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Forced Moves and Home Maintenance: The Amplifying Effects of Mortgage Payment Burden on Underwater Homeowners

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Abstract

Although well-known that high CLTV is necessary for mortgage default, the amplifying effect of high PTI that can force families to move has received limited attention. Using the 1985-2013 AHS panel, we show that high CLTV by itself has little effect on mobility, but high PTI prompts families to move and especially so when CLTV is high. Evidence also indicates that high PTI and CLTV discourage home maintenance. Our estimates suggest that loan modifications that lower PTI will likely be more effective at helping underwater families to remain in their homes and avoid mortgage default as compared to policies that lower CLTV.

Key words: Payment burden, Mobility, Maintenance, Mortgage Default
JEL Codes: R00, G50

1. Introduction

By late 2011, sharp declines in home prices following the 2007 housing market crash had pushed nearly 30 percent of homeowners with a mortgage into negative net equity, prompting huge numbers of mortgage defaults.[1] Nevertheless, dramatic as the default crisis was, Bhutta et al (2017) show that most underwater families did not immediately default. Instead, they estimate that the median homeowner needs to have a current loan-to-value ratio (CLTV) in excess of 170 percent before default occurs, far higher than simple put-option models would predict.[2] The large number of underwater families that resist default reinforces double-trigger views of when a default occurs: homeowners must have negative net equity and an unwillingness or inability to make their mortgage payments (see Foote et al (2008), Elul et al. (2010), Bricker and Bucks (2016), and Ganong and Noel (2020b) for related discussion). This latter condition necessitates a move out of the home, at which point the family must either default or draw on sources of wealth beyond home equity to pay off the outstanding balance on the mortgage. For these reasons, whether a household moves out of its home plays an integral role in driving mortgage default, but one that has received limited attention.[3] This paper takes a different approach.

We assess the influence of drivers of default risk on household mobility with a primary focus on the joint effect of high levels of CLTV and payment-to-income (PTI) ratios, measures that are central to loan underwriting standards. High levels of CLTV satisfy the first necessary condition for default while high PTI levels have potential to force underwater families out of their homes. Moreover, interaction between high levels of both CLTV and PTI has potential to

[1] See a description of CoreLogic estimates of at-risk homeowners at: https://www.reuters.com/article/usa-housing-corelogic/share-of-us-mortgages-underwater-up-in-q4-corelogic-idUSL2E8E1BFH20120301 .

[2] Put-option models based on Kau et al (1994) suggest that in a frictionless setting with no transaction costs, default will generally occur when CLTV exceeds roughly 120 percent.

[3] That tendency is not surprising given that most mortgage default studies draw on loan performance data as with recent work by Bhutta et al (2017) and Ganong and Noel (2020a). Such data provide rich information on loan performance but typically little information on when and why a family moves out of its home.

further exacerbate default risk. This can occur if high CLTV levels preclude opportunities for a homeowner to refinance into a lower monthly payment mortgage, impairing their ability to reduce PTI.

The idea that high levels of CLTV and PTI can interact in ways that amplify mortgage default risk lies behind two major U.S. federal policies introduced shortly after the 2007 housing market crash. These are the Home Affordable Refinance Program (HARP) and the Home Affordable Modification Program (HAMP). While this paper does not evaluate these programs, they are indicative of a class of policies that seek to help underwater families to remain in their homes and reduce mortgage default. Under HAMP and HARP, homeowners remain obligated to pay off all (HARP) or nearly all (HAMP)[4] of the outstanding debt on their mortgages. Other programmatic features, however, enable qualifying families to lower monthly payments and PTI, reducing the need for families to move, and through this mechanism reducing default risk.[5] In the case of HARP, underwater families that are current on their payments are able to refinance into new market rate loans regardless of how deep underwater the family might be.[6] HAMP, in contrast, was designed for families that were delinquent on their loan payments and whose PTI exceeded 31 percent. Under HAMP, qualifying homeowners had their existing loans restructured by extending loan term or lowering the loan rate until PTI was reduced to 31 percent.

High levels of CLTV and PTI also have potential to exacerbate the severity of lender losses should a default occur. This occurs because high CLTV and PTI erode a family's

[4] Under select conditions, HAMP can provide principal forgiveness for a small portion of the outstanding debt on a homeowner's mortgage. For details, see: https://www.irs.gov/newsroom/principal-reduction-alternative-under-the-home-affordable-modification-program.

[5] For related details on HAMP and HARP, see the URLs below:
https://www.treasury.gov/initiatives/financial-stability/TARP-Programs/housing/mha/Pages/hamp.aspx ,
https://www.makinghomeaffordable.gov/get-answers/Pages/program-HARP.aspx ,
http://library.hsh.com/articles/government-programs/hamp-versus-harp-which-is-right-for-you/ .

[6] This was especially valuable for families that had secured deeply teasered adjustable rate mortgages prior to 2007 only to experience sharply higher payments a few years later when their loan rates reset to much higher levels.

incentives and ability to engage in home maintenance, something that we also address. As CLTV rises beyond 100 percent, default risk increases and investment motives to maintain the home disappear since any hope of recouping equity from a future sale of the home goes away (see Henderson and Ioannides (1983), Ioannides and Rosenthal (1994), Haughwout et al (2013), Melzer (2017), and Rosenthal (2020) for related discussion). As PTI rises to a burdensome level, the likelihood of moving soon reduces a family's consumption benefits from home repairs while also undermining its ability to engage in discretionary spending, both of which will reduce maintenance. For these reasons, high levels of CLTV and PTI have potential to reduce home maintenance and exacerbate lender default costs by accelerating deterioration of the home.[7]

To address these issues, we draw on the 1985-2013 American Housing Survey (AHS) panel. The survey includes detailed information on the attributes of the home and its occupants, and unique among surveys, follows the homes and not the individuals over time, returning to homes every two years. This makes it possible to determine whether a family has moved out of a home (e.g. Harding et al (2007), Rosenthal (2014)) by examining a series of questions that document when a family moved into the home, when the home was purchased, etc. Also included in the survey is detailed information on home maintenance expenditures. Based on these and other features of the data, we were able to compute whether a family moves in the next two years in addition to time varying measures of household characteristics, CLTV, PTI and maintenance expenditures.

[7] Harding et al (2007) estimate that in the absence of any maintenance, the typical single family home in the United States would lose roughly 3 percent in real value each year. It is also worth noting that the Bureau of Economic Analysis (BEA) reports that home maintenance expenditures in the United States decreased roughly 13% from 2006 to 2012, coinciding with the jump in underwater families and default, and consistent with the arguments above that default risk contributes to deterioration of the housing stock (Rosenthal and Ross (2015)). See also Gyourko and Saiz (2004) for related evidence.

Our ability to identify the causal effect of CLTV and PTI on household mobility and maintenance expenditures rests on five complementary features of our model design. The first is that we draw on the panel structure of the data to lag CLTV and PTI measures when explaining move and maintenance decisions. This helps to ensure that CLTV and PTI controls are predetermined. A similar lag structure is used for other model controls in some of the specifications. A second important feature is that we control for an extensive array of other factors that may affect household mobility and home maintenance. Details of these additional controls are provided later in the paper and in the appendixes. Here we note that they include household demographic attributes and income, family structure, information on the mortgages held by the family, attributes of the house, and MSA by year fixed effects. A third part of our identification strategy is to construct interaction terms that target underlying mechanisms that drive mobility and maintenance. These interaction terms are designed in ways to be revealing of the joint influence of high levels of CLTV and PTI.[8] A fourth feature of our models is that we discretize CLTV and PTI into broad categories that reduces potential for these measures to be correlated with the model error terms. A final part of our empirical strategy examines potential bias that could be present if homeowners overestimate the value of their homes, a common concern related to homeowner assessments of home value.[9] We model possible homeowner overestimates of home value and also consider a subsample for which such concerns are not likely to be relevant. Results are robust.

[8] Ferreira, Gyourko, and Tracy (2010) also examine the impact of CLTV on household mobility using the AHS panel. However, they control for household income but not PTI. We control for both in addition to including roughly 1,800 MSA-by-year fixed effects and a richer set of controls while also drawing on a longer panel.

[9] See, for example, Goodman and Ittner (1992), Kiel and Zabel (1999), Melser (2013) and Tur-Sinai et al (2020), all of whom examine this issue using data from the United States, Australia and Israel. Additional detail on these studies and our approach to addressing possible concerns about homeowner overassessment of house value are provided later in the paper.

Our findings confirm that high levels of PTI increase household mobility and in a manner that exacerbates default risk. Among families with PTI below 45 percent, high levels of CLTV have little effect on mobility, even for households that are deep underwater. Among families that are not underwater, high levels of PTI (above 45 percent) increase two- and four-year mobility rates by roughly 3 and 5 percentage points, respectively. For families with CLTV above 120 percent, these effects jump to 11.4 and 16.4 percentage points, respectively. These and other results confirm that by itself, high levels of CLTV do not prompt households to move and default. However, when combined with high PTI, mobility rates increase substantially. This is consistent with arguments that lie behind programs like HARP and HAMP: lowering PTI reduces the tendency for underwater families to move out of their homes, and that in turn reduces default.

Analogous effects are also found for home maintenance. Here we focus primarily on whether a family spends a positive amount on maintenance since underwater families that anticipate moving soon have little incentive to conduct any maintenance. Estimates show that when PTI is high, home maintenance is reduced by 2 to 3 percentage points regardless of whether CLTV is high. When PTI is low and discretionary spending is possible, CLTV over 120% reduces the tendency to maintain by 3.6 percentage points. This effect, however, can be offset if local home prices are rising rapidly. Together, these patterns suggest that among families for whom discretionary spending is possible, high CLTV erodes investment motives to maintain the home, consistent with evidence in Melzer (2017). High PTI erodes consumption motives for home maintenance by forcing families to move while also restricting a family's ability to maintain the home because of limited discretionary spending.

Our estimates parallel recent findings in Ganong and Noel (2020a) who analyze loan performance data for underwater families, including some who participated in HAMP. Using a regression discontinuity design, Ganong and Noel (2020a) estimate that principal forgiveness, which reduces CLTV, does not affect mortgage default, while extending loan term, which reduces payment burden, reduces mortgage default while also increasing consumption. Our estimates on mobility and home maintenance echo these conclusions: we provide evidence that reducing mortgage payment burden is likely more effective at helping underwater families to remain in their homes as compared to policies designed to reduce mortgage debt and lower CLTV.

Our findings also reinforce conclusions that reduced home maintenance associated with mortgage default risk may contribute to contagion effects by pulling down nearby property values (e.g. Harding et al. (2009), Fisher et al. (2015), Gerardi et al. (2015)).[10] In part, this can occur as undermaintained homes take on a shabbier appearance (Towe and Lawley (2013), Lambie-Hanson (2015)).[11] Vacant homes following mortgage default may also attract crime that can further contribute to neighborhood decline (e.g. Ellen et al. (2013), Cui and Walsh, (2015)).[12] Yet another mechanism is that large numbers of nearby defaults can temporarily flood a localized market with homes for sale (e.g. Anenberg and Kung (2014), Campbell et al. (2011), Hartley (2014)), further depressing local property values.

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[10] See also Immergluck and Smith (2006), Leonard and Tammy (2009), Lin et al. (2009), Rogers and Winter (2009), and Campbell et al. (2011).

[11] Lambie-Hanson (2015), for example, investigates the relationship between the foreclosure process and property conditions in Boston, Massachusetts. She finds that complaints about property maintenance increase as a property moves through the foreclosure process, beginning when a borrower becomes seriously delinquent, but especially after a borrower is formally in foreclosure and the property becomes bank-owned.

[12] Ellen et al (2013) find that additional foreclosures in an individual street segment lead to additional crimes. Cui and Walsh (2015) find that foreclosures result in vacancies lead to increased crime in the immediate neighborhood as neglected vacant buildings may offer criminals places to gather and conduct their activities. For a summary of the evolution of the existing literature on foreclosure and crime, see Cui and Walsh (2015).

To establish our results, the next section provides conceptual arguments that link the decisions of whether to default on a mortgage, move out of the home, and engage in home maintenance. Section 3 describes the data and summary measures. Section 4 presents results on mobility while Section 5 presents estimates of the home maintenance regressions. Section 6 concludes.

