House Prices and Risk Sharing*

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Abstract

Homeowners in the Panel Study of Income Dynamics are able to maintain a high level of consumption following job loss (or disability) in periods of rising local house prices while the consumption drop for homeowners who lose their job in times of lower house prices is substantial. These results are consistent with homeowners being able to access wealth gains when housing appreciates as witnessed by their ability to smooth consumption more than renters. A calibrated model of endogenous homeownership and consumption is able to reproduce the patterns in the data quite well and provides an interpretation of the empirical results.

Keywords: Job displacement; Disability; Housing collateral.

JEL Classification: D91, E21.

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1. Introduction

Many countries, including the United States, experienced large fluctuations in house prices over the last decade. For example, house prices increased by 75 percent from 2001 to 2005 in the Providence, R.I., Metropolitan Statistical Area (MSA), while Los Angeles, on the opposite coast, saw a gain of 91 percent.[1] However, Providence house prices declined by 18 percent from 2006 to 2010, while those of Los Angeles fell even more, by 22 percent. As housing is the largest asset for most families, such price movements are associated with large swings in consumers' net worth and it is of first-order importance to understand the impact of these fluctuations on consumption.

Homeowners are able to maintain their level of nondurable consumption after income losses when house prices are increasing, but during deep recessions, such as the subprime crisis that started in 2007, the drop in consumption can be severe for homeowners who become displaced or disabled. Our point estimates imply that job displacement for a homeowner in the Providence MSA would result in a drop in nondurable consumption during 2006–2010 that is more than 28 percentage points larger over this four-year period than it would have been during 2001–2005.[2] The effect of house prices would be even larger in cities such as Los Angeles and housing depreciation is likely to be a severe drag on the recovery of the aggregate U.S. economy from the subprime crisis.

The individual-level data is from the Panel Study of Income Dynamics (PSID) and the focus is to study consumption changes following the onset of disability or job displacement (arguably exogenous shocks to income). In particular, we investigate households' ability to maintain—"smooth"—consumption in the face of such shocks, and the empirical focus is on deviations from countrywide fluctuations, or "risk sharing." Risk sharing is interesting

[1] First quarter data from the Federal Housing Finance Agency (FHFA), formerly known as the Office of Federal Housing Enterprise Oversight.

[2] These numbers are calculated using Table 1, column (2).

per se and focusing on risk sharing allows us to abstract from a host of difficult-to-control-for aggregate variables that may affect consumption. House-price appreciation arguably provides exogenous shocks to homeowners' wealth and collateral and the main contribution is to study how risk sharing varies with house-price appreciation by matching PSID data and house price data at the metropolitan level from the FHFA. The core empirical result is that homeowners maintain relatively higher (lower) levels of nondurable consumption after job displacement or disability when house values increase (decrease).

To interpret the findings, we calibrate and simulate a life-cycle model of households with preferences for housing (shelter) and nondurable consumption. The model captures the main features of homeownership—in particular the role of housing as both a consumption good and an asset: homeownership is endogenous and housing services can be obtained either in the rental market or through homeownership. Households adjust (nondurable, non-housing) consumption, and possibly housing, in response to income fluctuations although buying or selling a house requires paying a proportional commission. This makes the effect of house price shocks more complicated than the effect of liquid wealth shocks, such as winning the lottery. For homeowners with housing equity above a minimum down payment, a positive capital gain in housing is fully liquid—although the household may choose to upgrade to a larger house while paying a proportional commission. Homeowners who own less than the minimum down payment will only be able to access capital gains in housing if housing appreciation pushes their equity above the required minimum. In the face of a persistent negative shock to housing, a homeowner may choose to downsize or move to rental housing—in particular, if the shock happens at the same time as a persistent income loss.

Panel-data regressions are performed on simulated data in the same fashion as on the real data and the estimated parameters from the real and simulated data are compared, and—to the degree that magnitudes match—interpreted. The simulations show that homeowners maintain consumption better than renters when the relative price of housing increases.

The model leaves out many real-world complications; nonetheless, the predictions of the model match the results from the PSID well. We do not attempt to structurally fit the model as Li, Liu and Yao (2009) who have a different focus but use a similar model. The disadvantage of the present approach, compared with a structural approach, is that one cannot test the model. The advantage is that the empirical findings are robust to many forms of model misspecification.

Related work has attempted to measure the direct impact of housing appreciation on consumption—typically under the label of "wealth effects." Because national house prices correlate with economic conditions in general, the quantification of the effect of house prices on consumption remains controversial. The most promising avenue seems to be regressions that rely on regional house prices as pioneered by Attanasio and Weber (1994)—such regressions allow for control of nationwide effects. Further, these authors simulate a theoretical model to evaluate the plausibility of their empirical estimates. Two papers in that vein are Campbell and Cocco (2007), who find evidence of a wealth effect, and Attanasio, Blow, Hamilton and Leicester (2009), who argue that common causality is a more likely explanation for the patterns of consumption and house-price growth in the United Kingdom. Like these authors, this article uses regional house prices and compares renters to owners, and young households to old households.

Several other papers are related to the present article: Hurst and Stafford (2004) document that house equity is used as a mechanism to smooth income shocks due to unemployment. Their empirical focus is on the decision to refinance while this work directly considers consumption. Lustig and Van Nieuwerburgh (2010) find more risk sharing between U.S. metropolitan areas in periods when average U.S. house-price appreciation is high.[5] Chetty and Szeidl (2007) study consumption patterns when a part of wealth is "committed" and cannot be easily adjusted as is the case for our consumers in the sense that it is costly to adjust housing consumption. Finally, Leth-Petersen (2010) considers the effect of increasing the ability to use housing as collateral by studying the effect of an exogenous relaxation of home-equity lending restrictions in Denmark.

The empirical strategy is described in Section 2 while the data and empirical estimations are presented in Section 3. The theoretical model and its implications are in Section 4 while Section 5 reports the results of regressions using simulated data. Section 6 concludes.

