Mortgage Debt Overhang:

Reduced Investment by Homeowners with Negative Equity

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August 2012

Abstract

Homeowners at risk of default face a debt overhang that reduces their incentive to invest in their property: in expectation, some value created by equity investments will go to the lender. Using rich microdata on household expenditures, I show that debt overhang plays an important role in household financial decisions, as negative equity homeowners cut back substantially on home improvements and mortgage principal payments. At the same time, these households do not reduce spending on physical assets that the homeowner may retain in default, including vehicles and home-related durables (appliances and furnishings). Even higher income and wealthier homeowners, who appear financially unconstrained, reduce improvements and principal payments when they are in a negative equity position. In fact, the effect of negative equity on investment is particularly large for wealthy homeowners in non-recourse states, where strategic default is more likely because lenders have limited claim on non-housing wealth. Debt overhang best explains this set of facts. These findings highlight an important financial friction that is suppressing household investment during the recovery from the housing crash and recession of the late 2000s.

JEL codes: Investment Decisions (G11); Personal Finance (D14); Housing Demand (R21)

* I thank Gene Amromin, Daniel Cooper, Kevin Davis, Xavier Giroud, Erik Hurst, Ravi Jagannathan, Jiro Kondo, Lindsey Leininger, David Matsa, Ed Mills, Laudo Ogura, Jonathan Parker, Alessandro Previtero, Tim Riddiough and Joe Tracy for helpful comments. Seminar participants at Duke University, Ivey Business School, Kellogg School of Management, Loyola University Chicago, Stanford GSB and the Federal Reserve Banks of Boston and Chicago also provided valuable feedback, as did conference participants at the Summer Real Estate Symposium, NBER Summer Institute (Real Estate and Public Economics), Consumer Expenditure Survey Users' Workshop, and the annual meetings of the Midwest Economics Association, Western Finance Association and Financial Intermediation Research Society. I gratefully acknowledge ICPSR for providing the Consumer Expenditure data files used in this study, Fiserv for providing Case-Shiller Home Price Index data, and Laura Paszkiewicz from the BLS for help with the Consumer Expenditure data. Aaron Yoon and Kexin Qiao provided helpful research assistance.

I. Introduction

A long-standing and important idea in finance theory is that leverage can distort investment decisions. Myers (1977) introduces the notion of corporate debt overhang, emphasizing that high leverage can cause firms to underinvest, since the benefits of new capital investments accrue largely to debt holders rather than equity holders. In public finance, Keynes (1920), Krugman (1988) and Sachs (1990) emphasize that heavy public debt loads reduce incentives for public sector investments in infrastructure and private sector investments in physical and human capital. This paper applies the same thinking to household financial decisions, and provides evidence that households with mortgage debt overhang invest less in their homes.

The reasoning behind debt overhang is straightforward. For an incremental investment in a debt-free asset, the owner captures the investment's payoffs in all states of the world. In contrast, for a levered asset with some risk of default, the investment's payoffs accrue to the foreclosing lender if the owner defaults. Faced with the same investment outlay today and the prospect of sharing the future payoffs with the lender, the owner of a levered asset may underinvest, foregoing economically efficient investments.

Following the precipitous decline in the United States housing market between 2007 and 2009, during which average home prices fell by 14% nationwide and by as much as 50% in some states, mortgage debt overhang has become an important issue.[1] Up to 15% of homeowners are in a negative equity position, facing mortgage liabilities that exceed the value of their home, and another 7.5% of homeowners have minimal equity (less than 10% of home value). Understanding how these homeowners behave is important in evaluating foreclosure reduction

[1] These figures are based on the Case-Shiller Home Price Index between the second quarter of 2007 and the first quarter of 2009. State-level declines of 40% to 50% occurred in Arizona, California, Florida, Michigan and Nevada.

policies and forecasting home improvement spending, which constitutes roughly one third of housing investment.[2] Establishing the empirical relevance of mortgage debt overhang is also important, given the potential for distortions to housing investment.

This paper contributes to these broad goals by answering, first, whether housing investments in the form of improvements, maintenance and mortgage principal payments differ among highly leveraged households and, second, whether debt overhang explains these differences. To answer these questions, I use rich household microdata from the Bureau of Labor Statistics' Consumer Expenditure Survey (CE). These data contain comprehensive property-specific information for a national sample of homeowners, including mortgage balances and principal payments, home improvement and maintenance expenditures, and property values as estimated by the homeowners. Using these inputs to construct mortgage loan-to-value, I estimate the difference in housing investment between homeowners with and without large mortgage debts.

I find that negative equity homeowners spend $200 less per quarter on home improvements and maintenance, a 30% reduction relative to positive equity homeowners. Households with negative equity also pay down less of their mortgage principal: controlling for differences in mortgage balance, they cut unscheduled principal payments by $200, or 44%. This disparity in home investment is not explained by differences in total expenditures, income or wealth. Nor is it explained by variation in household demographic characteristics (age, race, education and household size), property characteristics (property value, age of home, duration of ownership and various traits of the physical structure) or mortgage characteristics (mortgage age, interest rate, fixed/variable rate and mortgage insurance status).

[2] Between 1993 to 2007 improvement and maintenance spending averaged $142 billion per year (measured in 2009 dollars), almost half of the $300 billion invested annually in construction of new homes over this period.

Aside from indicating debt overhang, negative equity may proxy for other differences between households – differences in wealth, borrowing capacity or investment opportunities, or varied exposure to economic shocks – that might explain their lower spending on home investments. The detailed household-level data of the CE are useful in ruling out these alternatives to the debt overhang interpretation. For example, a regional economic shock that drives down real estate values and household spending (including improvement spending) would not explain my findings, which are identified using household-level variation in negative equity within a region, controlling for differences in total household expenditures. Borrowing and liquidity constraints also fail to explain the results: among homeowners with higher incomes, more assets and limited unsecured debt, who are evidently not financially constrained, being in a negative equity position still predicts lower spending on home investments. Finally, it is natural to question whether negative equity homeowners, many of whom have experienced a large decline in their home's value, invest less because they perceive low returns from improvements.[3] Even debt-free owners might invest less in these circumstances. But this line of thinking does not account for the reduction in principal payments, which do not change the underlying asset and therefore should not fall simply due to low forecast returns from incremental investments. Nor can it explain the pattern in improvement spending, which declines around the negative equity region and continues to fall as leverage rises.[4]

Two falsification exercises strengthen the case for debt overhang by confirming that negative equity does not reduce durable investments in categories that are not subject to

[3] The models of Jorgenson (1963) and Tobin (1969) offer a rational explanation for lower spending: investment returns are low when market values are below replacement cost. Choi, Hong and Scheinkman (2011) propose that homeowners reduce improvements because they underestimate returns when home prices have fallen.

[4] Though homeowners are known to reduce investments when values are below replacement cost (Gyourko and Saiz 2004), one would not expect this particular pattern between improvements and loan-to-value unless debt overhang also plays a role.

mortgage overhang. Notably, negative equity homeowners do not spend less on home furnishings and appliances, which are home improvements that face no overhang because they are not sacrificed to the lender in the case of default. Nor do they cut spending on vehicles; if anything vehicle spending increases among negative equity homeowners, perhaps because less resources are allocated to home improvements and mortgage payments. Viewed together with the main results, this evidence strongly supports debt overhang relative to other accounts, since it demonstrates within-household variation in overhang that explains the investment patterns of negative equity homeowners. Alternative hypotheses that postulate a household-level difference among heavily indebted homeowners – like the expectation of low future income or a preference, not captured by observables, to invest little in home improvement and durables – would not account for these facts.

The final extension of the main analysis tests whether the choices of negative equity homeowners depend on state foreclosure laws. Eleven states provide mortgage creditors with recourse, or the ability to claim mortgage debtors' other assets when the value of the collateral falls short of the loan balance. If negative equity homeowners in these states are less likely to default, as Ghent and Kudlyak (2011) find, then they should also be less likely to cut back on principal payments and home improvements, particularly when they have financial assets to lose. Evidence on this point is mixed. In the full sample, only principal payments show the expected pattern. However, among homeowners with at least $100,000 of financial assets, recourse affects both principal payments and improvement spending as expected: negative equity homeowners cut back their investments substantially more in non-recourse states than in recourse states.

There is an extensive theoretical literature that incorporates debt overhang into models of real estate, corporate finance, public finance and macro finance.[5] In light of the recent housing crisis, Mulligan (2008) proposes a model of labor supply in which mortgage debt overhang plays a crucial role, and Haughwout, Peach and Tracy (2010) conjecture that negative equity homeowners will underinvest in their homes as well as their neighborhoods. But the only empirical study of households that touches on this topic is by Olney (1999), who identifies aggregate loan delinquency patterns during the Great Depression that are consistent with debt overhang.[6] I provide more direct and expansive evidence, grounded in microdata, that households are forward looking in their investment choices and that leverage affects these choices above and beyond the effects of borrowing or liquidity constraints.[7]

The rest of the article proceeds as follows. The next section outlines the predictions tested in the regression analysis. Section III describes the data and basic sample statistics. Sections IV and V cover the regression model and estimation results. Sections VI and VII provide discussion, and Section VIII concludes.

II. Debt Overhang, Negative Equity and Home-related Investments

The central insight of Myers (1977) is that debt contracts, which may improve *ex ante* efficiency for a variety of reasons, introduce *ex post* inefficiency by creating an agency conflict that worsens as default becomes more likely. Though the owner controls the asset and bears the

[5] Titman, Tompaidis and Tsyplakov (2004) apply debt overhang in modeling default risk for commercial real estate loans. Myers (1977), Mello and Parsons (1992), Hennessy (2004) and Admati et al. (2012) emphasize the debt overhang channel for corporate investment and financing decisions. Krugman (1988) and Sachs (1990) study debt overhang in the context of public finance. Lastly, Lamont (1995), Occhino and Pescatori (2010), Phillipon (2010) and Phillipon and Schnabl (2011) incorporate debt overhang as a friction in macroeconomic models.

[6] Households continued to pay installment loans secured by durable goods in which they typically had equity, but ceased payments on (non-recourse) mortgages that likely exceeded their home's value.

[7] The evidence in Hurst and Stafford (2006) and Mian and Sufi (2011) suggests home equity is used to finance current expenditures, particularly among households that appear liquidity constrained.

full cost of investments, she reaps only a portion of payoffs, with the lender capturing the payoffs in the event of default. Accordingly, the owner foregoes some investments that would otherwise be efficient and postpones principal payments that subsidize the lender's position.[8]

The discussion below outlines the testable predictions of the debt overhang hypothesis, framing each hypothesis with negative equity (presence or depth) as the independent variable of interest. Negative equity serves as a practical measure of debt overhang, founded on research that shows substantially higher mortgage default rates among negative equity homeowners (Deng, Quigley and Van Order 2000; Deng and Gabriel 2006; Foote, Gerardi and Willen 2008). Section III.2 provides further discussion of this choice.

Prediction 1: Negative equity homeowners will invest less in improving and maintaining their homes.

Prediction 2: Negative equity homeowners will reduce discretionary, or unscheduled, mortgage principal payments.