2. Conceptual framework

This section clarifies conditions under which mortgage default may be linked to a family's decision of whether to remain in their home and home maintenance decisions.

2.1 Mortgage default and the decision to move

Suppose initially that PTI is low enough to preclude any financial pressure for the family to move. Under such conditions, three arguments in the literature suggest that high levels of CLTV could discourage the family from moving out of their home.

The first of these is the put-option feature present in mortgage contracts as emphasized by Kau et al (1994). Mortgage contracts in the U.S. give homeowners the opportunity to default on their mortgage but typically with limited penalty. Upon defaulting on the mortgage, households effectively sell the home to the lender for an amount equal to the outstanding balance on the mortgage. In doing so, they give up the option to benefit from possible future capital gains should home prices rise. Under this view, if moving is costless and there are no other transactions costs, default can be treated as a pure financial option and underwater homeowners will tend to delay defaulting until CLTV is well above 100%. This will discourage mobility for many underwater families who may hope to benefit from future home price appreciation.[13]

A second argument in the literature, evidence for which is provided by Genesove and Mayer (2001), rests on the idea that capital markets are imperfect. In this case, families with limited non-housing wealth but secure income would be unable to purchase a new home of comparable or higher quality relative to the current home unless they recoup sufficient net equity from the sale of the present home for a down payment. In such instances, even families with a small amount of positive net equity, say with CLTV between 90 and 100 percent, should be discouraged from moving out of their present home. For families with CLTV above 100 percent the disincentive to move is even stronger.

A third reason high CLTV can discourage household mobility is loss aversion. In this instance, when home values fall below the nominal price at which the family purchased their home, emotional distress may cause homeowners to resist selling their homes until they can secure a sale price above the nominal purchase price. Genesove and Mayer (2001) also provide evidence that loss aversion exists in the Boston condominium market independent of effects from credit barriers or other mechanisms. Engelhardt (2003) provides evidence that loss aversion discourages families from moving out of their homes. At the same time, while loss aversion can deter mobility, it is worth noting that the reference point here is the nominal purchase price of the home. It is possible, for example, that loss aversion associated with a decline in local home prices could discourage a family from moving even when their CLTV is well below 100 percent.

[13] As noted earlier, Kau et al (1994) estimate that in a frictionless setting, default would typically occur when CLTV exceeds 120 percent. For underwater households with extremely high CLTV, therefore, it is possible that the default option could encourage some families to move and default. See also Deng et al. (2000) for an analysis of homeowner default behavior when the option is in the money.

Suppose now that PTI is high enough to be burdensome but CLTV is low. In this instance, the family cannot afford their monthly mortgage payments and they have two options. Most obviously, the family can sell their home, collect the net equity, and purchase a new, less expensive home for which monthly payments and PTI would be lower. A second option is that the family could refinance into a different type of loan with lower monthly payments, one example of which would be to increase the term of the loan.

The final case we highlight is when PTI is high enough that families cannot make their monthly payments, non-housing wealth reserves are limited, and CLTV is high. In this instance, underwater homeowners would not be able to refinance into a new loan with lower monthly payments because they would lack the necessary down payment. Such families would have no alternative except to move out of their homes. Moreover, in those instances where CLTV is above 100 percent, families would be unable to pay off their outstanding mortgage debt and would be forced to default. It is these families that programs like HARP and HAMP are especially designed to assist by enabling them to refinance (HARP) or restructure (HAMP) their loans so as to reduce monthly payments and PTI.

Summarizing, three arguments above point to reasons why high levels of CLTV alone could reduce mobility, including the put-option feature of mortgage contracts, credit barriers and loss aversion. One argument points to increased mobility, which is the inability of underwater families to reduce their monthly payments. This last argument suggests that high levels of CLTV amplify the tendency for high PTI to prompt families to move, implying an interaction between high CLTV and high PTI.[14] Our empirical models provide evidence on this point.

[14] For related discussion of the influence of high values of CLTV on household mobility see Bloze and Skak (2016), Andersson and Mayock (2014), Ferreira, Gyourko, and Tracy (2010), Chan (2001), Stein (1995).

2.2 Home maintenance

High CLTV and PTI can also discourage home maintenance and increase lender default costs for that reason. We explain why below.

Investment motives for maintaining the home erode as CLTV increases ever higher above 100% and families become deeper underwater. That is because as CLTV rises, underwater families are unlikely to recoup any positive net equity from maintenance expenditures. For homeowners to believe otherwise, they would have to anticipate that local market prices would rise by an amount sufficient to push their CLTV back below 100% before they eventually move out of the home.[15] Reinforcing this view, Melzer (2017) provides convincing evidence that underwater homeowners behave in a forward-looking fashion and respond to debt overhang and default risk by reducing investment in their home. Melzer obtains most of his results using individual level data from the Consumer Expenditure Survey (CES) while controlling for state-year fixed effects. Our data provide a different set of opportunities, including the ability to control for MSA-year fixed effects which helps to control for more localized time-varying market conditions. In addition, we interact high levels of CLTV with MSA-level house price inflation over the previous two years. This helps to capture the potential for underwater households to reestablish positive net equity.

Different from above, consumption motives for maintaining the home should be sensitive to high levels of PTI. That is because high PTI increases the likelihood that the family will move soon, and just prior to moving, homeowners derive little consumption flow from additional

[15] In principle, holding the home long enough to pay down the balance on the mortgage would also eventually reduce CLTV below 100%. However, most mortgage loans amortize very slowly so this is not likely to affect household decisions about mobility and home maintenance.

maintenance. In addition, high PTI will tend to curtail discretionary spending which will further reduce home maintenance.

The arguments above suggest that CLTV and PTI should both have independent effects on maintenance. CLTV and PTI may also interact in ways that could further affect maintenance expenditures although in a potentially nuanced fashion. Families with positive net equity retain incentive to invest in the home but could still curtail home maintenance if PTI is so high as to preclude discretionary spending. Conversely, families with low PTI retain the financial ability to maintain the home but may choose away from home maintenance if CLTV is high enough to erode anticipated investment returns. To allow for these interactions, our most robust maintenance regressions stratify families into those with low (< 25%) versus high (> 25%) PTI.

3. Data and Summary Statistics

3.1 AHS panel

Our primary data source is the 1985-2013 American Housing Survey (AHS) panel.[16] The Panel follows roughly 55,000 owner-occupied and rental housing units over time, revisiting the homes every two years. Detailed information is provided each survey on the occupants of the home and the house itself. This enables us to construct key measures for our study, including whether a family moves in the next two years, home maintenance expenditures in the last two years, CLTV and PTI. Extensive information is also available on other controls that affect mobility and home maintenance decisions. Additional detail on the manner in which several of these variables were cleaned and coded is described in Appendix A. Here we provide an overview of the data cleaning process and related restrictions on sample composition. This

[16] Census started a new panel after 2013 which is why we only follow AHS homes to that year.

section also presents summary measures including the distribution of CLTV and PTI values over the 1985-2013 horizon.

3.2 Sample restrictions and data cleaning

Several restrictions are imposed on the composition of the estimating samples. The first is that we limit our sample to just owner-occupied homes in larger metropolitan statistical areas (MSAs) for which MSA location is identified in the data. This includes about half of the overall AHS sample since Census does not report MSA location for homes in smaller MSAs in order to protect confidentiality. Limiting the sample in this fashion reduces sample size to roughly 200,000 house-year observations but allows for more robust specifications of the regression models. This includes the ability to control for MSA by year fixed effects in both the mobility and maintenance models and the ability to interact Federal Housing Finance Agency (FHFA) MSA-level house price indexes with CLTV in the maintenance regressions.

We also restrict the estimating sample to instances in which the occupants of the home are present for at least two consecutive surveys and in some instances at least three. In the case of the mobility models, for example, we evaluate whether a family moves in the next two years and whether they move in the next four years. The two-year move models require that families be present for at least two consecutive surveys, while the four-year move models require at least three consecutive surveys. In the case of the maintenance regressions, it is important to note that maintenance is reported retrospectively for expenditures in the previous two years. For that reason, CLTV and PTI are lagged two years in the maintenance regressions to ensure that they are predetermined. This requires that occupants be present in the home for at least two consecutive surveys.

We also develop a cleaning procedure when measuring CLTV that draws on up to three adjacent surveys for a given house occupant, details of which are described in Appendix A. Here we note briefly that we use the homeowner's assessed value of the home in the denominator when forming CLTV. If there are obvious discrepancies in assessed value in two consecutive surveys, we examine house value in a third adjacent survey. Depending on the observed pattern, we then modify the erroneous data point when it can be reliably adjusted using adjacent survey home values along with the FHFA home price index for the MSA in which the home is situated. As an example, if house value is reported as $200,000, $22,000 and $250,000 in three successive surveys, we assume that the middle value was miscoded by a factor of ten and adjust it to a value equal to the previous survey value scaled by the home's MSA-level appreciation as measured by the FHFA home price index.[17] In instances where discrepancies in assessed home value in adjacent surveys cannot be resolved with sufficient reliability, observations are dropped.

Other observations are dropped from the estimating sample for more standard reasons. Most often, this is when one or more of the control measures in the mobility or maintenance regressions are not reported in a given survey year.

3.3 CLTV and PTI

Tables 1 and 2 report the distribution of CLTV and PTI for each survey year from 1985 to 2013. Broad features of the patterns are consistent with evidence from other sources which lends support to our data cleaning procedures. Many other details in the table are new to the literature and possible to display because of the special nature of the AHS panel. Before

[17] In analogous fashion, we also draw on consecutive surveys to ensure that time-invariant attributes are similarly coded across surveys. This includes fixed attributes such as the size and structure-type of the home, as well as semi-fixed variables as with mortgage loan terms for a loan that is held across surveys.

reviewing these patterns, it is also worth noting that the correlation between the CLTV and PTI measures is no more than about ten percent, on average (see Appendix B, Table B-1 for details). The two measures therefore capture different features of a household's financial circumstances.

Turning to Table 1 (CLTV) and pooling data over the entire 1985-2013 period (the bottom row in the table), notice that roughly 30% of homeowners do not have a mortgage, consistent with evidence from other sources.[18] Among homeowners with a mortgage, roughly 44% have CLTV between 50% and 80%, the largest portion among all categories, and roughly 9% of homes are underwater. The pooled year averages, however, mask well known variation across years. That variation is most easily seen by plotting the values in Tables 1 and 2. These appear in Figure 1 and Figure 2 for CLTV and PTI, respectively. Observe in Figure 1 that the share of underwater families was roughly 4% to 7% prior to 2007 but rose to 19% in 2009 and 23% in 2011 following the market crash of 2007. House prices began to rise once again in 2011 in many markets, after which the share of underwater families declined, falling to 19% in our data in 2013. Notice also that the share of deep underwater families, defined here as CLTV over 120%, peaked at 8% in 2011 and then fell back to 5.6% in 2013. These patterns are consistent with reports from other sources including RealtyTrac.[19]

Corresponding trends in the share of homeowners with high levels of PTI are displayed in Table 2 and in Figure 2. Notice that between 2003 and 2007, there was an increase in homeowners with PTI levels above 25% and also those with PTI above 45%. These upward trends likely reflected the influence of relaxed underwriting standards in the pre-2007 period that allowed many households to secure low-downpayment, high PTI mortgages. With the housing

[18] Citing data from the American Community Survey in an Urban Institute online report, Neal (2019) indicates that roughly 32% of homeowners did not have a mortgage in 2005 and almost 36% did not have a mortgage in 2013.
[19] Corresponding measures at RealyTrac at can be seen at http://www.realtytrac.com/news/mortgage-and-finance/year-end-2014-underwater-home-equity-report/.

market crash in 2007 and subsequent Great Recession, the incidence of high PTI homeowners spiked further as many families experienced sharp declines in income. Taking these events together, among homeowners with a mortgage, the share of families with PTI above 45% peaked at 12% in 2009 and then declined thereafter, along with the incidence of other families with PTI in the 25 to 45% range.