2. Regression specification

In an endowment economy with one nondurable good and complete Arrow-Debreu markets, all consumers will have identical consumption growth rates if they have identical constant relative risk aversion preferences. Mace (1991) tests this prediction in a panel-data regression of consumption on income with controls for aggregate effects while Cochrane (1991) examines whether consumers are fully hedged against job loss. Let $z_{it} = \log Z_{it} - \log Z_{it-4}$ be the growth rate of a generic variable Z, such as consumption C, of individual i from year $t-4$ to t, and let $\bar{z}_t$ be the period t specific mean of any generic variable z. Let hp_{mt} be the four-year growth rate of house prices in the metropolitan area m where individual i lives and let D_{it} be a dummy taking the value 1 if the head of household i suffers displacement and 0 otherwise. Alternatively, D_{it} is an indicator that takes the value 1 at the onset of disability, –1 if the household head exits from disability,

[5] Lustig and Van Nieuwerburgh (2010) consider the role of housing collateral in a general equilibrium model with state-contingent claims. However, they use U.S. regional data and do not consider renters versus homeowners.

and 0 otherwise. Pooling data from regions with different house-price appreciation, the impact of job loss (disability) on consumption and the risk-sharing role of housing in the face of job displacement (disability) is evaluated by estimating the relation

$$c_{it} - \bar{c}_t = \mu + \beta\,(hp_{mt} - \overline{hp}_t) + \xi\,(D_{it} - \bar{D}_t) + \zeta\,(D_{it} - \bar{D}_t) \times (hp_{mt} - \overline{hp}_t) + (X_{it} - \bar{X}_t)'\delta + \varepsilon_{it}\,, \tag{1}$$

where X_{it} is a vector of controls (age, the square of age, and family size). The time-specific mean is subtracted from all variables because the subtraction of the aggregate non-diversifiable component gives all estimated coefficients the interpretation of showing deviations from perfect risk sharing. In particular, by subtracting $\overline{hp}_t$ from hp_{mt}, the nationwide average house-price appreciation is removed from the time-varying coefficient. The time-series variation in average house prices is likely correlated with other aggregate variables, such as stock market performance, and we want to hedge against house prices capturing such variables. Here, the derivative of idiosyncratic consumption growth with respect to a disability (displacement) shock is $\xi + \zeta(hp_{mt} - \overline{hp}_t)$, which would be 0 under perfect risk sharing. When these coefficients are not 0, a positive coefficient of ζ implies that house-price appreciation dampens the effect of displacement on consumption growth—that is, risk sharing goes up with house-price appreciation. The regressions are similar to those of Cochrane (1991) with a house-price interaction added.[8] Briefly, under full insurance of nondurable consumption and housing services, deviations of idiosyncratic consumption growth from the nationwide average should be orthogonal to idiosyncratic shocks to income such as disability or displacement. This should also be true for the interaction term of idiosyncratic income shocks with regional house-price growth, assuming

[8] Cochrane (1991) estimates cross-sectional regressions but panel data regressions with time fixed effects can be seen as weighted averages of cross-sections. Cochrane's definition of involuntary job-loss is essentially the same as the present definition of "displaced" and the regressions confirm his results. (Cochrane (1991) also leaves out income.)

house prices are uncorrelated with measurement error in consumption and shocks to the relative taste for consumption of nondurables and housing services. That is, under the null of full insurance, the coefficients β, ξ, and ζ should be equal to zero. If, however, risks to nondurable consumption are shared nationally but risks to consumption of housing services are shared only within a region, only $\hat{\xi}$ and $\hat{\zeta}$ should be statistically indistinguishable from zero. See Appendix A for more detailed interpretation of equation (1).[9]

3. Empirical estimations

Individual- and household-level data is from the PSID, which is a longitudinal study of U.S. households, and this section provides a brief description of the estimation sample.[11]

The PSID maintains Geocode Match Files, which contain identifiers necessary to link the main PSID data to Census data allowing for adding data on characteristics of each respondent's neighborhood to the already rich array of socioeconomic variables collected in the PSID.[12] Households are matched to their MSA of residence and house-price appreciation is at the metropolitan level.

Food consumption is used as the measure of consumption because of a lack of broader consumption aggregate, although results are also shown for imputed nondurable consumption. Food consumption consists of food consumed at home and away from home (excluding food purchased at work or school). Household income is the sum of real labor and transfer income of head and wife before taxes. Food consumption at home and away from home and household income are deflated by the all-items-less-housing consumer price index (CPI) from the Bureau of Labor Statistics.

[9] Appendices with supplemental material are available on Science Direct.

[11] For more details on sample selection, see Appendix B.

[12] The Geocode Match data is highly sensitive (usually pinpointing the census tract in which families live), and is available only under special contractual conditions designed to protect the anonymity of respondents.

A household head is considered displaced if the head's "previous company folded or changed hands or moved out of town; employer died, went out of business," because of "strike, lockout," or because the head was "laid off/fired."[13] The disability variable is constructed from two questions typically referred to as "limiting conditions."[14] The first asks: "Do you (head) have any physical or nervous condition that limits the type of work or amount of work you can do?" The second question asks: "How much does it limit your work?" The head is considered to be disabled if he or she answers yes to the first question and states "can do nothing " or indicates that disability limits the ability to work somewhat or a lot.

Because food consumption is imprecisely measured at the annual frequency, four-year (overlapping) growth rates are used. This choice reduces measurement error and averages out temporary fluctuations in income and consumption. Economists typically agree that longer-lasting ("permanent") shocks matter more for welfare, so little is lost by looking at the longer frequencies where permanent shocks are relatively more important.[16]

In the regressions, the disability variable enters as 0 if there was no change in the disability status from period $t-4$ to t, as 1 if the head reports disability at t but not at $t-4$, and as –1 if the head reports disability at $t-4$ but not at t. The displacement variable enters as 1 if the head reports being displaced in year $t-3$, $t-2$, $t-1$, or t. When presenting results by housing tenure status, a homeowner (renter) is a household that owned a house (rented) in all periods involved in calculating the consumption growth rate.

The analysis is restricted to families with stable composition (same head and wife during the four-year span), whose head of household is of prime age (25–65) with infor-

[13]The PSID did not collect information on displacement during the 1994–1997 waves.

[14]In 1973, 1974, and 1975, only new heads were asked these questions. In cases where the answer in one of those years is missing, the value is imputed using the answer from a preceding year.

[16]Cochrane (1991) uses three-year growth rates, similar to our frequency. An even number of years is used here to match up with the biennial sampling frequency initiated by the PSID in 1997.

mation on housing status and region of residence during the four-year span. The Latino and Immigrant samples of the PSID are excluded but households from the representative core sample and the Survey of Economic Opportunities (SEO), the sub-sample of low income households, are included. The sample is also restricted to households that reside in the same metropolitan area during a given four-year period so they can meaningfully be assigned four-year MSA house-price changes—households that move within the MSA remain in the sample.

<u>Total (imputed) nondurable consumption.</u> Consumer research typically focuses on the response of total nondurable consumption and Blundell, Pistaferri and Preston (2008) impute nondurable consumption of PSID households in a study of consumption and income inequality. Using data from the Bureau of Labor Statistics' Consumer Expenditure Survey (CEX) for 1980–1992, these authors estimate a structural equation for food consumption as a function of nondurable consumption and demographics and invert the estimated equation to obtain a measure of nondurable consumption for PSID households. We follow their imputation strategy using extracts of the CEX for 1980–2002 from the NBER.