The reasoning behind these two predictions is given above. For principal payments, debt overhang changes the allocation of payoffs between the owner and the lender without causing any direct inefficiency. Nevertheless, Prediction 2 is helpful in identifying the debt overhang effect. For example, one reason negative equity homeowners may reduce improvement spending is that they perceive poor returns from such improvements. Yet with the debt overhang channel shut down (zero risk of default), principal payments should not be sensitive to this consideration; their marginal return in that case is determined by the interest rate on the loan.

[8] I assume that informational frictions – difficulty specifying optimal improvements and maintenance, and difficulty identifying homeowners that are underinvesting – prevent borrowers and lenders from overcoming debt overhang through *ex ante* contracting and contract renegotiation.

Prediction 3: The reduction in principal payments and home investments will not be limited to negative equity homeowners that are financially constrained.

Homeowners with negative equity might prefer to invest more in their home but are unable to finance those expenditures. They lack a key source of secured funding – borrowing against home equity through cash-out refinancing or a line of credit. In fact, homeowners that refinance or take out home equity loans often report home improvement as the use of the proceeds (Brady, Canner and Maki 2000), so accounting for liquidity and borrowing constraints is crucial.

Prediction 3 separates debt overhang from current financial constraints: debt overhang should still affect the improvement spending of homeowners with more assets, higher income and limited unsecured debt, provided that they are at risk of default. Given that those homeowners appear to have the savings or borrowing capacity to fund improvements, current financial constraints are an unlikely explanation for any differences in spending that they display. Of course, negative equity homeowners may also cut back spending in anticipation of being constrained in the future. The following prediction helps to address this issue.

Prediction 4 (Falsification): Negative equity homeowners will show no decline in spending on durable investments that are not attached to the home, including outlays for vehicles and home improvements that do not go to the mortgage lender, like furniture and home equipment.

Durable assets, like vehicles, and home improvements that are not part of the property's physical structure, like furniture and most home appliances, stay with the homeowner in the event of default as long as the mortgage lender lacks recourse or chooses not to exercise this right. So the debt overhang hypothesis predicts no difference in expenditures on these items or

possibly an increase in spending if resources otherwise allocated to improvements and principal payments are used to purchase other durables. In contrast, other explanations that posit a different taste for durable or home-related spending among negative equity homeowners would predict lower spending in these categories too. Likewise, if negative equity homeowners were foregoing improvements due to concerns about future financial constraints, they would likely reduce spending on other durables as well.

Prediction 5: The decrease in principal payments and home investments will begin at loan-to-value of 80-100% and continue as loan-to-value rises.

This prediction refines Predictions 1 and 2, focusing on the pattern of investments relative to mortgage loan-to-value. Both empirically (Foote, Gerardi, and Willen 2008) and in calibrated quantitative models (Campbell and Cocco 2011), the likelihood of future default begins to rise around 80% loan-to-value and accelerates from there. This prediction distinguishes debt overhang from the alternative view that negative equity homeowners reduce investment because housing values are below replacement cost. Under this alternative, housing investment should decline with housing value, but not exclusively in the region where value is at or below the loan amount.

Prediction 6: The reduction in principal payments and home investments will be smaller for negative equity homeowners in recourse states, especially for homeowners with financial wealth.

In states that allow mortgage lenders recourse to borrowers' other assets or future income through deficiency judgments, mortgage default among negative equity homeowners should be less prevalent, since the loss of other assets offsets the gain from defaulting on the mortgage.

Ghent and Kudlyak (2011) offer confirming evidence: default rates among negative equity homeowners in recourse states appear to be at least 30 percent lower.[9] Accordingly, the difference in principal payments and improvement spending attributable to negative equity should be smaller in recourse versus non-recourse states, particularly for homeowners with financial assets.

III. Data

The primary data for this study come from the Consumer Expenditure Interview Survey, which follows a rotating random sample of roughly 7,500 households for a year-long period and provides quarterly observations on each household's expenditures. These data are well-suited for this study because they combine detailed information on housing expenditures with information on mortgage debt and property characteristics, including the owner's valuation of the home.

CE expenditure data are both detailed and comprehensive, allowing for analysis of housing expenditures holding fixed total expenditures. Housing expenditures are measured by property, broken down into narrow categories. For this study, the classifications of interest are home improvements and maintenance, home furnishings and equipment, and vehicles.[10] In principle home furnishings and equipment are improvements, but I exclude them from the improvements measure, focusing instead on projects that are closely tied to the physical structure, like electrical work, insulation, plumbing, additions and remodeling. In extensions of the main analysis, I rely on the homeowner's description of the job (e.g., outside painting or

[9] Ghent and Kudlyak's (2011) data do not measure financial assets, but in their analysis recourse does have a substantially larger effect on default for homes with high appraisal values.

[10] Improvement and maintenance expenditures are constructed from the CRB detailed expenditure file. The improvements variable includes all spending for materials, tools and labor, but excludes the cost of home appliances. For vehicle spending I use the CE's "evehpur" variable, which measures vehicle-related outlays during the quarter, specifically the down payment, principal and interest paid on vehicle loans and the purchase amount for vehicles that are not financed. For home furnishings and equipment spending I use the CE's "houseq" variable.

electrical work) as well as their classification of the job into one of five categories: new construction, addition, alteration (remodeling), maintenance and repair, and replacement.

Mortgage information is crucial in measuring the flow consumption of housing, so the BLS also takes care in measuring mortgage liabilities and payments. Homeowners report mortgage borrowing per property and by type of loan – first mortgage, home equity loan (lump sum) and home equity line of credit. For first mortgages and lump sum home equity loans, borrowers report their monthly mortgage payment and the amount of any additional, unscheduled principal payments during the quarter. Regarding scheduled principal, the questionnaire's phrasing likely elicits the required payment rather the actual payment made in recent months, so the data are not well suited for assessing delinquency. Respondents also provide the origination date, original principal balance, loan type (fixed/floating and interest only), interest rate, mortgage insurance status and loan duration. For first mortgages and lump sum home equity loans, the CE does not ask for the current mortgage balance, instead estimating it by applying the appropriate amortization schedule to the original balance, given the loan characteristics.[11] For lines of credit, borrowers report the loan balance and the total payment made during the quarter, from which the CE imputes principal and interest assuming an interest rate of prime plus 1.5 percentage points. Summing across the actual or estimated balance in each loan category, I form an estimate for total mortgage debt on each property as of the beginning of the quarter. Likewise, I estimate unscheduled principal payments for each property as the sum of estimated principal paid on the home equity line of credit and additional principal payments reported for first and second mortgages.

[11] The current mortgage balance will be measured with error if the homeowner has deviated from the mortgage payment schedule prior to entering the survey. However, more significant errors due to refinancing events are not an issue. The CE probes for refinancing events, and records up to date information as of the refinancing date.

The final component of CE data used in this study is housing information. The CE collects a variety of property characteristics, discussion of which I leave to the subsequent section on the sample's summary statistics. Most important for this study is the homeowner's estimate of property value, which the survey elicits with the question: "About how much do you think this property would sell for on today's market?" Some respondents refuse to answer and for these instances I follow an imputation scheme designed to use only directly related information. If the homeowner never reports a home value in any interview, I leave property value as missing for each quarter. If the homeowner provides a valid response in some but not all quarters, I replace the missing value with the prior quarter's home value, if available, or by the next quarter's home value, if not.

To supplement the CE data I code state foreclosure laws, largely following the classification of lender recourse in Ghent and Kudlyak (2011) and Pence (2006). The seven non-recourse states represented in the CE data are Alaska, Arizona, California, Minnesota, Oregon, Washington and Wisconsin. Within California, I code homeowners with non-purchase mortgages as subject to recourse since deficiency judgments are prohibited only for purchase mortgages.

III.1 Regression Sample

The regression sample includes homeowners surveyed in the CE between the first quarter of 2006 and the first quarter of 2011. In total there are roughly 115,000 household-quarter observations. Missing data among key independent variables limit the sample: property values and mortgage balances are missing for 20,700 and 5,300 observations, respectively, and state identifiers are suppressed for roughly 12,200 observations in states with small populations. The remaining sample has observations with very low home values and in some cases implausibly

high loan-to-value ratios. A natural explanation is that these cases are reporting or coding errors, where the reported value is missing a zero or is reported in thousands. With no systematic way of identifying and correcting these cases, I focus the analysis on homes with value above $30,000 and loan-to-value ratio of 2 or less.[12] This selection rule excludes roughly 5,500 observations, leaving the final analysis sample at just over 70,000 observations.

III.2 Negative Equity

The empirical analysis primarily uses an indicator variable for negative equity (*NegEquity*), defined as one if the property value equals or exceeds the total mortgage balance, and zero otherwise. There is a strong rationale for estimating a non-linear effect of mortgage loan-to-value, as I do coarsely with the negative equity indicator and more flexibly with a series of loan-to-value indicators. First, negative equity is a necessary condition of mortgage default in most models; among borrowers unable to pay debt service, selling or refinancing the home dominates defaulting when there is positive equity. Second, among borrowers with the resources to pay, negative equity beyond a certain level becomes a sufficient condition for default.[13] For both of these reasons, homeowners' probability of default should accelerate at or around the point where combined mortgage balances exceed the home value, a fact that is roughly confirmed by Foote, Gerardi and Willen (2008), who show that default rates rise when equity falls below 15% of the mortgage balance (corresponding to an 87% loan-to-value).

The prevalence of negative equity in the CE data increased dramatically over the sample period, rising from 2.2% of homeowners in the third quarter of 2006 to 7.1% in the first quarter

[12] Even within a sample of homeowners in the worst performing housing markets, who also had combined loan-to-value of 100% at origination, Bhutta, Dokko and Shan (2010) find very few instances of LTV in excess of 2.
[13] As noted in Kau, Keenan and Kim (1994), simply being above 100% loan-to-value is not sufficient for default; there is option value in delaying default while there is still reasonable chance of regaining positive equity.

of 2011. The latter number is similar to other estimates that use the homeowner's valuation, but lower than estimates that rely on non-subjective measures of home values.[14] For example, data from First American CoreLogic, a large mortgage loan servicer, suggests 14% of homeowners had negative home equity in the first quarter of 2011. Much of this difference can be explained by the fact that homeowners, particularly those with higher loan-to-value ratios, overestimate their home value (Goodman and Ittner 1992; Agarwal 2007; Anenberg, Nichols and Relihan 2011) by 5 to 10%. Within the CE in the first quarter of 2011, the proportion of negative equity increases to 12.5% if home values are reduced by 10%.

Though negative equity is underestimated in the CE, it displays the pattern that one would expect in the cross-section. Figure 1 shows a scatter plot comparing the CE and First American estimates of negative equity by state between 2009 and the first quarter of 2011. Florida, Michigan, Nevada, Arizona and California have among the highest rates of negative equity, consistent with the First American report, and the correlation of negative equity in the CE and in First American data is quite high at 0.85.[15] The fact that the variation across states looks sensible bodes well for the quality of measured variation in mortgage loan-to-value. Though this cannot be tested, the hope is that cross-household variation is similarly high quality.

III.4 Summary Statistics

Table 1 shows sample statistics for improvements and maintenance spending and unscheduled principal payments at quarterly frequency. Both distributions have substantial mass at zero (roughly 80% of observations in each case) and display right skew. Focusing on the

[14] Underestimating negative equity is not specific to the Consumer Expenditure Survey. The proportion of homeowners reporting negative equity in the American Housing Survey in 2009 is around 6%, similar to the CE.
[15] Some averages in the CE are calculated with a small number of observations, so state-level CE averages are weighted by the number of CE observations when calculating this correlation.

differences between positive and negative equity homeowners, one observes less spending by the negative equity group for both expenditure categories. These declines are evident across the spending distribution: fewer negative equity homeowners make an expenditure and those that do so spend less, with similar proportional declines at the 25th, 50th and 75th percentiles.

