The Effect of Housing on Portfolio Choice*

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Abstract

A recent theoretical literature predicts that housing has substantial effects on financial markets, but empirical evidence on these effects is scarce. We estimate the causal effect of changes in mortgages and home equity on portfolio allocations. We use two instruments – average house prices in an individual's state in the current year and in the year he purchased his home – to generate variation in home equity and mortgages that is plausibly orthogonal to unobserved determinants of portfolios. Using data from the Survey of Income and Program Participation, we estimate that a $10,000 increase in a individual's mortgage (holding fixed total wealth) reduces the share of liquid wealth he holds in stocks by 6.5%. This effect is driven by a combination of extensive margin (stock market participation) and intensive margin effects. Auxiliary evidence suggests that housing induces individuals to hold more conservative portfolios primarily because of a "consumption commitment" effect rather than because of house price risk. The impact of housing on portfolio choice is substantial: our estimates imply that if their mortgage debt were forgiven, households would increase the amount they invest in stocks by 40%.

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1 Introduction

How does homeownership affect households' financial investment decisions? The interaction between housing and financial markets has attracted considerable attention in recent work because of its potential importance for understanding macroeconomic fluctuations and asset pricing. Theoretical studies have shown that because housing is both a consumption good and an asset, it may substantially alter optimal portfolio allocations through two channels. First, homeownership increases a household's exposure to risk (Brueckner, 1997, Flavin and Yamashita, 2002). Under plausible assumptions, this can induce a household to hold a more conservative financial portfolio. Second, adjustment costs in housing effectively amplify risk aversion because they force households to concentrate fluctuations in wealth of a subset of goods. This "consumption commitment" effect further reduces the optimal share of stocks in liquid wealth (Grossman and Laroque 1990, Fratantoni 2001, Chetty and Szeidl 2007). Together, these effects can have large quantitative effects on portfolio allocations. For example, simulations by Cocco (2005) show that the presence of housing can reduce stock market participation rates from 76% to 33% in a calibrated life-cycle model.

The goal of this paper is to evaluate these theoretical predictions by estimating the effects of owning a more expensive house on portfolio choice empirically. Previous empirical work has documented the cross-sectional correlation between property values and portfolio choice using OLS regressions (Fratantoni 1998, Heaton and Lucas 2000, Yamashita 2003, Cocco 2005). Because both housing and portfolios are endogenous choices, these studies do not identify the causal effect of housing on portfolios. We implement a simple instrumental variables strategy to estimate the causal effect of changes in mortgage debt and home equity on portfolio choice.[1]

We motivate our empirical analysis using a simple, analytically tractable model of portfolio choice that incorporates both the commitment and price risk effects of housing. The model yields an estimating equation for the stock share of liquid wealth in terms of home equity, property value, and measures of background risk and total wealth. The challenge

[1] Yamashita (2003) also reports some two-stage-least-squares estimates using age, family size, home tenure, and aggregate housing returns as instruments. Unfortunately, standard models would generate direct relationships between all of these variables and portfolio choice, independent of the housing channel. Our study builds on Yamashita's work by using instruments that are more likely to satisfy the exclusion restriction and by separating the effects of mortgage debt and home equity wealth.

in estimating the coefficients of this model is that home equity and property value are endogenous choices, and we do not observe many components of background risk and lifetime wealth that have been shown to affect these choices (Cocco 2005, Shore and Sinai 2009). We therefore use two instruments to generate exogenous variation in home equity and property values that is plausibly uncorrelated with unobserved determinants of portfolio choice: the average current house price in an individual's state and the average house price in that state at the time the individual purchased his house, calculated using repeat-sales indices. The current house price index is naturally a strong predictor of property values. However, the current house price also creates variation in a household's wealth: increases in house prices increase home equity and total wealth, which can affect the stock share of liquid wealth through a wealth effect. To isolate the causal effect of purchasing a more expensive house while holding fixed wealth, we exploit the second instrument – the average house price at the time of purchase. Individuals who purchase houses at a point when prices are high tend to have less home equity and a larger mortgage. Together, the two house price index instruments generate independent exogenous variation in property value and home equity, allowing us to separate the effect of housing on portfolio choice from wealth effects.

We implement this strategy using microdata on housing and portfolios for 69,164 households from the Survey of Income and Program Participation panels spanning 1990 to 2004. We use two-stage-least-squares specifications to estimate the effect of increases in mortgages and home equity on the share of liquid wealth that a household holds in stocks. We identify this effect purely from differential within-state variation in property values by including state and year fixed effects in all regression specifications. The estimates imply that a $10,000 (20%) increase in a household's mortgage (holding fixed home equity) causes a reduction in the stock share of liquid wealth of approximately 6.5%, an estimate that is significant with $p < 0.01$ across a broad range of specifications. In contrast, a $10,000 increase in home equity (holding fixed total property value) increases the stock share of liquid wealth by 6.7%. Hence, it is critical to distinguish changes in mortgage debt from changes in home equity wealth to understand the effects of housing on portfolios. The portfolio responses are driven by a combination of extensive and intensive-margin responses. Larger mortgages induce reductions in both the probability of stock market participation and the amount of stocks held conditional on participation. Extrapolating based on these estimates, we conclude that in the absence of mortgage payments – i.e., if all mortgage debt were forgiven – households would increase the amount of money invested in stocks by 33%. In this sense, housing induces substantial shifts in financial portfolios, consistent with the predictions of previous simulations of theoretical models.

The exclusion restriction underlying our identification strategy is that current house prices and house prices at the time of purchase do not affect portfolios directly, independent of the housing channel. We assess the validity of this restriction by examining the correlation between the house price indices and portfolio shares *prior* to home purchase for a small subset of households for whom we observe portfolio shares twice. We find no link between local price variation and portfolio shares prior to home purchase, supporting the identification strategy.

Our baseline empirical analysis does not tell us whether the effect of housing on portfolios is driven by the home price risk or commitment channels. To distinguish between these two channels, we examine how the effect of housing on portfolios varies across markets with different level of house price risk and adjustment costs. The home price risk hypothesis predicts that the effect of property value on stock shares will be more negative in markets with more volatile house prices. The commitment channel predicts that the effect should be larger in more illiquid housing markets. We proxy for house price risk using historical house price volatility by state and for adjustment costs in housing using predicted housing tenures based on observables. The estimated effects of property value on stock shares are virtually identical in low- and high-risk states, but are significantly higher for individuals with higher predicted home tenures (i.e., those with higher adjustment costs). These results suggest that the commitment effect is the more important driver of the link between housing and portfolios. This finding is consistent with the results of Sinai and Souleles (2005), who show that most individuals are effectively well hedged against house price risk because they do not move across markets frequently. However, these auxiliary tests must be interpreted only as suggestive correlations, because they rely on cross-sectional variation in house price risk and adjustment costs.

Our estimates of the effect of housing on portfolios – an elasticity of -0.33 of stock shares with respect to mortgage debt and 0.47 of stock shares with respect to home equity wealth – are larger in magnitude than those of previous cross-sectional studies. The results of previous studies are sensitive to controls and sample specification, perhaps because they do not directly address the endogeneity of housing. For example, Fratantoni (1998) finds an elasticity of stock share with respect to mortgage debt of approximately -0.15. In contrast, Heaton and Lucas (2000) and Cocco (2005) show that once property value is included as a covariate, mortgages are *positively* associated with the stock share in OLS regressions. Yamashita (2003) finds an elasticity of stock share with respect to property value of approximately -0.1 in a specification that does not include mortgage debt. Our instrumental-variable estimates are more robust than previous estimates because the variation we use is orthogonal to most individual-level determinants of portfolios. Moreover, our analysis shows that it is critical to distinguish home equity and mortgage debt to understand the effect of housing on portfolios. The mixed results of prior studies may be partially driven by the way in which they treat this distinction.