In the CEX, households report at most four quarterly observations on consumption components and only households that respond in all four quarters are included. If consumption is recorded in years t and $t+1$, annual consumption is assumed to refer to year t if that year contains at least six months of records and to year $t+1$ otherwise.[18] The final CEX sample consists of households with heads 25–65 years old and born between 1915 and 1978. Nondurable consumption is the sum of annual expenditures on food, alcohol and tobacco, clothes and personal care, domestic services, transportation, entertainment,

[18] In the PSID, males are considered household heads, while in the CEX the head is the person who rents or owns the residential unit. To make the definitions of heads compatible, the male is assigned to be the head for CEX couples. Households whose heads are part-time or full-time college students are dropped. As for the PSID sample, observations with zero or missing records for food consumption at home are dropped and the annual distribution of total food is trimmed at the 1st and the 99th percentiles.

gambling and charity, and utilities.[19]

House-price appreciation. MSA house-prices are from the FHFA, which reports quarterly house-price indices for single-family detached properties.[21] Merging FHFA data with PSID data results in a sample that covers 1976–2005. The overall (four-year) mean house-price appreciation is 6 percent, with a 19 percent standard deviation while median house-price appreciation is lower at 4 percent. There is rich variation across MSAs and over time during this period. Three of the MSAs with lowest house-price appreciation during the period are Binghamton, Houston, and New Orleans, which have mean (standard deviation) appreciation of –7.7 (13.5), –5.7 (14.5), and –3.3 (13.4) percent, respectively. Three of the MSAs with the highest house-price appreciation are the Boston, San Francisco, and New York City areas, at 15.3 (28.2), 14.7 (22.9), and 11.5 (24.5), respectively.[22]

3.1. Estimation results

The regressions described in Section 2 are estimated using a two-stage Prais-Winsten GLS procedure, which is efficient in the case of first-order autocorrelation; the observations

[19] Table A-3 reports the results of an IV-regression of food consumption on nondurable consumption, demographic controls, and prices. In an OLS setting, the estimated elasticities may be biased because of measurement error in nondurable consumption and because of endogeneity of food and nondurable consumption. The regressions follow Blundell et al. (2008) and instrument log-nondurable consumption (and its interactions with year and education dummies) with the head's sex-education-year-cohort specific averages of log hourly wages (and their interactions with year and education dummies). The estimated coefficients in Table A-3 are used to impute nondurable (non-housing) consumption to PSID households for 1980–2002.

[21] The agency bases these reports on data on conventional conforming mortgage transactions obtained from the Federal Home Loan Mortgage Corporation (Freddie Mac) and the Federal National Mortgage Association (Fannie Mae). The house-price indices are based on the methodology proposed by Case and Shiller (1989) deflated by the all-items-less-housing CPI. The index for each geographic area is estimated using repeated observations of housing values for individual single-family residential properties on which at least two mortgages were purchased or securitized by either Freddie Mac or Fannie Mae since January 1975.

[22] See Appendix C for more details.

are overlapping and therefore, by construction, autocorrelated.[23] The standard errors are calculated using robust clustering at the MSA level.

The range of four-year log differences of consumption is between –1.8 and 1.7, while that of income is even larger. House prices also show large deviations from the U.S. mean. On average, about 12 percent of the sample receives a displacement shock during a four-year time span, while 5 percent suffers from a limiting condition and 3 percent recovers from one.[25]

Table 1 shows results for owners, renters, and the pooled sample. Disability and displacement are first considered separately and then combined into a variable called "bad news." Bad news is a dummy variable that equals one if a household head becomes either displaced or disabled (or both). The results for homeowners in columns (1) and (2) indicate that the main effect of disability or displacement is similar with a drop in nondurable consumption of about 4 percent. The direct impact of house-price appreciation is robustly estimated at about 14 percent for owners. The interaction of house prices with disability is very large, estimated at about 0.33, while the interaction with displacement is about 0.16. In the regression using bad news—column (3)—the main effect of bad news is –0.05 while the interaction term is 0.18. These numbers imply that nondurable consumption drops by about 5 percent when the household head becomes disabled or displaced in the absence of house-price appreciation but if house prices appreciate by 10 percent over the relevant four-year span, the drop in nondurable consumption is only about 3 percent (ignoring the main effect of house-price appreciation).

For renters, there is a large direct effect of house prices which likely is due to house prices being correlated with components of income or with expectations of future income.

[23]The data will have autocorrelation of order higher than one but typically most efficiency gains are obtained as long as first-order correlation is allowed for.

[25]See (appendix) Table A-1.

The interaction of disability and displacement with house-price growth is negative for renters with a larger (although insignificant) coefficient for disability. The direct effect of disability is estimated at –0.06, and the direct effect of displacement at –0.08. Combining these into bad news we find a coefficient of –0.07 while the interaction term becomes very close to 0—the variable "bad news" delivers less noisy results and, in the following, we use this variable only. The last column shows the results for a combined sample of owners and renters and the results are in-between those found for each of these samples.

Table 2 explores different samples and specifications in order to explore robustness and add to our understanding. Only the direct effects of house price growth, bad news, and their interaction are presented to conserve space. The table includes a column for owners and one for renters and, for convenience, repeats the results of Table 1 as the first entry. The second entry limits the sample to households that did not move during each four-year period. This addresses the issue of whether the results are mainly due to households freeing up home equity by downsizing their residence after being hit by a bad news shock. However, the results are similar to the baseline case and the insurance effect of house-price appreciation is therefore not mainly a result of downsizing. The results are also robust to using non-overlapping intervals although the interaction terms are large for both owners and renters, yet not significant for renters. The non-overlapping regressions are clearly estimated with less precision.

The large coefficient to house-price appreciation for renters is puzzling. Household income may contain a regional component correlating with house-price growth and an attempt was made to extract the component of house-price appreciation orthogonal to income by regressing house-price appreciation on average income growth in the MSA and using the residuals as our measure of house-price appreciation.[27] This lowers the

[27]MSA income is per capita real income received by all persons from all sources and is available from the Bureau of Economic Analysis.

estimated coefficient to house-price appreciation slightly for renters but does not change the coefficients of any variable strongly. These results highlight how careful one needs to be in interpreting aggregate correlations between appreciation of house values and nondurable consumption as causal. The next two sets of results consider young and old households, respectively. Consumption of young renters reacts positively to house-price appreciation consistent with a correlation of house-price appreciation with income expectations; however, the interaction term is insignificant for young owners as well as renters. Older individuals are hit harder by bad news. Old owners and, in particular, old renters react less strongly to house-price appreciation while the interaction term is highly significant for older owners only. The latter result may reflect that older homeowners, on average, have a larger amount of accumulated housing equity that helps them insure nondurable consumption.

