Housing Lock: Dutch Evidence on the Impact of Negative Home Equity on Household Mobility*

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Abstract

This paper tests the "housing lock hypothesis": the conjecture that homeowners with limited or negative home equity, low levels of financial assets and restricted opportunities to borrow are unable to move. It employs unique, administrative population data on residential location, home-ownership, family structure, and household balance sheets from the Netherlands. The rapid rise in Dutch house prices during the 1995-2008 period, and their substantial decline thereafter, has generated large variation in the home equity of buyers who bought homes a few years apart. I find that buyers in the cohorts that purchased homes around the peak have higher Loan-To-Value (LTV) ratios than earlier buyers, and also have much lower mobility rates in every year after purchase. A decline in home equity, particularly with LTV ratios between 90 and 110%, is associated with large and statistically significant reductions in household mobility. The reduction in mobility is observed both within and across labor markets. The mobility effects of falling home equity are substantially larger for households with low financial asset holdings. These results emerge from comparisons of mobility rates from different purchase cohorts after removing time and region effects, as well as from an analysis of homebuyers whose purchase timing was determined by arguably exogenous changes in family structure. Since Dutch mortgages are full recourse, which rules out strategic default behavior, the findings provide new support for the "housing lock hypothesis".

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1 Introduction

Household mobility in several developed economies plummeted during the Great Recession. This coincided with the collapse of the housing and labor markets. Mobility among homeowners fell by 30% in the US and by 35% in the Netherlands. Stiglitz (2009), Krugman (2010), Katz (2010) and others have suggested that the house price crash contributed to the decline in mobility and in turn impaired the labor market. For example, Krugman (2010) wrote: "Workers are trapped in place by negative equity, and can't move to where jobs are." One account that could explain these patterns is the "housing lock" or "balance sheet channel", that was identified and studied by Stein (1995). This hypothesis recognizes that households with limited or negative home equity and low levels of financial asset holdings cannot secure the resources needed to pay off the balance on their existing mortgage and to make a downpayment on a new home. As a result, they cannot move.

Two influential recent studies investigate the relationship between home equity and mobility using American Housing Survey (AHS) data, and they reach different conclusions. While Ferreira, Gyourko and Tracy (2010) find 35% lower mobility for underwater owners, Schulhofer-Wohl (2012) detect higher mobility for underwater owners.[1] These conflicting findings as well as the mixed evidence culled from a more extensive array of the literature is largely due to the absence of a representative panel database with precise information on household mobility decisions, homeownership status and balance sheets. Scholars such as Ferreira et al. (2011) and others also emphasize the endogeneity of home equity (as housing and labor markets co-move) and the difficulty of addressing this challenge given the data limitations in the US context.

This paper aims to address the challenges of testing the housing lock hypothesis by using unique administrative data from the Netherlands, which provide information on household mobility, housing, household balance sheets and family structure. The results based on household-level data suggest large, negative effects of high LTV ratios on household mobility, both within and across labor markets. The effects of falling home equity are substantially larger for households with low financial asset holdings. These results support the "balance sheet channel". After a long boom, Dutch house prices have experienced a sharp decline since 2008, and the fraction of underwater mortgages rose from 5% in 2007 to 30% in 2013. Property transaction volumes fell by 50%, and job-to-job transitions declined by 40% over the same period, aggregate facts consistent with the housing- and job-lock hypotheses.

The unique Dutch data allow me to track the administrative addresses of households. The population addresses make it possible to define the destination of the move and to distinguish moves within and across local labor markets. Studies using the American Housing Survey (AHS) panel of properties (Ferreira et al. (2010), Schulhofer-

[1] The difference in results stems from a different definition of moving in the two studies due to the absence of person identifiers in the AHS. Ferreira et al. (2010) defines mobility as "selling property" by dropping observations where an owner-occupied house becomes vacant or occupied by renters in the subsequent survey. By including these observations the Schulhofer-Wohl (2012) definition finds 60% more "moves" including temporary moves and potentially a number of false positives (Ferreira, Gyourko and Tracy (2011)).

Wohl (2012)) cannot follow movers, while papers that use the Panel Study of Income Dynamics (PSID) (Coulson and Grieco (2013)) use only the geographic information on the state of residence, which is an imperfect proxy for the local labor market. Existing studies using survey data typically have a small number of underwater observations (125 in Henley (1998), 230 in Coulson and Grieco (2013), 1,800 in Ferreira et al. (2010) and Schulhofer-Wohl (2012)). The administrative dataset in this paper features more than 580,000 underwater person-year observations. This detailed data allows me to employ richer empirical strategies and to provide precise estimates, which I use to extrapolate the aggregate impact.

It is often argued that home equity affects household mobility through at least two channels. The balance sheet or housing lock channel suggests lower mobility rates for underwater households. On the contrary, the strategic default channel predicts higher mobility rates for underwater owners, who can simply walk away from their mortgages in markets where mortgages are non-recourse, such as in the US.[2] In the Netherlands, mortgages are full recourse, as borrowers are liable for the remaining balance after a property's sale. In this full-recourse setting, the quasi-absence of defaults permits me to isolate the housing lock channel and shut down the strategic default channel.

The empirical strategy in this paper exploits the rapid rise in house prices during the period 1995-2008, as well as their substantial decline thereafter, which has generated large variation in the home equity of buyers who bought homes only a few years apart. Buyers in the cohorts that purchased homes around the peak have higher Loan-To-Value (LTV) ratios than do their peers who bought homes just a few years earlier. Consistent with the housing lock hypothesis, these peak cohorts also have much lower mobility rates in every year after purchase than do the earlier buyers. For instance, the cumulative fraction of the cohort that has moved within 4 years after purchase is 45% lower for the 2007 purchase cohort than for the 2004 purchase cohort. To address the possibility that these cohort patterns reflect that house prices decline precisely when labor markets and employment opportunities deteriorate, my empirical model eliminates local business-cycle effects. I estimate the effects of LTV ratios on mobility in a model that includes fixed effects for the interaction between the calendar year and the region.

This variation in home equity across purchase cohorts would be ideal if home purchases were randomly timed. However, changes in the credit market or in entry into homeownership over time may lead to the sorting of different mobility types into different purchase cohorts. To overcome this concern, I develop a more refined test focusing on life-events, such as divorces and cohabiting-couple splits, that exogenously shift purchase dates and make for quasi-exogenous variation in the LTV ratio of the new home after the split. I first show that divorce rates in the Netherlands are relatively unaffected by the state of labor and housing markets and the broader economy. I then demonstrate that home-purchase decisions are much more likely to take place in the year of divorce. Comparing the subsequent mobility of recent divorcees, who purchase homes at different points of the housing price cycle, confirms

[2] The correlation between defaults, foreclosures and mobility in the US is large but not perfect (Molloy and Shan (2014)). Households can rent the home back after a forced sale or, if they are sufficiently liquid, sell the home and move to avoid the costs of default.

the large housing lock effects associated with high LTV ratios.