The reduced-form empirical results here point to potentially important linkages between housing and asset markets. For example, our results suggest that recent increases in mortgage debt relative to liquid wealth in the U.S. may have induced households to withdraw funds from the stock market. This shift in demand for risky assets could have further precipitated the sharp decline in asset prices. A full quantitative analysis of the effect of housing market shocks on asset markets would require a general equilibrium model of financial and real estate markets. The elasticities we report here can be used when calibrating such a model, and the model we present below could provide a tractable starting point for such work.

The remainder of the paper is organized as follows. The next section presents a portfolio choice model and derives an estimating equation that forms the basis for the empirical analysis. Section 3 describes the data and section 4 presents the identification strategy and results. Section 5 concludes.

2 Model and Estimating Equation

This section develops a model that incorporates house price risk and moving costs in a portfolio choice framework. The objective is to provide intuition for the channels through which housing can affect portfolios and guide the specification of an estimating equation.

Consider a discrete-time environment with periods $t = 0, 1, ..., T$. The agent consumes only in periods $t = 1, ..., T$ and maximizes total consumption utility

$$\sum_{t=1}^{T} \frac{c_t^{1-\gamma}}{1-\gamma}$$

where we abstract from discounting and assume that the coefficient of relative risk aversion $\gamma > 1$. Following Cocco (2005), let c_t denote a Cobb-Douglas composite of food (f) and housing (h) consumption. Housing h is itself a composite of two types of durable goods, commitments (x) and adjustables (a), so that

$$c = f^{\mu} h^{1-\mu} \text{ and } h = \left(\frac{x}{\theta}\right)^{\theta} \left(\frac{a}{1-\theta}\right)^{1-\theta}. \tag{1}$$

The parameter θ governs the adjustability of housing consumption. The committed component of housing (x) can never be adjusted from its prior level, while component a is freely adjustable at all dates $t \geq 1$. Hence, if $\theta = 0$, all housing is instantaneously adjustable; if $\theta = 1$, housing consumption is completely fixed. We normalize the denominator of the expression for h by $\theta^{\theta}(1-\theta)^{1-\theta}$ to ensure that a dollar of housing expenditure generates the same amount of housing consumption for all values of θ. At $t = 0$, the household is endowed with L_0 dollars of liquid wealth (cash); an initial house of size h_0, of which $x_0 = \theta h_0$ is unadjustable and $a_0 = (1-\theta) h_0$ is adjustable; and a mortgage of face value M. All these variables are exogenously fixed – the agent makes choices over housing and food only starting $t = 1$. Moreover, the commitment portion of housing is fixed for the lifetime of the household: $x_t = x_0$ for all t. This stark method of modelling consumption commitments allows us to obtain a closed form portfolio choice equation.

The agent can invest in two assets in each period $t = 0, 1, ..., T$: stocks and a risk free bond. Normalize the risk free borrowing and lending rate to zero. As in Chetty and Szeidl (2007a), we assume that all uncertainty is realized between $t = 0$ and $t = 1$, which implies that after $t = 1$, stocks earn a zero return. Since all assets are risk free after $t = 1$, the only non-trivial portfolio choice problem is at $t = 0$. Let R denote the net return on stocks between $t = 0$ and $t = 1$, and assume that $\log(1 + R)$ is normally distributed with variance σ^2. The agent has a riskless labor income stream of y_t; let $Y = \sum_{t=1}^{T} y_t$ denote the present value of labor income.

In addition to the stock market, the agent faces risk from fluctuations in the price of housing between $t = 0$ and $t = 1$.[2] We assume that the prices of adjustable and commitment housing are equal, and denote their price in period t by p_t. After $t = 1$, housing prices are fixed at $p_t = p_1$. Assume that housing and the stock market are perfectly correlated, so that the return on housing (p_1/p_0) from period 0 to 1 is perfectly replicated by a financial portfolio that invests some share κ in stocks and $1-\kappa$ in bonds. Hence, κ can be interpreted as a measure of the riskiness of housing.

Denoting the share of liquid wealth invested in stocks by α, the agent's maximization problem is thus

$$\max_{\alpha, f_1, \ldots, f_T, a_1, \ldots, a_T} E \sum_{t=1}^{T} \frac{c_t^{1-\gamma}}{1-\gamma}$$

subject to (1) and the budget constraint

$$(1 + \alpha R) L_0 + Y + (p_1 h_0 - M) = \sum_{t=1}^{T} (f_t + a_t \cdot p_1/T + x_0 \cdot p_1/T) .$$

The budget constraint requires that the sum of financial wealth, labor income, and home equity, all measured at $t = 1$, equals the sum of food consumption; adjustable housing consumption, which has a per period (rental) price p_1/T, and committed housing consumption. The committed component of housing reduces the disposable income that the agent has to allocate to food as income fluctuates. Home price risk affects the agent's budget constraint in two ways: it introduces background wealth risk in that the value of the initial property $p_1 h_0$ fluctuates and it introduces risk in the relative price of housing and food (p_1/T) in periods $t \geq 1$.

The following proposition characterizes the agent's optimal portfolio choice at $t = 0$ (α) as a function of initial liquid wealth (L_0), home equity $(p_0 h_0 - M)$, property value $(p_0 h_0)$, and total labor income (Y).

Proposition 1 *The optimal share of stocks out of liquid wealth at $t = 0$ is, to a log-linear approximation,*

$$\alpha^* = C_1 \cdot \frac{\textit{liquid wealth} + \textit{labor income} + \textit{home equity}}{\textit{liquid wealth}} - [\theta C_1 + \kappa C_2] \cdot \frac{\textit{property value}}{\textit{liquid wealth}} \qquad (2)$$

[2] It would be straightforward to introduce background risk in labor income that is perfectly correlated with the stock market.

where C_1 and C_2 are non-negative constants:

$$C_1 = \frac{ER - (1-\gamma)\,\mu_a \cdot \kappa\sigma^2}{\sigma^2\left[1 - (\mu + \mu_a)(1-\gamma)\right]} \quad \textit{and} \quad C_2 = 1 - \theta$$

and $\mu_a = (1-\mu)(1-\theta)$ is the Cobb-Douglas share of adjustable housing consumption.

To understand the proposition, first focus on the special case when $\theta = \kappa = 0$, i.e., when all of housing is adjustable and there is no home-price risk. In that case the final term in (2) is zero; stockholdings are constant share of total wealth, as in the standard power utility model. With either home price risk ($\kappa > 0$) or commitments ($\theta > 0$), stockholding is negatively related to property value, conditional on total wealth. In the presence of home price risk, a larger house translates into larger background risk, resulting in lower stockholdings. In the presence of commitments, a larger home means that more wealth is "tied up" in fixed housing payments; hence a given loss in wealth results in a larger proportional drop in food consumption, driving up risk aversion and reducing stockholdings.