3.4 Additional model controls and summary measures

Table 3 reports sample means and standard deviation for additional measures used as controls in the mobility regressions to follow. Most of these variables are also included as controls in the maintenance regressions except in instances where a variable is more likely to be endogenous to maintenance (e.g. house value). In the regression tables nearly all of these controls are suppressed to conserve space, focusing instead on the influence of CLTV and PTI in the main body of the tables. The full set of variables included in the regressions is listed in the table footnotes. Summary measures in Table 3 are based on pooled data across survey years.

In Table 3, controls in the mobility models are grouped into several broad categories. These include standard demographic attributes of the household head and family, such as race, age, marital status, etc. Other controls include real household income and whether the household head is self-employed. Commitment to remain in the home is proxied in part by a self-reported one-to-ten index of how much the family likes the home and also how much the family likes the neighborhood. Other socioeconomic controls that would affect mobility include changes in the number of children in the family between surveys, years since the family moved into the home, and whether a family currently perceives a nominal capital loss (1 if yes; 0 if no) relative to home purchase.

Another group of controls include house type, including size (based on number of rooms), multi-family versus single family, and condominium status. These controls help to proxy for the cost of moving since it is typically more expensive to move out of a larger home. Partly for related reasons, further controls include real home purchase price and MSA level house price inflation since it is more expensive to move out of a higher valued home.

Mortgage attributes are entered in two ways to help proxy for a family's financial stability and unobserved wealth as this may also affect mobility. The first is to include controls for FHA and VA versus conventional mortgages, and whether the current mortgage is a refinance loan. Conventional loans typically require more robust financial footing for the loan applicant while evidence of a prior refinancing may signal intent to remain in the home.

A mortgage interest rate residual is also included in the mobility model as a proxy for a family's credit risk and future ability to refinance. The residual was created by first regressing the household's mortgage interest rate for their primary mortgage on other terms and features of the loan.[20] The residual from this regression was then discretized into ten bins to reflect different degrees of below and above average loan rate. Positive categories proxy higher than average risk while the reverse is true for negative bin categories. Separate 1-0 dummies for the different categories were included in the mobility models.

Finally, our more robust regression models control for MSA by year fixed effects as will be discussed shortly.

[20] Those features included loan term, type (FHA, VA, conventional, refinanced), original LTV (OLTV), PTI, loan size, house type (multi-family, single family, condominium), and year fixed effects.

4. Mobility regressions

This section reports results from a series of linear probability models of whether the family moves in the next two years and whether it moves in the next four years. As discussed earlier, our primary focus is on the influence of CLTV and PTI but we also control for an extensive array of other measures to aid identification. Additional checks at the end of the section also demonstrate that our findings are robust to possible concerns about whether homeowners may overestimate the value of their homes.

4.1 Core models

Our regressions are of the following general form:

$$Move\ in \text{ the } Next\ \tau\ Years_{i,\,c,\,t} = \alpha_1 CLTV_{i,c,t} + \alpha_2 PTI_{i,c,t} + X_{i,t}\beta + \delta_{c,t} + e_{i,c,t}. \quad (1)$$

In this expression, τ can be 2 or 4 years so that the dependent variable is coded 1 if the household moves between year t and year $t+\tau$, and 0 otherwise, where t indexes the survey year. Subscript i denotes home i and c refers to the MSA in which the house is located.

As indicated in Section 3, the estimating equation includes a rich set of control variables, denoted as $X_{i,t}$. These include sociodemographic attributes, mortgage-related factors, variables that capture the impact of loss aversion and other indicators of household preferences for the house and neighborhood, changes in the family structure, and the size and other attributes of the current home. Most of the mobility models also control for MSA-by-year fixed effects, $\delta_{c,t}$. These capture the influence of unobserved time-varying MSA-level factors. Because there are roughly 1,800 fixed effects, we estimate the models using a linear probability specification. Because of the long list of controls, only the main variables of interest are tabled out for the discussion below. A complete set of regression results for column 4 of Table 4-1 is provided in

Appendix B, Table B-2a for reference. That appendix table helps to make clear the extensive set of controls included in the models.

Table 4-1 displays coefficients on the core variables of interest from an initial set of mobility models. Column 1 reports results based on a 2-year move regression using the full sample. Columns 2 and 3 stratify the sample into families with CLTV under 80% and those with CLTV over 80%. The remaining columns 4-6 in Table 4-1 do the same but with a dependent variable based on 4-year moves. Notice that all of the models discretize CLTV levels into broad categories. These include whether the family does not have a mortgage, CLTV above 0 but below 50% (the omitted category), CLTV 50-80%, CLTV 80-100%, CLTV 100-120% and CLTV greater than 120%.

The first message to take from Table 4-1 is that high PTI encourages households to move. The evidence on this is robust and large in magnitude. PTI levels between 25% and 45% have no effect on mobility relative to PTI below 25% (the omitted category). However, PTI levels above 45 percent increase the probability of moving in the next two years by 2.7 percentage points for families with CLTV below 80% and by 5.8 percentage points for families with CLTV over 80%. The corresponding effects on 4-year move probabilities are higher: 5.7 percentage points and 8.6 percentage points, respectively.

In column 1, notice also that higher levels of CLTV encourage families to move even when the household is not underwater. CLTV between 50% and 80%, for example, increases mobility by 1.5 percentage points relative to families with CLTV below 50%. This estimate is echoed in column 2 which restricts the sample to families with CLTV below 80%. The important point to recognize in these estimates is that CLTV levels of 50-80% are too low for families to be concerned about default risk. Instead, the positive coefficient on CLTV of 50-80% must be driven by something else. On the other hand, notice in column 4, for the 4-year move, the coefficient on CLTV over 120% is notably higher than the coefficient on CLTV 100-120%: 0.057 versus 0.038.[21] For these two groups of households, positive net equity is zero and, for that reason, the marginal effect of being deeper under water on household wealth should be limited. This suggest that the greater mobility of families with CLTV over 120% is likely consistent with a default risk effect that is relatively free of influence from unobserved wealth. To explore this possibility further, Table 4-2 provides a more complete specification that adds interactions between the CLTV and PTI in a manner that better targets the potential influence of default risk.

4.2 Interactions between high PTI and CLTV

To avoid proliferation of controls, in Table 4-2, PTI is coded as a single measure based on whether PTI is above or below 45%, consistent with evidence in Table 4-1 that 45% is an important threshold. PTI is then entered as a direct control in addition to being interacted with CLTV. The direct effect of PTI captures the influence of high PTI when the household is not underwater (CLTV below 100%). As before, the effect is large, positive, and highly significant: for the 2- and 4-year moves, the coefficients on PTI are 2.8 and 4.9 percentage points with t-ratios roughly 5 or higher. Observe also that when PTI is below 45%, the coefficients on CLTV over 100% in the upper portion of the table are small and insignificant.

A further pattern is evident in the interaction terms. In both columns 1 and 3, high levels of CLTV amplify the impact of high PTI on mobility. For the 2-year move the effect is 5.6 percentage points while for the 4-year move the effect is 6.9 percentage points. This pattern is consistent with earlier discussion of HARP and HAMP and the possibility that underwater

[21] A similar but smaller pattern is present in column 1.

families are often unable to refinance into a lower monthly payment mortgage that might enable the family to remain in their home.

Columns 2 and 4 (for the 2- and 4-year moves) split CLTV > 100% into two categories for CLTV 100-120% and CLTV over 120%. Notice that the coefficient on the interaction with CLTV > 120% is much larger in magnitude than the interaction with CLTV 100-120%. In column 2 for the 2-year move, the coefficients are 3.8 percentage points versus 8.6 percentage points, while in column 4 (for the 4-year move) the corresponding coefficients are 4.1 and 11.5 percentage points. This further confirms that adverse effects of high PTI on a family's tendency to move out of their home are amplified if the family is also underwater, consistent with double-trigger views of mortgage default (e.g., Foote et al. (2008), Bhutta et al. (2010), Elul et al. (2010), Ganong and Noel (2020b)). As suggested earlier, this sort of interaction effect could arise if high CLTV prevents financially stressed families from refinancing into a lower monthly payment loan, forcing them to move.

4.3 Robustness to possible overestimates of house value

Prior studies have suggested that homeowners may overstate the market value of their homes.[22] To the extent that occurs, this could cause reported home values in the AHS to be biased upward causing our measures of CLTV to be too low. This section presents a set of

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[22] Using American Housing Survey (AHS) data from 1985 and 1987, Goodman and Ittner (1992) estimate that households overestimate their home values by 6%. Based on 1978-1991 AHS data, Kiel and Zabel (1999) obtain a similar estimate of 5% while also providing evidence that overassessment might be even higher among recent buyers. Both studies report little evidence of systematic bias based on household or housing attributes. Analogous estimates using Australian data suggest less bias, about 2.5% (see Melser, 2013), while other estimates based on Israeli data are higher, about 20% (see Tur-Sinai, et al (2020). As we are using AHS data for the United States, the previous work by Goodman and Ittner (1992) and Kiel and Zabel (1999) who also examined AHS data is likely most relevant.

robustness checks to evaluate whether our mobility results are sensitive to such concerns. They are not.

We begin by noting that our models are specified with CLTV discretized into broad categories with special attention given to whether CLTV is 100% to 120% and whether it is over 120%. The question, therefore, is whether possible underestimates of CLTV might result in sufficient misclassification of CLTV into lower categories as to affect our results. Bearing this in mind, Figure 3 provides some guidance by displaying histograms of the CLTV distribution for the two-year mobility sample. In Panel A, which uses the full sample, modal CLTV is just below 80% and there is a large drop in mass just above 100%. In Panel B, which considers just those homes for which CLTV is above 100%, the horizontal axis is measured at a much finer scale. In this panel, there is a mass point just above 100%, beyond which mass declines and is small just below 120%. In Panel C, which focuses on homes for which CLTV is above 120%, modal CLTV is 120% and the histogram displays a roughly smooth, exponential decline for higher values of CLTV.

Because few observations in Figure 3 have CLTV just below 120% (see Panels A and B), our estimates of the influence of being deep underwater on mobility are unlikely to be affected by possible overassessment of home value. The same does not necessarily apply, however, for estimates of CLTV between 100% and 120%. That is because a notable share of observations have CLTV just below 100%. That pattern is to be expected because in some market settings lenders have shrunk down payment requirements to very small levels, causing loan to value ratios to approach 100% from below. But we also cannot rule out the possibility that homeowner overassessment of house value contributed to downward biased measures of CLTV.

To explore these issues further, Tables 4-3a and 4-3b present a set of robustness checks that are guided in part by the patterns in Figure 3. In each instance we re-estimate the two- and four-year mobility models from Table 4.2 but with either a different way of measuring CLTV or a different sample design. In Table 4-3a, we scale CLTV by 1.05 and by 1.10. This allows for the possibility that homeowners may overvalue their homes by up to 5% or even 10%. In Table 4-3b, we omit observations for which CLTV is between 90% to 100% and 110% to 120%. These are the observations for which CLTV is most at risk of being miscoded in ways that might affect our results.[23]

For each of the models in Tables 4-3a and 4-3b, estimates of the qualitative patterns are always identical to those in Table 4-2. In most instances, estimates are also numerically quite close. Based on these estimates and the patterns in Figure 3, it seems unlikely that our estimates of household mobility are sensitive to miscoding of CLTV.

5. Maintenance regressions

This section reports results from the maintenance regressions. In this instance, concerns that homeowners may overestimate house value (and underestimate CLTV) do not carry over as our goal is to evaluate whether homeowner perceptions of default risk affect home maintenance expenditures. That perception depends on what homeowners think their home is worth which is what the AHS reports. We begin with two sets of summary measures.

Table 5-1, Panel A describes the distribution of maintenance expenditures in $2014 for both the full AHS sample and the restricted sample used for the estimation. An important pattern

[23] We also tried restricting the sample to families that have been in their home no more than three years. Kiel and Zabel (1999) show that recent movers overestimate their home values by a larger amount than families who have been present in the home for a longer period. Restricting to recent movers then provides a different sort of robustness check. Nevertheless, point estimates were very similar to those in Tables 4-2, 4-3a and 4-3b.

to observe is that the distribution of maintenance expenditures in the estimating sample is similar to that of the broader AHS sample. This suggests that sample restrictions discussed earlier are not affecting the representativeness of the maintenance measures used for the estimation.