Table 3 presents further robustness results. The interaction effect may be due to changes in house prices tightening or loosening credit constraints. Poorer households may be subject to tighter credit constraints and households in the SEO sample, the subsample of low-income households, may have larger interaction terms than individuals in the representative core sample. The interaction term is slightly larger for the SEO sample but the difference is not statistically significant.[29]

Table 3 further shows two sets of results for the sample split into an early period 1980–1994 and a later period 1994–2005.[30] This split results in a similar number of observations

[29]Further, the interaction term is higher for SEO households with low home equity relative to consumption which is consistent with this group having to adjust consumption more in the case of bad news and negative shocks to house prices. The role of home equity is explored in more detail following the presentation of the model.

[30]The disability indicator is used instead of bad news because information on disability was collected consistently throughout the sample period while information on displacement, used for constructing the bad news indicator, was not collected during 1994–1997. Using bad news instead delivers qualitatively similar estimates: for the 1980–1994 sample the interaction term is estimated at about 0.19, significant at the 5 percent level, while the interaction term for the 1994–2005 sample is about 0.20, nearly significant at the 10 percent level.

for the two subsamples. If financial liberalization and higher use of home-equity lines of credit made housing equity easier to access one would expect to find more consumption insurance in the latter sample. However, the results are very robust to the sample period. Likely, people with liquid life-cycle savings were able to draw on those in the early sample, possibly by taking out a second mortgage.

The results for owners, when using imputed nondurable consumption, are virtually identical to the results using food consumption. For renters, the estimated impact of house-price appreciation is even larger with this measure and so is the interaction term, but the coefficient for the interaction is still nowhere near significant statistically. While imputed nondurable consumption is surely imperfect, these results do not point to the findings being spurious due to the food-only consumption measure.

Finally, the bottom panel of Table 3 displays results where income is included as a regressor. As expected, the coefficient to bad news becomes slightly smaller because part of the impact is captured by income, but the reduction is not large—likely because income shocks are partly transitory and partly persistent while the bad news shocks are overwhelmingly persistent and not well captured by measured income.

4. The model and calibration

To interpret the results, we introduce a model and perform similar regressions using simulated data.

4.1. The model

An important feature of the model is that homeownership is a choice for households (i.e., an endogenous tenure choice). As in Díaz and Luengo-Prado (2008) households have finite life-spans and derive utility from consumption of a nondurable good and housing services that can be obtained in a rental market or through homeownership. House buyers pay a down payment, buyers and sellers pay transactions costs, and housing equity above a required down payment can be used as collateral for loans. There are no other forms of credit. Tax treatment of owner-occupied housing is preferential as in the United States. Households face uninsurable earning risk and uncertainty arising from house-price variation.

Preferences, endowments, and demography. Households live for up to T periods and face an exogenous probability of dying each period. During the first R periods of life they receive stochastic labor earnings and from period R on they receive a pension. When a household dies, it is replaced by a newborn and its wealth is passed on as an accidental bequest. Houses are liquidated at death; thus, newborns receive only liquid assets.

Households derive utility from nondurable goods and from housing services obtained from either renting or owning a home. One unit of housing stock provides one unit of housing services. The per-period utility of an individual of age t born in period 0 is $U\left(C_t, J_t\right)$ where C stands for nondurable consumption and J denotes housing services. Households cannot rent and own a home at the same time. The expected lifetime utility of a household born in period 0 is $E_0 \sum_{t=0}^{T} \frac{1}{(1+\rho)^t} \zeta_t U\left(C_t, J_t\right)$, where $\rho \geq 0$ is the time discount rate and ζ_t is the probability of being alive at age t.

Market arrangements. A household starts period t with a stock of residential assets, $H_{t-1} \geq 0$, deposits, $A_{t-1} \geq 0$, and collateral debt (mortgage debt and home-equity loans), $M_{t-1} \geq 0$. Deposits earn a return r^a and the interest on debt is r^m. A house bought in period t renders services from the beginning of the period. The price of one unit of housing stock (in terms of nondurable consumption) is q_t, while the rental price of one unit of housing stock is r_t^f.

When buying a house, households must make a down payment $\theta q_t H_t$.[33] Therefore, a

[33] There are no income requirements for people purchasing houses. Many lenders follow the rule of

new mortgage must satisfy the condition $M_t \leq (1-\theta)\, q_t\, H_t$. For homeowners who do not move in a given period, houses serve as collateral for loans (home-equity loans) with a maximum loan-to-value ratio (LTV) of $(1-\theta)$.

If house prices go down, a homeowner can simply service debt if he or she is not moving; i.e., as long as the homeowner stays in the same house, M_t could be higher than $(1-\theta)\, q_t\, H_t$ if $M_t < M_{t-1}$. Foreclosure is not allowed so a homeowner can be "upside-down" (have negative housing equity) for as many periods as the household desires.[35]

Households pay a fraction κ of the house value when buying a house (e.g., sales tax or search costs). When selling a house, a homeowner loses a fraction χ of the house value (brokerage fees). Houses depreciate at the rate δ^h and households can choose the degree of maintenance. Buying and selling costs are paid if $|H_t/H_{t-1} - 1| > 0.05$ which indicates that only homeowners upsizing or downsizing housing services by more than 5 percent pay adjustment costs.

Households sell their houses for various reasons. First, households may want to increase or downsize housing consumption throughout the life cycle. Second, selling the house is the only way to realize capital gains beyond the maximum LTV for home-equity loans so households may sell the house to prop up nondurable consumption after depleting their deposits and maxing out home-equity loans. Third, households may also be forced to sell their houses as they are subject to an idiosyncratic moving shock, z_t. This shock is meant to capture the effect of "geographical" mobility stemming from job change and demographic shocks are not modeled for simplicity.

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thumb of "three times income" in determining the size of mortgages. However, the empirical literature finds that wealth constraints are more important than income constraints when people purchase a home. See, for example, Linneman, Megbolugbe, Watcher and Cho (1997) or Quercia, McCarthy and Watcher (2000).

[35]These assumptions simplify the computation of the model while allowing us to consider both down-payment requirements and home-equity loans without modeling specific mortgage contracts. See Li and Yao (2007) for an alternative model with refinancing costs and Campbell and Cocco (2003) for a discussion of optimal mortgage choice.

The government. The government taxes income, Y, at the rate τ_y. Imputed housing rents for homeowners are tax-free and interest payments are tax deductible with a deduction percentage τ_m so taxable income in period t is $Y_t^\tau = Y_t - \tau_m r^m M_{t-1}$. Proceeds from taxation finance government expenditures that do not affect individuals at the margin.