Table 2 presents summary statistics for the regression covariates, again separating observations by *NegEquity*. Naturally, households with negative equity have larger mortgage balances. Their mortgage debts are higher in each category, with the largest difference in the first mortgage balance; they owe $268,200 through first mortgages, compared to $140,200 for mortgagors with positive equity. Negative equity households also own lower value homes, $220,900 on average compared to $309,100. Homes in which the owner has positive equity are older – built 6 years earlier on average – but in size and other physical characteristics there is little difference between the two groups.

Negative equity households do not differ much in income and education, but they are younger, spend more and are more likely to be minorities. Both groups have annual income of $90,000, but those with positive home equity spend less: $15,900 per quarter compared to $17,200 per quarter. In education, the positive equity group has more variance – more with a high school diploma or less and more with graduate degrees – but average levels of education are similar. The two groups are also at different points in the life-cycle: *NegEquity* households have owned their home for 6 years on average, compared to 15 for those with positive equity; they are also younger, with a head of household 10 years younger, at 43 compared to 53; and they are less likely to be retired. Racial and ethnic composition also differs between the groups: African-American, Hispanic and Asian groups comprise a larger share of negative equity households.

Looking ahead to the empirical analysis, a number of these differences must be accounted for, particularly those that are expected to influence home improvement spending. New homeowners and younger households are known to spend more on improvements (Mendelsohn 1977; Montgomery 1992; Gyourko and Tracy 2006; Davidoff 2006). Older and larger homes are also likely to require more maintenance (Mendelsohn 1977; Montgomery 1992). Financial constraints are a key issue, as discussed in the Introduction and Section II. Based on life cycle and wealth information, negative equity households appear more likely to be financially constrained. Because of the rich, household-level detail in the CE, I am able to measure and control for these differences.

IV. Regression Model

The main regression model is given by:

$$y_{ipst} = \alpha + \beta NegEquity_{ipt} + \vec{\gamma} X_i + \vec{\delta} Z_p + \eta_{st} + \varepsilon_{ist}$$

Depending on the specification, the dependent variable is quarterly expenditures on improvements and maintenance or quarterly mortgage principal payments of household *i* on property *p* in state *s* during year *t*. The vectors X and Z include household- and property-level controls, respectively. Household-level covariates in X are: total quarterly expenditures; number of household members; quadratic in head of household's age; and a set of dummy variables indicating the head of household's education and race.[16] Property-level covariates in Z include both housing and mortgage characteristics. The housing characteristics are: quadratics in age of home and number of years owned; number of rooms, bedrooms and bathrooms; and indicators for central air conditioning, off street parking, porch and swimming pool. The mortgage

[16] The racial categories are: white, black, Hispanic, Asian and other. The education categories are: less than high school degree, high school degree, some college, college degree and graduate degree.

characteristics are: mortgage interest rate; quadratic in age of mortgage; indicators for whether the property secures a mortgage, the type of mortgage (fixed or floating interest), whether the property secures a home equity line of credit and whether the borrower pays mortgage insurance. All specifications include state-year fixed effects, signified by η.

In models explaining home improvement and maintenance spending, Z also includes a linear control in property value to ensure that differences in maintenance and improvements due to housing quantity are not attributed to negative equity, which naturally correlates with property value. Likewise, mortgage balance is mechanically related to negative equity and also correlates with unscheduled principal payments, so Z also includes a linear control for total mortgage balance in models explaining principal payments. Property value and mortgage balance are both included in models with the full set of controls.

The model is estimated with OLS, providing an estimate of beta, the difference in mean spending on improvements, for example, between positive and negative equity homeowners. In calculating standard errors, observations are clustered by state for two reasons: first, to account for cross-sectional correlation of residuals caused by geographic clustering of negative equity; and second, to account for serial correlation in residuals due to persistence in negative equity and household spending.

V. Results and Discussion

V.1 How Do Home Investments Vary with Negative Equity?

Before discussing the regression analysis, I will begin with the raw data. The top half of Figure 2 shows the average level of unscheduled principal payments and investment spending by loan-to-value category. Improvements and unscheduled principal payments decline consistently

as loan-to-value rises, with particularly rapid declines within the negative equity region, if not exactly at 100% LTV.

Table 3 shows the main regression results. Both in dollar amount and as a proportion of total expenditures, principal payments and improvements and maintenance spending are dramatically lower among negative equity homeowners. Controlling for differences in mortgage balance, negative equity homeowners spend $228 less per quarter on principal payments, a 50% reduction relative to the average quarterly payment of $450 by mortgagors.[17] Adding property value as a covariate makes little difference, as the coefficient on *NegEquity* declines only slightly to -199, and remains strongly significant. Modeled as a proportion of expenditures, principal payments likewise are lower among negative equity homeowners. In these models, the *NegEquity* coefficient ranges from -0.29 to -0.35, indicating roughly 20% lower payments relative to the average normalized payment of 1.5% among mortgagors.[18] In each case the *NegEquity* coefficient estimate is significant at the 1% level. Turning to spending on improvements and maintenance, I find less investment in negative equity properties. Controlling for differences in property value, negative equity homeowners invest $208 less than their positive equity counterparts. Similarly, as a proportion of total expenditures, spending on improvements and maintenance is 87 basis points lower among negative equity homeowners. These differences are statistically significant and substantial, as they imply roughly 30% lower improvements among those with negative equity.

[17] Both components – estimated principal payments on lines of credit and unscheduled payments on first and second mortgages – decline with *NegEquity* (see Appendix Table 2).

[18] This result may be surprising in light of the prevalence of prepayment penalties among high-LTV homeowners, a group that is almost certainly over-represented in the negative equity group. However, the vast majority of prepayment penalties, which are indeed common in high-LTV loans, apply only to payments that exceed 20% of principal outstanding.

These results confirm the first two predictions about debt overhang: negative equity households invest less in their homes, both in incremental improvements and in debt payments. At this stage, though, these relationships are suggestive correlations. More analysis is needed to distinguish debt overhang from other factors that vary with negative equity.

V.2 Does Negative Equity Proxy for Liquidity and Borrowing Capacity?

The analysis presented in Table 4 explores whether the spending differences of negative equity homeowners are driven by financial constraints. The approach is to limit the sample to households with higher incomes, more borrowing capacity and more financial assets, who are evidently not financially constrained, and estimate the impact of negative equity among these households.

The regression results show that negative equity homeowners invest less in their properties, even when they appear financially unconstrained. Among households with relatively high income (in the top decile, above $165,000 per year), those with negative equity pay $386 (p-value 0.09) less in unscheduled principal and spend $806 (p-value 0.03) less on improvements. Likewise, among households that report no unsecured debt (credit cards and installment loans), those with negative equity spend $202 (p-value 0.006) less paying down principal and $276 (p-value 0.08) less on improvements and maintenance compared to their positive equity counterparts. Finally, for homeowners that report financial assets of at least $100,000, negative equity corresponds to a $444 reduction in mortgage principal payments and a $573 reduction in improvements and maintenance. The results for this subsample are less informative, given that the estimates have very wide confidence intervals. Across all three subsamples, the *NegEquity* coefficients imply somewhat larger differences in improvement

spending (40-50% reductions) than the main results (30% reduction). For principal payments, the differences are similar to those in the main regression: roughly 40-50% lower principal payments among negative equity homeowners compared to the average payment of mortgagors in the subsample.

These findings confirm Prediction 3 by showing that the main result – lower home investment spending among negative equity households – is not explained by financial constraints. We should not conclude, however, that home equity plays no role in relaxing liquidity constraints or that liquidity constraints have no effect on home improvement spending. The regressions include total expenditures as a dependent variable, so if non-improvement expenditures also rise as liquidity constraints are relaxed, then variation in improvements due to liquidity constraints will load on total expenditures rather than *NegEquity*. Furthermore, the regression results show differences between negative and positive equity homeowners, but do not explore how improvement spending differs among those with positive equity, where equity might be important in financing spending.

Given the ability of wealthier households to continue making mortgage payments in the case of job loss, the large spending declines observed in this subsample are somewhat surprising. Being in a negative equity position should not expose them to substantially higher default risk unless they are considering strategic default to avoid paying the excess mortgage balance above the value of the home. In that case, mortgage lenders' recourse to their other assets ought to affect their risk of default. The analysis in Section V.6 explores the role of lender recourse.

It is worth noting that "constrained" homeowners also reduce improvement spending when they are in a negative equity position, quite substantially for those with more than $10,000 of unsecured debt (-44%) or zero financial assets (-57%) and somewhat less (-15%) for those

with income below $100,000. Mortgage principal payments show less robust declines with *NegEquity* in the "constrained" samples: the subsample with zero financial assets reduces payments substantially (-83%), but those with unsecured debt or lower income show smaller, statistically insignificant differences of -16% and -13%, respectively. These results are reported in Appendix Table 1.

V.3 How Does Other Durable Spending Vary with Negative Equity?

Though the CE data allow for a number of important controls, a nagging concern is that some unobservable difference between households – one that correlates with both negative equity and durable or property-related spending – might be responsible for the main findings. The results in Figure 2 and Table 5 help to address this question.

Again, I will begin with the raw data on spending, which is plotted against loan-to-value in the bottom half of Figure 2. In contrast to principal payments and improvements, spending on vehicles and home furnishings and equipment does not differ much between positive and negative equity homeowners. Vehicle spending shows no relationship with loan-to-value, as it is relatively constant across all loan-to-value categories. Home-related durable spending, while somewhat lower in two negative equity categories, does not show a consistent and steep decline with loan-to-value, as do principal payments and structural improvements.

Table 5 displays results from the corresponding regression analysis. These models examine spending both in dollar amounts and as a proportion of total expenditures, with the same set of covariates as in the earlier regressions (total expenditures; housing, household and mortgage characteristics; and state-year fixed effects). In the first model, controlling for differences in property value, the regression estimates imply that negative equity households

spend $38 (p-value 0.47) less on vehicles and $23 (p-value 0.64) less on home-related durables. These point estimates are statistically insignificant and small in magnitude, even relative to average spending in these categories. With a control for mortgage balance as well, the *NegEquity* coefficients increase and imply that negative equity homeowners spend $191 (p-value 0.003) more on vehicles and $74 (p-value 0.21) more on home-related durables. The results for proportional expenditures are quite similar in the fully controlled model: *NegEquity* is positively correlated with vehicle spending (76 basis point increase from 5% average) and shows no statistically significant relationship with home durable spending (12 basis point decrease from 2.5% average). Without mortgage balance as a control, normalized spending on home-related durables is lower by 30 basis points (p-value 0.001), or 12%.