This paper robustly finds that high LTV ratios are associated with reduced mobility. In a flexible estimation of the effect of the LTV ratio on mobility, I uncover a non-linear but monotone pattern of mobility, which declines in the LTV ratio. An LTV ratio of between 100 and 110% is associated with a mobility rate that is 22% lower than a LTV ratio of between 50 and 90%. Consistent with Stein (1995)'s model featuring positive moving or downpayment costs, LTV ratios between 90 and 100% also hamper mobility, but the effect is smaller and amounts to 5%. When I study household mobility across local labor markets, I find negative effects of high LTV ratios of similar magnitude.

Stein (1995)'s balance sheet model also predicts that high LTV ratios hamper mobility more severely for households with low Financial-Assets-To-Value ratios. I uncover compelling evidence for this prediction. A LTV ratio above 110 is associated with a large decline in mobility of 40% for owners with Financial-Assets-To-Value ratios below 15%. In contrast, high Financial-Assets-To-Value holdings above 35% allow households to "unlock the housing lock", as their mobility is not significantly altered by high LTV ratios. Tightening the link between the Stein (1995) balance sheet theory and the empirical models further, I then show that total net liquid assets after a potential house sale, defined as the sum of home equity and household liquid financial asset holdings, have larger predictive power than LTV ratios alone in explaining the housing lock. This last finding highlights the importance of an integrated view of household balance sheets in understanding household mobility.

In a battery of robustness tests, I show that the housing lock finding is resilient to the elimination of variation across purchase cohorts when I exploit regional variation in house price trajectories and LTV ratios within purchase cohorts. The results are also remarkably insensitive to excluding the Great Recession purchase cohorts as well as to using alternative definitions of household mobility and local labor markets.

This paper concludes by simulating the partial equilibrium effects of counterfactual house price- and borrowing trajectories on household mobility. I use the estimates of the effects of LTV ratios on mobility as well as micro-data to demonstrate that the effect of the housing lock during recessions on total owner-occupied mobility can be substantial. These indicative simulations, which rely on a series of assumptions, suggest a contribution of the housing lock to the total decline in Dutch owner-occupied mobility during the Great Recession of 20 to 25%. Given the highly non-linear effects of LTV ratios on mobility, I find that relatively small shocks to house prices or borrowing levels can have large effects on aggregate mobility.

1.1 Related literature

An extensive literature from Kain (1968) to Andersson, Haltiwanger, Kutzbach, Pollakowski and Weinberg (2014) discusses the aggregate employment effects of spatial mismatches between supply and demand for work. Labor mobility across regions can allow the adjustment of employment and wages to negative local labor demand shocks, as the departure of workers reduces local labor supply (Blanchard and Katz (1992)). According to the Oswald (1997) hypothesis, high home-ownership rates increase the natural unemployment rate as home-owners are less able to simply move away in response to labor demand shocks. In an integrated view of labor and goods markets, the migration of workers-consumers out of depressed regions may also aid those who stay behind if the demand shortfall occurs in the tradable sector (Farhi and Werning (2014)). The insurance value of migration against local labor demand shocks depends on moving costs as well as on the access of moving workers to employment opportunities in well-performing regions (Yagan (2014)). As unemployed homeowners may turn down job offers that would require them to move, the decline in house prices and home equity and the associated reduction in geographical mobility could increase unemployment for a given level of vacancies (Sterk (2012)). The robust finding in this paper that lost home equity hampers mobility across local labor markets highlights the potential macroeconomic importance of the housing lock channel.

The relationship between home equity and mobility has been investigated in a prior literature, which arrives at mixed conclusions. This research uses either aggregate data or relatively small panel surveys of properties or households. On the one hand, Henley (1998), Chan (2001) and Ferreira et al. (2010) find an adverse impact of negative home equity on mobility using, respectively, British Household Panel Survey (BHPS) 1992-1994 data, prepayment data on loans originated in the Northeast of the US in the early 90s, and 1985-2007 data on properties from the AHS. On the other hand, Schulhofer-Wohl (2012) and Coulson and Grieco (2013) find that underwater owners move more through using the AHS and the 2001, 2005 and 2007 PSID data, respectively. A parallel line of inquiry uses aggregate data. Donovan and Schnure (2011) exploits the American Community Survey (ACS) and concludes that negative equity reduces intra-county migration but leaves out-of-state migration unaffected. Molloy, Smith and Wozniak (2011) finds no correlation between the 2006-2009 change in state-level migration and negative equity shares using the Census and Current Population Survey (CPS). Nenov (2012) employs state level Internal Revenue Service (IRS) and Corelogic data and finds that negative equity reduces in-migration rates, but has no impact on out-migration. To address the data availability and measurement challenges in this literature, this paper uses administrative population data on household mobility and household balance sheets for the Netherlands.

Researchers have investigated several mechanisms linking house prices and household mobility. First, the models in Stein (1995) and Ortalo-Magne and Rady (2006) suggest a critical role for household balance sheets and credit market imperfections in explaining the decline in transactions when house prices decline. A second line of inquiry investigates the effects of nominal loss aversion on residential mobility (Genesove and Mayer (2001), Engelhardt (2003), Annenberg (2011)). Focusing on condominiums in Boston in the 1990s, Genesove and Mayer (2001) find that owners subject to nominal losses set and attain higher prices prices and are less likely to sell than other sellers. The impact of negative home equity on strategic defaults and associated moves constitutes the third channel. Ghent and Kudlyak (2011) demonstrate that this channel is relevant in non-recourse mortgage markets, such as the US, in particular when the recovery rate is relatively low. In an application of option theory, Deng, Quigley and Order (2000) construct a model where no-recourse borrowers default when home equity becomes sufficiently negative. The level of negative home equity that triggers default depends on the realization of income shocks (Bhutta, Dokko and Shan (2010)) and on the importance of borrowing constraints (Campbell and Cocco (2014)). By demonstrating the importance of household financial asset holdings, this paper supports the Stein (1995) balance sheet channel.

