: one is that banks were not particularly picky about to whom they gave mortgages in 2003. The other, however, is that wealthier borrowers were more likely to lay down a large down payment in 2003 (and in 2005) or to not take out a mortgage at all than they were in 2001. This pattern of behavior would mean that the larger mortgages actually mask even larger house values than would be expected. Since descriptive analysis shows that the average buyer was not any worse off in 2003 than in 2001, the latter explanation appears more likely. The effect of wealth can also explain the falling proportion of mortgage recipients among buyers.

The two buyer preference variables also fluctuate between years. House value nearly doubles as a predictor of mortgage size between 2001 and 2003 before falling by over 50% between 2003 and 2005. The high coefficient in 2003 coupled with the increased size of mortgages and the rising price of houses suggests that larger mortgages were simply there for the asking for qualified borrowers. The value of the house became much more important in driving the size of principal than it had been beforehand. Mortgage lending did have major permissive effects for those borrowers switching from borrowing to lending in 2003. The massive decrease in housing value's importance in 2005 matches the large increase in house value unconnected to an increase in average mortgage principal in 2006. Here, the wealthier average buyer becomes more important, pushing out borrowers from the most expensive houses with his higher available down payments, making house value a less important predictor of mortgage size. The effect of rooms did not change significantly across periods, suggesting that borrowers were more interested in other house qualities than size.

The effect of interest rate rises significantly between 2001 and 2003: however, the decrease in the negative coefficient on the squared term quickly cancels out this increase. By the time the interest rate reaches the 2003 average, the change in principal is about equal across the three periods. The positive effect of interest rates on principal seems surprising, but it should be interpreted as necessitating reading the relationship in reverse: the coefficients should be treated as the amount of principal needed to trigger a 1 percent increase in interest rates. The predictions from these coefficients suggest that given the average interest rates, average principal in the bubble period should have remained stable, even though the interest rates were much

lower. Again, wealthier buyers in 2005 could have received lower interest rates while still taking on more mortgage principal due to their high down payment, eroding the effect of interest rates on mortgage principal size.

The location variables also provide interesting results. The larger mortgage principals in urban areas do not just reflect the higher property prices, since housing values are included in the regression. Rather, banks must have become more willing to hand out bigger loans in these regions independent of house value: it is the result of increasing competition over the scarce housing resources. Comparing with the house value regression again shows that those who buyers who could afford the more expensive houses of the 2005 bubble period could do so without receiving a mortgage. Most of the increase in the effect of taking out a mortgage in an urban area in 2003 is covered by the increase in the mortgage coefficient, but this is not the case in 2005. The effect of living in the West on mortgage principal size seem generally disconnected from housing prices.

Overall, the analysis of mortgage principal determination shows that while it seemed to have a strong effect on the value of houses that buyers could find in 2003, by 2005, those who would have been receiving the bulk of their financing from mortgages were priced out of the top of the market by wealthier individuals with larger down payments. This explains why mortgage principal remains steady even as the average house value of a mortgage buyer increases.

V. Conclusions

This analysis has provided a microeconomic picture of how the housing bubble developed and how buyers and sellers behaved during this bubble. In considering

demographics, income dynamics and house value characteristics, it has reached several important conclusions:

1. There was no expansion of credit to new groups during the housing bubble period:

The analysis showed that the income of the sample and of the buyers within the sample remained identical across periods. Higher income actually became more predictive of choosing to buy a house in the bubble years of the sample. Wealth did not increase either. Mortgages were not given out to a larger proportion of buyers, nor were the buyers poorer or younger. In the early bubble, at least, credit and the housing market was not extended to more blacks: the regression and demographic results both show that being black made a person less likely to buy a house as the bubble began. Rising prices prevented new groups from entering the market, because they could not secure the credit to do so.