The raw data and regression results largely confirm Prediction 4, as we do not observe systematically lower vehicle and home-related durable spending among negative equity homeowners. In fact, vehicle spending seems to increase with *NegEquity*, perhaps in response to the additional room in the household budget from reductions in improvements and principal payments. The muted response of vehicle and home durable spending is not due to general inelasticity in these spending categories: across households in the CE, home durable and vehicle expenditures appear more income-elastic than home improvement expenditures, and home durable expenditures also appear more wealth-elastic than home improvements.[19]

These facts are helpful in interpreting the main results, since the spending decline attributed to negative equity is specific to categories for which we expect mortgage overhang: they are specific to the home and even within the home they are specific to investments in the permanent structure. Because the main regression results do not isolate specific, exogenous

[19] Across households in the CE, log expenditures on home durables show higher correlations with log income and log financial wealth than do log expenditures on improvements and maintenance. With vehicle spending, the same relationship holds for income, but not for wealth.

variation in negative equity, it is natural to worry that the correlations do not reveal a causal effect of negative equity on home investments. For example, underinvesting might cause negative equity, or heavily indebted borrowers, those at greatest risk of negative equity, might be a different type of homeowner for whom most positive equity homeowners are a poor comparison group. But it is hard to imagine that such unobserved heterogeneity across households would not show up in other durable spending, particularly in home improvements that are closely related, but not attached, to the home.[20]

V.4 Varying Functional Form: Tobit Results

Ordinary least squares regressions may provide misleading estimates with dependent variables that cluster at zero, as do the key measures in this study. The Tobit model (Tobin 1958), which has been used by others studying home improvements (Gyourko and Saiz 2004), is an alternative approach that accounts for left censoring in the dependent variable. Table 6 displays Tobit estimation results for principal payments and investments in durables. The table shows three marginal effects of interest: the effect of negative equity on 1) the likelihood of any spending; 2) the amount spent by those with positive spending; and 3) the amount spent unconditionally, including both zero and positive spending.

For principal payments, the *NegEquity* coefficient implies a 9% reduction in the likelihood of any payment (-1.3 percentage point decline from 15% probability) and a reduction of $123 among those making positive payments. Combining these two effects, the effect of negative equity on average principal payments is smaller than in the OLS model: *NegEquity* is

[20] Given the short CE panel and limited time variation in negative equity, a model with household fixed effects does not yield informative results; confidence intervals for the *NegEquity* coefficients are very wide and encompass the confidence intervals from the main regressions.

associated with a $48 decline in principal payments, far below the $199 decline from the OLS model.

The Tobit results for improvement spending are very similar to the OLS results. Improvement spending shows a significant decline with *NegEquity*, both in the likelihood of improvements (a 13% decline, or -3.2 percentage points from 24% baseline likelihood) and in the amount of spending among those making improvements (a $266 decline). Comparing magnitudes, the Tobit model implies, on average, $225 less improvement spending by negative equity homeowners, which is very close to the OLS estimate.

Finally, the Tobit results for vehicles and home-related durables are very similar to the fully-controlled OLS results. Spending on home furnishings and equipment shows no relationship with *NegEquity*, while spending on vehicles increases with *NegEquity* (estimates imply a $150 increase, similar to the OLS estimate).

Overall, the Tobit results concur with the OLS results: principal payments and improvements decline with negative equity, vehicle spending rises, and spending on home equipment and furnishings shows no difference. The main difference in the Tobit model is the smaller effect of negative equity on principal payments.

V.5 Home Investments and the Depth of Negative Equity

As stated in Prediction 5, the effect of debt overhang should be minimal until loan-to-value reaches 80% to 100% and should intensify as negative equity deepens. To test this prediction I revisit the plots of spending by loan-to-value category in this case with residual spending. Figure 3 plots residual spending against loan-to-value, where the residuals are formed from an OLS regression model with the full set of control variables but without *NegEquity*. The

residuals for both improvements and principal payments show little relationship with loan-to-value up to 75% loan-to-value, but decline substantially from there and reach their low point in the highest loan-to-value categories, where debt overhang is largest. In contrast, the residual for other household durables displays no systematic relationship with loan-to-value, and the residual for vehicle spending is positive in the negative equity region, but does not increase continuously throughout that region.

Table 7 reports the regression analog of these plots. This analysis repeats the main regressions, with a series of loan-to-value indicator variables in place of *NegEquity*. For unscheduled principal payments the regression sample is restricted to mortgagors and the excluded category is 0 to 25% loan-to-value. In the other three models, the excluded category is non-mortgagors. As in the residual plots, the regression results show declining improvements and principal payments throughout the negative equity region, with the lowest spending in the highest loan-to-value categories. In both cases, the spending decline begins at somewhat lower loan-to-value than expected, in the 50 to 75% loan-to-value category. Nevertheless, there is still quite a substantial decline as loan-to-value moves up to and over 100%. For vehicles, spending is substantially higher among mortgagors than among non-mortgagors, and generally increases with loan-to-value. Finally, for home furnishings and equipment, spending shows no relationship with loan-to-value.

V.6 Foreclosure Laws, Lender Recourse and Negative Equity Effects

The analysis presented in Table 8 tests whether the spending differences attributable to *NegEquity* vary with state foreclosure laws. The coefficient of interest is the interaction term between *NegEquity* and *Recourse*, an indicator for whether the state permits mortgage lenders to

pursue borrowers' other assets when the collateral value falls short of the loan balance. Prediction 6 suggests that debt overhang matters less in recourse states and that the interaction coefficient should be positive.

The evidence on recourse is mixed in the full sample. For unscheduled principal payments the coefficient on the *NegEquity-Recourse* interaction is positive, as predicted, but not statistically significant. For improvements, the interaction is still insignificant but also has the wrong sign; it appears that negative equity leads to larger spending declines in recourse states than in non-recourse states.

However, the homeowners for whom lender recourse is most relevant – those with financial assets to lose in a deficiency judgment – do show the spending pattern that one would expect. In the subsample of homeowners with at least $100,000 of financial assets, the *NegEquity-Recourse* coefficient is positive (though not significant) and fairly close in magnitude to the main *NegEquity* coefficient for both principal payments and improvements. These estimates, while somewhat imprecise, suggest that *NegEquity* has a much smaller, if nonzero, effect on spending in recourse states. On the other hand, negative equity homeowners in non-recourse states cut their investments substantially, paying $1070 (p-value 0.006) less in unscheduled principal and spending $1397 (p-value 0.007) less on improvements. Both declines are large enough to eliminate the average wealthy homeowner's spending in that category. In contrast, negative equity homeowners in recourse states make much smaller cuts that are not statistically different than zero, paying $232 less in principal and spending $316 less on improvements based on coefficient point estimates for *NegEquity* and its interaction with *Recourse*.

Finally, within the sample of homeowners with less than $100,000 of financial assets, one would expect recourse to have less impact. For principal payments this prediction is borne out, as the *NegEquity-Recourse* interaction is small and insignificant in this subsample. On the other hand, for improvements the recourse interaction is negative and larger in magnitude (but not significant), while the coefficient on *NegEquity* is small and insignificant. From these point estimates it appears that negative equity has little effect on improvements in non-recourse states and a negative effect in recourse states. While this finding is not necessarily at odds with the debt overhang interpretation, it suggests that there are other important differences between recourse and non-recourse states, since recourse laws *per se* cannot explain this pattern in spending.

V.7 Matched Sample Analysis

As noted in the discussion of summary statistics, there are important differences between positive and negative equity homeowners. While the main analysis controls for many observable differences, the inferences from those models may be unreliable because of lack of overlap between the positive and negative equity samples or because of errors in the assumed functional form.

The analysis in Table 9 probes further by matching each negative equity homeowner to a similar positive equity homeowner and comparing their spending. I match homeowners on their predicted probability of having negative equity, as calculated from a probit model with the following explanatory variables: state-year fixed effects, age of homeowner, years of ownership, age of mortgage, income, financial asset balance and unsecured credit balance.

The matching procedure is effective in balancing the sample. As shown in Panel A, the average values of the key covariates are quite similar in the positive and negative equity subsets

of the matched sample, with only the modest differences in financial assets and years of ownership significant at the 10% significance level.

Panel B shows the estimated spending differences between the positive and negative equity groups. As in the main analysis, principal payments and improvement spending are significantly lower among those with negative equity, while spending on home durables shows no difference and spending on vehicles is modestly higher in the negative equity sample. The difference in principal payments is -$128, implying a 33% decline relative to the average $381 payment among the positive equity control group. This estimate is slightly smaller than the 40-45% decline estimated in the main analysis. The difference in improvement spending is -$168, or 30% relative to the average of $558 spent by the matched positive equity sample. This difference is very close to the proportional decline estimated in the main analysis.

The matching analysis confirms the inferences drawn in the main analysis. While the positive and negative equity groups may still differ in unobservable characteristics, narrowing the comparison to observably similar positive and negative equity homeowners does not meaningfully change the results.

V.8 Robustness

Table 10 examines the robustness of the main findings. The first model uses a log transformation of the dependent variable. Log principal payments among *NegEquity* households are lower by 0.17 (p-value 0.001), implying a 17% decline. This magnitude is more in line with the Tobit results than the main OLS results. Log improvements are lower by 0.27, implying a 27% reduction that is quite similar to the Tobit and main OLS findings. The next two columns present results for normalized improvement spending (dividing by property value), which

confirm the main finding that negative equity homeowners spend less than their positive equity counterparts, albeit with a smaller decline in improvements when mortgage balance is included as a control variable.[21] Finally, as an attempt to reduce measurement error in *NegEquity*, the third model collapses to a single observation per household-property, averaging both quarterly spending and *NegEquity* over the household's full time in the sample. For this model, the *NegEquity* coefficient of -215 for principal payments is close to the main results, but the coefficient of -476 for improvements is substantially larger than the main results.

The three models in Panel B explore the sensitivity of the main findings to different sets of covariates. First, I confirm that controlling for income in place of total expenditures does not change the main results. Second, I find that including quadratics in financial asset balance and unsecured credit balance does not change the *NegEquity* coefficient estimate for principal payments, and reduces the coefficient very modestly to -161 for improvements. Third, I include MSA-year fixed effects, a change that limits the sample to the 45% of observations for which I observe the homeowner's MSA (revealed for MSAs with population above 100,000). This model restricts the identifying variation in negative equity by controlling for city-level trends, including trends in housing markets. The negative equity coefficients are unchanged, which confirms that the main results do not rely on a potentially flawed comparison across cities with very different real estate markets.

V.9 Other Explanations

The value of improvements and maintenance includes materials and outside labor, but excludes the value of the homeowner's labor, which is meaningful. Within the CE survey, the homeowner reports doing all of the work in 36% of improvement jobs and some of the work in

[21] Mortgage payments as a proportion of mortgage balance also decline with *NegEquity* (Appendix Table 2).

another 11% of jobs. If negative equity homeowners were still improving their properties, but were substituting away from outside labor, the coefficients on *NegEquity* would overstate the effect of negative equity on home investments. Yet there is no evidence that such substitution is occurring, as shown in the first column of Appendix Table 2. Conditional on making improvements, negative equity homeowners are no more or less likely to report doing some or all of the work on their own.

Another important consideration is the inter-temporal substitution of improvements. High improvement spending in the past may explain low spending today, and serve as a confounding factor if *NegEquity* in the current period is positively correlated with past spending. Such a correlation may result, for example, if homeowners funded past improvements by refinancing and increasing their mortgage balance. To account for such a relationship, the main regressions include controls for mortgage age with linear and quadratic terms. Likewise, the matching analysis pairs observations based on mortgage age. Lastly, in a model with a more precise control for recent refinancing (adding an indicator for mortgage aged 12 to 36 months), the *NegEquity* effect remains (result in Appendix Table 2).