This study fits into the expanding international household finance literature (IMF (2011), Lea (2011), Campbell, Ramadorai and Ranish (2014), Badarinza, Campbell and Ramadorai (2014)). The structure of housing finance varies considerably across countries. The high Dutch mortgage levels *ex ante* and the absence of strategic defaults *ex post* make the Netherlands particularly suitable to study the balance sheet channel. However, the finding of substantial housing lock when house prices fall and home equity declines must be recognized as conditional on the housing and mortgage institutions in the Netherlands, which therefore affect the transmission of house price shocks to household mobility and the macroeconomy.

This paper also contributes to the literature on the role of household balance sheet heterogeneity and liquidity constraints for household behavior and for the aggregate economy. Several studies have rejected the Modigliani-Miller prediction that household net worth is irrelevant for the response to financial shocks of consumption (Mian, Rao and Sufi (2013), Baker (2014)), debt repayments (Agarwal, Liu and Souleles (2007)) or small business creation (Adelino, Schoar and Severino (2013)). Focusing on another critical household outcome variable, this paper complements these studies by demonstrating the importance of balance sheet factors and liquidity constraints for residential mobility.

This paper is organized as follows. Section 2 describes aggregate Dutch mobility and house price patterns in the Great Recession and variation in home equity and mobility across purchase cohorts. Section 3 lays out the empirical strategy. Section 4 describes the institutions and the data. Section 5 first reports the results based on house price trajectory variation across purchase cohorts, then estimates the balance sheet effects and finally presents the estimates for the life-event buyers. Section 6 performs robustness checks. Section 7 simulates mobility under alternative trajectories for house prices and borrowing. Section 8 concludes.

2 Aggregate House Price and Mobility Patterns

This section presents aggregate information on Dutch housing mobility and pricing trends. As a starting point for analyzing house prices and mobility, Figure 1 presents the moving behavior of owners and renters over time using 7 waves of the Dutch housing survey. In the period 2009-2011, the mobility of homeowners declined by approximately 35%. Consistent with the housing lock hypothesis, the mobility of owners drops much more than the mobility of renters when house prices decline. Consistent with the Stein (1995) hypothesis of binding constraints on moving, the fraction of homeowners that would like to move rises by 30%, while moving intentions of renters are flat (see Appendix Figure A.1). Both the large decline in household mobility as well as the rise in mobility intentions are thus concentrated among home-owners.[3]

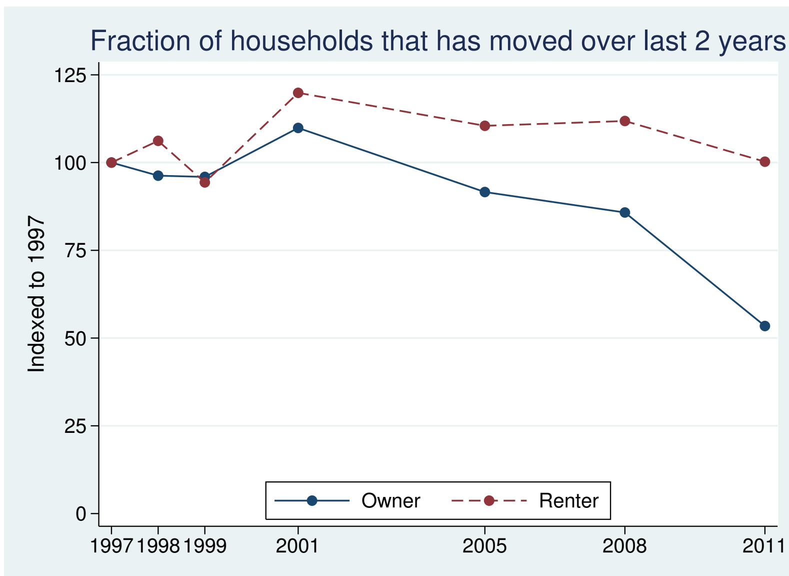


Figure 1: Mobility of owners and renters over time

Notes: The data are from the WBO 1998, 1999, 2000 and WoON 2002, 2006, 2009 and 2012 surveys. WoON (WoonOnderzoek Nederland) is a repeated, cross-sectional, nationally representative survey of about 70,000 individuals about their housing situations known as WBO (WoningBehoefteOnderzoek) until 2000.

Figure 2 presents house price trends for the Netherlands and the United States. It shows the long boom of Dutch house prices which rose faster than in the US from the 1995 starting point. Aggregate Dutch house prices continued to increase in 2007 and in the first half of 2008 and then began to decline from the fourth quarter of 2008 onwards until mid 2013. The cumulative decline of national nominal house prices from the peak to the trough equals 20%.

[3]Both patterns are robust to restricting the sample to households with similar observables predictive of ownership.

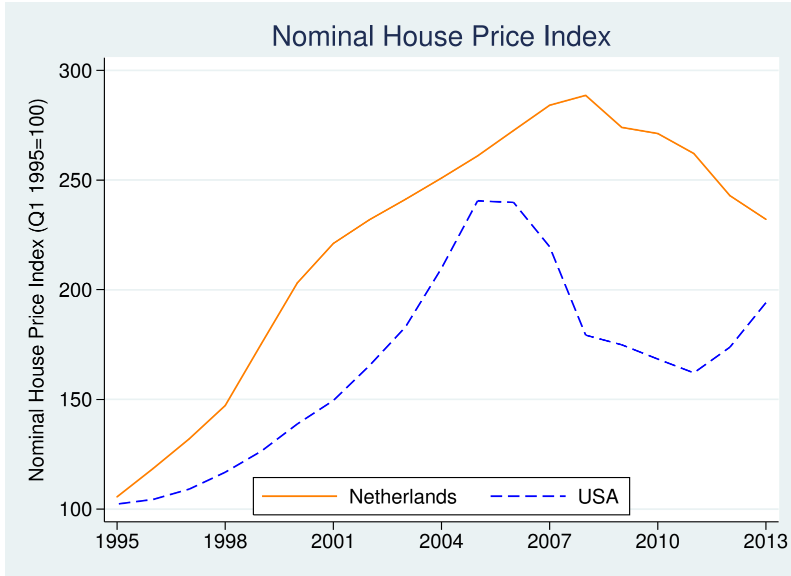


Figure 2: Nominal house price index for the US and the Netherlands

Notes: The source is the *The Economist* house price index which uses data from FHFA, OECD, S&P, Thomson Reuters, CBS and NVM.