2. There was an expansion of credit to members of a stable potential buyer pool:

Despite the rising house prices, the income of buyers in the sample remains stable across years. While mean wealth rises in 2005, the distribution of wealth among the lower 90% of buyers does not change; the same proportions of buyers have zero or negative wealth and are of lower than average income as in earlier periods. This could not have matched up with the rising house prices unless banks had been willing to extend increasing amounts of mortgage credit to the marginal buyers. What the expansion of credit did was not drive the housing bubble, but did permit it to happen. Expanding credit allowed the marginal buyers to keep buying

the low end houses and prevented the bottom from falling out of the housing market.

3. There was no structural shift in the composition of buyers:

All of the demographic analysis shows that no single group of expected buyers as predicted by the regression increased in size or changed their buying habits during the bubble period. Since credit did not expand to new groups, as per conclusion 1, the proportions of the various groups that made up the potential buyer pool remained fairly constant across samples. Therefore, this avenue for a demand side explanation of the housing market is closed off.

4. There were two distinct stages to the inflation of the bubble before 2005:

The regression results for house value and mortgage principle, as well as the tenure choice regression results, show statistically significant differences in many of the most important predictor variables from year to year. In particular, income and marriage have radically different effects between 2003 and 2005. This means that there were major changes in the way housing prices were driven up between the 2001-2003 period and the 2003-2005 period, reflecting the shift in macroeconomic conditions from recession to growth. The 2003 early bubble period involved a moderate increase in housing prices driven by increasing mortgage principal and rising buyer rents, while the 2005 full out bubble drew most of its demand-side fire from the higher wealth of the buyer class.

5. House prices were initially increased by a convergence of mortgage payments and rents, and a supply constraint across houses:

Buyers in 2003 paid much higher rents than buyers in 2001, despite having similar income and wealth levels, and despite not residing in larger residences.

Such a situation would have meant buyers accustomed to spending a larger portion of their income on shelter, and so buyers who were willing to spend more on houses. Simultaneously, low interest rates made it easier for these buyers to purchase more housing for the amount of money they had earmarked. This combination helped drive mortgage principals upward as buyers who could receive as much mortgage principal as they wanted realized they could buy large houses for only marginally more than their rent payments. This activity has to be seen as rational: the average 2001 buyer increased his spending on shelter by almost $500 a month, while the average 2003 and 2005 buyer increased his spending by only about $300. Even as this occurred, the sell rates for owners for the period ending in 2003 fell from their 2001 levels. This secondary constraint can explain the moderate appreciation of house prices across the spectrum between 2001 and 2003, despite falling sample income.

6. The market for expensive houses experienced significant supply constraints between 2003 and 2005:

The analysis has shown that although sell rates rose between 2003 and 2005, the value of houses being sold did not match the increases in the sample's house values. It was the individuals with above average value homes who chose not to exit the housing market in the numbers that they normally would have. This is visible most vividly in the falling number of 65+ sellers in the market, as well as in the stagnant value of sold houses in the urban areas where overall house prices increased most rapidly.

7. Wealthier buyers entered the market in 2005, even as average sample

wealth stagnated:

The 2005 vintage buyers had an average wealth of over $30000 higher than buyers in the other periods. However, the distribution of wealth across the bottom 90% of the sample remained fairly similar in each of the three periods. This means that the increase in mean wealth came from the top 10% of buyers. These buyers would have had been able to afford more expensive houses than previous buyer groups, and also would have been able to make large down payments in order to facilitate higher principal mortgages.

8. The bulk of mean house price appreciation came from the top 10% of the sample:

While the median house in the sample increased in value by $19000 between 2003 and 2005, the 90th percentile house increased by over $130000. At most percentiles, the increase in house value between 2003 and 2005 was about double the increase between 2001 and 2003; for the 90th percentile, it was tripled. Such a disparity in increase suggests much greater competition over the more expensive houses. This result is further borne out by the regression on house value. The changes in coefficient showed that higher homes appreciated in value more quickly between for the 2003-2005 period than in either of the others, and that only in that period did they appreciate more quickly than less expensive homes. This set of results mean that what is classically meant by “the housing bubble” mostly arises from this top 10% of houses.