Panel B of Table 5-1 reports the median and mean level of maintenance (in $2014) by CLTV and PTI level. For each level of CLTV and PTI, the distribution of maintenance expenditures is skewed, with higher mean spending than median. The median level of maintenance over the previous two years is also quite similar for different CLTV and PTI levels, ranging roughly between 1,600 and 3,000 (in $2014). The same is true for the mean level of maintenance which ranges from roughly $6,000 to $8,500. These magnitudes and patterns affect design of the maintenance regressions to follow as will become apparent.

Table 5-2 reports the distribution of 2-year MSA-level nominal house price changes for the sample used in the maintenance regressions. For reasons that were described earlier, some of the specifications to follow control for local house price inflation. Notice that for the typical home-year observation, the most common occurrence is that home prices at the MSA level are relatively stable, with changes between -10% and 10%. Pooling sample across years (see the bottom row), 54.75 percent of the sample experienced home price changes in this range. Reading down the rows and across columns, however, there is also considerable variation in the distribution of house price inflation across years. In 2005, for example, 59.98 percent of sample homes were in MSAs that experienced 2-year house price increases over 20 percent, and in 2009 33.22 percent of homeowners were in MSAs in which house prices declined by more than 20%.

Consider now Table 6 which presents our maintenance regressions. As before, because of the extensive set of controls, only the main variables are tabled out to conserve space. A complete set of regression results for column 2 is provided in Appendix B, Table B-2b for reference. Recall also that maintenance is reported based on expenditures over the previous two years (in $2014). For that reason, in all of the models CLTV and PTI are lagged two years to help ensure that the measures are predetermined. This avoids a possible mechanical relationship with perceived home value that could affect CLTV, and also second loan payments that could affect PTI (e.g. as might occur with a draw on a home equity line of credit).

Two sets of maintenance regressions are presented in Table 6. The first, in columns 1-4, consider whether families conduct any maintenance (maintenance > 0), while the second, in columns 5-8, evaluate whether the family spent more than $2,500 on home maintenance (in $2014). In both cases, the dependent variable is coded 1 for yes and 0 for no. We specify maintenance in this fashion because the arguments discussed earlier suggest that families should conduct zero maintenance if they expect to move very soon and default on their loan. It is possible, however, that some families may anticipate a move and default in the relatively near future, but still conduct essential maintenance that yields immediate consumption value. Setting the maintenance threshold to $2,500 in columns 5-8 allows for this possibility.[24]

Four models are presented for each of the dependent variables in Table 6. The first includes MSA and year fixed effects along with MSA-level house price inflation over the previous two years. The second includes MSA by year fixed effects and interactions between local house price inflation and the CLTV measures. The remaining two models repeat this last specification with the sample restricted to families with PTI above and below 25%, respectively.

Focus now on the PTI estimates in the full sample models in columns 1 and 2 (maintenance > 0) and 5 and 6 (maintenance > $2,500). Estimates indicate that families are 2 to 4

[24] For comparison, we also estimated the models in Table 6 using a continuous measure for maintenance. This model is not our preferred specification given our focus is on whether the family conducts positive versus zero maintenance. Bearing that in mind, results from the continuous maintenance model are qualitatively similar to estimates in Table 6. Those estimates are reported in Appendix B, Table B-3 for reference.

percentage points less likely to engage in the specified level of maintenance when PTI is above 35%, with t-ratios ranging from 2.4 to 3.8. This pattern is consistent with the view that high PTI limits discretionary spending, curtailing home maintenance (as in Melzer (2017) and analogous to estimates in Ganong and Noel (2020a)). It is also consistent with forced moves that reduce a family's consumption benefits from home repairs and improvements.

The CLTV patterns in these same models are less straightforward. In columns 1 and 2 (maintenance > 0), CLTV above 80% has no discernible effect on home maintenance. For maintenance > $2,500 (columns 5 and 6), the corresponding CLTV coefficients are larger and mostly significant, with estimates ranging from roughly -2.5 to -3.5 percentage points. This suggests mixed evidence of whether high CLTV discourages home investment. Other estimates in Table 6, however, suggest a more conclusive pattern.

Consider the impact of home price inflation in columns 1 and 5. The corresponding coefficients are 0.03 and 0.085, with t-ratios of 1.90 and 3.55, respectively. This confirms that families are more likely to engage in home maintenance when local home prices are rising, consistent with an increase in perceived investment returns.

Focus next on columns 2 and 6, where home price inflation is interacted with the CLTV measures. In both models, the interaction terms associated with CLTV below 120% are small and not significant. The interaction terms associated with CLTV above 120%, however, are large, positive, and significant: 0.168 and 0.348 in columns 2 and 6, respectively, with t-ratios of 2.03 and 2.80. This suggests that rising local home prices increase the tendency to maintain the home but primarily for just those families with CLTV above 120%. The remaining models in Table 6 reinforce this interpretation but with a further caveat.

Columns 3 and 7 restrict the sample to families for whom PTI is above 25%. This reduces sample size to just 9,846 observations while still including over 1,400 MSA by year fixed effects. Our ability to reliably identify patterns is therefore reduced. Bearing this in mind, the direct effect of CLTV on whether to conduct any maintenance (column 3) is small and insignificant for all of the CLTV categories as are the interaction terms with local home price inflation. The point estimates are larger in column 7 for maintenance above $2,500, but there too the estimates are imprecise and not significant. The limited effect of CLTV in these models could arise because households with high PTI are cash constrained, reducing their ability to maintain the home, or because they expect to move soon, reducing their desire to maintain the home.

Columns 4 and 8 restrict the sample to families with PTI below 25%. Discretionary spending should be possible for this group and PTI is low enough to preclude forced moves. Sample size is also roughly 50,000 observations so power is not a concern. Keeping these features in mind, the estimates in columns 4 and 8 are similar to those for the full sample models but with two important differences: the direct effect of CLTV > 120% is notably larger as is the corresponding and offsetting effect of home price inflation as captured by the interaction term. In column 4, the coefficient on CLTV > 120% is -0.036 with a t-ratio of 2.13, while the coefficient on its interaction with home price inflation is 0.315 with a t-ratio of 2.78. These estimates suggest that a 10% or greater increase in local home prices is needed to offset the discouraging effect of CLTV > 120% on incentives to conduct home maintenance. Larger estimates are obtained in column 8 for maintenance above $2,500.

Summarizing, high mortgage payment burdens reduce the tendency for families to engage in home maintenance. In addition, among families with lower PTI for whom discretionary spending is viable and forced moves are not a concern, high CLTV (CLTV > 120%) discourages maintenance. This effect, however, is offset if local home prices are rising at a sufficiently high rate. Together, these patterns reinforce evidence elsewhere that the homeowner's equity position affects investment in the home through multiple channels, including debt overhang and financial constraints that limit liquidity (e.g., Melzer (2017), Cooper (2013), Mian, Rao, and Sufi (2013)). Our key contribution here is to highlight the role of mortgage payment burden on home investment which has received limited attention in previous work. A related finding by Ganong and Noel (2020b) is that consumption is reduced by high payment burdens. Our estimates on home maintenance are analogous.

6. Conclusion

A central message of this paper is that high PTI interacts with high CLTV in ways that amplify risk that underwater homeowners will be forced out of their homes and default on their mortgages. A further message is that should a default occur, lender loses are exacerbated by high PTI and high CLTV which erode a homeowner's ability and incentive to maintain the home.

We reach the conclusions above based on analysis of the 1985-2013 American Housing Survey (AHS) panel. Estimates indicate that high CLTV by itself has little effect on household mobility, but PTI above 45% prompts families to move and especially so when homeowners are deep underwater with CLTV above 120%. The amplifying effect of high PTI on underwater families is not surprising given the twin challenges of making high PTI monthly payments and restricted ability to refinance into a more affordable loan when home equity is negative. Additional estimates indicate that high PTI always curtails home maintenance, likely reflecting a combination of impaired incentives and reduced ability to maintain the home. When PTI is low enough to allow for discretionary spending, high CLTV has a sharp, negative effect on maintenance, reflecting once again the adverse incentive effect of high CLTV, but pressure to move is absent.

An implication of our results is that programs like HARP and HAMP that lower PTI are likely to be more effective at helping underwater households to remain in their homes and avoid mortgage default than policies that focus on lowering CLTV (as with principal forgiveness). Lowering PTI will also tend to increase home maintenance which will slow deterioration of homes and mitigate lender losses should a default occur.

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Table 1: Current Loan to Value Ratio (CLTV) by Year [a]

Year	Observations [a]	Percent Without Mortgage	Percent With a Mortgage	CLTV Distribution Among Owner-Occupiers With a Mortgage [b]						
				> 0% and ≤ 50%	50% to 80%	80% to 90%	90% to 95%	95% to 100%	100% to 120%	> 120%
1985[c]	1,174[c]	12.95[c]	87.05[c]	14.29	46.18	24.66	7.73	3.62	2.25	1.28
1987	3,208	33.45	66.55	17.28	50.31	17.10	7.30	3.14	3.79	1.08
1989	4,370	34.32	65.68	22.79	49.03	16.55	4.74	2.44	3.24	1.22
1991	4,357	29.95	70.05	18.84	48.88	17.40	5.90	3.04	4.75	1.18
1993	5,691	30.17	69.83	16.11	46.63	19.55	6.54	4.05	5.89	1.23
1995	6,191	27.93	72.07	17.71	43.61	19.83	8.12	3.97	5.22	1.54
1997	5,643	30.68	69.32	17.82	45.82	18.44	6.68	3.88	5.93	1.46
1999	6,505	35.72	64.28	20.82	51.46	15.71	5.48	2.77	4.09	1.21
2001	5,474	28.90	71.1	23.46	49.25	13.90	4.63	3.19	4.16	1.41
2003	6,793	32.67	67.33	27.57	47.56	12.13	4.86	2.97	3.70	1.22
2005	5,588	29.24	70.76	31.23	43.22	12.27	4.83	3.24	3.77	1.44
2007	4,771	23.98	76.02	32.95	39.52	12.25	4.60	3.58	5.21	1.91
2009	5,132	26.48	73.52	23.16	34.32	13.60	5.48	4.86	12.16	6.42
2011	5,091	24.26	75.74	18.75	33.06	13.69	6.59	5.35	14.52	8.04
2013	5,687	35.43	64.57	17.38	37.09	15.58	6.75	4.09	13.47	5.64
Total	75,673	30.02	69.98	21.75	44.10	15.68	5.92	3.64	6.42	2.52

[a] Sample is restricted to owner-occupied houses in an identified MSA and those that have reliable information for CLTV, PTI, real purchase housing price, and change in housing price index since move-in. Details on the sample cleaning procedures are provided in the data section.

[b] CLTV is calculated as the loan amount at origination divided by homeowner assessed home value in the current survey year. Calculated in this fashion, variation in CLTV over time is driven by the change in the perceived value of the house.

[c] The number of observations in 1985 is lower than in subsequent years as is the share of homes for which occupants report not having a mortgage. Both patterns arise because 1985 is the first survey year in the panel and as such all homes are newly introduced to the panel in that year. In instances in which a mortgage was originated more than two years prior to when a home entered into the survey we code the mortgage data as missing and do not include that observation in the sample. This is because in such instances we are unable to follow the mortgage data across earlier survey years and this prevents us from determining whether the loan is a home purchase or refinance mortgage. This skews the data in 1985 towards occupants with a recently originated mortgage. This tendency diminishes with subsequent survey years as homes turnover and a growing share of occupants are first observed after the home was entered into the survey.