Home equity and mobility patterns across purchase cohorts. I now turn to the graphical presentation of the main empirical strategy in this paper, which exploits variation in home equity across buyer purchase cohorts. Figure 3 visualizes the differential effect of house prices on purchase cohorts by plotting the share of underwater mortgages of each purchase cohort of borrowers over time. Rising house prices until the end of 2008 increased the denominator of the LTV ratio and reduced the LTV ratio as well as the share of loans underwater for the early cohorts. When house prices declined, the LTV ratio and the fraction of mortgages with high LTV ratios rose for all the cohorts. There is one important difference between cohorts that bought several years before the peak such as the 2002 cohort and cohorts that buy closer to the peak such as the 2007 cohort. The earlier cohorts have benefited from several years of rising house prices. The cumulative house price appreciation increased the denominator of the LTV ratio and reduced the LTV ratio for earlier cohorts.[4] The differential exposure to the rise in house prices has also generated substantial variation across purchase cohorts in the share of mortgages above 90, as shown in Appendix Figure A.2. As the earlier purchase cohorts had substantially lower LTV ratios, the housing lock hypothesis suggests that these cohorts were less locked-in and moved more.

[4]Dutch mortgages amortize less than mortgages in most other countries. The accumulation of capital by early borrowers in the form of savings deposits or life insurances on associated accounts over a longer horizon also reduced the LTV ratio of the early cohorts more relative to later cohorts but is quantitatively less important. Finally, rising LTV ratios at origination may also have contributed to the pattern of high current LTV ratios for late cohorts.

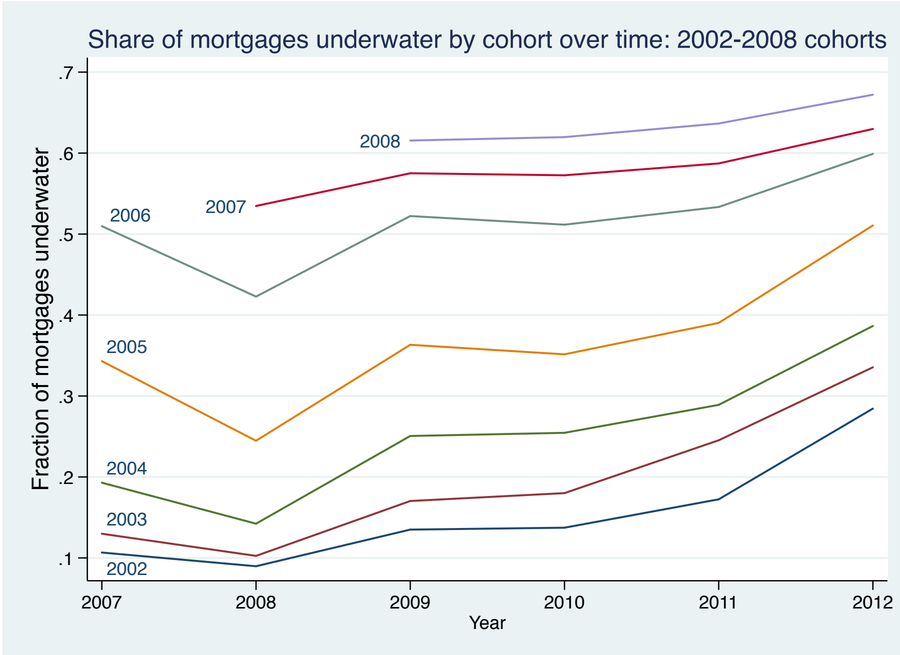
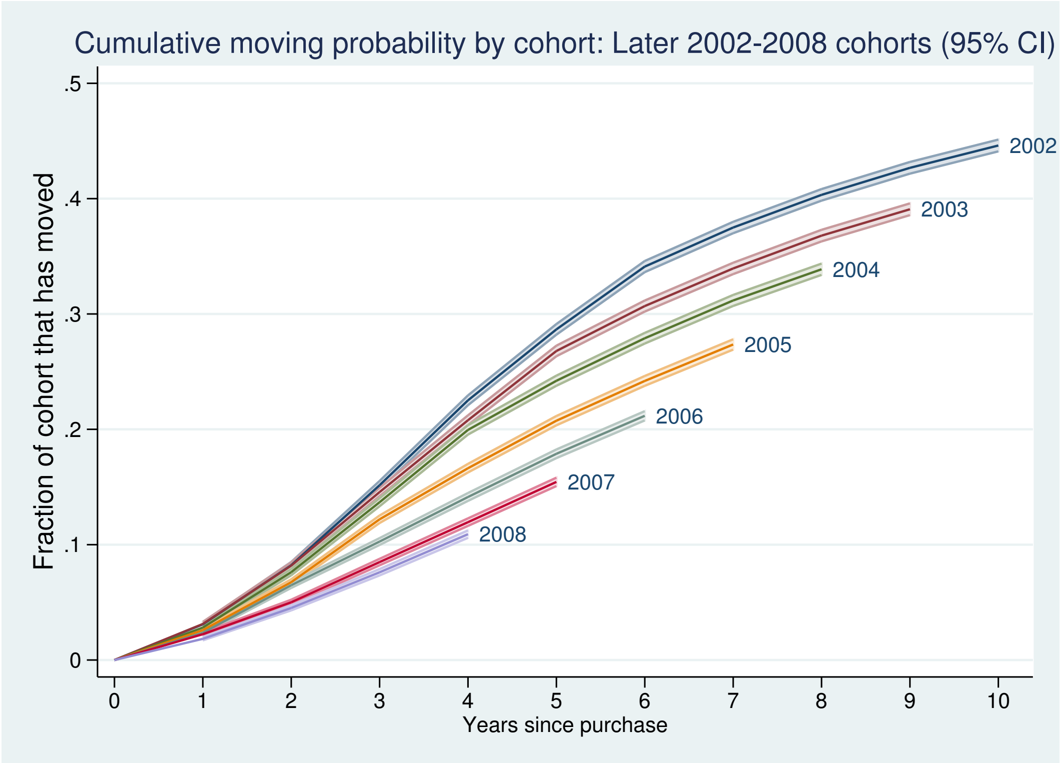


Figure 3: Fraction of mortgages underwater by purchase cohort over time

Notes: The share of mortgages underwater within a purchase cohort by year is based on CBS household balance sheet, transaction price and regional house price index data. See section 4 of the text for more details.