Finally, the homeowner's horizon of ownership may affect spending on improvements, particularly for projects that provide utility to the current owner but may not be valued by a future owner. The effect of household mobility is uncertain, as some research finds that negative equity owners move less frequently (Chan 2001; Ferreira, Gyourko and Tracy 2010) and other research finds no relationship (Schulhofer-Wohl 2012). Nevertheless, if negative equity happens to be more prevalent among short horizon homeowners, then *NegEquity* would predict lower spending even in the absence of a debt overhang effect. Following Sinai and Souleles (2005; 2009), I proxy for differences in geographic mobility with an indicator variable for each age-

occupation-marital status cell.[22] Doing so barely changes the *NegEquity* coefficient (reported in Appendix Table 2), which suggests that variation in mobility is not driving the main coefficient estimates.

VI. Interpretation

In the extreme, debt overhang is unsurprising behavior. When a homeowner is days away from default and certain of this outcome, it is not surprising that they do not invest in their home. But the magnitude of the estimates in this analysis suggests that a much larger group of homeowners is cutting back, and doing so on a forward looking basis as they anticipate the increased possibility, if not certainty, of default. Foreclosure starts peaked at a quarterly rate of 1.4% of loans (0.91% of homeowners) and the stock of foreclosures peaked at 4.6% of loans (3.0% of homeowners). So, even if home improvement spending goes to zero for homes heading into foreclosure, average quarterly spending would fall by less than 5%, far below the 30% reduction that I estimate. The sample statistics reported in Table 1 also support the conclusion that the decline in improvements and principal payments is broad-based within the negative equity group. The declines in improvements and principal payments in the subsample with *NegEquity* occur throughout the size distribution.

Studies of mortgage default are mixed on the extent of strategic default: while Foote, Gerardi and Willen (2008) note that only 6% of negative equity homeowners in Massachusetts in the 1990s defaulted, Bhutta, Dokko and Shan (2010) and Guiso, Sapienza and Zingales (2011) estimate that 20% to 30% of recent defaults are strategic. My results imply that strategic default is an important consideration, at least for some homeowners; otherwise, it is difficult to account

[22] Households are classified into 1 of 8 age categories (each group spanning 10 years), 5 marital status categories and 19 occupation categories.

for wealthier homeowners' response to *NegEquity* in non-recourse states. I would not claim, however, that strategic default is the only mechanism at work, since I also find lower spending among negative equity homeowners that lack financial wealth. For such homeowners, being in a negative equity position increases the likelihood of default due to job loss as it does the likelihood of strategic default.

VII. Implications

The results imply that national spending on home improvements, a sizeable component of total housing investment, will be 3-5% lower (10-15% of homeowners with negative equity reducing spending by 30%) until the debt overhang problem is resolved through price appreciation, default or principal reduction. For the states where negative equity is most prevalent – e.g., California, Florida, Michigan, Arizona and Nevada – debt overhang may be responsible for spending declines of 10% or more. These findings corroborate the conjecture in Laeven and Laryea (2009) and the evidence in Mian and Sufi (2010) that household indebtedness has held back residential investment during the recent recession and ongoing economic recovery.

The results also suggest that home prices will grow more slowly in the future because of reduced investment, especially in states with substantial debt overhang. For a state like Nevada, with substantial prevalence (50% of homeowners) and depth of negative equity, a 15 to 25 basis point reduction in the annual growth of home values is not out of the question.[23]

Regarding foreclosure mitigation policy, my findings highlight the importance of mortgage principal reduction in restoring homeowners' incentives to pay their mortgages,

[23] This calculation assumes that improvements and maintenance add 1% per year to the value of the home (Harding, Rosenthal and Sirmans 2007), and that among the 50% of homeowners with negative equity, improvement spending declines by 30-50%.

consistent with Haughwout, Okah and Tracy (2009), but also to care for their homes.[24] The latter point suggests an additional economic motivation for principal reduction as part of a mortgage modification program: principal reduction potentially mitigates costly underinvestment in housing. Indeed, debt overhang likely contributes to the neglect of homes that end up in foreclosure, which sell for 20-30% less than comparable homes outside of foreclosure (Campbell, Giglio and Pathak 2011; Harding, Rosenblatt and Yao 2012).

As noted in Myers (1977), the social cost of debt overhang depends on the nature of the foregone investment. The efficiency loss is largest for investment opportunities that disappear or decline in value if not exercised. For example, foregone maintenance of some types – failing to fix a foundation problem or a plumbing leak – can be quite socially costly when the subsequent owner faces greater damage and a more costly repair in the future. Foregone additions and remodeling are examples of investment opportunities that do not vanish, but the delay introduced by debt overhang reduces welfare for the current homeowner while she remains in the home. For these types of projects, the efficiency loss is smaller, but increases with the duration of debt overhang. Additionally, mortgage market subsidies have almost surely created overcapacity in housing already, so foregone additions to the quantity of housing likely have less effect on social welfare than foregone additions to quality.

To assess the welfare implications of mortgage debt overhang, it is helpful to delve more deeply into the types of projects that negative equity homeowners forego. Appendix Table 2 shows regression results for various categories of improvement spending. It appears that negative equity homeowners are not simply foregoing cosmetic improvements or investments that tailor the home to their taste. Spending that alters existing space – most commonly remodeling of

[24] Agarwal, et al. (2010) also examine re-default following mortgage modifications, but do not draw a definitive conclusion on the effect of principal reduction due to limited statistical power.

kitchens, bathrooms, basements and attics – declines, but so does spending for repair and replacement of the "guts" of the home both outside (roofs, gutters, siding, masonry, painting, windows and doors) and inside (plumbing, electrical wiring, HVAC and insulation) the home. Interestingly, negative equity does not simply affect the quantity of housing: foregone spending on additions and new construction is minimal. While there is too little information about the context and nature of these investments to paint a dire picture of social value destroyed through undermaintenance, we can certainly rule out the possibility that the foregone investments would have gone towards unneeded capacity and purely cosmetic changes.

VIII. Conclusion

This paper extends our understanding of the financial decisions made by heavily indebted homeowners, a topic of significance after the rapid rise in mortgage borrowing – a doubling between 2000 and 2007 – and the substantial fall in U.S. home values thereafter. For up to 15% of homeowners, mortgage debts even exceed the value of their home. Finance theory predicts that homeowners in these circumstances will reduce both mortgage principal payments and home improvement spending due to debt overhang.

Using detailed household-level data on housing expenditures, I test these hypotheses and find that negative equity homeowners do indeed cut back on principal payments and improvements, by roughly 30% each. These differences do not reflect a general spending decline by negative equity homeowners, nor are they limited to borrowing or liquidity constrained households. In fact, wealthy homeowners in non-recourse states reduce their principal payments and improvement spending quite substantially when they have negative equity. Within household

spending, the cutbacks are specific to durable investments in the physical structure, on which the mortgage lender has a claim in foreclosure. Debt overhang best explains this set of facts.

These findings highlight an important financial friction that has suppressed residential investment during the recent recession and ongoing economic recovery. The estimates imply that debt overhang has reduced spending on home improvements by 3% to 5% nationally and by 10% or more in the states with the highest proportion of negative equity homeowners. These declines will persist until the debt overhang problem is resolved through foreclosure, price appreciation or mortgage modifications. Regarding mortgage modifications, the analysis also offers indirect evidence on the efficacy of principal reduction. Provided that positive equity is restored, such a policy appears to improve homeowners' willingness to make mortgage payments and to care for their homes.

REFERENCES

Admati, Anat, Peter M. DeMarzo, Martin F. Hellwig and Paul Pfleiderer. 2012. Debt Overhang and Capital Regulation. Working paper.

Agarwal, Sumit. 2007. The Impact of Homeowners' Housing Wealth Misestimation on Consumption and Savings Decisions. *Real Estate Economics*, 35(2): 135–154.

Agarwal, Sumit, Gene Amromin, Itzhak Ben-David, Souphala Chomsisengphet, and Douglas D. Evanoff. 2010. Market-Based Loss Mitigation Practices for Troubled Mortgages Following the Financial Crisis. Federal Reserve Bank of Chicago Working Paper, WP 2011-03.

Anenberg, Eliot, Joseph B. Nichols, and Lindsay Relihan. 2011. Trends in the Accuracy of Home Owners' Estimates of House Value. Working paper.

Bhutta, Neil, Jane Dokko, and Hui Shan. 2010. The Depth of Negative Equity and Mortgage Default Decisions. Federal Reserve Board Working Paper, FEDS 2010-35.

Brady, Peter J., Glenn B. Canner, and Dean M. Maki. 2000. The Effects of Recent Mortgage Refinancing. *Federal Reserve Bulletin*, 86(7): 441-450.

Bucks, Brian K., Arthur B. Kennickell, Traci L. Mach and Kevin B. Moore. 2009. Changes in U.S. Family Finances from 2004 to 2007: Evidence from the Survey of Consumer Finances. *Federal Reserve Bulletin*, 95(1): A1-A55.

Campbell, John Y., and Joao Cocco. 2011. A Model of Mortgage Default. Working paper.

Campbell, John Y., Stefano Giglio, and Parag Pathak. 2011. Forced Sales and House Prices. *American Economic Review*, 101(5): 2108–2131.

Chan, Sewin. 2001. Spatial Lock-in: Do Falling House Prices Constrain Residential Mobility? *Journal of Urban Economics*, 49(3): 567-586.

Choi, Hyun-Soo, Harrison Hong and Jose Scheinkman. 2011. Speculating on Home Improvement. Princeton University – Economic Theory Center Research Paper No. 22-2011.

Davidoff, Thomas. 2006. Maintenance and the Home Equity of the Elderly. Working paper.

Deng, Yongheng, John M. Quigley, and Robert Van Order. 2000. Mortgage Terminations, Heterogeneity and the Exercise of Mortgage Options. *Econometrica*, 68(2): 275-308.

Deng, Yongheng, and Stuart A. Gabriel. 2006. Risk-Based Pricing and the Enhancement of Mortgage Credit Availability among Underserved and Higher Credit-Risk Populations. *Journal of Money, Credit and Banking*, 38(6): 1431-1460.

Ferreira, Fernando, Joseph Gyourko, and Joseph Tracy. 2010. Housing Busts and Household Mobility. *Journal of Urban Economics*, 68(1): 34–45.

Foote, Christopher L., Kristopher Gerardi, and Paul S. Willen. 2008. Negative equity and foreclosure: Theory and evidence. *Journal of Urban Economics*, 64(2): 234-245.

Ghent, Andra C., and Marianna Kudlyak. 2011. Recourse and Residential Mortgage Default: Evidence from U.S. States. *Review of Financial Studies*, 24(9): 3139–3186.

Goodman, John L., and John B. Ittner. 1992. The Accuracy of Home Owners' Estimates of House Value. *Journal of Housing Economics*, 2(4): 339–357.

Guiso, Luigi, Paola Sapienza, and Luigi Zingales. 2011. The Determinants of Attitudes towards Strategic Default on Mortgages. *Journal of Finance*, forthcoming.