Table 2: Payment to Income (PTI) Ratio by Year

				PTI Distribution Among Owner-Occupiers With a Mortgage [b]			
Year	**Observations [a]**	**Percent Without Mortgage**	**Percent With a Mortgage**	**> 0% and ≤ 25%**	**25% to 35%**	**35% to 45%**	**Greater than 45%**
1985	1,174[c]	12.95[c]	87.05	66.93	20.94	6.56	5.58
1987	3,208	33.45	66.55	76.30	15.88	4.49	3.32
1989	4,370	34.32	65.68	74.04	15.36	5.27	5.33
1991	4,357	29.95	70.05	72.93	15.99	5.51	5.57
1993	5,691	30.17	69.83	75.94	12.80	4.20	7.05
1995	6,191	27.93	72.07	72.26	14.68	4.37	8.70
1997	5,643	30.68	69.32	77.08	11.92	4.66	6.36
1999	6,505	35.72	64.28	78.39	10.98	4.32	6.29
2001	5,474	28.90	71.1	76.62	11.56	4.67	7.14
2003	6,793	32.67	67.33	71.10	14.60	5.51	8.79
2005	5,588	29.24	70.76	69.98	14.80	5.60	9.64
2007	4,771	23.98	76.02	68.40	13.89	7.09	10.62
2009	5,132	26.48	73.52	66.17	14.61	7.18	12.04
2011	5,091	24.26	75.74	68.52	14.71	6.38	10.40
2013	5,687	35.43	64.57	73.83	12.61	4.71	8.84
Total	75,673	30.02	69.98	72.76	13.89	5.30	8.05

[a] Sample is restricted to owner-occupied houses in an identified MSA and those that have reliable information for CLTV, PTI, real purchase housing price, and change in housing price index since move-in. Details on the sample cleaning procedures are provided in the data section.

[b] PTI ratio is generated by dividing the combined monthly payments for the primary mortgage and the secondary mortgage (if exist) by the monthly income of the mortgage borrower. The monthly payment includes Principal, Interest, Taxes, and Insurance (PITI) paid by the mortgagor.

[c] The number of observations in 1985 is lower than in subsequent years as is the share of homes for which occupants report not having a mortgage. Both patterns arise because 1985 is the first survey year in the panel and as such all homes are newly introduced to the panel in that year. In instances in which a mortgage was originated more than two years prior to when a home entered into the survey we code the mortgage data as missing and do not include that observation in the sample. This is because in such instances we are unable to follow the mortgage data across earlier survey years and this prevents us from determining whether the loan is a home purchase or refinance mortgage. This skews the data in 1985 towards occupants with a recently originated mortgage. This tendency diminishes with subsequent survey years as homes turnover and a growing share of occupants are first observed after the home was entered into the survey.

Table 3: Summary Statistics for Owner-Occupied Homes Used to Estimate Mobility in the Next Two Years[a]
(Sample Size = 64,247)[b]

Variable	Mean	Std. Dev.
PTI (primary + secondary mortgages)	0.1733	0.1944
OLTV (excluding those without a mortgage)	0.7658	0.1889
CLTV (excluding those without a mortgage)	0.6928	0.2418
Percent without a mortgage (1 if without)	0.2473	0.4315
Interest rate residual[c]	-0.0445	1.0482
Mortgage loan rate minus 10-year treasury rate	1.444	1.475
ARM loan	0.1676	0.3735
FHA loan	0.1432	0.3502
VA loan	0.0461	0.2097
Refinanced loan	0.2997	0.4581
Percent change in HPI since move-in	0.5293	0.8247
Real purchase price (in 2014 US dollars)	258,780	214,818
Nominal capital loss since purchase (1 if yes)	0.0956	0.2940
Years since move-in	7.96	7.24
Real family income (in 10,000s, 2014 dollars)	9.9602	9.3880
Self-employed	0.1315	0.3380
High school graduate	0.2214	0.4152
Some college	0.2536	0.4351
College graduate	0.2455	0.4304
Two or more years of graduate school	0.1542	0.3611
Age of household head	47.5	15.0
Female household head	0.3421	0.4744
White or Asian household head	0.8048	0.3963
Married	0.6521	0.4763
Divorced since previous survey	0.0279	0.1646
Children present of school age	0.1794	0.3836
Fewer children in home than previous survey	0.0882	0.2836
More children in home than previous survey	0.0735	0.2609
“Feel about the house” (1-worst, 10-best)	8.483	1.413
“Feel about the neighborhood” (1-worst, 10-best)	8.178	1.664
Number of rooms	5.948	1.600
Multifamily	0.1533	0.3602
Condominium	0.1405	0.3475

[a] Means and standard deviations are calculated for the full sample that is used to estimate household mobility in the next 2 years. Observations are restricted to those in identified MSAs with their tenure status reported as owner-occupied.
[b] The sample for this table matches that of column 1 in Table 4-1 and is slightly smaller than the sample used for Tables 1 and 2 because of missing values in some of the control measures in the regressions to follow.
[c] We use interest rate residuals from loan rate regression to reflect the risk profile of the borrower. Specifically, loan rate is regressed on OLTV categorical variables, PTI categorical variables, the type of the loan (ARM loan, FHA loan, VA loan, and refinanced loan), multi-family house or not, condominium or not, and also including year dummies, loan term controls, indicators for loan size.

Table 4-1: Household Mobility
(t-stats are reported in parentheses based on clustered standard errors at the MSA-year level)

	MOVE in Next Two Years			MOVE in Next Four Years		
	Full Sample [a]	0 < CLTV <= 80%	CLTV > 80%	Full Sample	0 < CLTV <= 80%	CLTV > 80%
	(1)	(2)	(3)	(4)	(5)	(6)
CLTV						
0% (No Mortgage)	0.026	-	-	-0.038	-	-
	(1.53)	-	-	(-1.53)	-	-
50% to 80%	0.015	0.009	-	0.028	0.021	-
	(3.68)	(2.27)	-	(5.41)	(3.83)	-
80% to 100%	0.015	-	-0.021	0.036	-	-0.031
	(3.13)	-	(-1.67)	(5.27)	-	(-1.74)
100% to 120%	0.016	-	-0.008	0.038	-	-0.020
	(2.05)	-	(-0.62)	(3.51)	-	(-1.09)
> 120%	0.022	-	-	0.057	-	-
	(1.95)	-	-	(3.31)	-	-
PTI						
0.25 to 0.35	-0.004	1.8e-04	-0.006	0.004	0.007	0.010
	(-1.02)	(0.03)	(-0.79)	(0.62)	(0.90)	(0.87)
0.35 to 0.45	-0.002	2.4e-04	0.001	-0.003	0.003	0.003
	(-0.29)	(0.03)	(0.11)	(-0.29)	(0.24)	(0.56)
> 0.45	0.033	0.027	0.058	0.055	0.057	0.086
	(5.69)	(3.96)	(4.80)	(6.72)	(5.85)	(5.24)
MSA by Year FE	1,779	1,724	1,612	1,741	1,649	1,554
Within R-squared	0.030	0.027	0.033	0.050	0.047	0.056
Observations [a]	64,247	32,260	16,098	59,869	30,433	14,436
% Dep Variable = 1	9.99	9.23	12.2	20.0	18.7	25.6

[a] Sample is restricted to owner-occupied houses whose MSA information, CLTV, and PTI are clearly identified. Other control variables include interest rate residual categories, the difference between the current loan rate and the 10-year treasury rate, OLTV categories, real purchase price, percentage change in quality adjusted MSA-level house prices since move-in year based on the FHFA house price index, indicators for ARM loan, FHA loan, VA loan, and refinancing loan, years since move-in, perceived nominal capital loss since purchase, real family income, self-employment status, demographic control for educational background, race, gender, age, and marital status, how the household feels about the house and the neighborhood, whether the household has school-age kids present, whether they recently had more children or lost children, whether the house is a multi-family house or a condominium, number of rooms in the house.

Table 4-2: Mobility, Negative Home Equity and High PTI
(t-stats are reported in parentheses based on clustered standard errors at the MSA-year level)[a,b]

	MOVE in Next Two Years		MOVE in Next Four Years	
	(1)	(2)	(3)	(4)
CLTV > 100%	-0.004	-	0.009	-
	(-0.64)	-	(0.99)	-
CLTV 100% to 120%	-	-0.003	-	0.008
	-	(-0.43)	-	(0.85)
CLTV > 120%	-	-0.008	-	0.011
	-	(-0.67)	-	(0.65)
PTI > 0.45	0.028	0.028	0.049	0.049
	(4.83)	(4.82)	(6.15)	(6.15)
PTI > 0.45 * CLTV > 100%	0.056	-	0.069	-
	(2.98)	-	(2.53)	-
PTI > 0.45 * CLTV 100% to 120%	-	0.038	-	0.041
	-	(1.66)	-	(1.29)
PTI > 0.45 * CLTV > 120%	-	0.086	-	0.115
	-	(2.55)	-	(2.61)
MSA by Year FE	1,779	1,779	1,741	1,741
Within R-squared	0.030	0.030	0.050	0.050
Observations	64,247	64,247	59,869	59,869
% Dep Variable = 1	9.99	9.99	20.0	20.0

[a] Sample is restricted to owner-occupied houses whose MSA information, CLTV, and PTI are clearly identified.
[b] Additional control variables included in the models but not shown are the interest rate residual categories, the difference between the current loan rate and the 10-year treasury rate, OLTV categories, and the real purchase price. Also included as controls are the percentage change in quality adjusted MSA-level house prices since move-in year based on the FHFA house price index, indicators for ARM loan, FHA loan, VA loan, and refinancing loan, years since move-in, and the perceived nominal capital loss since home purchase. A final set of controls in all of the models include real family income, self-employment status, demographic controls for educational background, race, gender, age, and marital status, how the household feels about the house and the neighborhood, whether the household has school-age kids present, whether they recently had more children or lost children, whether the house is a multi-family house or a condominium, number of rooms in the house.

Table 4-3a: Robustness - Scaling CLTV
(t-stats are reported in parentheses based on clustered standard errors at the MSA-year level)[a]

	MOVE in Next Two Years				MOVE in Next Four Years			
	CLTV Scaled by 1.05		CLTV Scaled by 1.10		CLTV Scaled by 1.05		CLTV Scaled by 1.10	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CLTV > 100%	-0.009	-	-0.012	-	0.004	-	-0.000	-
	(-1.64)	-	(-2.44)	-	(0.54)	-	(-0.01)	-
CLTV 100% to 120%	-	-0.011	-	-0.013	-	0.003	-	-0.001
	-	(-1.88)	-	(-2.71)	-	(0.32)	-	(-0.17)
CLTV > 120%	-	-0.002	-	-0.004	-	0.011	-	0.007
	-	(-0.19)	-	(-0.41)	-	(0.78)	-	(0.53)
PTI > 0.45	0.027	0.027	0.025	0.025	0.048	0.048	0.049	0.049
	(4.66)	(4.66)	(4.18)	(4.19)	(5.96)	(5.96)	(5.90)	(5.90)
PTI > 0.45 * CLTV > 100%	0.051	-	0.049		0.065	-	0.042	-
	(3.01)	-	(3.24)		(2.73)	-	(1.94)	-
PTI > 0.45 * CLTV 100% to 120%	-	0.038	-	0.039	-	0.046	-	0.026
	-	(1.96)	-	(2.23)	-	(1.72)	-	(1.06)
PTI > 0.45 * CLTV > 120%	-	0.072	-	0.067	-	0.098	-	0.076
	-	(2.38)	-	(2.36)	-	(2.46)	-	(2.14)
MSA by Year FE	1,779	1,779	1,779	1,779	1,741	1,741	1,741	1,741
Within R-squared	0.030	0.030	0.030	0.030	0.050	0.050	0.050	0.050
Observations	64,247	64,247	64,247	64,247	59,869	59,869	59,869	59,869

[a] Sample and all control measures are as described in the note for Table 4-2 with one important difference. In this table CLTV measures are scaled up by a constant proportional factor, 1.05 in columns 1-2 and 5-6, and 1.10 in columns 3-4 and 7-8. The scaled measures are then used to classify homes into the CLTV group categories (< 100%; 100 to 120%; > 120%).