The top panel of Figure 4 presents the cumulative fraction of the purchase cohorts that has moved against the years since purchase for the 2002 until 2008 purchase cohorts. The closer individuals buy to the peak, the less they have subsequently moved out of their home within any number of years since purchase. The differences in mobility across cohorts are large and monotonic as predicted by the monotonic exposure to rising house prices in the run-up. For instance, within five years since purchase, 30% of the 2002 buyers have moved, in contrast to 15% of the 2007 buyers. The average household mobility rates of the various purchase cohorts are also very precisely estimated. While the home equity and mobility cohort patterns are consistent with the housing lock, one alternative explanation might be that cumulative moving patterns would have been unstable across cohorts in the absence of the negative shock to house prices. To investigate this explanation, the bottom panel of Figure 4 presents the cumulative moving patterns for the earlier 1996 until 2001 cohorts before the negative realization of house prices. During this period, the relationship between the cumulative moving probability and the years since purchase was remarkably stable across these placebo cohorts, in sharp contrast to the pronounced pattern in the top panel of Figure 4. Prices in the run-up did not increase at a constant rate. Hence, variation in mostly low LTV ratios also exists across the placebo purchase cohorts. The identical moving behavior of the placebo cohorts in the bottom panel is a foreshadowing of the asymmetric response of mobility to low and high LTV ratios, which this paper will demonstrate. Another alternative explanation is the sorting of low and high mobility types into different purchase cohorts. To overcome this concern, I will use life-events as shifters of purchase dates. Overall, the home equity and mobility patterns from Figures 3 and 4 provide compelling, suggestive evidence of the housing lock.



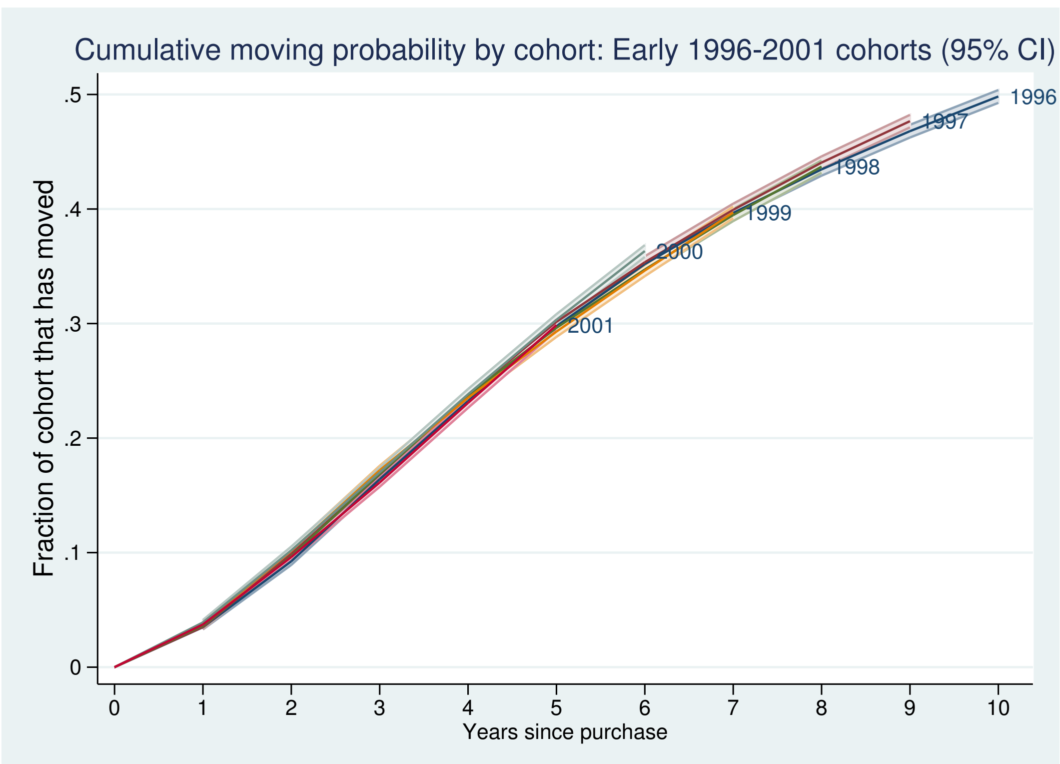


Figure 4: Mobility of purchase cohorts given the years since purchase

Notes: The top panel presents average cumulative moving probabilities and 95% confidence intervals for the "treated" later 2002-2008 cohorts, which are differentially exposed to declining house prices. For instance, while the 2008 cohort has only been exposed to declining prices, the 2002 cohort has benefited from 6 years of positive house price growth. The bottom panel presents cumulative moving probabilities and 95% confidence intervals for the placebo cohorts. The early 1996-2001 cohorts are placebo cohorts, as they all benefited only from rising house prices over the 1996-2006 calendar-year period (shown in the bottom panel), which reduced their LTV ratios to low levels. The moving data are based on the Transactions Registry and the Address Registry from Statisistics Netherlands (CBS). See section 4 of the text for more details.

Figure 4 compares the mobility of different purchase cohorts, holding the years since purchase constant, in *de facto* different calendar years. As mobility can vary over time for reasons other than the housing lock, my econometric analysis will compare different purchase cohorts in the same calendar year by including time fixed effects, for which Figure 5 provides intuition. The red curve plots the differential cumulative fraction that has moved since the end of 2008 by purchase cohort, for 2004 and 2007 buyers who did not move until the end of 2008. Over the period 2008-2012, the low-leverage 2004 purchase cohort moves significantly more than the high-leverage 2007 purchase cohort. In 2012, the loan age year of the 2004 purchase cohort was 8 (and 5 for the 2007 purchase cohort). The large 2004-2007 mobility gap, considered in isolation, may in principle be due both to the differential housing lock exposure and to the loan age effect. To investigate the latter, the differential cumulative moving fraction is plotted for the 1997 and 2000 cohorts in the same loan age space. The 1997-2000 differential mobility was much smaller than the 2004-2007 difference and even became negative. Relying on the 1995-2011 purchase cohorts, including those unaffected by the house price drop such as the 1997 and 2000 cohorts, I am thus able to rule out the loan age effect explanation and retain the housing lock as the most compelling explanation for the cohort patterns. The next section formalizes the empirical strategy.