The degree of home price risk and commitments affect the coefficient on property value in (2) in intuitive ways. An increase in home price risk (higher κ) amplifies the effect of property value on portfolios because every additional dollar of housing leads to greater exposure to price risk.[3] When housing is less adjustable (higher θ), the property value coefficient changes in two ways. First, the size of the commitment effect increases. Second, the impact of home price risk is reduced: in the limit where $\theta = 1$ and houses are never sold, home price risk becomes irrelevant. Higher adjustment costs unambiguously amplify the effect of housing on portfolio choice in environment where home price risk has little effect on portfolios (κ low).

Borrowing constraints. Homeowners with outstanding mortgage debt often have limited capacity to take further loans. How do such borrowing constraints affect our predictions? A stylized way of limiting borrowing in our model is to introduce a borrowing horizon $T_{BC} < T$, so that agents are free to transfer resources across periods up to T_{BC}, but are prevented from borrowing or saving between dates before T_{BC} and dates after T_{BC}. This constraint captures

[3] Home price risk also affects portfolios independently of this property value effect by creating fluctuations in the relative price of housing (Yogo 2006, Piazzesi et al 2007). Under our simplifying assumption that housing and the stock market are perfectly correlated, higher κ can increase the stock share through this channel (higher C_1), because stocks are a hedge against relative price risk. In practice, a more plausible hedge against fluctuations in the rental price of housing is to buy a house instead of rent (Sinai and Souleles 2005).

the intuition that agents have limited ability to borrow against their future labor income. Assuming that a share θ of mortgage payments are due before T_{BC}, we show in the Appendix that the optimal portfolio share of stocks is now

$$\alpha^*_{BC} = C_1 \cdot \frac{\text{liquid wealth} + \text{labor income}_{BC}}{\text{liquid wealth}} - \theta C_1 \cdot \frac{\text{mortgage}_{BC}}{\text{liquid wealth}} \tag{3}$$

where the labor income_{BC} is total labor income from $t = 1$ to $t = T_{BC}$ and mortgage_{BC} is the total amount of mortgage debt that must be repaid during the same period. Housing continues to have a negative effect on stockholdings: expenditure commitments captured by the mortgage term reduce the optimal stock share. Higher home price risk amplifies this effect (higher κ increases C_1) through greater exposure to fluctuations in the relative price of housing and food. Thus, the main qualitative predictions of the model are preserved under borrowing constraints.

Estimating Equation. While the portfolio choice rule in (2) depends on specific functional forms and modelling assumptions, we believe that the basic intuitions it captures extend to more general setting that allow for endogenous moving decisions, the ability to take second mortgages, and decreasing relative risk aversion. In general, we expect that the portfolio share of stocks is determined as

$$\alpha^* = f\left(\text{liquid wealth}\ ,\ \text{labor income}\ ,\ \text{home equity},\ \text{property value}\right) \tag{4}$$

where the first three arguments capture different components of wealth and hence have a positive effect on stockholdings, while property value reduces stocks through the commitment and home price risk channels. For example, in the model with borrowing constraints, (3) can be rewritten in this form using the accounting identity connecting property value, home equity and mortgage.

Linearizing equation (4) motivates an estimating equation for the stock share of liquid wealth of the form

$$\text{stock share} = \alpha + \beta_1 \text{liquid wealth} + \beta_2 \text{labor income} + \beta_3 \text{property value} + \beta_4 \text{home equity} + \varepsilon \tag{5}$$

Under the null hypothesis that housing involves no commitment and no risk, $\beta_3 = 0$. The error term ε in equation (5) captures other sources of heterogeneity in portfolios. These may include entrepreneurial risk (Heaton and Lucas 2000), investment mistakes (Odean 1999, Calvet, Campbell and Sodini 2007), heterogeneity in risk aversion γ, or measurement error. Unfortunately, some of the effects captured by the error term may be correlated with property value, creating bias in an OLS estimate of β_3. One possible endogeneity problem, emphasized by Cocco (2005), stems from variation in unobserved labor income. To see how this affects the estimation, suppose that lifetime labor income is $Y = Y_1 + Y_2$, where Y_1 is observed by both the household and the econometrician, while Y_2 is only observed by the household. The error term in (5) now becomes $\varepsilon = \beta_2 Y_2 + \nu$, where ν represents other sources of heterogeneity. If property value is positively related to unobserved (e.g., future) labor income Y_2, $\mathrm{E}[\varepsilon \cdot \text{property value}] > 0$, and hence the OLS estimate of β_3 is biased upward. Similarly, if households have heterogenous risk aversion γ and less risk averse households buy larger houses, we would again observe a spurious positive correlation between stockholdings and property value. This problem makes it essential to formulate an instrumental variable strategy that generates variation in property value orthogonal to ε.

3 Data and Sample Definition

We estimate equation (5) using data from the 1990-2004 asset modules of the Survey of Income and Program Participation (SIPP). The SIPP collects income, asset, and demographic information from a sample of approximately 20,000-30,000 households. The asset data is only collected once for each household during most of the panels, and hence the data we use here are primarily repeated cross-sections. The main advantages of the SIPP relative to other commonly used datasets on financial characteristics such as the SCF and PSID are its large sample size and detailed information about covariates such a complete housing history. We obtain quarterly data on average housing prices by state from 1975-2004 using the repeat sales index constructed by the Office of Federal Housing Enterprise Oversight (OFHEO).

The raw SIPP data contains information on 97,798 homeowners. 70,857 of these households bought their current house after 1975 and therefore have OFHEO data for the year of home purchase, which is essential for our instrumental variable analysis. We exclude 2,733 households whose total reported stockholdings are negative or exceed their liquid wealth. This exclusion does not affect the qualitative results reported below. After imposing these sample restrictions, we are left with 69,164 households in our analysis sample.

Table 1 gives summary statistics for the analysis sample. Individuals in this sample own houses that are worth approximately \$122,000 on average in 1990 dollars. The average amount of home equity is \$71,000 and the average outstanding mortgage is \$51,000. Mean liquid wealth is \$62,600, but this distribution is very skewed; the median level of liquid wealth is only \$12,200. Mean total wealth (which includes liquid wealth, home equity, and other illiquid assets such as cars) is \$166,500. Households hold on average approximately 11% of their liquid wealth in the form of stocks in taxable (non-retirement) accounts and 37% in the form of "safe" assets (savings accounts and bonds). The relatively small fraction of wealth held in stocks reflects the fact that only 27% of the households in the data hold stocks outside their retirement accounts (consistent with Vissing-Jorgensen 2002). Among participants, the mean stock share of liquid wealth is approximately 40%. The average individual in the sample is 47 years hold and has lived in his current house for 8.5 years. The substantial dispersion in home tenures (standard deviation = 6.5 years) generates the variance in mortgages and house prices that underlies the empirical analysis.

The 1996 and 2001 SIPP panels collect asset and housing data three times within the panel. This allows us to construct a subsample of 6,145 households for whom we observe portfolios in the year or two years *before* purchasing a new house. We use this small subsample of "future home buyers" to test for selection effects that would affect that causal interpretation of our estimates. The observable characteristics of the future home buyers are broadly similar to those of the main analysis sample. The difference between the average incomes in the two samples is statistically insignificant. Individuals in the future homebuyer sample tend to be about 7 years younger on average and have 0.3 children more in the household on average, as one would expect. Hence, the future homebuyer sample is a group of individuals similar to those in the main analysis sample, but observed at an earlier point in the lifecycle.