Gyourko, Joseph, and Albert Saiz. 2004. Reinvestment in the Housing Stock: the Role of Construction Costs and the Supply Side. *Journal of Urban Economics*, 55(2): 238–256.

Gyourko, Joseph, and Joseph Tracy. 2006. Using Home Maintenance and Repairs to Smooth Variable Earnings. *The Review of Economics and Statistics*, 88(4): 736-747.

Haughwout, Andrew, Ebiere Okah, and Joseph Tracy. 2009. Second Chances: Subprime Mortgage Modification and Re-Default. Federal Reserve Bank of New York Staff Report no. 417.

Haughwout, Andrew, Richard Peach, and Joseph Tracy. 2010. The Homeownership Gap. *Federal Reserve Bank of New York Current Issues in Economics and Finance*, 16(5): 1–11.

Harding, John P., Stuart S. Rosenthal, and C.F. Sirmans. 2007. Depreciation of Housing Capital, Maintenance, and House Price Inflation: Estimates from a Repeat Sales Model. *Journal of Urban Economics*, 61(2): 193–217.

Harding, John P., Eric Rosenblatt, and Vincent W. Yao. 2012. The Foreclosure Discount: Myth or Reality? *Journal of Urban Economics*, 71(2): 204–218.

Hennessy, C.A. 2004. Tobin's Q, Debt Overhang, and Investment. *Journal of Finance*, 59 (4): 1717–1742.

Hurst, Erik, and Frank Stafford. 2004. Home is Where the Equity is: Mortgage Refinancing and Household Consumption. *Journal of Money, Credit and Banking*, 36(6): 985-1014.

Jorgenson, Dale W. 1963. Capital Theory and Investment Behavior. *American Economic Review*, 53(2): 247–259.

Keynes, John Maynard. 1920. *The Economic Consequences of the Peace*. New York: Harcourt, Brace and Howe.

Krugman, Paul R. 1988. Financing vs. Forgiving a Debt Overhang. *Journal of Development Economics*, 29(3): 253-268.

Laeven, Luc, and Thomas Laryea. 2009. Principles of Household Debt Restructuring. IMF Staff Position Note No. 2009/15.

Lamont, Owen. 1995. Corporate-Debt Overhang and Macroeconomic Expectations. *American Economic Review*, 85(5): 1106–1117.

Mello, Antonio S. and John E. Parsons. 1992. Measuring the Agency Cost of Debt. *Journal of Finance*, 47(5): 1887–1904.

Mendelsohn, Robert. 1977. Empirical Evidence on Home Improvements. *Journal of Urban Economics*, 4(4): 459-468.

Mian, Atif, and Amir Sufi. 2010. Household Leverage and the Recession of 2007 to 2009. *IMF Economic Review*, 58(1): 74–117.

Mian, Atif, and Amir Sufi. 2011. House Prices, Home Equity-Based Borrowing, and the U.S. Household Leverage Crisis. *American Economic Review*, 101 (5): 2132–2156.

Montgomery, Claire. 1992. Explaining Home Improvement in the Context of Household Investment in Residential Housing. *Journal of Urban Economics*, 32(1): 326-350.

Mulligan, Casey B. 2008. A Depressing Scenario: Mortgage Debt Becomes Unemployment Insurance. NBER Working Paper 14514.

Myers, Stewart C. 1977. Determinants of Corporate Borrowing. *Journal of Financial Economics*, 5(2): 147-175.

Occhino, Filippo and Andrea Pescatori. 2010. Debt Overhang in a Business Cycle Model. Federal Reserve Bank of Cleveland Working Paper, 10-03.

Olney, Martha L. 1999. Avoiding Default: The Role of Credit in the Consumption Collapse of 1930. *Quarterly Journal of Economics*, 114(1): 319-335.

Parrino, Robert, and Michael S. Weisbach. 1999. Measuring Investment Distortions Arising from Stockholder-Bondholder Conflicts. *Journal of Financial Economics*, 53(1): 3–42.

Pence, Karen M. 2006. Foreclosing on Opportunity: State Laws and Mortgage Credit. *The Review of Economics and Statistics*, 88(1): 177-182.

Phillipon, Thomas. 2010. Debt Overhang and Recapitalization in Closed and Open Economies. *IMF Economic Review*, 58(1): 157–178.

Phillipon, Thomas, and Phillip Schnabl. 2011. Efficient Recapitalization. *Journal of Finance*, forthcoming.

Sachs, Jeffrey D. 1990. A Strategy for Efficient Debt Reduction. *Journal of Economic Perspectives*, 4(1): 19-29.

Schulhofer-Wohl, Sam. 2012. Negative Equity Does Not Reduce Homeowners' Mobility. *Federal Reserve Bank of Minneapolis Quarterly Review*, 35(1): 2–14.

Sinai, Todd and Nicholas Souleles. 2005. Owner-Occupied Housing as a Hedge Against Rent Risk. *Quarterly Journal of Economics*, 120(2): 763–789.

Sinai, Todd and Nicholas Souleles. 2009. Can Owning a Home Hedge the Risk of Moving? Working Paper.

Titman, Sheridan, Stathis Tompaidis, and Sergey Tsyplakov. 2004. Market Imperfections, Investment Flexibility, and Default Spreads. *Journal of Finance*, 59(1): 165 – 205.

Tobin, James. 1958. Estimation of Relationships for Limited Dependent Variables. *Econometrica*, 26(1): 24–36.

Tobin, James. 1969. A General Equilibrium Approach to Monetary Theory. *Journal of Money, Credit and Banking*, 1(1): 15–29.

FIGURES

Figure 1

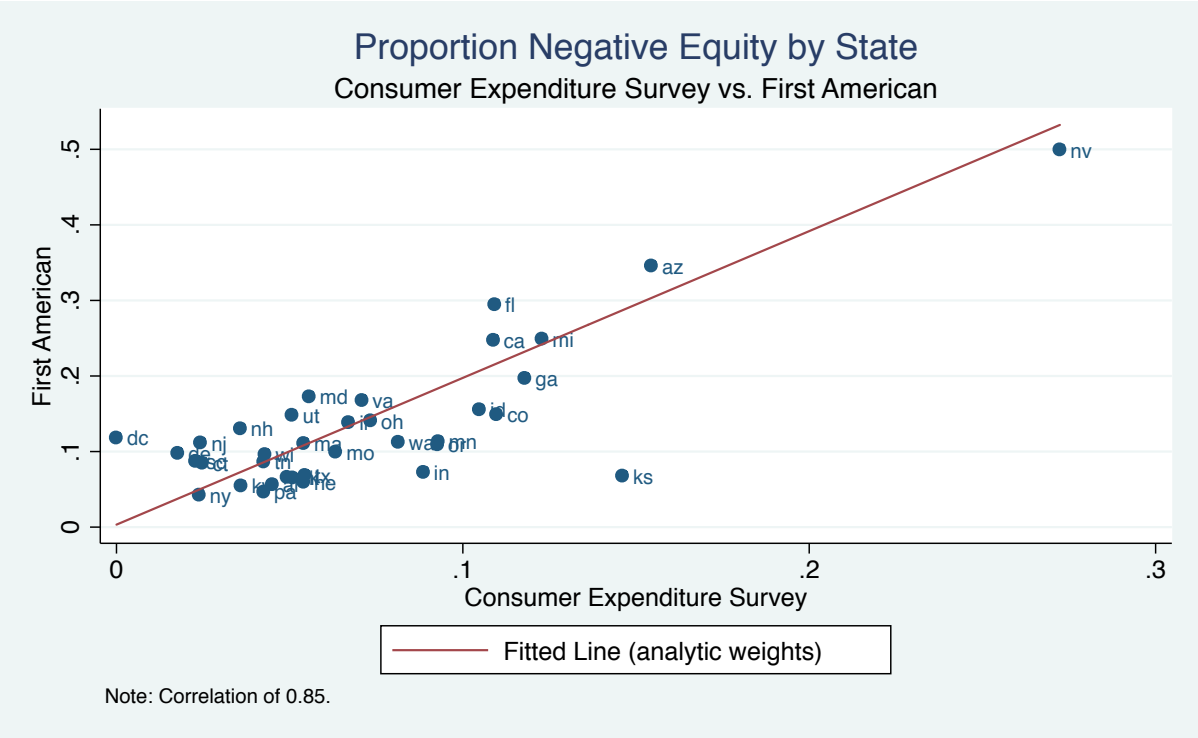


Figure 2

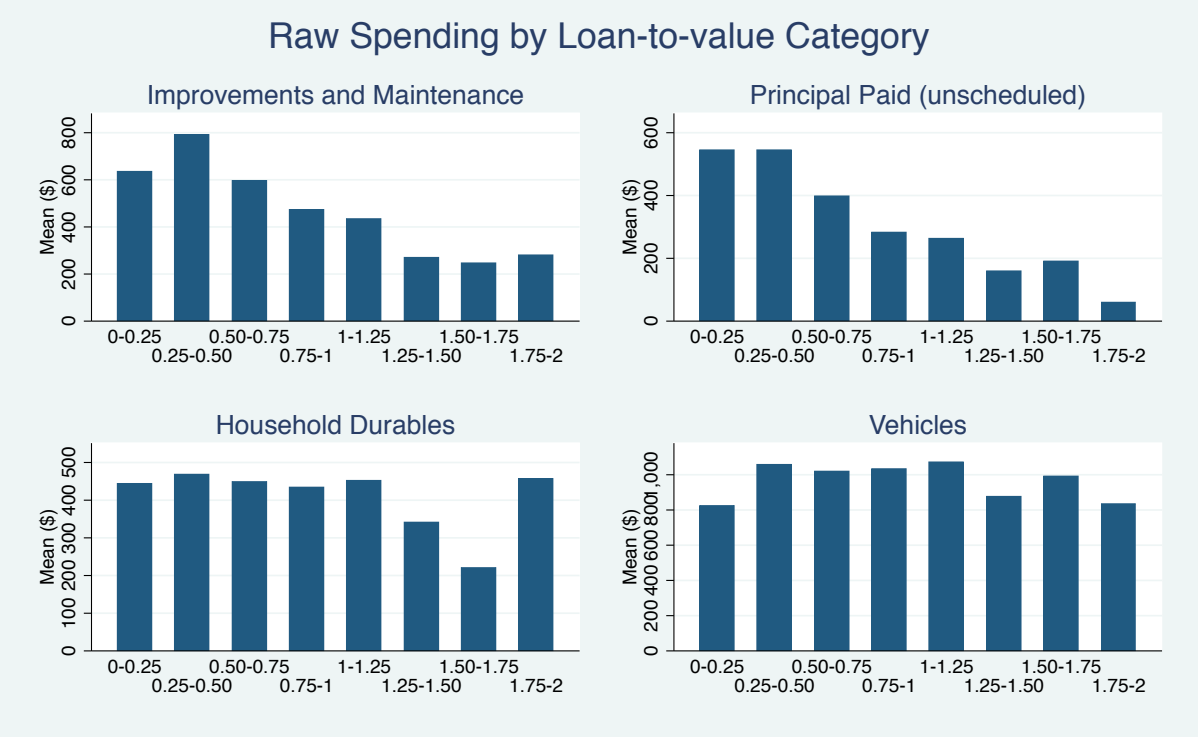
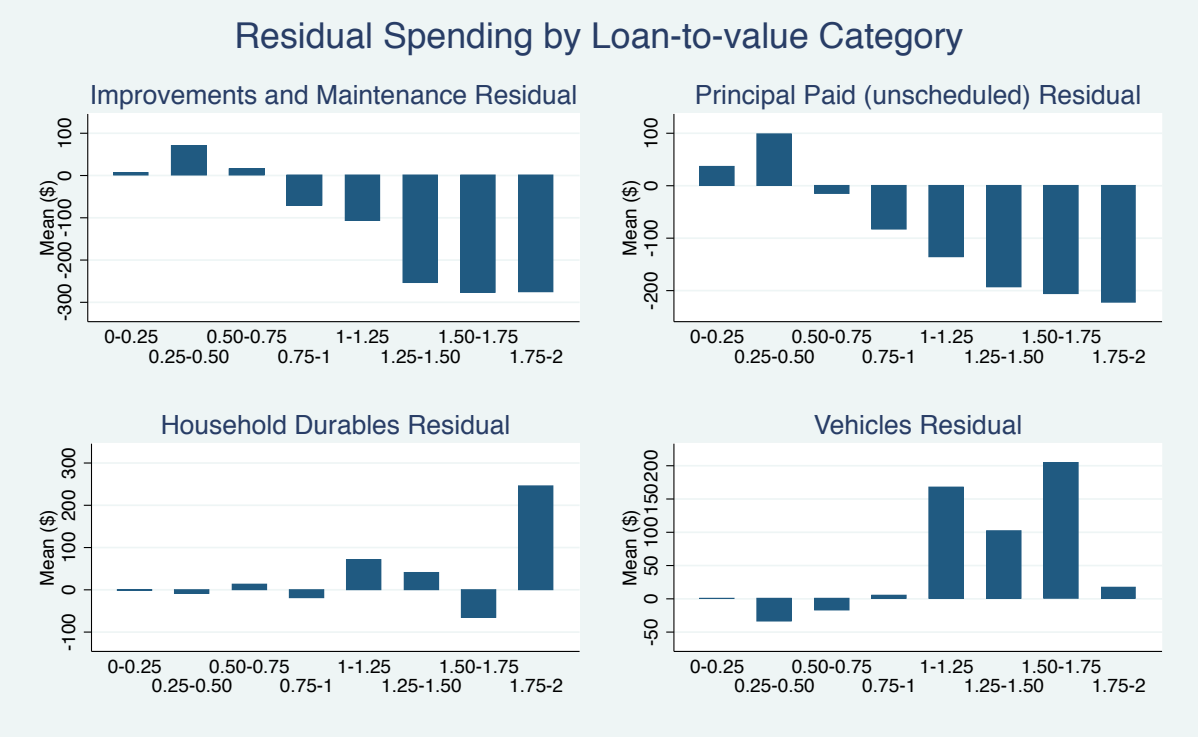