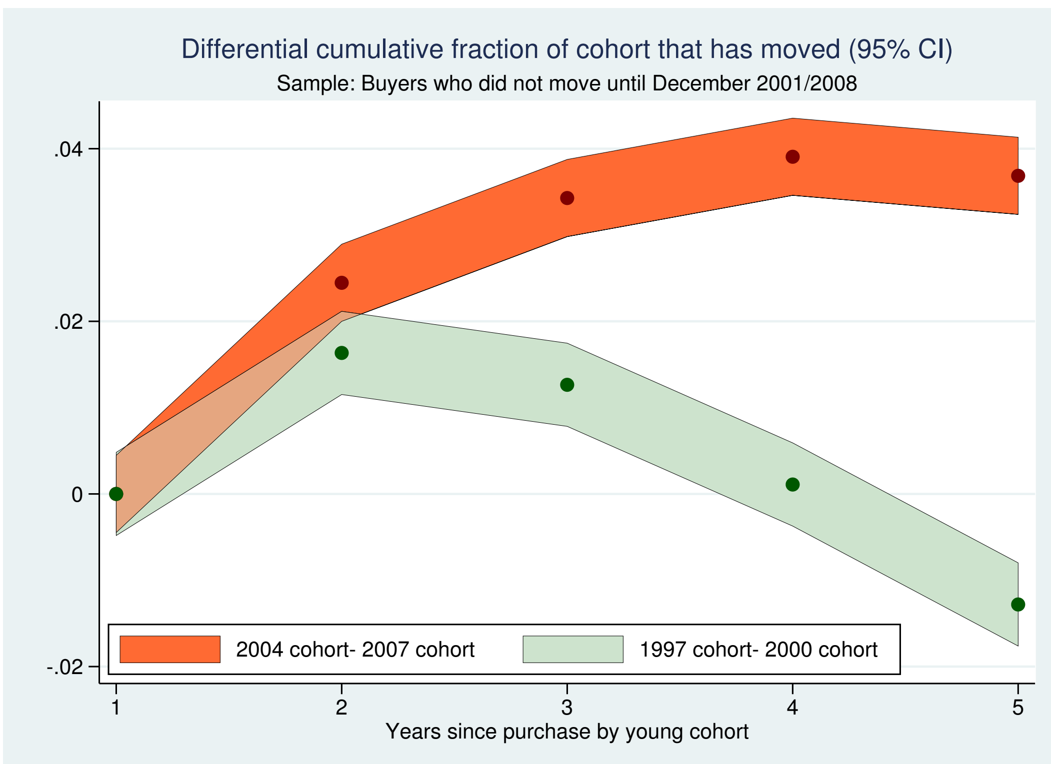


Figure 5: Mobility of cohorts fixing the calendar year

Notes: The moving data are based on the Transactions- and Address Registries from Statisistics Netherlands (CBS). See See section 4 of the text for more details.

3 Empirical Strategy

The main strategy to identify the impact of the housing lock on hmobility is to exploit the differential effect of house prices on LTV ratios of different purchase cohorts. The unit of observation is a buyer-year for buyer i in calendar year t. A buyer-year always belongs to a purchase cohort year c and a region r where he/she lives in a property from January 1st of the year t. For this buyer-year, who has not moved until year t from a given home, I code an annual mobility indicator y_{icrt} equal to 1 when the buyer moves in year t. Consider the following model of the relationship between the mobility indicator y_{icrt} and indicator variables for different LTV ratio categories $\mathbf{1}\left[l_k < LTV_{it} \leq h_k\right]$:

$$y_{icrt} = \lambda_{tr} + \sum_{k} \delta_{1k} \mathbf{1}\left[l_k < LTV_{icrt} \leq h_k\right] + X_{it}^{'}\beta + \epsilon_{icrt} \qquad (1)$$

The parameters of interest in equation (1) are the coefficients δ_{1k}, which flexibly measure the effect of the LTV ratio on moving probability. Equation (1) features a rich set of covariates $X_{it}^{'}$ to control for the multiple factors determining moving risk. Households typically move into a new home, either for a job, for family reasons, or to match their housing consumption with their expected income and preferences. The controls comprise 5 person age category fixed effects, 5 household size fixed effects, family structure characteristics, indicators for changes in the family size as well as 3 household financial assets category fixed effects. I also include loan age year indicators $\sum_a \mathbf{1}\left[a = t - c\right]$, since the empirical moving rate depends on the length of time a that individual i has lived in that home.[5] Intuitively, both very recent owners and historical owners are unlikely to move in a given year, with the rate being higher between these two low-moving probability regions.

Regarding job and income motives for moving, the identification challenge is that labor and housing markets co-move. Shocks to regional labor demand can affect both unobservable job opportunities in the error term ϵ_{icrt} as well as house price appreciation $\frac{V_{it}}{V_{ior}}$, which is a critical factor in the LTV ratio (together with the LTV ratio at origination and the current to original loan balance). The specification in equation (1) includes fixed effects λ_{tr} for the interaction between the region r and calendar year t. These fixed effects account flexibly for regional labor market incentives to move out, regional new income opportunities, and regional time-varying future income prospects, which may motivate moves to trade-up homes. The regression estimates δ_{1k} correspond to the causal effect of the LTV ratio category on mobility if the conditional independence assumption is verified. The conditional independence assumption implies that, conditional on observables X_{it} and region-time interactions, potential mobility rates $y_i(k)$ at which individual i would move, are independent from LTV ratio categories k. The housing lock hypothesis predicts that the coefficients δ_{1k} will decline in the LTV ratio for ratios close to and above the 100% threshold.

[5] Previous studies typically allow for less flexibility including one up to three polynomials of the loan age.

I will test predictions of the Stein (1995) balance sheet mechanism by analyzing the role of household liquidity in section 5.2. First, I will estimate equation (1) for subsamples of household-years as a function of the Financial-Assets-To-Value ratio. I then study the effect of the net liquid assets after a potential house sale, the sum of home equity and financial assets, on mobility. I will thus exploit variation across purchase cohorts in Net Liquid Assets after a potential house sale (NLAS) by estimating the following model:

$$y_{icrt} = \lambda_{tr} + \sum_j \delta_{2j}\mathbf{1}\left[l_j < NLAS_{icrt} \leq h_j\right] + X_{it}^{'}\beta + \epsilon_{icrt} \tag{2}$$

The Stein (1995) balance sheet hypothesis leads to two predictions. First, high LTV ratios should hamper mobility more for households with low Financial Assets-To-Value ratios (i.e. those households feature lower coeffficients δ_{1k} in the critical LTV region). Second, the marginal effect of extra liquidity on mobility should be large and positive in regions where the liquidity constraint binds for many households (i.e. the coefficients δ_{2j} should rise quickly in the NLAS value in the critical region).

To address the possibility that property buyers near the peak were somehow different from those who bought homes at other times, Section 5.3 examines the post-purchase mobility patterns of individuals who were part of married couples that divorced, or cohabiting couples who split up, in various years. Such family structure shocks are a valuable source of arguably exogenous variation in when individuals purchase homes, as the Dutch split rates are very stable over time. In practice, I restrict the estimation of equation (1) to the subsample of life-event buyers, who start their period of ownership in a given year because of a divorce or a cohabitation split.