4 Empirical Analysis

4.1 Identification Strategy

Recall the estimating equation

$$\text{stock share} = \alpha + \beta_1 \text{liquid wealth} + \beta_2 \text{wage income} + \beta_3 \text{property value} + \beta_4 \text{home equity} + \varepsilon \tag{6}$$

The coefficient β_3 measures the impact of changes in housing on portfolios (holding fixed wealth), while β_4 measures the impact of changes in wealth (holding fixed housing). We seek variation in home equity and property value that is orthogonal to liquid wealth, wage income, and other unobserved determinants of portfolio choice (ε). We generate such variation using two instruments: the average price of houses in the individual's state in the current year (the year in which portfolios are measured) and the average price of houses in the individual's state in the year that he bought his house. The intuition for this identification strategy is illustrated in Figure 1, which plots average real home prices in California from 1975-2005 using the OFHEO data. Consider a hypothetical experiment involving a set of individuals who buy identical houses and only pay the interest on their mortgage (so that debt outstanding does not change over time). As a baseline, consider individual A who buys a house in 1985 (dashed red line) and whose portfolio we observe in 2000 (solid blue line), as shown in Panel A. Now compare this individual to individual B who buys the same house in 1990 and whose portfolio we also observe in 2000. Individuals A and B have the same current property value, but individual B has less home equity and a larger mortgage because prices were higher in 1990 than 1985. Now consider a second experiment, comparing panel C to A. Individual C buys the same house in 1985, but we observe his portfolio in 2005. This individual has the same mortgage debt as individual A (under the assumption that individuals only pay interest to service their debt), but has higher home equity and wealth at the time we observe his portfolio. Together, the two experiments (instruments) allow us to separately identify the causal effects of mortgages and home equity on portfolios.

In practice, our implementation of this strategy differs from the hypothetical examples in two ways. First, we do not just compare individuals who buy at different times, as such comparisons may be contaminated by aggregate trends or correlations between portfolios and home tenure or age. Because we have data on individuals who purchase houses in different years and observe portfolios in different years in 50 states, we include state, current year, year of house purchase, and age fixed effects in every regression specification below. Thus, we identify β_3 and β_4 purely from variation in house prices within state. Second, unlike in the hypothetical example, individuals buy smaller houses when prices are high and reduce their mortgage debt over time by paying more than mortgage interest. The first stage effects of the house price indices on mortgage and home equity account for these effects.

Table 2 reports first stage regressions of mortgage, home equity, and property value (mortgage plus home equity) on the two instruments. The specifications in columns 1-3 include only state, year of purchase, current year, and age fixed effects as covariates. Column 1 shows that higher current house prices strongly predict higher property values, with a t-statistic of 42. Conditioning on current prices, higher house prices at the time of purchase predict slightly lower current property values, confirming that individuals purchase smaller houses if they buy at times when prices are relatively high. Column 2 shows that higher current prices strongly predict higher home equity, showing that much of the increase in property value comes from higher home equity, as expected. Higher prices at the time of purchase strongly predict lower home equity, with a t-statistic of 18. Conversely, column 3 shows that higher prices at the time of purchase predict much larger mortgages. Higher current prices also predict (to a smaller extent) larger mortgages, an effect that may be driven by refinancing – when current prices are high, individuals tap into their home equity. Finally, columns 4-6 show that these first-stage effects remain similar when we include individual level controls for liquid wealth, income, education, and number of children and control for the local business cycle using the state unemployment rate in the current year as well as the year of home purchase. Overall, Table 2 indicates that the two instruments meet the first condition for consistency of IV estimation, namely that they are powerful determinants of mortgage and home equity even conditional on a rich set of covariates.

The exclusion restriction for these instruments is that changes in average state house prices are orthogonal to unobserved determinants of portfolio decisions (ε). There are two potential threats to the validity of this exclusion restriction. First, fluctuations in local housing markets could be correlated with fluctuations in labor market conditions, which might in turn directly influence portfolio choices. Second, the exclusion restriction could be violated via selection effects. People who buy houses when local prices are relatively high may have different risk preferences from those who buy when prices are lower. This could generate a spurious correlation between stock shares and house price indices. We implement auxiliary tests to evaluate these threats to our identification strategy after presenting a set of baseline results.

4.2 Results

Table 3 reports two-stage least squares estimates of β_3 and β_4 in (6), where home equity and property value are instrumented using the two OFHEO price indices. In column 1, we estimate the model including current year, year of purchase, age, and state fixed effects. The null hypothesis that changes in property value have no effect on financial portfolios is rejected with $p < 0.01$. The point estimate of the property value coefficient implies that a $100,000 increase in an individual's mortgage reduces his stock share of liquid wealth by 6.52 percentage points. To interpret the magnitude of this coefficient, note that the mean stock share in the analysis sample is 10% and the mean mortgage is $51,000. Hence, a 10% increase in mortgage debt ($5,100) is estimated to reduce stock shares by 0.33 percentage points, or 3.3%. Hence, the elasticity of the stock share of liquid wealth with respect to mortgage debt is approximately -0.33. As the theory predicts, individuals with more expensive houses hold more conservative financial portfolios when total wealth is held fixed.

The estimate of the home equity coefficient in column 1 implies that a $100,000 increase in home equity raises the stock share by 6.89 percentage points when total property value is held fixed. The mean home equity in the sample is $71,000, implying an elasticity of stock share of liquid wealth with respect to home equity wealth of approximately 0.47. Because property value is the sum of mortgage debt and home equity, the results imply that an increase in home equity holding fixed *mortgage debt* has no significant effect on portfolio allocations. It is therefore crucial to disentangle the two components of property value in order to uncover the effects of housing on portfolios. An implication is that the demand for risky assets will not covary with current house price fluctuations (because they affect both wealth and housing simultaneously), but will covary negatively with outstanding mortgage debt.

Column 2 of Table 2 replicates column 1 with the full set of covariates in addition to the fixed effects – liquid wealth spline, education, income, number of children, and the state unemployment rate in the current year as well as the year of home purchase. The estimates of the coefficients of interest are virtually unaffected by the inclusion of this set of controls. Since controlling for observed heterogeneity – including local economic conditions – has little impact on the estimates, one can be more confident that unobserved heterogeneity is unlikely to be driving the results. Moreover, because liquid wealth is held fixed in this specification, the results confirm that the changes in stock share are driven by the numerator (reductions in stocks) rather than changes in liquid wealth. Consistent with this result, we find using analogous regression specifications that increases in property value reduce dollars held in stock but do not have a significant effect on liquid wealth (not reported).

In columns 3-6, we decompose the effects of housing on stock shares into stock market participation decisions and intensive margin changes in portfolio weights. Column 3 replicates column 1, replacing the dependent variable with an indicator for owning stocks. A $100,000 increase in an individual's mortgage is estimated to reduce his probability of participating in the stock market by 14%, relative to a mean of approximately 28%. Hence, the elasticity of stock market participation with respect to mortgage debt is approximately -0.25. Conversely, increases in home equity wealth increase the probability of stock market participation by a similar magnitude. Column 4 shows that these stock market participation estimates are unaffected by the inclusion of additional controls.