Earnings and house-price uncertainty. Households are subject to household-specific risk in labor earnings and house-price risk common to residents of the same region. For working-age households, labor earnings, W_t, are the product of permanent income and transitory shocks (P_t, ν_t, and ϕ_t, respectively): $W_t = P_t \nu_t \phi_t$. ν_t is an idiosyncratic transitory shock with $\log \nu_t \sim N\left(-\sigma_\nu^2/2, \sigma_\nu^2\right)$ while ϕ_t is a transitory displacement/disability ("bad") shock which reduces income by a proportion μ with a small probability p_ϕ. In turn, permanent income is $P_t = P_{t-1}\gamma_t \epsilon_t \varsigma_t$. Thus, permanent income growth, $\Delta \log P_t$, is the sum of a non-stochastic life-cycle component, $\log \gamma_t$, an idiosyncratic permanent shock, $\log \epsilon_t \sim N\left(-\sigma_\epsilon^2/2, \sigma_\epsilon^2\right)$, and an additional permanent "bad" shock $\log \varsigma_t$, which reduces permanent income by the proportion λ_t with a small probability p_ς. λ_t is allowed to vary with age, the cut being more drastic for older households.[37] Retirees receive a pension proportional to permanent earnings in the last period of their working life. That is, for a household born at time 0, $W_t = bP_R$, $\forall t > R$.[38]

House prices are uncertain and, following Li and Yao (2007), house-price appreciation is assumed to be an i.i.d. normal process: $q_t/q_{t-1} - 1 = \varrho_t$, with $\varrho_t \sim N(\mu_\varrho, \sigma_\varrho^2)$. This specification implies that house-price shocks are permanent.[39] In the benchmark calibration, these shocks are serially uncorrelated and not correlated with household labor

[37]The combination of permanent and transitory bad shocks is meant to capture employment and/or disability shocks that may or may not affect income for more than one period and may affect households differently.

[38]This simplification is required for computational reasons and is common in the literature. See, for example, Cocco, Gomes and Maenhout (2005).

[39]This assumption is common in the literature (e.g., Cocco 2005, Campbell and Cocco 2003), and greatly simplifies the computation of the model by facilitating a renormalization of the household problem with fewer state variables.

earnings.

4.2. Calibration

The calibration is constructed to reproduce three statistics from the Survey of Consumer Finances: the homeownership rate, the median wealth-to-earnings ratio for working-age households, and the median ratio of home value to total wealth for homeowners (70 percent, 1.80, and 0.82, respectively).

To match the targets, the discount rate is set to 3.45 percent, the weight of housing in a Cobb-Douglas utility function to 0.2, and the minimum house-size that consumers can purchase is 1.65 times permanent income. The general strategy in choosing the remaining parameters is to focus whenever possible on empirical evidence for the median household.[41]

5. Regression results from simulated data

Simulations are performed for 27 "regions" with 5,000 people each for a number of periods. House-price shocks are common to all individuals in a given region (there are only three possible house-price shocks) while all other shocks (income and moving shocks) are idiosyncratic. In regions 1 through 9, the house-price shock is at the lowest value for the last four periods (house-price depreciation). In regions 10 through 18, the house-price shock is at the middle value (constant house prices), while in regions 19 through 27, the house-price shock is at the highest value (house-price appreciation). Simulated data from the last five periods (which represent 10 years, as one period in our model corresponds to two years) is used in these regressions.[42]

To match the specification in the empirical section, four-year log differences in consumption, income, and house prices, and overlapping growth rates are used in the regres-

[41] See Appendix D for details and Table 4 for parameter values.

[42] Results are similar if more periods are included in the regressions.

sions. The bad news dummy equals 1 in period t if the household suffers a bad shock in periods t, $t-1$, $t-2$, or $t-3$ and not in $t-4$. As in the data, when presenting results by tenure status, a homeowner (renter) is a household that owned (rented) a house in all periods involved in calculating the consumption growth rate. To facilitate comparisons with the empirical results, regressions are estimated using households with heads aged 28–64.[43]

Table 5, first panel, shows that 10 percent house-price appreciation results in a 2.7 percent increase in nondurable consumption for owners with no effect for renters. The direct effect of bad news is a drop in nondurable consumption of 17 percent for owners versus 21 percent for renters. The coefficients are estimated very precisely—the t-statistics are much larger than those in the data which reflects that the model is a simplification where all consumers are a priori identical. Importantly, the sensitivity of consumption to bad news goes down when houses appreciate as shown by the estimated positive coefficient for the interaction term. Nondurable consumption drops by about a percentage point less if housing appreciates by 10 percent. Compared to the data, the coefficient to house prices is larger, maybe reflecting higher costs or more stringent financing constraints for some households in the real world. The effect of bad news is smaller in the real world —maybe reflecting informal help from family (who may live in the same MSA) or assets not present in the model—while the interaction is smaller in the model.

The other panels in Table 5 explore the properties of the theoretical model in order to understand the impact of relative house prices, financing constraints, etc. on the results. The second panel shows the results for the case with no homeownership and "house prices" simply capture changes in rental prices. In this case, house-price changes do not affect nondurable consumption directly or through the interaction with the bad-news shock.

[43] As explained in Appendix D, households are born at age 24 and retire at age 66.

This set of results verifies that the findings regarding house prices are not due to changes in relative prices per se which, of course, reflects the specific utility function used.[45]

The next set of results analyzes a model where homeownership can be obtained with no down payment. In this case, the barriers to home ownership are a minimum required size of the house and the potential trading costs if the house has to be sold again. These results are quite similar to the benchmark case, although the interaction effect is slightly larger because a larger fraction of home equity can be used as collateral for loans. If, alternatively, there is a down payment but no transaction costs, the interaction term gets somewhat smaller as homeowners can easily downsize making home equity completely liquid—talking about collateral in this case is purely semantics. The direct effect of bad news for renters is larger because they are less affluent in this simulation. Interestingly, there is a significant effect of house prices for renters. This effect can, for example, be due to older renters giving up on accumulating enough savings for a down payment and using part of their accumulated savings for nondurable consumption. The negative significant interaction could be due to young renters saving for a down payment.

If there is no down payment, adjustment costs, or minimum house size requirement, house equity is fully liquid for all owners and the insurance effect measured by the interaction terms takes its largest value across the simulations. It appears that the liquidity of house equity is important for the direct effect of house prices: if housing consumption cannot be easily adjusted, nondurable consumption reacts more strongly. The interaction effect is, however, larger when housing can be freely adjusted.

In the situation with a down payment of 100 percent, home equity is, in principle, not liquid and the interaction term becomes smaller. It is, however, still highly significant due

[45]The within-period preferences for consumption of nondurables and housing services are Cobb-Douglas. Thus, in a perfect rental market setting, consumers keep fixed proportions of their spending on each type of good: if house prices go up, real consumption of housing services goes down but nondurable consumption remains unchanged.

to owners that have paid off their full mortgage. For such owners, an increase in house prices is associated with an increase in life-cycle savings as most owners will eventually sell the house and they are therefore willing to draw on their liquid (non-housing) wealth.