9. The combination of conclusions six and seven caused conclusion eight:

The housing bubble was a perfect storm of older and wealthier owners choosing to exit the housing market in smaller numbers than had previously been the case and new, wealthy buyers seeking out these expensive homes in larger numbers than before. Together, these factors would have conspired to raise the price of expensive homes. However, those buyers who held out in 2005 could not hold out forever; they were merely delaying their eventual need to sell their homes. Even though there were good, market based reasons for expensive houses to increase in value, the resulting increase was still a bubble, because the lack of any structural shifts in the house buying population should have suggested that the long-term value of those houses did not rise and that the market would eventually correct itself.

10. The reasons for owners choosing not to sell are unclear:

It is possible that the increase in 2003 values convinced owners that they could accumulate more wealth by continuing to wait on their houses. This matches Case, Shiller's (1989) dictum that expectations create housing bubbles, although not in the way that they meant it. Perhaps the group moving through simply had different tenure choice preferences: the sample size is too small for a logit regression about this to be well-behaved. This group may have had particularly high debt burdens from multiple houses and high insurance rates, forcing them to hope that home prices would tide them over where their incomes alone could not. Regardless of their decision-making process, the choice not to sell by these wealthy owners must be considered a major overlooked cause of the housing bubble

Charts

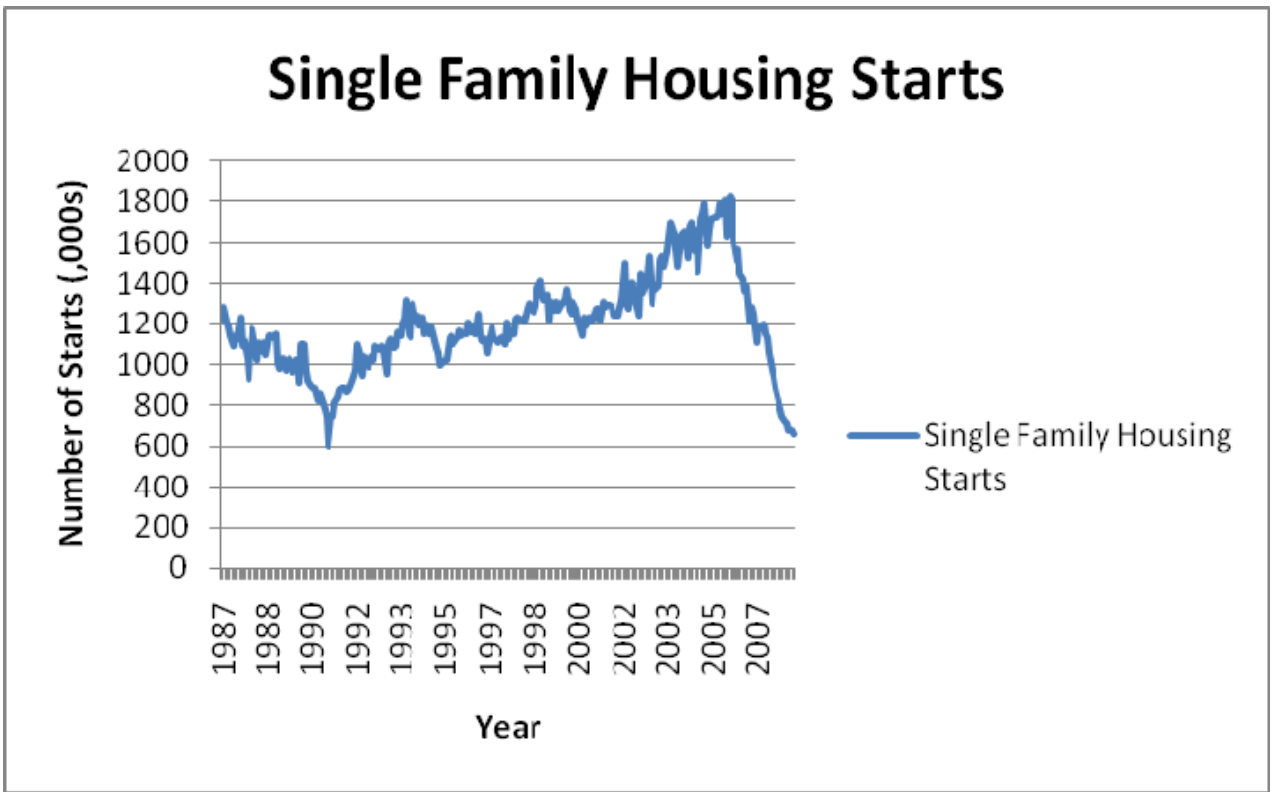

Chart 1: Single Family Housing Starts, 1987-2008

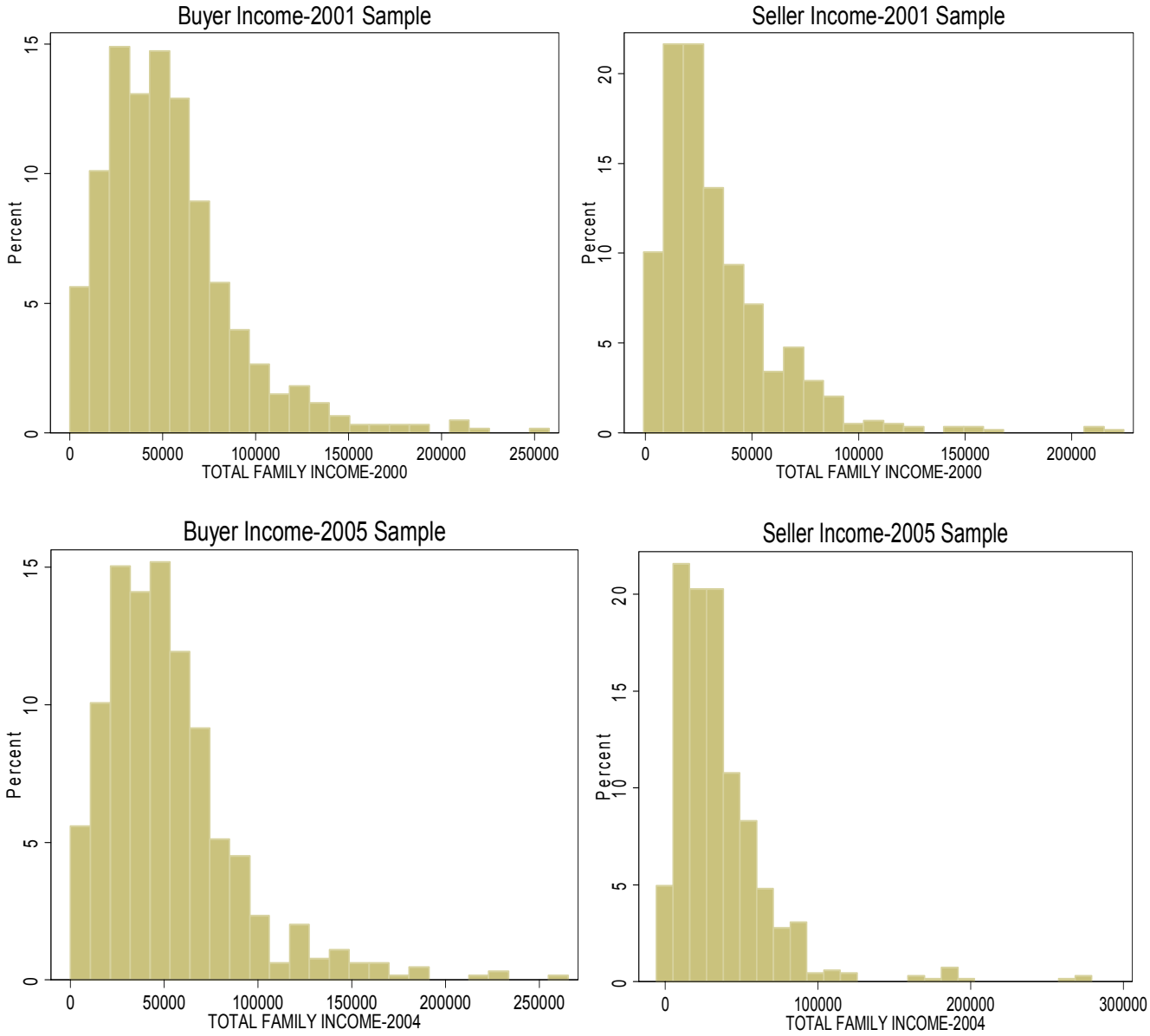