Columns 5 and 6 isolate the intensive margin response – the change in stock shares conditional on participating in the stock market. These columns report estimates of two-stage Tobit specifications. These models are analogous to the two-stage-least-squares estimates, but correct for the fact that some individuals are non-participants using a Tobit specification where the stock share is left censored at 0.[4] The specification in column 5 includes only the fixed effects as covariates. The estimates imply that a $100,000 increase in the mortgage outstanding reduces stock shares for stock market participants by 20.6% relative to a base of 31%. This implies an intensive-margin elasticity of stock shares with respect to mortgage debt of -0.49. Home equity changes again have similar effects in the opposite direction. The estimates in column 6 confirm that these estimates are robust to the inclusion of additional covariates.

[4]Estimating a TSLS model only on the subsample of stock market participants leads to biased estimates because changes in home equity and mortgages affect stock market participation rates, generating selection effects.

The magnitude of the effects of housing on portfolios are large. Our estimates imply that forgiving all mortgage debt would raise stock market participation by 7 percentage points, or 25%. Conditional on holding stocks, eliminating mortgages would raise stock shares of portfolios by 10 percentages points, or 33% of the current level.

Robustness Checks. In Table 4, we evaluate the robustness of our estimates to alternative specifications and sample definitions. In column 1, we estimate the model in logs instead of levels for the independent variables. We instrument for log(property value) and log(home equity) with the logs of the two OFHEO price indices. We retain the stock share in levels on the left hand side because of the large number of individuals with 0 stock shares in our sample. We include the full set of fixed effects and other covariates. Consistent with the results in Table 4, the estimates reveal that increases in property value significantly reduce the share of stocks in liquid wealth while increases in home equity wealth increase stock shares.

Column 2 reports estimates from a specification where the endogenous regressors are also defined in shares, like the independent variable. We replace property value by the ratio of property value to liquid wealth and home equity by the ratio of home equity to liquid wealth. We then use the level of the two OFHEO price indices as in Table 4 as instruments for these ratios. The advantage of this approach is that we do not have to include liquid wealth as a separate regressor to control for liquid wealth, which is preferable because it is an endogenous variable. The disadvantage is that we introduce substantial outliers: there are many observations with near-zero liquid wealth and large property values. To reduce noise from these outliers, we exclude observations with ratios of property value or home equity to liquid wealth in the top 1%. The estimates are consistent with those obtained in Table 3, but less precisely estimated as expected because of the instability of the ratios.

In column 3, we replicate the baseline levels specification in column 2 of Table 3, but restrict the sample to individuals with more than $100,000 of total wealth. The objective of this specification is to assess whether the effects we have identified are also present amongst high-wealth households, whose behavior may be most relevant for financial market aggregates. The point estimate of the property value coefficient is very similar in magnitude to that in the full sample, although it is less precisely estimated because of the reduced sample size ($p < 0.1$). Housing remains an important determinant of portfolio choice even for wealthier households.

Threats to Identification. Having established that there is a robust relationship between mortgage debt and portfolios, we now return to the two threats to identification discussed in the previous subsection. In order to evaluate these concerns, it is useful to understand the reduced-form relationships underlying the two-stage-least-squares estimates above. Two reduced-form relationships drive the results in Tables 3 and 4. First, individuals who buy houses when housing prices are relatively high in their state hold less stocks in subsequent years. Second, homeowners' stock shares do not vary substantially with contemporaneous changes in housing prices. The first finding tells us that households with higher mortgage debt and lower home equity have lower stock shares. To determine which channel is responsible for the reduction in stockholding, we use the second finding, which shows that fluctuations in home equity have no effect on stock shares. This leads us to conclude that increases in mortgage debt reduce stockholding, as shown in Table 1.

The first threat to causal interpretation of the two reduced-form relationships is that fluctuations in current home prices are correlated with local labor market conditions that directly affect portfolio choice. Three points suggest that such effects are unlikely to be responsible for our findings. First, as shown above, controlling for the local business cycle using state unemployment rates has little effect on the estimates. In addition, residual fluctuations in local house prices conditional on the set of fixed effects are not correlated with fluctuations in income or labor force participation. In particular, we find insignificant coefficients on property value and home equity in regressions that replace the dependent variable in specification 2 of Table 3 by income or an indicator for working. Second, the estimates reported in columns 2 and 3 of Table 3 remain similar and statistically significant when we restrict the sample to older workers (above age 50), who are less exposed to fluctuations in local labor market conditions (not reported). Finally, the most plausible omitted variable stories would bias the estimated effect of current house prices on stock shares upward. The finding that current house prices have much smaller effects on portfolios than house prices at the time of purchase is unlikely to be spuriously generated by such biases.

The second threat to identification is that fluctuations in house prices at the time of purchase are correlated with portfolios because of selection effects. Individuals who buy when house prices are relatively high may tend to hold safer portfolios simply because they have different risk preferences. To evaluate whether this is the case, we turn to a smaller subsample of homeowners for whom we observe portfolios in the year *prior* to the date of home purchase. If our results are driven by selection, we should see that individuals who buy when prices are high hold more conservative portfolios even before they buy the house.[5] Because we only see portfolios in the year before home purchase, there is little difference between current house prices and prices in the year of purchase. We therefore fit models with a single endogenous regressor – property value at the time of purchase – and instrument for it with prices in the year of purchase.

Column 4 of Table 4 reports estimates of the "placebo" effect of future property value (in year $t+1$) on stock share in year t, where property value is instrumented using the local price index in the year of purchase. We include the same set of fixed effects and other covariates as in the full controls specifications above. The price index remains a very powerful instrument for property values at the time of purchase in this subsample: the coefficient on the price index in the first stage of this regression has a t-statistic of 10. However, in contrast with the results above, the point estimate in the two-stage-least-squares specification reported in Column 4 is positive and statistically insignificant. Fluctuations in prices at the time of house purchase are uncorrelated with portfolio allocations *prior* to the purchase of the house, contradicting the selection explanation.

For comparison, column 5 replicates the same specification as column 4 on the analysis sample of current homeowners. Here we find a large and statistically significant negative effect of owning a larger house on the stock share of liquid wealth, consistent with the evidence in Table 3. Finally, in column 6 we restrict attention to recent home buyers, who bought their current house within the past two years. Again, in the sample we find a statistically significant negative coefficient on property value. The difference in portfolios between individuals who buy when house prices are high and low emerges immediately *after* home purchase, suggesting that these differences are caused by the house itself and not intrinsic variation in risk preferences across individuals. We conclude that selection and omitted variables are less likely to be driving our findings than a causal effect of housing on portfolios.

[5] The most plausible form of selection is that individuals with lower risk aversion or less background risk buy houses when house prices are high. This would lead to a positive correlation between house prices in the year of purchase and stock shares. Such a correlation would bias the two-stage-least-squares estimates in Table 3 toward zero.

Commitments vs. House Price Risk. The model shows that there are two reasons why larger mortgages and property values may induce households to hold safer portfolios: (1) greater exposure to house price risk and (2) a larger consumption commitment. We now present some suggestive evidence to distinguish between these two channels. The tests we implement are motivated by the comparative statics of the portfolio choice equation in (2). We examine how the effect of housing on portfolios covaries with the volatility of the local housing market and the household's adjustment costs. The house price risk channel predicts that owning a larger house should have a larger effect on stock shares in riskier markets, while the commitment channel predicts that the effect should be larger for households that face higher adjustment costs.