Figure 3


Residual Spending by Loan-to-value Category
Improvements and Maintenance Residual
Mean ($)
-300 -200 -100 0 100
0-0.25
0.25-0.50
0.50-0.75
0.75-1
1-1.25
1.25-1.50
1.50-1.75
1.75-2
Principal Paid (unscheduled) Residual
Mean ($)
-200 -100 0 100
0-0.25
0.25-0.50
0.50-0.75
0.75-1
1-1.25
1.25-1.50
1.50-1.75
1.75-2
Household Durables Residual
Mean ($)
-100 0 100 200 300
0-0.25
0.25-0.50
0.50-0.75
0.75-1
1-1.25
1.25-1.50
1.50-1.75
1.75-2
Vehicles Residual
Mean ($)
-50 0 50 100 150 200
0-0.25
0.25-0.50
0.50-0.75
0.75-1
1-1.25
1.25-1.50
1.50-1.75
1.75-2

TABLES

Table 1: Summary Statistics for Improvements & Maintenance, Unscheduled Principal Payment
Below are sample statistics for quarterly improvements and maintenance, and unscheduled principal payments, split by negative equity status.

Panel A: ***Improvements & Maintenance***

		For Y > 0				
Sample	Prob(Y>0)	Mean ($)	25th pctile	50th pctile	75th pctile	Max
NegEquity = 1	0.20	1,880	133	410	1,500	144,600
NegEquity = 0	0.24	2,890	200	600	2,300	356,500

Panel B: Unscheduled Principal Payment (Mortgagors Only)

		For Y > 0				
Sample	Prob(Y>0)	Mean ($)	25th pctile	50th pctile	75th pctile	Max
NegEquity = 1	0.18	1,260	105	330	840	68,700
NegEquity = 0	0.23	2,060	153	420	1,100	95,900

Table 2: Summary Statistics, Stratified by Negative Equity

	NegEquity= 0		*NegEquity = 1*		Diff. significant
PANEL A: *Housing Characteristics*	obs	mean	obs	mean	at 5% level
Property value	66,804	309,100	3,503	220,900	*
Age of home	66,804	37.9	3,503	31.5	*
Years owned	66,804	14.8	3,503	5.9	*
Rooms	66,804	6.9	3,503	6.7	*
Bedrooms	66,804	3.2	3,503	3.2	*
Bathrooms	66,804	1.9	3,503	1.9	
Central air (d)	66,804	0.70	3,503	0.75	*
Swimming pool (d)	66,804	0.12	3,503	0.14	*
Porch (d)	66,804	0.84	3,503	0.83	
Off-street parking (d)	66,804	0.82	3,503	0.81	*
PANEL B: *Mortgage Characteristics*					
Mortgagor (d)	66,804	0.64	3,503	1	*
Total mortgage	42,508	140,200	3,503	268,200	*
First mortgage	42,508	129,900	3,503	250,800	*
Home equity loan	42,508	2,800	3,503	6,600	*
Home equity LOC	42,508	7,500	3,503	10,800	*
Age of mortgage (months)	42,508	72.3	3,503	44.3	*
Mortgage interest rate (%)	42,508	5.88	3,503	6.45	*
Fixed rate mortgage (d)	42,508	0.85	3,503	0.87	*
Variable rate mortgage (d)	42,508	0.08	3,503	0.13	*
Mortgage insurance (d)	42,508	0.08	3,503	0.14	*
PANEL C: *Household Characteristics*					
Income/Wealth					
Annual income	66,804	89,200	3,503	90,100	
Expenditures (quarterly)	66,804	15,900	3,503	17,200	*
Financial assets	57,024	90,000	2,899	29,100	*
Unsecured credit	66,804	4,400	3,503	9,100	*
Education					
No high school diploma	66,804	0.08	3,503	0.08	
High school diploma only	66,804	0.22	3,503	0.18	*
Some college	66,804	0.29	3,503	0.34	*
College degree	66,804	0.24	3,503	0.28	*
Graduate degree	66,804	0.16	3,503	0.12	*
Race/Ethnicity					
White	66,804	0.80	3,503	0.69	*
Black	66,804	0.07	3,503	0.11	*
Hispanic	66,804	0.08	3,503	0.12	*
Asian	66,804	0.04	3,503	0.06	*
Other	66,804	0.02	3,503	0.02	*
Other					
Age	66,804	53.8	3,503	43.2	*
Family size	66,804	2.7	3,503	3.1	*

Table 3: Negative Equity and Home Investments

Below are OLS estimation results for regressions of principal payments, improvements and maintenance spending on an indicator for negative equity and control variables. Due to outlying observations, the proportional measures are Winsorized at the 0.5th and 99.5th percentiles. Standard errors, in parentheses, are calculated with observations clustered by state.

	Dependent Variable [mean]							
	---------- Unscheduled Principal Payment ----------				*-------- Improvements & Maintenance --------*			
	Amount ($) [450]		% of Expenditures [1.53]		Amount ($) [680]		% of Expenditures [2.98]	
NegEquity	-228	-199	-0.35	-0.29	-208	-201	-0.87	-0.87
	(55)	(47)	(0.111)	(0.097)	(68)	(72)	(0.12)	(0.13)
Property Value (000s)		0.19		0.0004	0.84	0.84	0.0023	0.0023
		(0.08)		(0.0001)	(0.19)	(0.20)	(0.0003)	(0.0003)
Mortgage Balance (000s)	0.53	0.38	-0.0011	-0.0014		-0.06		0.000002
	(0.22)	(0.19)	(0.0004)	(0.0004)		(0.32)		(0.0005)
R^2	0.05	0.05	0.15	0.15	0.03	0.03	0.02	0.02
N	70,307	70,307	70,307	70,307	70,307	70,307	70,307	70,307
State-year FEs?	Y	Y	Y	Y	Y	Y	Y	Y
Total expenditures?	Y	Y	N	N	Y	Y	N	N
Housing controls?	Y	Y	Y	Y	Y	Y	Y	Y
Household controls?	Y	Y	Y	Y	Y	Y	Y	Y
Mortgage controls?	Y	Y	Y	Y	Y	Y	Y	Y

Table 4: Negative Equity Effects for Financially Unconstrained

This table presents OLS regression coefficients estimated on subsets of the main sample, chosen to isolate households that are not financially constrained. Standard errors, in parentheses, are calculated with observations clustered by state.

	Dependent Variable [mean]					
	Unscheduled Principal Payment [1128]	*Unscheduled Principal Payment* [516]	*Unscheduled Principal Payment* [1068]	*Improvements & Maintenance* [1653]	*Improvements & Maintenance* [705]	*Improvements & Maintenance* [1321]
Sample:	Income ≥ 165K	Unsecured Debt = 0	Fin'l Assets ≥ 100K	Income ≥ 165K	Unsecured Debt = 0	Fin'l Assets ≥ 100K
NegEquity	-386	-202	-444	-806	-276	-573
	(222)	(70)	(518)	(345)	(151)	(722)
Property Value (000s)	0.05	0.13	0.10	1.14	0.70	0.36
	(0.14)	(0.09)	(0.22)	(0.52)	(0.27)	(0.48)
Mortgage Balance (000s)	0.22	0.71	1.28	0.81	0.53	1.77
	(0.48)	(0.27)	(0.58)	(1.02)	(0.69)	(1.65)
R^2	0.09	0.06	0.09	0.06	0.04	0.06
N	8,674	37,923	8,071	8,674	37,923	8,071

* Each model includes state-year fixed effects, total expenditures, and housing, household and mortgage characteristics as control variables.

Table 5: Falsification, Negative Equity and Other Durables

Below are OLS estimation results from two falsification exercises, in which spending on vehicles and spending on other property-related durables are regressed on the negative equity indicator and control variables. Due to outlying observations, the proportional measures are Winsorized at the 0.5th and 99.5th percentiles. Standard errors, in parentheses, are calculated with observations clustered by state.