Chart 2: Distribution of Buyer Income

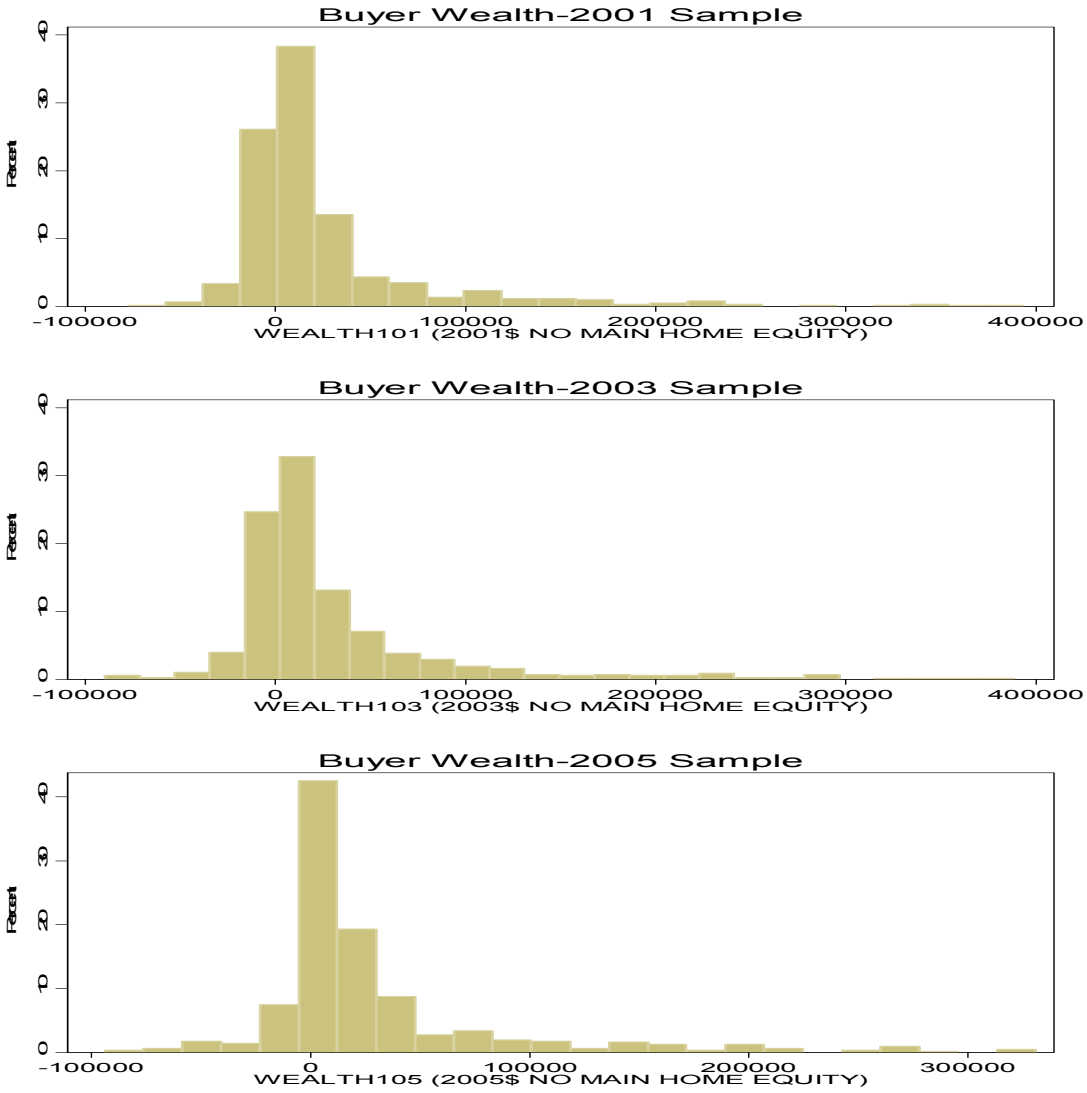

Chart 3: Distribution of Buyer Wealth

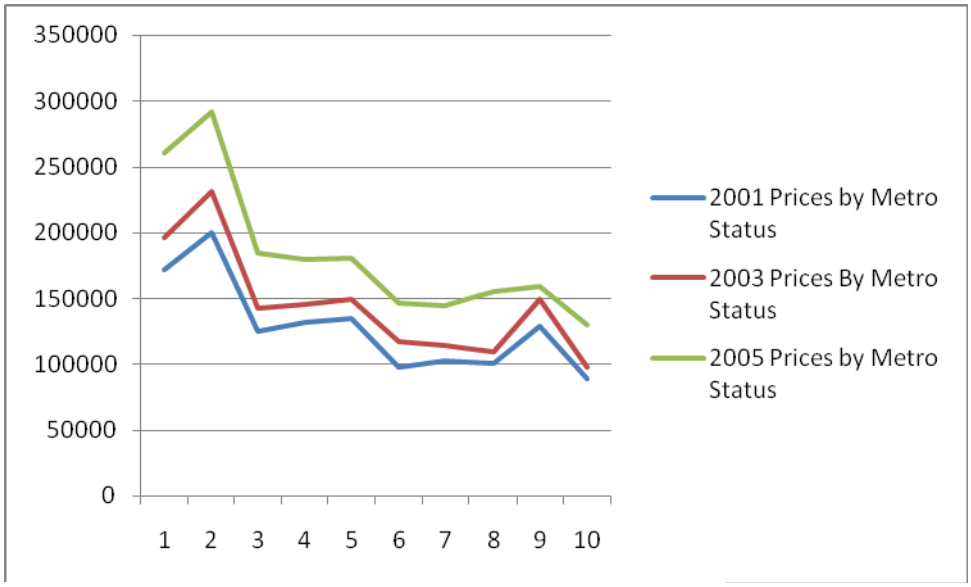

Chart 4: Changes in House Prices by Metro Status

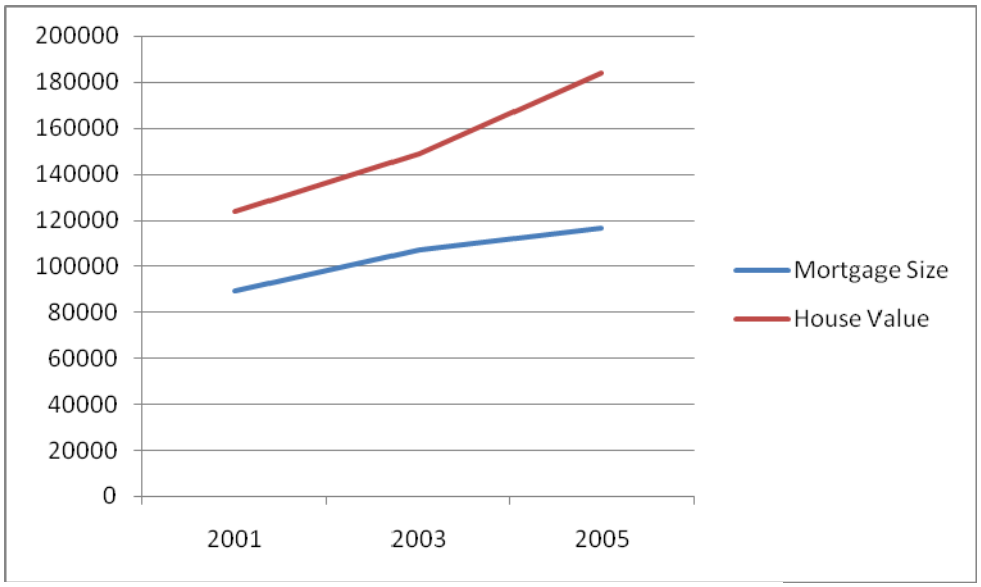

Chart 5: Divergence between house value and mortgage size

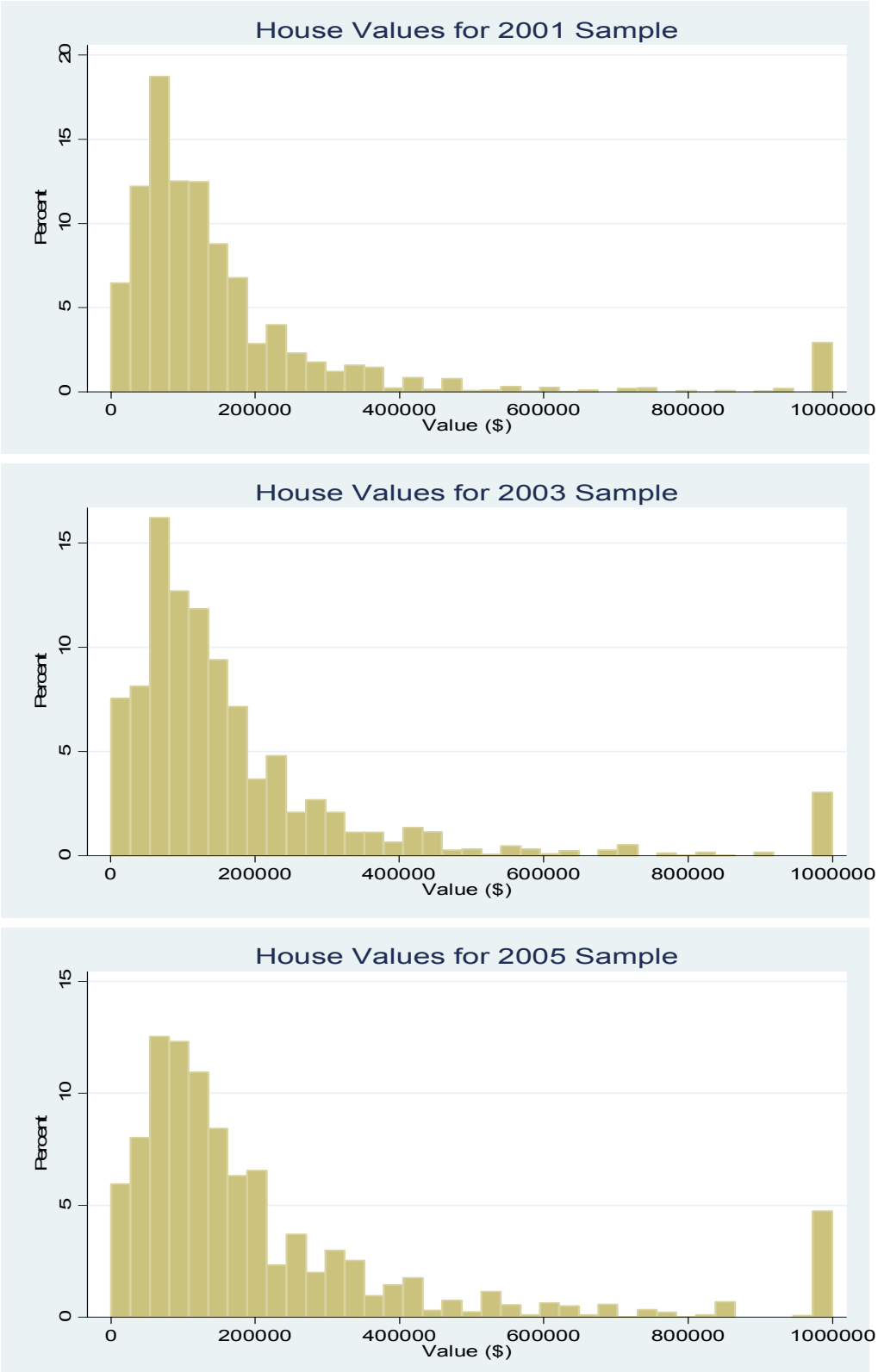

Chart 6: Distribution of housing prices
Truncated at $1 million

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