Table 4-3b: Robustness – Omitting Observations with CLTV 90-100% and 110-120%[a]
(t-stats are reported in parentheses based on clustered standard errors at the MSA-year level)

	MOVE in Next Two Years		MOVE in Next Four Years	
	(1)	(2)	(3)	(4)
CLTV > 100%	-0.010	-	0.009	-
	(-1.47)	-	(0.94)	-
CLTV 100% to 120%	-	-0.011	-	0.009
	-	(-1.34)	-	(0.80)
CLTV > 120%	-	-0.010	-	0.012
	-	(-0.88)	-	(0.67)
PTI > 0.45	0.024	0.024	0.048	0.048
	(4.06)	(4.06)	(5.77)	(5.77)
PTI > 0.45 * CLTV > 100%	0.064	-	0.085	-
	(3.29)	-	(2.80)	-
PTI > 0.45 * CLTV 100% to 120%	-	0.045	-	0.062
	-	(1.82)	-	(1.70)
PTI > 0.45 * CLTV > 120%	-	0.090	-	0.115
	-	(2.69)	-	(2.59)
MSA by Year FE	1,778	1,778	1,733	1,733
Within R-squared	0.030	0.030	0.050	0.050
Observations	59,144	59,144	55,286	55,286

[a]Sample and all control measures are as described in the note for Table 4-2 except that observations are omitted when CLTV is between 90% and 100% and also when CLTV is between 110% and 120%.

Table 5-1: Maintenance Expenditure Summary Statistics

Panel A: Entire AHS Panel Versus Estimating Sample

		Maintenance Sample Share in Percent (categories in $2014)						
	Sample Size	Missing	Zero	One - 1,000	1,000-5,000	5,000-10,000	10,000-50,000	50,000 or more
Entire Sample[a]	205,035	6.76	23.93	16.49	27.69	11.51	12.48	1.16
Estimating Sample[b]	59,714	0.00	13.60	19.30	34.98	14.48	16.03	1.61

Panel B: By CLTV and PTI Lagged 2 Years (2014 Dollars)[b]

CLTV (lagged 2 years)	**Observations**	**Median**	**Mean**	**Std Dev**
0% (No Mortgage)	22,559	1,638	6,094	17,576
> 0% and ≤ 50%	8,476	2,852	8,628	23,063
50% to 80%	16,604	2,781	7,641	19,279
80% to 100%	9,217	2,252	5,832	12,412
100% to 120%	2,122	2,201	6,332	13,620
> 120%	736	1,984	6,437	20,617
PTI (lagged 2 years)				
0% (No Mortgage)	22,559	1,638	6,094	17,576
> 0% and ≤ 25%	27,309	2,781	7,688	19,329
25% to 35%	5,197	2,303	6,552	16,492
35% to 45%	1,919	2,032	5,933	17,429
> 45%	2,730	2,032	6,057	15,208

[a] All owner-occupied homes in the AHS panel for which MSA is identified.
[b] Sample restricted to observations in the maintenance regressions.

Table 5-2: Distribution of Nominal MSA-Level House Price Inflation in the Last 2 years ($\%\Delta \mathrm{HPI}_{t,t-2}$)

Year	Observations	< -20%	-20% to -10%	-10% to 10%	10% to 20%	> 20%
1987	1,728	1.39	2.03	28.36	28.99	39.24
1989	3,427	0.00	0.96	38.63	31.08	29.33
1991	3,242	0.00	0.00	79.09	17.89	3.02
1993	4,406	0.27	0.00	90.35	8.08	1.29
1995	4,924	0.00	10.30	71.04	17.53	1.14
1997	4,029	0.00	0.00	80.41	18.59	0.00
1999	6,061	0.00	0.00	49.93	45.93	4.14
2001	4,553	0.00	0.00	18.25	61.67	20.07
2003	5,561	0.00	0.00	34.81	31.76	33.43
2005	4,063	0.00	0.00	27.07	15.95	56.98
2007	3,414	0.00	0.00	64.53	27.77	7.70
2009	4,874	33.22	22.36	44.42	0.00	0.00
2011	3,879	4.69	31.22	64.09	0.00	0.00
2013	5,553	0.00	0.00	68.58	29.25	2.18
Total [a]	59,714	3.08	4.82	54.74	24.60	12.76

[a] Sample is restricted to observations that are used to estimate the maintenance regressions.

Table 6: Home Maintenance
(t-stats are reported in parentheses based on clustered standard errors at the MSA-year level)[a,b]

	Maintenance > $0				Maintenance > $2,500			
	Full Sample		PTI > 25%	PTI <= 25%	Full Sample		PTI > 25%	PTI <= 25%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CLTV Effects								
$CLTV_{t-2}$ 80% to 100% (X_1)	0.004	0.002	0.008	-0.004	-0.026	-0.026	-0.029	-0.027
	(1.05)	(0.32)	(0.81)	(-0.79)	(-4.02)	(-3.31)	(-1.89)	(-2.89)
$CLTV_{t-2}$ 100% to 120% (X_2)	-0.005	-0.003	-0.008	-0.004	-0.031	-0.024	-0.017	-0.028
	(-0.70)	(-0.38)	(-0.88)	(-0.46)	(-2.63)	(-1.75)	(-0.78)	(-1.75)
$CLTV_{t-2}$ > 120% (X_3)	-0.001	-0.009	0.001	-0.036	-0.023	-0.034	-0.021	-0.065)
	(-0.05)	(-0.76)	(0.06)	(-2.13)	(-1.28)	(-1.78)	(-0.69)	(-2.60)
HPI Effects								
$\%\Delta HPI_{t,t-2}$	0.030	-	-	-	0.085	-	-	-
	(1.90)	-	-	-	(3.55)	-	-	-
X_1 * $\%\Delta HPI_{t,t-2}$	-	0.037	-0.026	0.053	-	0.018	0.117	-0.067
	-	(1.31)	(-0.47)	(1.41)	-	(0.38)	(1.48)	(-1.11)
X_2 * $\%\Delta HPI_{t,t-2}$	-	0.011	-0.047	0.027	-	-0.044	0.045	-0.117
	-	(0.21)	(-0.56)	(0.42)	-	(-0.46)	(0.31)	(-1.07)
X_3 * $\%\Delta HPI_{t,t-2}$	-	0.168	0.033	0.315	-	0.348	0.285	0.414
	-	(2.03)	(0.25)	(2.78)	-	(2.80)	(1.62)	(1.98)
Payment-to-Income Effects								
PTI_{t-2} 0.25 to 0.35	-0.002	-0.002	0.035	-	-0.008	-0.009	0.032	-
	(-0.34)	(-0.51)	(3.90)	-	(-1.05)	(-1.17)	(2.43)	-
PTI_{t-2} 0.35 to 0.45	-0.020	-0.019	0.009	-	-0.040	-0.037	-0.005	-
	(-2.50)	(-2.40)	(0.84)	-	(-3.34)	(-3.10)	(-0.32)	-
PTI_{t-2} > 0.45	-0.026	-0.025	-	-	-0.030	-0.028	-	-
	(-3.87)	(-3.81)	-	-	(-2.94)	(-2.73)	-	-
MSA FE	128	-	-	-	128	-	-	-
Year FE	13	-	-	-	13	-	-	-
MSA by Year FE	-	1,784	1,426	1,781	-	1,784	1,426	1,781
Within R-Squared	0.095	0.069	0.041	0.075	0.080	0.068	0.043	0.073
Observations	59,714	59,714	9,846	49,868	59,714	59,714	9,846	49,868
% Dep Variable = 1	86.4	86.4	88.6	86.1	47.6	47.6	46.6	47.8

[a] Samples are restricted to owner-occupied houses with households that don't move between 1 survey ahead and current survey and have MSA information, CLTV and PTI clearly identified.
[b] Additional control variables included in the models but not shown are the interest rate residual categories, the difference between the current loan rate and the 10-year treasury rate, OLTV categories, real purchase price, percentage change in quality adjusted MSA-level house prices since move-in year based on the FHFA house price index, indicators for ARM loan, years since move-in, real family income, self-employment status, demographic control for educational background, race, gender, age, and marital status, how the household feels about the house and the neighborhood, whether the household has school-age kids present, whether they recently had more children or lost children, whether the house is a multi-family house or a condominium, number of rooms in the house.

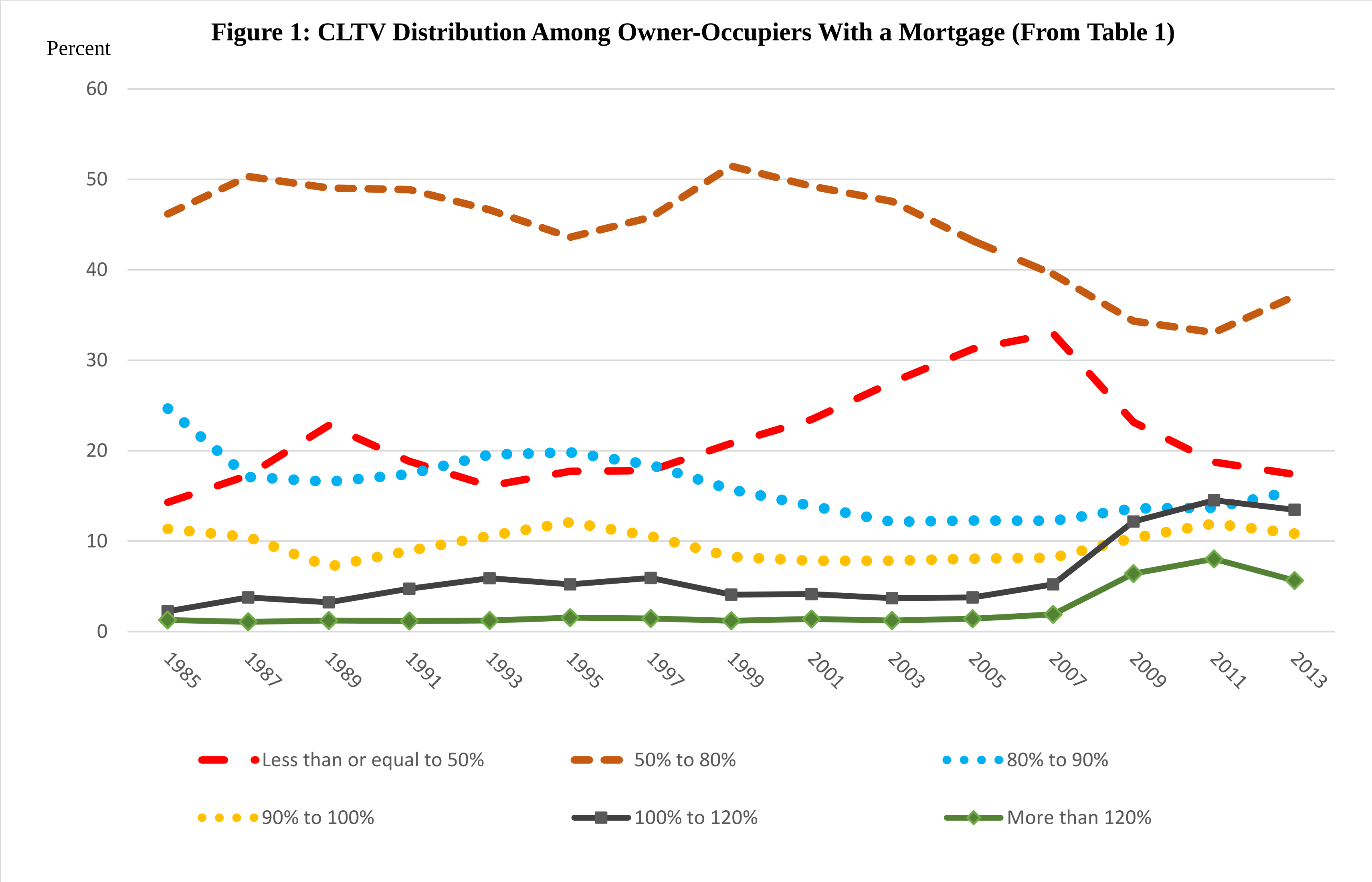


Figure 1: CLTV Distribution Among Owner-Occupiers With a Mortgage (From Table 1)
Percent
60
50
40
30
20
10
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
Less than or equal to 50%
50% to 80%
80% to 90%
90% to 100%
100% to 120%
More than 120%