Columns 1 and 2 of Table 5 test for differential effects of housing on portfolio choice by the riskiness of the local housing market. We first compute the standard deviation of annual house price growth rates using the OFHEO data by state. States with above-median volatility are classified as "high risk," while the remainder are classified as "low risk." The standard deviation of annual house price growth rates is 3.7% in low risk states, compared with 6.1% in high risk states. To test whether the effects of housing on portfolios differ in high vs. low risk environments, we interact the high risk indicator with property value and home equity and estimate a specification analogous to (6). We instrument for the interaction effects using the interactions of the two OFHEO price indices and the high risk indicator. We use the same set of covariates as in the full controls specifications above and also include the high risk indicator directly. The coefficient estimates in column 1 imply that a $10,000 increase in property value reduces the stock share of liquid wealth by 8.3%. The coefficient on the interaction between property value and the high risk indicator has a coefficient of +1.3% and is statistically insignificant. Similarly, the interaction of home equity and the risk indicator is near zero and insignificant. Hence, housing appears to have a similar effect on portfolios in low and high risk states. Column 2 replicates the specification in column 1 but replaces the dependent variable with an indicator for owning stocks. Consistent with the stock share results, housing has a substantial and statistically significant effect on stock market participation, but does not have a differential effect in low- and high-risk states.

Next, we test for differential effects of housing on portfolios by the household's adjustment costs. Because we do not directly observe adjustment costs, we proxy for them using predicted home tenures (number of years spent living in a house). We regress household's tenures on the full set of covariates above, excluding the year of home purchase. We then predict home tenure for each household in the sample using the estimated coefficients. We classify households with predicted home tenures above the median (9 years) as "high adjustment cost" and the remaining households as "low adjustment cost." On average, high adjustment cost households live in their houses for 11.8 years, compared with 5.6 years for low adjustment costs households. Columns 3 and 4 replicate columns 1 and 2 of Table 5, replacing the high risk indicator with the high adjustment cost indicator. The interaction effects are instrumented for using interactions of the two OFHEO price indices and the high adjustment cost indicator. The coefficient estimates imply that a $10,000 increase in property value reduces the stock share by 4.5% for low adjustment cost households and by 8% for high adjustment cost households. Consistent with the prediction of the commitment model, the elasticity of stockholding with respect to housing is nearly 75% larger for households with high adjustment costs.[6] Similarly, changes in home equity also have larger effects on portfolios for households with high adjustment costs. The interactions of home equity and property value with the high adjustment cost indicator are both significant with $p < 0.05$. Column 4 shows that results for stock market participation are similar: owning a more expensive house reduces the probability of stock market participation significantly for more households who are unlikely to move.

Although not conclusive, these auxiliary tests point in favor of the commitment effect as the main explanation for why having more housing induces households to hold safer portfolios. House price risk may have small effects on portfolios because most households are well hedged against house price risk (Sinai and Souleles 2005). This evidence suggests that the housing may induce individuals to invest less in stocks particularly during periods when the housing market is illiquid and mobility rates are low.

5 Conclusion

This paper has characterized the effect of housing on portfolio choice empirically. We find that holding more mortgage debt, holding wealth fixed, reduces a household's propensity to

[6] Consistent with the results of the two tests, the model predicts that higher adjustment costs will amplify the coefficient on housing precisely when the effect of home price risk on portfolios (κ) is small.

participate in the stock market and reduces the share of stocks in the portfolio conditional on participation. The elasticity of the share of liquid wealth allocated to stocks with respect to mortgage debt is approximately -0.33. An increase in home equity wealth while holding fixed property value increases stockholding. The elasticity of the stock share of liquid wealth with respect to home equity is approximately 0.47. These elasticities are larger for households with larger adjustment costs, but similar across high and low-risk housing markets. Overall, the evidence confirms the prediction of theoretical models and simulations such as that of Flavin and Yamashita (2002) and Cocco (2005), which predict that housing has substantial effect on financial portfolios. Our empirical results indicate that housing should indeed be a central element of portfolio choice and asset price models.

The evidence in this paper suggests that the interaction between housing and financial markets could have important consequences for the macroeconomy. In the recent past, there have been three rapid changes in housing markets: a substantial increase in mortgage debt, a rapid decline in property values, and a substantial increase in the illiquidity of housing as many individuals postpone selling their homes. Our empirical evidence suggests that each of these factors induces households to withdraw funds from stocks. Hence, recent changes in the housing market could potentially have reduced the demand for risky assets and exacerbated the decline in financial markets. In future work, it would be interesting to explore whether such interactions are consistent with historical fluctuations in housing and asset prices using calibrated general equilibrium models. Our analysis also suggests that housing amplifies the welfare costs of shocks, making households more risk averse. It would be valuable to explore methods of mitigating the effects of housing on risk preferences, e.g. by reducing transaction costs in the housing market. Such efforts could both raise individual welfare and allow households to improve their allocations of risk and return.

Appendix

Proof of Proposition 1. The total amount of resources available at $t = 1$ is

$$W_1 = L_1 + Y + p_1 h_0 - M$$

where L_1 is liquid wealth, Y is labor income, p_1 is the price per unit of housing, and M is mortgage. Out of this wealth, the consumer has committed buying Tx_0 units of the commitment good, which has a dollar cost of $T \cdot (p_1/T)\, h_0\theta$ since p_1/T is the per period price of housing. Thus, disposable wealth that can be spent on adjustable consumption is

$$W_1^D = L_1 + Y + p_1 h_0 - M - T \cdot (p_1/T)\, h_0 \theta.$$

The present value of this risky payoff at date zero is

$$W_0^D = L_0 + Y + p_0 h_0 - M - p_0 h_0 \theta$$

where L_0 is initial liquid wealth. The consumer's investment problem can now be broken into two parts. First, to finance commitment consumption, the consumer holds a portfolio that generates $p_1 h_0 \theta$ in date $t = 1$. This requires dollar stockholdings of $\kappa\theta p_0 h_0$ because of our assumption that $p_1/p_0 = 1 + \kappa R$.

Second, the consumer invests optimally out of W_0^D to finance adjustable consumption. We now solve for this optimal choice. Denote the relative price of renting by $q = p_1/T$. Cobb-Douglas preferences and the absence of discounting imply that the optimal choice of f and y in every period are

$$f_t = \frac{W_1^D}{T} \cdot \frac{\mu_f}{\mu_f + \mu_a} \text{ and } y_t = \frac{1}{q}\frac{W_1^D}{T} \cdot \frac{\mu_a}{\mu_f + \mu_a}.$$

Noting that $q = (1 + \kappa R)\, p_0/T$, the value function over adjustable consumption is proportional to

$$\frac{\left(W_1^D\right)^{\mu_f + \mu_x}}{(1 + \kappa R)^{\mu_x}}$$

where the denominator represents the relative price risk.