While equations (1) and (2) shut down all variation over time and across regions and are identfied based on the remaining variation, they, however, do not include fixed effects λ_{tc} for the interaction between the calendar year t and the purchase cohort year c, as I want to exploit variation in LTV ratios across different purchase cohorts. To account for the potential endogeneity of the purchase date, section 5.4 performs within cohort-year comparisons of buyers across different regions and exploits variation in regional house prices. I thus deal with the potential sorting of low and high mobility types for a given LTV ratio into different purchase cohorts. Sorting may, for instance, occur if credit market conditions change over time. Alternatively, financially less sophisticated buyers may be less likely to anticipate the bust, more likely to buy closer to the peak, and may also be more likely to be laid off and forced to move during a crisis. To overcome these potential concerns, I thus include fixed effects λ_{tc} for the interaction between the calendar year t and the purchase cohort year c and estimate the following linear probability model:

$$y_{icrt} = \lambda_{tc} + \sum_k \delta_{3k}\mathbf{1}\left[l_k < LTV_{icrt} \leq h_k\right] + X_{it}^{'}\beta + \epsilon_{icrt} \tag{3}$$

4 Institutional Setting and Data

Mortgage, housing and labor market institutions. With high LTV ratios at origination and limited amortization, the current Dutch residential mortgage-to-GDP ratio of approximately 120% is the highest in the world, which is approximately 45 percentage points higher than in the US, as shown in Appendix Figure A.3. LTV ratios at origination around 100 or even slightly above 100% are not unusual in the Netherlands. In the latter case, the loan proceeds can finance the entire purchase price of the house, transaction costs such as the 6% stamp duty (reduced to 2% in July 2011) or home improvements. High LTV mortgages are originated in an environment that provides relatively low incentives to default at a given LTV ratio, as lenders have full recourse. Therefore the defaulting borrower is personally liable for the remaining mortgage balance after a property sale. If the lender forecloses the property and the borrower cannot repay, the borrower faces the risk of personal bankruptcy. When entering this debt consolidation scheme, the debtor has to exert a maximum effort to generate funds to repay his creditors in a period of three years and limit consumption to the subsistence level. Lender recourse, priority of mortgages in bankruptcy and high recovery rates reduce incentives for borrowers to default strategically (Ghent and Kudlyak (2011)). Dutch foreclosure rates are equal to approximately 1% of US rates. The share of the housing stock going into foreclosure in 2010 was equal to 0.03% in the Netherlands and 2.23% in the US (RealtyTrac (2014)).

The vast majority of mortgages for the 1995-2011 purchase cohorts that I study are non-amortizing. Bullet loans are frequently combined with associated, pledged accounts where capital is built up in the form of savings deposits, life insurance or investment funds. Mortgage contracts often combine multiple loans with different repayment types, for instance a plain vanilla bullet loan, combined with a second bullet loan with an associated savings deposit account. Contracts with associated tax-exempt accounts allow borrowers to build up capital while maximizing the unlimited deduction of interest payments on the constant loan balance.[6] As owner-occupied homes are considered a source of income, an imputed rental income of 0.6% of the value of the house is included in taxable income. Relative to the US, both relatively high marginal tax rates on personal income, that rise from 36 to 42% at €19,646 of taxable income and to 52% at €56,532 of taxable income[7] and the absence of the itemizing precondition for claiming the deduction, increase the economic importance of the deduction. The typical mortgage features a maturity of 30 years and an interest rate that is fixed for 10 years and then periodically reset.

How can a household relocate if the full recourse mortgage is underwater in the Netherlands? To come up with the cash to cover the shortfall in funds to pay off the mortgage balance, there are three options. First, the household can reimburse the shortfall out of its own savings or savings in the family system.[8] Second, the household can borrow the shortfall through an unsecured, personal loan. Third, in principle, the household could carry over the shortfall to a new mortgage. Carrying over negative equity constitutes in theory an exceptional circumstance

[6] As of January 2013, new mortgages have to fully amortize to benefit from interest tax deduction.

[7] The maximum rate for interest deduction has been reduced gradually since 2014 from 52% to 38% by 50 basis points a year.

[8] A parent can give his/her child under age forty a one-off tax exempt gift of €51,407 to buy a home or amortize the mortgage.

that allows mortgages to exceed the norm on maximum LTV ratios at origination from the Code of Conduct for Mortgages (CCM), that is equal to 106% in 2012. However, survey evidence suggests that this third option is rarely pursued in practice (Conijn and Schilder (2012)) and that mortgages are hence *de facto* not assumable, a key credit market friction in the Stein (1995) model.[9]

The homeownership rate in the Netherlands is 60%. With estimated times until half of the buyers move from their homes of around 12 to 13 years, the mobility of Dutch homeowners is comparable to US levels (Emrath (2009)). The government plays an important role in the rental market, which is subject to rent controls and which makes up 80% of public housing. In the European Union the Netherlands is classified as a high-geographical and high-job-mobility country, together with the UK, the Scandinavian and Baltic states (Vandenbrande, Coppin and Van der Hallen (2006)). The average Dutch job duration is approximately 6 years compared to 8 years in the EU with shorter durations only for Denmark, the UK, Latvia and Lithuania.

Panel data on buyers. The sample consists of a large, random sample of buyers of owner-occupied existing homes who are the unique heads of household when they move in.[10] Appendix Figure A.4 visualizes the construction of the panel of buying heads of existing homes. The sample of 549,066 buyers have moved into their purchased properties in the cohort years 1995-2011. The econometric analysis of the impact of home equity relies on a 2007-2012 panel that includes household balance sheet information on the subsample of buyers who had not moved out of their properties before 2007. The graphical analysis of mobility patterns relies on a 1995-2012 panel, which follows all the 549,066 buyers prior, during and after their residence spell in the selected purchased home, exploiting 17 years of address data for the population. I construct the panel using several administrative datasets from Statistics Netherlands (CBS). The datasets are the transactions of the existing purchase dwellings Registry (*Bestaande Koopwoningen*), the universes of individual address- (*Adresbus*) and family structure (*Huishoudensbus*) spells, the household balance sheets (*Integraal Vermogen*) and the population socio-demographic characteristics (*Persoontab*). I now summarize the selection of transactions, the construction of the buyers panel and the variable definitions.