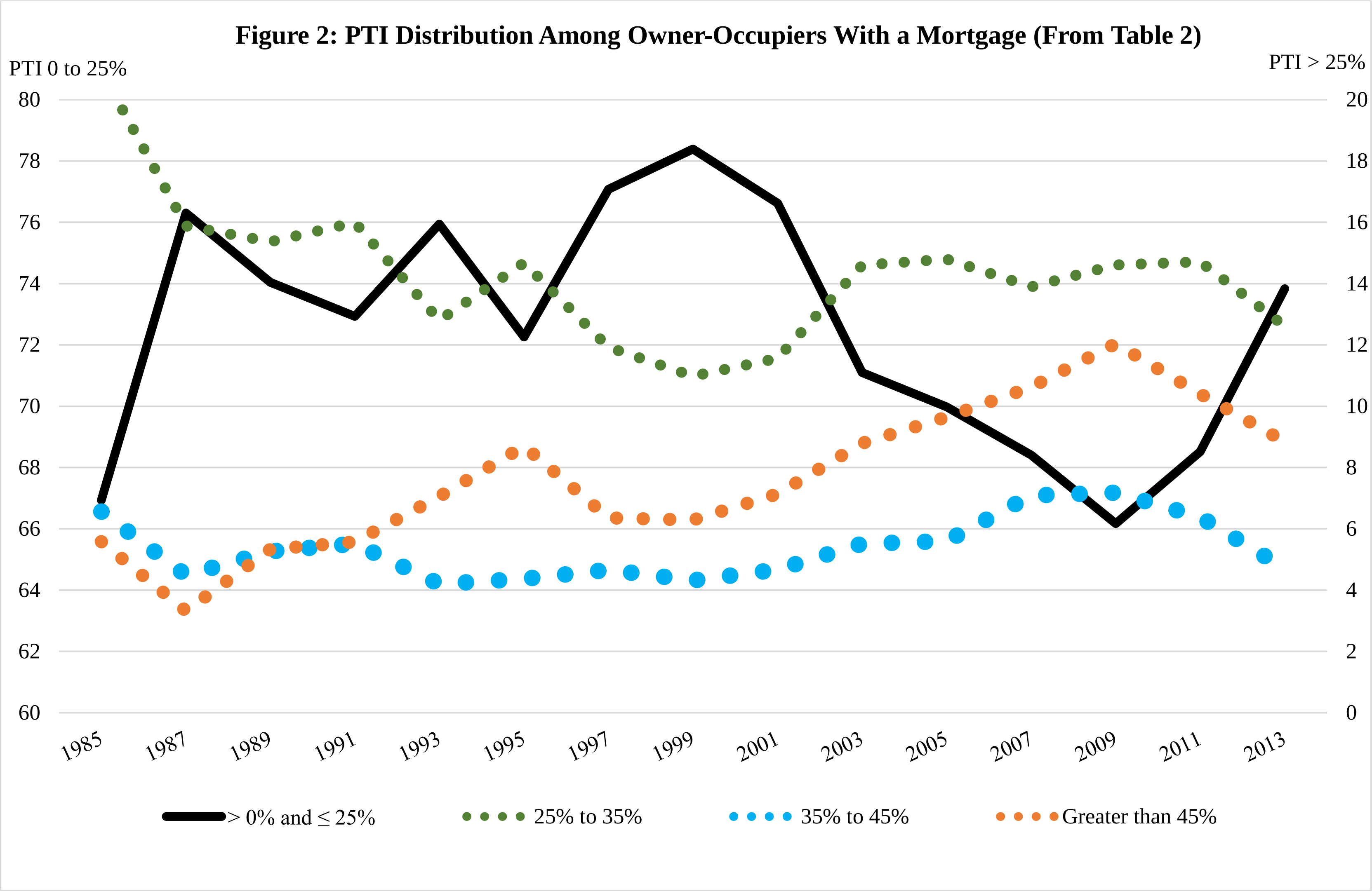
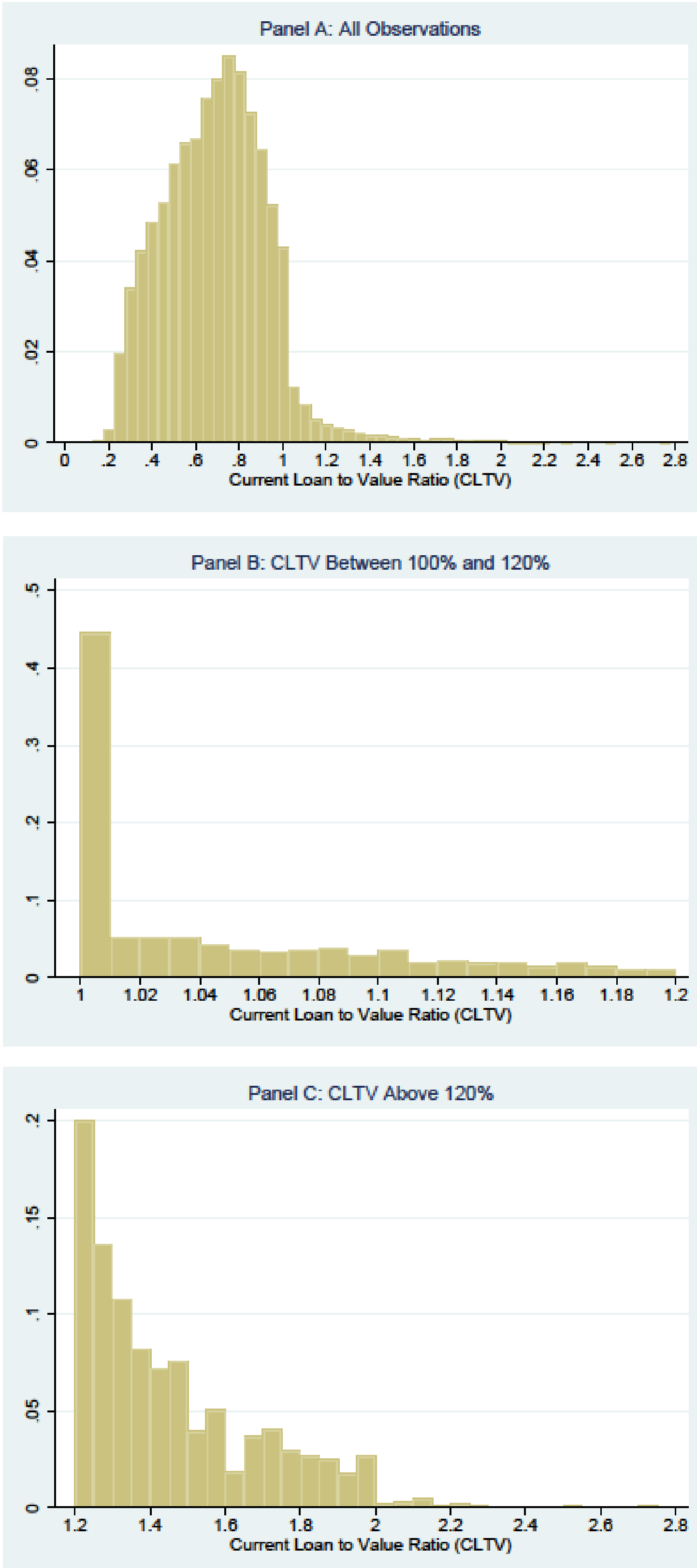


Figure 2: PTI Distribution Among Owner-Occupiers With a Mortgage (From Table 2)
PTI 0 to 25%
PTI > 25%
80
78
76
74
72
70
68
66
64
62
60
20
18
16
14
12
10
8
6
4
2
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
> 0% and ≤ 25%
25% to 35%
35% to 45%
Greater than 45%

Figure 3: Distribution of CLTV



Appendix A: Variable Construction

This appendix provides further detail on the cleaning and construction of the two- and four-year mobility variables, the PTI measure, and the CLTV measures.

A.1 Mobility

We determine whether a family moves out of their home in the next two or four years by drawing on the panel structure of the AHS along with three measures reported in the survey. This includes *samehh*, a 1-0 indicator of whether all household members are the same as in the previous survey year; *moved*, which indicates the year that the survey respondent reports having moved into the home; and *buyyr*, which indicates the year that the survey respondent reports having purchased the home.

Absent any reporting error, *moved* and *buyyr* should not change between surveys when the same household remains in the home. In practice, however, some variation is observed in these variables within a given house-occupant sequence but more so for *buyyr*. Accordingly, we first code the turnover variable as 0 if *samehh* indicates that all household members are the same as in the previous survey. If *samehh* is not reported we code the indicator measure as 0 if *moved* indicates that the family moved into the house prior to the previous survey year, and 1 if it moved in between the previous and current survey years. If, however, *moved* indicates an erroneous move date (e.g. after the present survey), or is missing, we rely on the *buyyr* variable. In that instance, if *buyyr* indicates home purchase prior to the current survey year then the turnover indicator variable is set to 0. If instead *buyyr* indicates an erroneous value or is also missing, then the turnover variable is coded as missing and the observation is dropped from the data. With the indicator variable coded in this manner, it is straightforward to follow the variable across surveys to determine whether the household moves in the next two or four years.

A.2 PTI and CLTV

PTI is calculated by dividing the combined monthly payments for the primary mortgage and the secondary mortgage (if present) by the borrower's monthly household income.[25] It is worth noting that the primary mortgage is the original home purchase loan if that loan has never been refinanced, and the most recent refinance loan in the event of a refinancing.[26]

CLTV is the ratio of the homeowner's mortgage loan balance divided by the owner's current assessment of house value. Coding this variable was more complicated and required a multi-step procedure to ensure reliable measures.

We calculate loan balance as the sum of the primary loan balance at origination plus the original balance on a second mortgage if present. Absent a refinancing, the primary loan is the home purchase loan. If instead that loan was refinanced, we used the refinance loan amount at origination. Measuring mortgage balance in this fashion will overstate the true outstanding loan balance since homeowners pay down their balance over time. However, most loans amortize quite slowly relative to the number of years in which a typical homeowner remains in the home and holds their loan so this approximation is close. Moreover, while the AHS reports loan balance at origination, information on principal payments is not reported and would have to be estimated.

A more significant potential source of error is with the reported homeowner assessment of current house value. In reviewing the data, we discovered several outlier values with obviously miscoded home values given comparison values from adjacent surveys. As an illustration, if home value was reported as $200,000, $22,000 and $250,000 in three successive surveys, it was obvious that the middle survey value

[25] The monthly payment includes Principal, Interest, Taxes, and Insurance (PITI).

[26] To determine whether a loan was refinanced, we examined whether key features of the loan changed between adjacent surveys for a given house-occupant-loan sequence. The first such indicator is whether the loan amount of the primary mortgage changes by more than $10,000 in the absence of a sale. The second indicator is whether the term of the loan changes by more than 8 years in the absence of a sale. The third indicator is whether, for owners with FRMs, the loan rate changes by more than 100 basis points in the absence of a sale. If at least two of these three conditions were met, we coded the primary loan as having been refinanced. A refinance variable is also reported in the AHS after 2001 but was not used to ensure a consistent coding procedure over the entire 1985-2013 sample horizon.

had been miscoded by roughly an order of magnitude. To address such instances, we created a data checking and correction procedure that drew on the panel structure of the data and the FHFA home price index for the MSA in which the home was located. In instances where a miscoded value could not be reliably corrected, the observation was dropped from the sample. Details are as follows.

For the first step in our procedure, within a given house-occupant sequence, a homeowner's reported assessment of house value was coded as not reliable if any of the following conditions were met: (i) homeowner reported house value is more than four times the original balance on the primary loan or less than 25% of that balance; (ii) homeowner reported house value is more than four times the home purchase price or less than 25% of purchase price; (iii) home purchase price was not reported; and (iv) homeowner reported house value was greater than 1 million dollars or less than 1 thousand dollars (in 2014 dollars). These criteria were selected to pick out outlier values that would almost certainly reflect substantial miscoding of the data, as with the illustration above.

The second step in our home value cleaning procedure focused on correcting miscoded values when sufficient information was available from adjacent surveys. Using the illustration above once again, suppose a homeowner reports house value in three successive surveys but the middle value is obviously miscoded while the first and third values are plausible. In such instances, we recoded the middle value to the previous survey value scaled by the percent change in the FHFA home price index for the MSA in which the home was situated. If instead the first value was obviously miscoded but the second two values were plausible, then the first value was recoded to the second value scaled back to the first period by the FHFA home price index. Similarly, if the third value was miscoded but the other two appeared plausible, the second value was scaled forward. It is worth noting that in adjusting miscoded values in this manner, we always required that three adjacent survey home value assessments were reported by the same house occupant. In addition, two of the three home value assessments had to meet all four of the criteria above and those two "reference" values had to be sufficiently similar in a manner consistent with the criteria above.