Finally, house-price growth is allowed to be perfectly correlated with income growth—in this case the direct effect of house prices is highly significant for renters but the interaction effect is not. Because it is very hard to properly control for correlations between house prices and income, testing for insurance effects of house prices is more robust than testing for direct effects of house-prices.

Table 6 summarizes the model's predictions when the sample is split by criteria similar to the splits used for the PSID data. The first panel shows that nondurable consumption reacts more strongly to house-price changes for non-movers. As in the empirical part, households are classified as young if the head is below 45 and old if above 50. As in the data, the effect of house-price appreciation on consumption (in the direction of more risk sharing) is strongest for old owners. Older owners have more equity and, likely more important, may be more willing to pay the adjustment cost because they plan to downsize to free up life-cycle savings anyway. The model results, however, do not display the very large difference between young and old found in the data. The significant interaction for old renters is likely due to some renters giving up on accumulating enough assets to ever obtain a house, which frees up the savings originally intended for a down payment.

The sample is further split according to net worth. The interaction term is larger for homeowners with low net worth—such households may only be able to access home equity by downsizing the residence (or moving to rental) but this involves transactions costs which may be hard to meet if the household is under water.[48] I.e., wealth may be effectively more "committed" for households with less wealth and this may be particularly

[48]Moving rates are much lower for households with low liquid wealth when displaced, particularly when houses depreciate (these results are not tabulated due to space constraints).

important when bad news happen at a time of declining house prices. This result is consistent with the larger coefficients found for the SEO sample in the empirical section. The last panel reports results controlling for income growth. We find a significantly higher propensity to consume out of income for renters pointing towards less overall risk sharing for this group. Controlling for income also brings the coefficient to the direct effect of bad news closer to its empirical counterpart, while having little effect on the interaction coefficients.

Finally, Table 7 examines the role of self-reported home equity—combining empirical results (in the left-most columns) and results from simulated data (in the right-most columns). We display results where the sample, for young and old separately, is split into households with initial high/low housing equity relative to consumption (the latter is averaged over the previous four years). The table confirms that older individuals smooth income losses due to bad news better than younger individuals and this result—particularly in the data but also in the model—is much stronger for households with large amounts of housing equity relative to their level of consumption. This finding is fairly intuitive and highlights that the results for age splits likely are partly due to the life-cycle and not only due to an effect of older individuals holding more liquid equity.[50]

6. Conclusion

In a calibrated theoretical model in which agents can own or rent, homeowners are better able to share income risks than renters. This result corresponds to the empirical

[50]A previous version of the paper explored if the results were capturing differences in household liquid wealth by splitting the sample by financial assets. The interactions of displacement and disability with house-price growth were found insignificant for renters of all wealth levels which indicates that the house-price variable is not standing in for differences in wealth. Those results were based on a limited sample because the PSID started collecting wealth data only in 1984, available at 5-year intervals up to 1999, and biennially afterwards. The sample requirement of household stability further limits the ability of getting reliable results using wealth data so those results are not tabulated.

finding that U.S. households are significantly better able to maintain their level of consumption after job loss or disability if they are homeowners in MSAs where housing is appreciating. Our interpretation is that this results from homeowners being able to access capital gains either using equity as collateral or by selling the house—although the results indicate that downsizing is not the primary channel.

The estimated coefficients are of economically significant magnitudes. Ignoring the direct effect of house prices (which is likely to partly reflect left-out variables, such as expectations of future income), the empirical estimates imply that a homeowner who becomes disabled will see a drop in consumption of about 5 percent over a four-year period if house prices are constant but no change in consumption if house prices in the metro area increase by about 26 percent during the same time period. However, if house prices fall by, say, 40 percent—as is not uncommon in the wake of the 2008 subprime crisis—a staggering consumption drop of 12 percent can be expected for a homeowner who becomes disabled.[52]

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[52]This illustration is based on the coefficients in column (3) of Table 1 ignoring the direct effect of house-price appreciation.

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Table 1: Risk Sharing Regressions for Owners vs. Renters

	Owners			Renters			All
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
House price growth	0.135***	0.136***	0.135***	0.222***	0.223***	0.213***	0.153***
	(5.68)	(5.82)	(5.92)	(4.88)	(4.90)	(4.86)	(8.17)
Disabled	–0.043***			–0.062***			
	(–4.06)			(–3.12)			
Disabled × house price gr.	0.329***			–0.174			
	(3.95)			(–1.32)			
Displaced		–0.043***			–0.076***		
		(–3.68)			(–4.30)		
Displaced × house price gr.		0.155**			–0.082		
		(1.98)			(–0.62)		
Bad news			–0.047***			–0.070***	–0.060***
			(–4.66)			(–4.09)	(–7.48)
Bad news × house price gr.			0.184***			0.012	0.118**
			(2.61)			(0.11)	(2.54)
Family size growth	0.335***	0.337***	0.334***	0.265***	0.273***	0.266***	0.307***
	(23.58)	(23.48)	(23.64)	(15.87)	(16.58)	(15.97)	(28.03)
Age	–0.009***	–0.009***	–0.009***	–0.005	–0.006	–0.005	–0.006**
	(–2.93)	(–2.88)	(–3.01)	(–0.87)	(–1.06)	(–0.94)	(–2.27)
Age sq./100	0.005	0.005	0.005	0.002	0.003	0.002	0.002
	(1.43)	(1.38)	(1.49)	(0.34)	(0.46)	(0.36)	(0.69)
Adj. R sq.	0.078	0.077	0.078	0.037	0.040	0.038	0.059
F	200.6	158.2	189.3	49.4	76.7	71.5	219.9
N	19,224	18,221	19,228	8,776	8,434	8,776	32,246

Notes: Sample is restricted to owners and renters defined as follows. Owners (renters) are households who continuously owned (rented) a house between years t and $t-4$, resided in the same MSA and did not change family composition during that time span. Serial correlation in the regression errors is corrected using the Prais-Winsten transformation; robust standard errors in the regressions clustered by the MSA where the household lives between years t and $t-4$. t-statistics in parentheses. *** (**) [*] significant at the 1 (5) [10]% level.