	Dependent Variable [mean]							
	Vehicles				*Home Furnishings & Equipment*			
	Amount ($) [961]		% of Expenditures [5.04]		Amount ($) [479]		% of Expenditures [2.48]	
NegEquity	-38	191	0.33	0.76	-23	74	-0.30	-0.12
	(53)	(60)	(0.27)	(0.27)	(49)	(58)	(0.09)	(0.09)
Property Value (000s)	-0.95	-0.71	-0.0015	-0.0010	-0.01	0.09	0.0004	0.0006
	(0.12)	(0.13)	(0.0002)	(0.0002)	(0.11)	(0.12)	(0.0001)	(0.0002)
Mortgage Balance (000s)		-2.10		-0.004		-0.89		-0.0016
		(0.30)		(0.001)		(0.22)		(0.0003)
R^2	0.18	0.18	0.04	0.04	0.15	0.15	0.02	0.02
N	70,307	70,307	70,307	70,307	70,307	70,307	70,307	70,307
State-year FEs?	Y	Y	Y	Y	Y	Y	Y	Y
Total expenditures?	Y	Y	N	N	Y	Y	N	N
Housing controls?	Y	Y	Y	Y	Y	Y	Y	Y
Household controls?	Y	Y	Y	Y	Y	Y	Y	Y
Mortgage controls?	Y	Y	Y	Y	Y	Y	Y	Y

Table 6: Tobit Marginal Effects

Below are estimation results from four Tobit regressions, each translated into three marginal effects: the effect of *NegEquity* on the likelihood of any spending, the average expenditure among positive spenders and the average expenditure including nonspenders. Standard errors, in parentheses, are calculated with observations clustered by state.

	Dependent Variable			
	Unscheduled Principal Payment	*Improvements & Maintenance*	*Vehicles*	*Home Furnishings & Equipment*
Pr(Y>0)	0.15	0.24	0.39	0.65
E(Y|Y>0)	2,012	2,844	2,480	737
E(Y)	305	680	961	479
NegEquity -> Pr(Y>0)	-0.013	-0.032	0.033	0.006
	(0.003)	(0.007)	(0.012)	(0.013)
NegEquity -> E(Y|Y>0)	-123	-266	129	11
	(29)	(55)	(47)	(22)
NegEquity -> E(Y)	-48	-225	152	15
	(12)	(49)	(54)	(30)
Pseudo-R^2	0.06	0.01	0.02	0.01
N	70,307	70,307	70,307	70,307

* Each model includes state-year fixed effects, total expenditures, property value, mortgage balance, and housing, household and mortgage characteristics as control variables.

Table 7: Expenditures by Loan-to-Value Category

Below are OLS regression results for a model that examines spending relative to loan-to-value (LTV). In the first column the sample includs only mortgagors, and the excluded group is mortgagors with LTV below 25%. The sample for the other three regressions includes all homeowners and the excluded group is non-mortgagors. Standard errors, in parentheses, are calculated with observations clustered by state.

	Dependent Variable			
	Unscheduled Principal Payment	*Improvements & Maintenance*	*Vehicles*	*Home Furnishings & Equipment*
0 < LTV < 25%		-32	141	-2
		(97)	(63)	(28)
25% ≤ LTV < 50%	53	-44	128	1
	(62)	(92)	(70)	(39)
50% ≤ LTV < 75%	-74	-142	162	28
	(49)	(144)	(66)	(51)
75% ≤ LTV < 100%	-158	-269	202	-0.3
	(83)	(167)	(68)	(50)
100% ≤ LTV < 125%	-184	-329	378	95
	(83)	(193)	(79)	(105)
125% ≤ LTV < 150%	-213	-489	319	67
	(98)	(194)	(131)	(94)
150% ≤ LTV < 175%	-224	-529	428	-37
	(147)	(211)	(146)	(97)
175% ≤ LTV ≤ 200%	-226	-525	239	275
	(109)	(263)	(186)	(210)
R^2	0.05	0.04	0.18	0.15
N	46,011	70,307	70,307	70,307

***** Each model includes state-year fixed effects, total expenditures, property value, mortgage balance, and housing, household and mortgage characteristics as control variables.

Table 8: Negative Equity and Mortgage Recourse

Below are regression results for a model that includes an interaction between *NegEquity* and *Recourse*, an indicator for whether the state allows mortgage lenders to claim other assets from defaulted homeowners. Standard errors, in parentheses, are calculated with observations clustered by state.

	Dependent Variable [Mean]					
	Unscheduled Principal Payment			*Improvements & Maintenance*		
Sample:	Full	Fin'l Assets ≥ 100K	Fin'l Assets < 100K	Full	Fin'l Assets ≥ 100K	Fin'l Assets < 100K
	[450]	[1068]	[269]	[680]	[1321]	[567]
NegEquity	-275	-1070	-233	-143	-1397	15
	(69)	(367)	(58)	(89)	(487)	(116)
*NegEquity*Recourse*	97	838	56	-72	1081	-143
	(86)	(589)	(85)	(108)	(1140)	(122)
R^2	0.05	0.09	0.05	0.03	0.06	0.03
N	70,307	8,071	51,852	70,307	8,071	51,852

* Each model includes *Recourse,* state-year fixed effects, total expenditures, property value, mortgage balance, and housing, household and mortgage characteristics as control variables.

Table 9: Matching Analysis

Below is analysis of a matched sample of positive and negative equity homeowners. Each negative equity homeowner is matched to the nearest positive equity homeowner based on propensity to have negative equity. Propensities are calculated from a probit model with the following explanatory variables: years of ownership, age of homeowner, age of mortgage, unsecured credit balance, amount of financial assets and state-year fixed effects.

Panel A: Balance of Matched Sample (Means)

	NegEquity = 0	*NegEquity* = 1	P-value (Difference = 0?)
Income	86,120	87,560	0.37
Age of homeowner (yrs)	43.8	43.6	0.52
Years owned	6.3	6.0	0.06
Age of mortgage (mths)	45.1	44.8	0.75
Financial assets	35,050	27,450	0.09
Unsecured credit	8,340	9,040	0.16

Panel B: Treatment Effects

Dependent Variable:	*Unscheduled Principal Payment*	*Improvements & Maintenance*	*Vehicles*	*Home Furnishings & Equipment*
[Mean]	[381]	[558]	[949]	[443]
NegEquity	-128	-168	73	2
	(77)	(91)	(67)	(49)
N	41,476	41,476	41,476	41,476

Table 10: Robustness

Panel A shows regression results for two variations on the dependent variables - log spending and proportional spending - and a model that averages spending and negative equity status over the year. Due to outlying observations, the proportional measures are Winsorized at the 0.5th and 99.5th percentiles. Panel B shows results for variations on the covariates: income in place of total expenditures, quadratics in financial assets and unsecured credit, and MSA-year fixed effects. Standard errors in each model are shown in parentheses and are calculated with observations clustered by state.

Panel A

	---------- Logs ----------		--------- % of Property Value ---------		---------- Averaged Over Year ----------	
	Unscheduled Principal Payment [1.37]	*Improvements & Maintenance* [1.55]	*Improvements & Maintenance* [0.22]	*Improvements & Maintenance* [0.22]	*Unscheduled Principal Payment* [450]	*Improvements & Maintenance* [680]
NegEquity	-0.17	-0.27	-0.05	-0.018	-215	-476
	(0.05)	(0.05)	(0.01)	(0.013)	(72)	(200)
R^2	0.37	0.05	0.02	0.03	0.13	0.09
N	70,307	70,307	70,307	70,307	19,777	19,777

Panel B

	---------- With income control ----------		With Quadratics in Fin'l Assets & Unsecured Credit		----- With MSA-Year Fixed Effects ---	
	Unscheduled Principal Payment	*Improvements & Maintenance*	*Unscheduled Principal Payment*	*Improvements & Maintenance*	*Unscheduled Principal Payment*	*Improvements & Maintenance*
NegEquity	-188	-210	-213	-161	-205	-197
	(49)	(74)	(56)	(65)	(67)	(85)
R^2	0.05	0.02	0.05	0.03	0.06	0.05
N	70,307	70,307	59,923	59,923	32,102	32,102
State-year-qtr FEs?	N	N	N	N	Y/N	Y/N
State-year FEs?	Y	Y	Y	Y	N	N
Total expenditures?	Y/N	Y/N	Y	Y	Y	Y
Property value?	Y	Y	N/Y	N/Y	Y	Y

* Each model includes mortgage balance, and housing, household and mortgage characteristics as control variables.

For Online Publication

ONLINE APPENDIX

Appendix Table 1: Negative Equity Effects for Financially Constrained

This table presents OLS regression coefficients estimated on subsets of the main sample, chosen to isolate households that are more likely to be financially constrained. Standard errors, in parentheses, are calculated with observations clustered by state.

	Dependent Variable [mean]					
	Unscheduled Principal Payment [268]	*Unscheduled Principal Payment* [380]	*Unscheduled Principal Payment* [338]	*Improvements & Maintenance* [457]	*Improvements & Maintenance* [668]	*Improvements & Maintenance* [592]
Sample:	Income < 100K	Unsec. Debt >= 10K	Fin'l Assets = 0	Income < 100K	Unsec. Debt >= 10K	Fin'l Assets = 0
NegEquity	-35	-63	-281	-69	-296	-336
	(45)	(102)	(133)	(45)	(99)	(128)
Property Value (000s)	0.25	0.17	0.15	0.52	0.60	0.87
	(0.11)	(0.17)	(0.12)	(0.17)	(0.36)	(0.23)
Mortgage Balance (000s)	-0.24	-0.12	0.92	-1.54	0.37	0.48
	(0.15)	(0.43)	(0.44)	(0.42)	(0.69)	(0.52)
R^2	0.04	0.08	0.06	0.03	0.07	0.04
N	48,118	9,186	19,739	48,118	9,186	19,739

* Each model includes state-year fixed effects, total expenditures, and housing, household and mortgage characteristics as control variables.

Appendix Table 2

Panel A shows OLS regression results for models that analyze the proportion of improvement projects that involve homeowner's labor, improvement spending while controlling for mobility and past refinancing, principal payments as a proportion of mortgage balance (Winsorized at 0.5th and 99.5th percentiles), and the components of unscheduled principal payments. Panel B shows Tobit results (marginal effect on average spending) for non-mutually exclusive components of improvement spending: Additions and New Construction, Alterations (mainly remodeling of existing space), Repair and Replacement (painting as well as repairs or replacement of compoenents of home's exterior and interior), Exterior (roofs, gutters, siding, masonry, painting, windows and doors), Interior-Structural (plumbing, electrical wiring, HVAC and insulation), and Interior (paint, plaster, wallpaper and flooring). Standard errors are calculated by state.

Panel A

	Homeowner Labor	Mobility Controls	Mortgage Age 12 to 36 Months - Dummy	% of Mortgage Balance	Components of Unscheduled Principal	
	Some or All Work	*Improvements & Maintenance*	*Improvements & Maintenance*	*Unscheduled Principal Payment*	*HELOC*	*1st and 2nd Mortgages*
Mean DV:	[0.47]	[680]	[680]	[0.48]	[240]	[210]
NegEquity	0.01	-207	-200	-0.19	-83	-117
	(0.02)	(70)	(72)	(0.03)	(43)	(27)
R^2	0.12	0.04	0.03	0.17	0.07	0.01
N	16,990	70,307	70,307	70,307	70,307	70,185

Panel B

	Additions & New Construction	*Alterations*	*Repair & Replacement*	*Exterior*	*Interior - Structural*	*Interior*
Mean DV:	[138]	[287]	[255]	[108]	[82]	[47]
NegEquity	-17	-110	-37	-27	-15	-5
	(10)	(29)	(17)	(10)	(7)	(5)
Pseudo-R^2	0.03	0.01	0.01	0.02	0.01	0.01
N	70,307	70,307	70,307	70,307	70,307	70,307

* Each model includes state-year fixed effects, total expenditures, property value, mortgage balance, and housing, household and mortgage characteristics as control variables.