A final step in the home value cleaning procedure was as follows. For all home value measures, including both adjusted measures as above and those that were not adjusted, we computed the percent change in assessed home value since the previous survey year. If that change was more than fifty percent greater than the corresponding increase in the FHFA home price index for the MSA in which the home is located, the assessed home value was considered unreliable. In that instance, the corresponding observation was dropped from the sample.

Appendix B: Supplemental Tables

Table B-1: Correlation Between CLTV and PTI
(excluding those without a mortgage)

Panel A: Entire Sample

	Observations	Correlation Between CLTV and PTI
Full Sample [a]	52,955	0.099
CLTV ≤ 100%	49,620	0.069
CLTV > 100%	3,335	0.085

Panel B: Estimating Sample for Two-Year Move Model

	Observations	Correlation Between CLTV and PTI
Full Sample [b]	48,358	0.106
CLTV ≤ 100%	45,584	0.074
CLTV > 100%	2,774	0.095

Panel C: Estimating Sample for Maintenance Model

	Observations	Correlation Between $CLTV_{t-2}$ and PTI_{t-2}
Full Sample [c]	37,155	0.095
CLTV ≤ 100%	35,151	0.074
CLTV > 100%	2,004	0.071

[a] Sample is restricted to owner-occupied houses in an identified MSA and those that have reliable information for CLTV, PTI, real purchase housing price, and change in housing price index since move-in. The number of observations reported here is not 75,673 as reported in Tables 1 and 2 because those without a mortgage are excluded to calculate the correlation.
[b] Sample restricted to observations in the regressions to estimate mobility in the next two years. The number of observations reported here is not 64,247 as reported in Table 3 because those without a mortgage are excluded to calculate the correlation.
[c] Sample restricted to observations in the maintenance regressions. The number of observations reported here is smaller than 59,714 as reported in Table 6 because those without a mortgage are excluded to calculate the correlation.

Table B-2a: Four-Year Mobility Regression From Table 4-2, Column 4
(t-ratios based on standard errors clustered at the MSA by Year level) [a]

CLTV 100% to 120%	0.008	Primary loan: ARM	0.001
	(0.85)		(0.15)
CLTV > 120%	0.011	Primary loan: FHA	-0.005
	(0.65)		(-0.86)
PTI > 0.45	0.049	Primary loan: VA	0.001
	(6.15)		(0.16)
PTI > 0.45 * CLTV 100% to 120%	0.041	Primary loan: Refinance	-0.000
	(1.29)		(-0.07)
PTI > 0.45 * CLTV > 120%	0.115	Years since move into home	0.002
	(2.61)		(4.71)
Mortg rate residual: < - 200 basis pts	0.010	Nominal loss in home price since purchase	0.011
	(0.72)		(1.50)
Mortg rate residual: - 150 to - 200 basis pts	0.008	High school degree (head)	-0.024
	(0.59)		(-4.34)
Mortg rate residual: - 100 to – 150 basis pts	-0.012	Some college (head)	-0.010
	(-1.15)		(-1.83)
Mortg rate residual: - 50 to – 100 basis pts	-0.007	College degree (head)	0.007
	(-0.79)		(1.19)
Mortg rate residual: 0 to – 50 basis pts	-0.006	Graduate degree (head)	0.006
	(-0.70)		(0.89)
Mortg rate residual: 0 to 50 basis pts	-0.004	Household income ($2014)	0.001
	(-0.45)		(3.96)
Mortg rate residual: 50 to 100 basis pts	-0.006	Self-employed (head)	0.003
	(-0.61)		(0.59)
Mortg rate residual: 100 to 150 basis pts	0.005	Age (head)	-0.015
	(0.40)		(-18.96)
Mortg rate residual: 150 to 200 basis pts	0.006	Age squared (head)	0.000
	(0.41)		(16.49)
Mortg rate residual: > 200 basis pts	0.023	Female (head)	0.001
	(1.72)		(0.24)
Mortg rate – 10 yr TB rate : 0 to 150 basis pts	-0.008	White or Asian (head)	0.028
	(-0.94)		(5.66)
Mortg rate – 10 yr TB rate : 150 to 300 basis pts	-0.011	Married	-0.003
	(-1.26)		(-0.69)
Mortg rate – 10 yr TB rate : 300 to 500 basis pts	-0.006	Divorced	0.049
	(-0.55)		(4.37)
Mortg rate – 10 yr TB rate : > 500 basis pts	-0.012	Like home (1 to 10 where 10 is best)	-0.003
	(-0.84)		(-2.18)
OLTV 0 to 50%	-0.019	Like neighborhood (1 to 10 where 10 is best)	-0.009
	(-3.34)		(-7.12)
OLTV 80% to 90%	0.006	School age kids present	-0.014
	(1.03)		(-3.16)
OLTV 90% to 95%	0.013	Fewer school age kids present since prior survey	0.009
	(2.12)		(1.45)
OLTV 95% to 100%	0.011	More kids present since prior survey	0.052
	(1.76)		(7.42)
OLTV not available (includes no mortgage)	-0.006	Number of rooms in the home	-0.025
	(-0.61)		(-19.86)
Home purchase price ($2014)	0.000	Multi-family structure	0.043
	(0.60)		(5.80)
% chg FHFA home price index since move-in	-0.033	Condominium	0.031
	(-8.38)		(4.13)
Observations	59,869		
R-squared	0.050		
MSA by year fixed effects	1,741		

[a] See the note in Table 4-2 for data description.

Table B-2b: Home Maintenance Regression From Table 6, Column 2
(t-ratios based on standard errors clustered at the MSA by Year level) [a]

$CLTV_{t-2}$ 80% to 100% (X_1)	0.002	Home purchase price ($2014)	0.000
	(0.32)		(-0.58)
$CLTV_{t-2}$ 100% to 120% (X_2)	-0.003	% chg FHFA price index since move-in	-0.003
	(-0.38)		(-0.91)
$CLTV_{t-2}$ > 120% (X_3)	-0.009	Primary loan: ARM	0.008
	(-0.76)		(1.90)
$X_1 * \%\Delta HPI_{t,t-2}$	0.037	Years since move into home	0.003
	(1.31)		(7.15)
$X_2 * \%\Delta HPI_{t,t-2}$	0.011	High school degree (head)	0.006
	(0.21)		(1.12)
$X_3 * \%\Delta HPI_{t,t-2}$	0.168	Some college (head)	0.031
	(2.03)		(5.69)
PTI_{t-2} 0.25 to 0.35	-0.002	College degree (head)	0.040
	(-0.51)		(7.29)
PTI_{t-2} 0.35 to 0.45	-0.019	Graduate degree (head)	0.052
	(-2.40)		(9.05)
PTI_{t-2} > 0.45	-0.025	Household income ($2014)	0.001
	(-3.81)		(5.97)
Mortg rate residual: < - 200 basis pts	0.015	Self-employed (head)	0.007
	(1.22)		(1.93)
Mortg rate residual: - 150 to - 200 basis pts	0.020	Age (head)	0.004
	(1.84)		(5.43)
Mortg rate residual: - 100 to – 150 basis pts	0.016	Age squared (head)	-0.625e-04
	(1.89)		(-9.53)
Mortg rate residual: - 50 to – 100 basis pts	0.027	Female (head)	-0.011
	(3.76)		(-3.86)
Mortg rate residual: 0 to – 50 basis pts	0.022	White or Asian (head)	0.017
	(3.28)		(4.16)
Mortg rate residual: 0 to 50 basis pts	0.015	Married	0.013
	(2.13)		(3.47)
Mortg rate residual: 50 to 100 basis pts	0.030	Divorced	-0.016
	(3.85)		(-1.66)
Mortg rate residual: 100 to 150 basis pts	0.010	Like home (1 to 10 where 10 is best)	-0.004
	(1.13)		(-3.36)
Mortg rate residual: 150 to 200 basis pts	0.017	Like neighborhood (1 to 10 where 10 is best)	-0.003
	(1.40)		(-2.88)
Mortg rate residual: > 200 basis pts	0.004	School age kids present	0.002
	(0.34)		(0.66)
OLTV 0 to 50%	0.002	Fewer school age kids present since prior survey	-0.001
	(0.47)		(-0.27)
OLTV 80% to 90%	0.008	More kids present since prior survey	0.010
	(1.80)		(1.98)
OLTV 90% to 95%	0.006	Number of rooms in the home	0.005
	(1.07)		(4.68)
OLTV 95% to 100%	0.005	Multi-family structure	-0.033
	(0.82)		(-4.99)
OLTV not available (includes no mortgage)	-0.028	Condominium	-0.085
	(-3.99)		(-11.85)
Observations	59,714		
R-squared	0.069		
MSA by year fixed effects	1,784		

[a] See the note in Table 4-2 for data description.

Table B-3: Continuous Measure of Home Maintenance
(t-stats are reported in parentheses based on clustered standard errors at the MSA-year level)[a,b]

	Maintenance Expenditure in the Past Two Years (2014$)			
	Full Sample		PTI > 25%	PTI <= 25%
	(1)	(2)	(3)	(4)
CLTV Effects				
$CLTV_{t-2}$ 80% to 100% (X_1)	-400.3	-301.2	-108.4	-331.5
	(-4.01)	(-2.43)	(-0.45)	(-2.26)
$CLTV_{t-2}$ 100% to 120% (X_2)	-340.2	-308.2	62.67	-493.3
	(-2.03)	(-1.68)	(0.19)	(-2.22)
$CLTV_{t-2}$ > 120% (X_3)	-283.7	-315.5	-89.45	-529.0
	(-1.07)	(-1.08)	(-0.20)	(-1.33)
HPI Effects				
$\%\Delta HPI_{t,t-2}$	1,678	-	-	-
	(3.85)	-	-	-
$X_1 * \%\Delta HPI_{t,t-2}$	-	-140.4	-56.34	-955.5
	-	(-0.17)	(-0.04)	(-0.95)
$X_2 * \%\Delta HPI_{t,t-2}$	-	479.4	-1,758	1,857
	-	(0.33)	(-0.83)	(0.99)
$X_3 * \%\Delta HPI_{t,t-2}$	-	3,836	2,445	4,735
	-	(1.80)	(0.96)	(1.50)
Payment-to-Income Effects				
PTI_{t-2} 0.25 to 0.35	-181.0	-219.9	512.2	-
	(-1.54)	(-1.85)	(2.77)	-
PTI_{t-2} 0.35 to 0.45	-745.6	-767.8	-218.2	-
	(-4.81)	(-4.93)	(-1.02)	-
PTI_{t-2} > 0.45	-434.7	-406.2	-	-
	(-2.89)	(-2.68)	-	-
MSA FE	128	-	-	-
Year FE	13	-	-	-
MSA by Year FE	-	1,784	1,426	1,781
Within R-Squared	0.099	0.082	0.051	0.089
Observations	59,714	59,714	9,846	49,868
Mean of Maintenance (2014 $)	5,472	5,472	5,256	5,514

[a] Samples are restricted to owner-occupied houses with households that don't move between 1 survey ahead and current survey and have MSA information, CLTV and PTI clearly identified. Dependent variable is the real expenditure on home maintenance in the past two year (in 2014 US dollars). We Winsorized this measure at the 97.5th percentile ($3,868) to reduce the influence of outlier values.
[b] Additional control variables included in the models but not shown are the interest rate residual categories, the difference between the current loan rate and the 10-year treasury rate, OLTV categories, real purchase price, percentage change in quality adjusted MSA-level house prices since move-in year based on the FHFA house price index, indicators for ARM loan, years since move-in, real family income, self-employment status, demographic control for educational background, race, gender, age, and marital status, how the household feels about the house and the neighborhood, whether the household has school-age kids present, whether they recently had more children or lost children, whether the house is a multi-family house or a condominium, number of rooms in the house.