Table 2: Risk sharing regressions—Data. Different samples

	Owners		Renters	
Main specification				
House price growth	0.135***	(5.92)	0.213***	(4.86)
Bad news	–0.047***	(–4.66)	–0.070***	(–4.09)
Bad news × house price gr.	0.184***	(2.61)	0.012	(0.11)
No. of obs.		19,228		8,776
Non-movers/same residence				
House price growth	0.132***	(5.73)	0.174**	(2.42)
Bad news	–0.042***	(–3.77)	–0.067***	(–3.05)
Bad news × house price gr.	0.172**	(2.30)	0.098	(0.58)
No. of obs.		16,573		4,343
Non-overlapping growth rates				
House price growth	0.124***	(2.74)	0.212*	(1.85)
Bad news	–0.079***	(–4.95)	–0.083***	(–3.44)
Bad news × house price gr.	0.356***	(3.03)	0.250	(1.51)
No. of obs.		6,251		2,771
House-price residuals				
House price growth	0.100***	(3.70)	0.180***	(3.92)
Bad news	–0.048***	(–4.79)	–0.070***	(–4.17)
Bad news × house price gr.	0.180**	(2.20)	0.050	(0.41)
No. of obs.		19,228		8,776
Young				
House price growth	0.136***	(4.29)	0.246***	(4.01)
Bad news	–0.045***	(–3.01)	–0.055***	(–2.97)
Bad news × house price gr.	0.044	(0.50)	–0.038	(–0.29)
No. of obs.		8,835		5,581
Old				
House price growth	0.122***	(4.09)	0.141	(1.64)
Bad news	–0.059***	(–4.63)	–0.113***	(–3.55)
Bad news × house price gr.	0.304***	(3.05)	0.093	(0.43)
No. of obs.		7,853		2,383

Notes: The following regression is estimated: $c_{it} - \bar{c}_t = \mu + \beta\ (hp_{mt} - \overline{hp}_t) + \xi\ (D_{it} - \bar{D}_t) + \zeta\ (D_{it} - \bar{D}_t) \times (hp_{mt} - \overline{hp}_t) + (X_{it} - \bar{X}_t)'\delta + \varepsilon_{it}$. Age, age squared, and family size growth are included in the regressions. Young is 25–45, old is 50–65. The estimated coefficients $\hat{\beta}$, $\hat{\xi}$ and $\hat{\zeta}$ are reported. Serial correlation in the regression errors is corrected using the Prais-Winsten transformation; robust standard errors in the regressions clustered by region. t-statistics in parentheses. *** (**) [*] significant at the 1 (5) [10]% level.

Table 3: Risk sharing regressions—Data. Different samples. Robustness

	Owners		Renters	
Main specification				
House price growth	0.135***	(5.92)	0.213***	(4.86)
Bad news	–0.047***	(–4.66)	–0.070***	(–4.09)
Bad news × house price gr.	0.184***	(2.61)	0.012	(0.11)
No. of obs.		19,228		8,776
SEO sample				
House price growth	0.205***	(4.61)	0.240***	(3.98)
Bad news	–0.039**	(–2.08)	–0.078***	(–3.24)
Bad news × house price gr.	0.231*	(1.94)	–0.001	(–0.01)
No. of obs.		6,191		5,663
Core sample				
House price growth	0.104***	(4.34)	0.165***	(2.71)
Bad news	–0.049***	(–4.78)	–0.036*	(–1.67)
Bad news × house price gr.	0.161*	(1.89)	0.013	(0.07)
No. of obs.		13,037		3,113
1980–1994: limiting condition only				
House price growth	0.131***	(4.67)	0.208***	(4.03)
Bad news	–0.032***	(–2.64)	–0.064**	(–2.51)
Bad news × house price gr.	0.317***	(3.46)	–0.220	(–1.42)
No. of obs.		10,504		5,813
1994–2005: limiting condition only				
House price growth	0.132***	(3.44)	0.276***	(4.10)
Bad news	–0.054***	(–2.99)	–0.060**	(–2.14)
Bad news × house price gr.	0.328**	(2.22)	0.017	(0.08)
No. of obs.		10,023		3,478
Imputed nondurables				
House price growth	0.144***	(4.48)	0.251***	(4.07)
Bad news	–0.050***	(–3.75)	–0.062**	(–2.42)
Bad news × house price gr.	0.174*	(1.74)	0.098	(0.62)
No. of obs.		14,274		6,168
Controlling for income				
Income growth	0.107***	(11.50)	0.186***	(12.71)
House price growth	0.118***	(5.53)	0.152***	(3.42)
Bad news	–0.037***	(–3.60)	–0.051***	(–2.93)
Bad news × house price gr.	0.171**	(2.58)	0.053	(0.47)
No. of obs.		18,431		8,220

Notes: See notes to Table 2.

Table 4: Benchmark Calibration Parameters

Preferences	
	Cobb-Douglas utility; .205 weight for housing.
	Discount rate 3.45%; curvature of utility 2.
Demographics	
	One period is two years.
	Households are born at 24, retire at 66 and die at 84 the latest.
	Mortality shocks: U.S. vital statistics (females), 2003.
Income	
	Overall variance of permanent (transitory) shocks 0.01 (.073).
	Displacement: Perm. shock: probability 3%; income loss 25 (40)% for young (old).
	Transitory shock: probability 5%; income loss 40%.
	Jointly match s.d. of "bad news" in the PSID.
	Pension: 50% of last working period permanent income.
Interest rates	
	4% for deposits; 4.5% for mortgages.
	No uncertainty.
Housing Market	
	Down payment 20%; buying (selling) cost 2% (6%).
Taxes	
	Proportional taxation.
	Income tax rate 20% (TAXSIM); mortgage interest fully deductible.
House Prices	
	Average real appreciation 0; variance 0.0131.
	Housing depreciation 1.5%.
	Rent-to-price ratio 5.7%.
	Moving defined as increasing or decreasing housing services more than 5%.
Moving shocks	
	1.5% probability when working-age; to match moving rates in PSID.
Other	
	No income and house-price correlation.
	No bequest motive but accidental bequests.