Now write $W_1 = (1 + \alpha R)\, W_0$ where W_0^D to find the optimal portfolio share out of disposable wealth α. We need to maximize

$$\frac{(1+\alpha R)^{\left(\mu_f+\mu_x\right)(1-\gamma)}}{(1+\kappa R)^{\mu_x(1-\gamma)}}.$$

Following Campbell and Viceira (2002), we solve this optimization problem using lognormal approximations. Assuming lognormality of both $1+\alpha R$ and $1+\kappa R$, our maximization problem is equivalent to

$$\max_{\alpha} \mathrm{E}r_p + \frac{1}{2}(1-\gamma)\left(\mu_f+\mu_x\right)\sigma_p^2 - (1-\gamma)\mu_x \mathrm{cov}\left[r_p, r_h\right]$$

where $r_h = \log(1+\kappa R)$. Using the approximations

$$\begin{aligned} r_p &= \alpha r + \frac{1}{2}\alpha(1-\alpha)\sigma^2 \\ r_h &= \kappa r + \frac{1}{2}\kappa(1-\kappa)\sigma^2 \end{aligned}$$

of Campbell and Viceira, we obtain a linear-quadratic problem in α which yields

$$\alpha = \frac{\left[\mathrm{E}r + \frac{1}{2}\sigma^2\right] - (1-\gamma)\mu_x \cdot \kappa\sigma^2}{\sigma^2\left[1-(1-\gamma)\left(\mu_f+\mu_x\right)\right]}.$$

The optimal dollar amount invested in stocks is the sum of stocks used to finance adjustable and housing consumption, i.e., $\alpha W_0^D + \kappa\theta p_0 h_0$. However, the household is already holding some stocks implicitly in the form of the house. This stock exposure corresponds to a implicit dollar stockholding of $\kappa p_0 h_0$. Thus the optimal portfolio share of stocks out of liquid wealth is

$$\alpha^* = \alpha\frac{L_0+Y+p_0h_0-M}{L_0} - \alpha\theta\frac{p_0h_0}{L_0} - \kappa(1-\theta)\frac{p_0h_0}{L_0}$$

which is the expression given in the proposition, with $C_1 = \alpha$ and $C_2 = 1-\theta$.

Derivation of mortgage equation. We assume a share θ of all mortgage payments M_{BC} due during the borrowing horizon are over the commitment good; so if $\theta = 0$, the agent has no committed expenditures. Disposable wealth available to the agent in period 1 is therefore

$$W_1^D = L_1 + Y_{BC} - \theta M_{BC},$$

the present value of which at date zero is

$$W_0^D = L_0 + Y_{BC} - \theta M_{BC}.$$

The agent uses this amount to finance adjustable consumption, and invests θM_{BC} in the safe asset to finance mortgage payments. The optimal share of stocks out of liquid wealth is thus

$$C_1 \cdot \frac{L_0 + Y_{BC} - \theta M_{BC}}{L_0}.$$

Equation (3) follows directly.

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TABLE 1
Summary Statistics for SIPP Analysis Sample

Variable	Mean (1)	Median (2)	Standard Deviation (3)
Property value ($)	122,682.40	96,860.94	90,622.69
Home equity ($)	71,226.95	48,430.47	73,352.17
Mortgage ($)	51,455.43	41,511.83	51,130.21
Liquid wealth ($)	62,602.71	12,210.73	535,341.10
Total wealth ($)	166,517.40	89,932.08	567,910.20
Percent of households holding stock	27.22%	0.00%	44.51%
Stock share (% of liquid wealth)	10.62%	0.00%	23.76%
Safe assets share (% of liquid wealth)	37.93%	22.22%	38.55%
Income ($)	46,882.68	38,503.40	41,032.21
Age (years)	47.74	46.00	13.92
Home tenure (years)	8.49	7.00	6.70
Years of education	13.52	13.00	2.82
Number of children	0.66	0.00	1.04

Notes: The table lists means, medians, and standard deviations for the analysis sample of 69,164 housholds. All monetary values are expressed in real 1990 dollars. Home tenure is defined as numbers of years living in current house.

TABLE 2
First Stage Regression Estimates

	Only Fixed Effects			Full Controls		
Dependent Variable.:	Prop Val	Home Equity	Mortgage	Prop Val	Home Equity	Mortgage
	($)	($)	($)	($)	($)	($)
	(1)	(2)	(3)	(4)	(5)	(6)
OFHEO state house price index in current year	377.52	326.01	51.50	345.49	296.19	49.30
	(9.06)	(7.61)	(4.97)	(8.70)	(7.73)	(5.07)
	[41.68]	[42.84]	[10.36]	[39.70]	[38.32]	[9.73]
OFHEO state house price index in year of purchase	-54.89	-187.05	132.16	-43.22	-172.20	128.98
	(11.76)	(9.88)	(6.46)	(10.93)	(9.70)	(6.36)
	[-4.67]	[-18.92]	[20.46]	[-3.96]	[-17.75]	[20.27]
Observations	69,164	69,164	69,164	67,067	67,067	67,067

Notes: Standard errors in parentheses and t-statistics in square brackets. Specifications 1-3 include fixed effects for household state of residence, current year (year in which portfolio allocations and current property value are measured), year in which individual purchased his house, and the individual's year of birth. Specifications 4-6 include these fixed effects as well as a 10-piece linear spline for liquid wealth, income, education, number of children, and state unemployment rate in current year as well as year of home purchase.

TABLE 3
Effect of Housing on Portfolio Choice: Instrumental Variable Estimates

	Two-Stage Least Squares				Two-step Tobit	
Dep. Var.:	Stock Share	Stock Share	Stock-Holder	Stock-Holder	Stock Share	Stock Share
Controls:	FE's only	Full	FE's only	Full	FE's only	Full
	(%)	(%)	(%)	(%)	(%)	(%)
	(1)	(2)	(3)	(4)	(5)	(6)
Property val.	-6.52	-6.86	-13.78	-14.86	-20.60	-16.68
(x $100K)	(2.19)	(2.14)	(4.13)	(3.75)	(7.69)	(7.38)
Home equity	6.89	4.74	14.60	10.62	24.21	18.75
(x $100K)	(2.53)	(2.51)	(4.77)	(4.40)	(8.77)	(8.53)
Obs.	69,164	67,067	69,164	67,067	69,164	67,067

Notes: Standard errors in parentheses. Specifications 1, 3, and 5 include fixed effects for household state of residence, current year (year in which portfolio allocations and current property value are measured), year in which individual purchased his house, and the individual's year of birth. Specification 2, 4, and 6 include these fixed effects as well as a 10-piece linear spline for liquid wealth, income, education, number of children, and state unemployment rate in current year as well as year of home purchase. Dependent variables in specifications 1-2 and 4-6 is dollars held in stocks divided by liquid (non-housing) wealth. Dependent variable in specifications 3 and 4 is an indicator for holding stocks. Specifications 1-4 are estimated using two-stage least squares; specifications 5 and 6 are estimates of a Tobit model with endogenous regressors using Newey's two-step estimator. Instruments for property value and home equity are the current-year and year of purchase OFHEO state price indices in all specifications. Coefficients can be interpreted as percentage point effect of a $100,000 change in property value and home equity.

TABLE 4
Robustness Checks and Selection Tests

	Dependent Variable: Stock Share of Liquid Wealth					
Specification:	Logs (%) (1)	Shares (%) (2)	High Wealth (%) (3)	Future Homebuyers (%) (4)	Full Sample (%) (5)	Home Owned < 2 yrs (%) (6)
log prop value	-21.78					
(x $100K)	(8.67)					
log home equity	8.56					
(x $100K)	(4.48)					
Prop val/liq wealth		-4.00				
(x $100K)		(1.91)				
Home eq/liq wlth		3.14				
(x $100K)		(1.63)				
Property value			-6.79	2.32	-9.89	-5.46
(x $100K)			(4.19)	(3.00)	(3.83)	(2.51)
Home equity			9.93			
(x $100K)			(5.38)			
Observations	67,067	46,871	31,039	6,145	67,627	14,397

Notes: Standard errors in parentheses. All specifications report two-stage-least square estimates and include fixed effects for state of residence, current year, year of home purchase, and year of birth. Specifications 1, 3, and 4-6 also include a 10-piece linear spline for liquid wealth, income, education, number of children, and state unemployment rate in current year as well as year of home purchase. Instruments for property value and home equity are the current-year and year of purchase OFHEO state price indices in specifications 2-3; in specification 1, we instrument for the logs of these variables with the logs of the price indices. In specification 2, the endogenous regressors are the ratio of property value to liquid wealth and the ratio of home equity to liquid wealth. Specification 3 replicates column 2 of Table 3, but restricts the sample to individuals with total wealth above $100,000. Specification 4 tests for selection effects using the sample of future home buyers, who buy homes in the year after portfolio shares are observed. This specification estimates the effect of property value in year t+1 on stock share in year t, where property value is instrumented using the local price index in the year of purchase. Specification 5 replicates 4 on the analysis sample of current homeowners. Specification 6 replicates 5 restricting the sample to those who bought their current house within the past two years.