Table 5: Risk sharing regressions–Model. Alternative Calibrations

	Owner		Renter	
Baseline (70% ownership)				
House price growth	0.27***	(140.39)	0.01	(1.56)
Bad news	–0.17***	(–120.89)	–0.21***	(–69.05)
Bad news × house price gr.	0.08***	(16.69)	–0.01	(–0.91)
No. of obs.		151,150		62,126
Ownership not allowed (0% ownership)				
House price growth			0.00	(1.61)
Bad news			–0.17***	(–131.54)
Bad news × house price gr.			0.00	(0.39)
No. of obs.				254,593
No downpayment (72% ownership)				
House price growth	0.28***	(121.47)	0.01**	(2.41)
Bad news	–0.17***	(–150.06)	–0.21***	(–76.75)
Bad news × house price gr.	0.09***	(19.87)	–0.02	(–1.55)
No. of obs.		146,289		66,021
No adj. cost (90% ownership)				
House price growth	0.25***	(162.12)	0.03**	(2.54)
Bad news	–0.16***	(–125.98)	–0.34***	(–32.91)
Bad news × house price gr.	0.06***	(14.56)	–0.10***	(–3.17)
No. of obs.		221,600		7,154
No dowpayment, adj. cost or min. house size (100% ownership)				
House price growth	0.23***	(147.41)		
Bad news	–0.17***	(–81.62)		
Bad news × house price gr.	0.11***	(16.98)		
No. of obs.	254,593			
100% downpayment (60% ownership) ♯				
House price growth	0.16***	(60.14)	–0.00	(–0.02)
Bad news	–0.19***	(–115.31)	–0.23***	(–99.23)
Bad news × house price gr.	0.05***	(7.91)	0.01	(0.89)
No. of obs.		142,000		82,819
Income/house price correlation (70% ownership)‡				
House price growth	0.39***	(219.91)	0.20***	(51.93)
Bad news	–0.17***	(–131.59)	–0.21***	(–80.83)
Bad news × house price gr.	0.06***	(14.24)	–0.01	(–1.17)
No. of obs.		156,217		62,983

Notes: The regression $c_{it} - \bar{c}_t = \mu + \beta\,(hp_{mt} - \overline{hp}_t) + \xi\,(D_{it} - \bar{D}_t) + \zeta\,(D_{it} - \bar{D}_t) \times (hp_{mt} - \overline{hp}_t) + (X_{it} - \bar{X}_t)'\delta + \varepsilon_{it}$ is estimated. Age and age squared are included in the regressions. The estimated coefficients $\hat{\beta}$, $\hat{\xi}$ and $\hat{\zeta}$ are reported. ♯ house size restriction eliminated to increase homeownership. ‡ recalibrated to match the same targets as in the benchmark. Serial correlation in the regression errors is corrected using the Prais-Winsten transformation; robust standard errors in the regressions clustered by region. t-statistics in parentheses. *** (**) [*] significant at the 1 (5) [10]% level.

Table 6: Risk sharing regressions–Model. Different Splits

	Owner		Renter	
Baseline				
House price growth	0.27***	(140.39)	0.01	(1.56)
Bad news	–0.17***	(–120.89)	–0.21***	(–69.05)
Bad news × House price gr.	0.08***	(16.69)	–0.01	(–0.91)
No. of obs.		151,150		62,126
Non-movers				
House price growth	0.34***	(52.56)	0.01	(1.56)
Bad news	–0.15***	(–97.43)	–0.21***	(–69.05)
Bad news × House price gr.	0.10***	(18.14)	–0.01	(–0.91)
No. of obs.		121,970		62,126
Young				
House price growth	0.25***	(65.79)	0.00	(1.13)
Bad news	–0.14***	(–49.70)	–0.25***	(–69.18)
Bad news × house price gr.	0.05***	(6.08)	–0.01	(–0.98)
No. of obs.		30,451		40,425
Old				
House price growth	0.29***	(152.53)	0.03**	(2.59)
Bad news	–0.19***	(–84.34)	–0.11***	(–28.37)
Bad news × house price gr.	0.11***	(13.69)	0.04***	(3.11)
No. of obs.		73,829		5,897
Poor				
House price growth	0.37***	(41.82)	0.01	(1.20)
Bad news	–0.20***	(–29.44)	–0.18***	(–52.80)
Bad news × house price gr.	0.17***	(7.03)	–0.00	(–0.38)
No. of obs.		6,337		37,199
Rich				
House price growth	0.25***	(157.24)	0.02	(0.47)
Bad news	–0.15***	(–53.73)	–0.10***	(–3.28)
Bad news × house price gr.	0.06***	(5.92)	–0.11	(–1.41)
No. of obs.		50,009		247
Controlling for current income				
Income growth	0.12***	(158.59)	0.30***	(186.42)
House price growth	0.27***	(180.72)	0.01	(1.60)
Bad news	–0.10***	(–82.99)	–0.08***	(–36.33)
Bad news × house price gr.	0.07***	(17.32)	–0.02**	(–2.10)
No. of obs.		151,150		62,126

Notes: The estimated regression is $c_{it} - \bar{c}_t = \mu + \beta\ (hp_{mt} - \overline{hp}_t) + \xi\ (D_{it} - \bar{D}_t) + \zeta\ (D_{it} - \bar{D}_t) \times (hp_{mt} - \overline{hp}_t) + (X_{it} - \bar{X}_t)'\delta + \varepsilon_{it}$. Age and age squared are included in the regressions. The estimated coefficients $\hat{\beta}$, $\hat{\xi}$, and $\hat{\zeta}$ are reported. Young is 28–45, old is 50–64. Poor (Rich) is below (above) the 25 (75)-th percentile of net worth in the initial period. Serial correlation in the regression errors is corrected using the Prais-Winsten transformation; robust standard errors in the regressions clustered by region. t-statistics in parentheses. *** (**) [*] significant at the 1 (5) [10]% level.

Table 7: Housing equity splits. Owners only

	Data		Model	
Young, low relative equity				
House price growth	0.087***	(2.28)	0.27***	(51.32)
Bad news	–0.039*	(–1.93)	–0.15***	(–32.84)
Bad news × house price gr.	0.003	(0.02)	0.03	(1.60)
No. of obs.		5,011		9,319
Young, high relative equity				
House price growth	0.143***	(3.13)	0.18***	(13.57)
Bad news	–0.052**	(–2.03)	–0.13***	(–12.28)
Bad news × house price gr.	–0.027	(–0.17)	0.04	(1.15)
No. of obs.		3,283		4,039
Old, low relative equity				
House price growth	0.072	(1.26)	0.24***	(69.06)
Bad news	–0.05**	(–2.19)	–0.18***	(–39.32)
Bad news × house price gr.	0.241*	(1.70)	0.12***	(7.33)
No. of obs.		2,683		19,120
Old, high relative equity				
House price growth	0.113***	(3.40)	0.30***	(56.22)
Bad news	–0.062***	(–3.57)	–0.21***	(–53.52)
Bad news × house price gr.	0.397***	(2.86)	0.16***	(10.47)
No. of obs.		4,702		29,288

Notes: Sample is restricted to owners defined as follows. Owners are households who continuously owned a house between years t and $t-4$, resided in the same MSA, and did not change family composition during that time span. "Low (high) relative equity" owners are those whose lagged housing equity to consumption ratio is below (equal to or above) the 50th percentile of the annual distribution of the ratio. The denominator of the ratio at time t is the average of consumption in periods $t-8$, $t-7$, $\ldots$, $t-4$. Young is 28–45, old is 50–64. Robust standard errors in the regressions clustered by the MSA where the household lives between years t and $t-4$. t-statistics in parentheses. *** (**) [*] significant at the 1 (5) [10]% level.