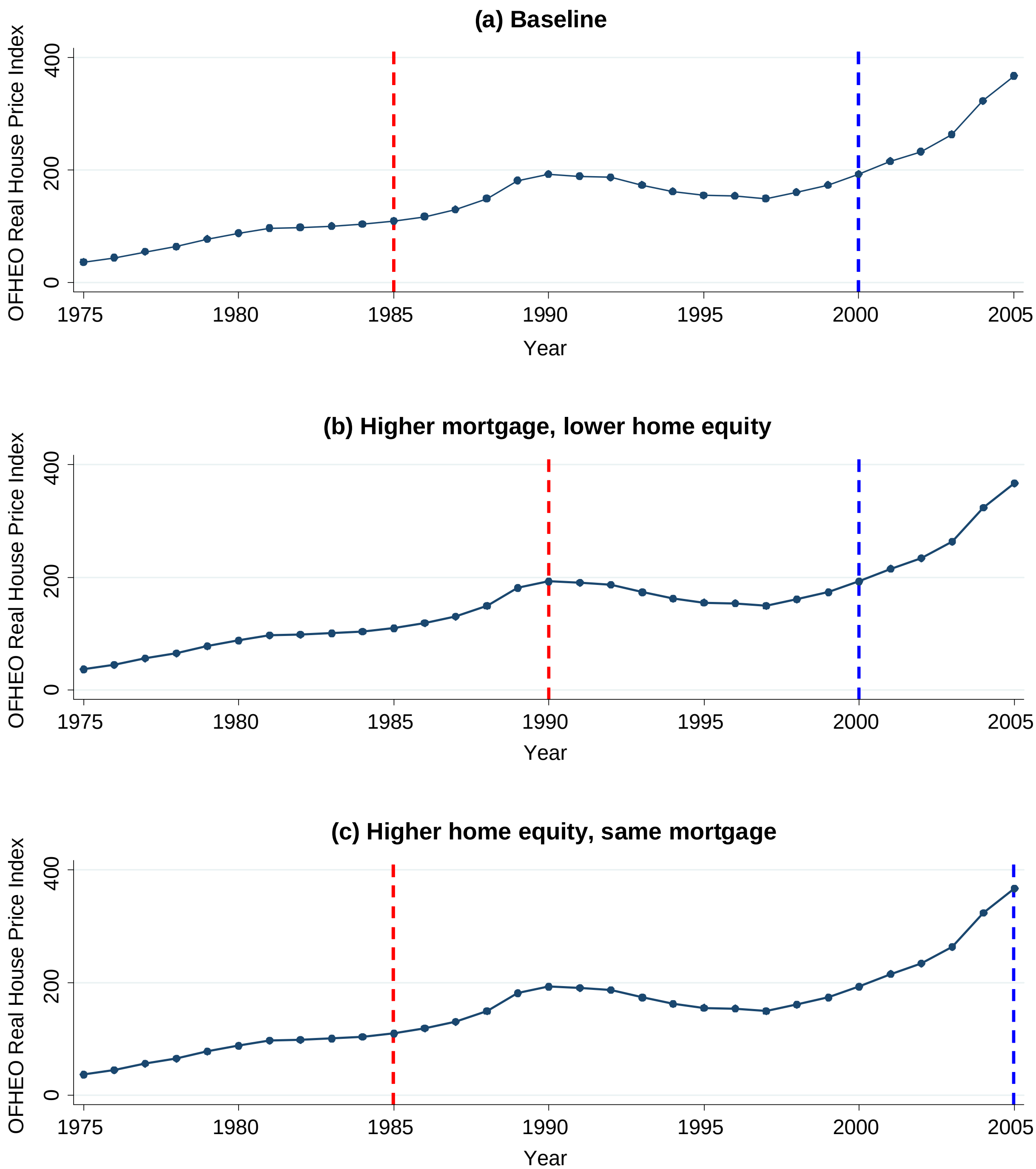
TABLE 5
House Price Risk vs. Commitment Effects

	Price Risk Interactions		Adj. Cost Interactions	
Dep. Var.:	Stock Share (%)	Stockholder (%)	Stock Share (%)	Stockholder (%)
	(1)	(2)	(3)	(4)
Property value (x $100K)	-8.93	-19.02	-4.48	-10.90
	(2.44)	(4.53)	(1.87)	(3.28)
Home equity (x $100K)	5.74	12.56	0.09	4.00
	(2.93)	(5.14)	(2.46)	(4.32)
High risk x prop val (x $100K)	1.52	3.05		
	(1.10)	(1.94)		
High risk x home equity (x $100K)	-0.44	-0.81		
	(1.22)	(2.13)		
High adj cost x prop value (x $100K)			-3.57	-8.56
			(1.78)	(3.12)
High adj cost x home equity (x $100K)			6.72	13.02
			(2.45)	(4.29)
Observations	67,067	67,067	67,067	67,067

Notes: Standard errors in parentheses. All specifications report two-stage-least square estimates where the instruments for property value and home equity are the current-year and year of purchase OFHEO state price indices. All specifications include fixed effects for household state of residence, current year (year in which portfolio allocations and current property value are measured), year in which individual purchased his house, the individual's year of birth, a 10-piece linear spline for liquid wealth, income, education, number of children, and state unemployment rate in current year as well as year of home purchase. In specifications 1 and 2, high risk is an indicator for whether the individual lives in a state whose standard deviation of house prices as computed based on the OFHEO index exceeds the median. These specifications include the high risk indicator and interactions of high risk with the property value and home equity variables. The instruments for the interactions are the interactions of the two price indices with the high risk indicator. Specifications 3 and 4 replicate 1 and 2, replacing the high risk indicator with a high adjustment cost indicator. The high adjustment cost indicator is defined to be 1 for households with predicted home tenures above the median, where home tenure is predicted for each household in the sample using the coefficients estimated from a regression of a household's tenures on the full set of covariates above, excluding the year of home purchase. The dependent variable is the stock share of liquid wealth in specifications 1 and 3 and an indicator for holding stocks in specifications 2 and 4.

FIGURE 1

Real Housing Prices in California, 1975-2005



NOTE–This figure illustrates our identification strategy by showing the OFHEO real housing price index in California from 1975 to 2005. Panel A depicts an individual who buys a house in 1985 and whose portfolio is observed in 2000. Panel B shows an individual who buys the same house in 1990 instead of 1985, and has approximately $100,000 more mortgage debt when observed in 2000 as a result. Panel C shows an individual who buys in 1985 and is observed in 2005. This individual has approximately $175,000 more home equity than individual A.