First, I select a random 25% of the 1995-2011 transactions of existing homes from the Transactions Registry, given CBS server memory constraints. From the obtained 747,554 house purchases, which have an address and a purchase date as identifiers, I match 630,947 purchases to the address spell of at least one individual/encrypted Social Security Number (SSN) moving into the address in the quarter of purchase, the subsequent quarter or two quarters after the purchase. When multiple individuals move to the property, I use the household head dummy

[9]Only 15% of the mortgage requests from households with negative equity are passed along by mortgage brokers to lenders, who reject 69% of the received requests. More than two-thirds of the mortgage brokers report that the maximum amont of negative equity that can be carried over for a house purchase of €235,000 by a household with sufficient income is lower than €5,000 (Conijn and Schilder (2012)). LTI norms from the CCM, which cap charges (including the cost of carry-over debt which is deductible for 10 years) given income, contribute to the rare nature of negative equity carry-overs (Conijn and Schilder (2013a), de Vries (2014)).

[10]As the Transactions Registry records the transactions of existing homes (on average 180,000 per year) as opposed to the construction of new homes (on average approximately 60,000 per year), the Registry covers approximately 75% of the moves into owner-occupied homes.

from the household spell Registry, which has a SSN-household spell as its unit of observation. To keep things simple and non-arbitrary, I focus on transactions for which I identify one household head that moves in. From the initial 747,554 purchases, I obtain 574,337 purchases (76.83%) by one head. These 574,337 matched transactions correspond to 549,066 distinct individuals, as some buyers purchase multiple selected properties. I then add the month and year of birth, gender and origin of the 549,066 selected buyers from the Person Registry.

Second, I construct a 1995-2012 panel for the 549,066 buyers with 9,883,188 person-years tracking mobility and controls over time. I record the addresses on December 31st for each person-year from the Address Spell Registry. The models of owner mobility and home equity are estimated in 2007-2012 for the approximately 1,950,000 person-years with balance sheet data and where the buyer lives in the selected property on January 1st. The graphical owner-occupied mobility analysis relies on the 3,780,00 person-years in 1996-2012 where the buyer lived in the selected property on January 1st. I also record addresses prior to and after spells from 1995 to 2012 to define moves across local labor markets. From the Household Spell Registry, I obtain variables such as the household size, the type of household (e.g. married without children) as well as the position of the individual in the household (e.g. partner in married couple without children). These household structure variables allow me to define shocks to family structure and home purchase dates. I then add for the address-years the associated province, the local labor market and the municipality. The Netherlands consists of 12 provinces, 40 so-called COROP local labor markets and approximately 415 municipalities.[11] The COROP local labor markets are areas with a core centre and a surrounding catchment commuting zone defined such that the working population and employment in each area overlap for at least 70%. As the COROP local labor markets are time-consistent and cover the entire country, Commuting Zones (CSs) (Tolbert and Sizer (1996), Autor and Dorn (2013)) rather than Metropolitan Statistical Areas (MSAs) constitute the US analogue. The data Appendix B provides further details on the construction of the buyer panel dataset. I will now define and present summary statistics for buyer variables.

An individual is considered to have moved in a given year when the addresses on December 31st of that year and on December 31st of the previous year differ and is considered not to have moved when they remain the same. The moving dummy is recorded as missing when either of the two addresses is missing.[12] For a given ownership spell of a buyer, the cohort year is defined as the year prior to the first year in which the buyer lived at the selected address on January 1st. The loan age year is the calendar year minus the cohort year. For instance, if a buyer purchased a house in March 2002 and moved in in May 2002 and moved out in October 2005, then the cohort is equal to 2002 in the years 2003, 2004 and 2005. The annual mobility model is estimated for this buyer-address in 2003 (0), 2004 (0) and 2005 (1) with loan age years equal to 1 in 2003, 2 in 2004 and 3 in 2005. The current Loan-To-Value ratio

[11] COROP is the abbreviation of the commission that defined the local labor markets: Coördinatie Commissie Regionaal OnderzoeksProgramma. I use the *Gemeente Wijk Buurt* address-municipality and the *Gebieden In Nederlanden* municipality-province-COROP linkage files.

[12] Among the 3,810,114 spell person-years respectively 0.70 and 0.76% of of the observations have a missing mobility indicator and a missing inter labor market mobility indicator.

in a given year is the ratio between the assessed net mortgage balance on the primary residential property where the person lives at the beginning of the year and the estimated market value of the property. The mortgage balance is net of estimated capital built up in associated mortgage savings or investment accounts.[13] The current market value of the property is estimated using the administrative purchase price multiplied by the appreciation of the CBS provincial house price index. I trim the data by coding the LTV ratio as missing for values below zero or above 150, which leaves more than 97% of the buyer-years in the estimation sample. I will report that the results are very similar when keeping the trimmed observations in the sample. The indicator for negative home equity is equal to one when the current LTV ratio is larger than 100%. Household financial asset holdings include the amounts in checkings and savings accounts and the values of equity and bond holdings. I define the Financial-Assets-To-Value (FATV) ratio as the ratio between household financial asset holdings and the estimated market value of the property. Net liquid assets after a potential house sale are defined as the sum of home equity and household financial assets. I define individuals with the position of partner in a married couple as married. A person is defined to belong to a cohabiting couple when he or she has the position of partner in a cohabiting couple. Partners in a cohabiting couple need to be a real couple and do not include, for instance, roommates or two siblings living together as the "position in the household" variable would be equal to "single" for roommates or "other member of the household" for two siblings living together. A person is newly divorced when the person was married last year but is not married this year. A person loses his or her status as a partner in a cohabiting couple when he or she was part of a cohabiting couple last year but not this year.

Table 1 presents descriptive statistics for buyers. The top panel presents mobility rates for all buyer-years in the 1995-2012 panel. The average mobility rate is 5.31 percentage points, of which approximately 26% are moves across labor markets. The middle panel presents summary statistics for the 2007-2012 panel of buyers with balance sheet data. The average mobility rate is equal to 4.31 percentage points of which, again, 26% are moves across labor markets. The average and median LTV are respectively equal to 75 and 81%. The LTV ratio is below 50 for 25% of the observations, between 50 and 90 for 33% of the buyer-years and between 90 and 100 for 12% of the observations. 12% of the buyer-years have a LTV ratio between 100 and 110 while 17% of the observations feature a LTV ratio between 110 and 150. 30% of the person-years thus have negative home equity. The mean home equity amounts to €74,000, while the median equals €41,000. Among the owners with negative home equity, the average home equity is - €29,000. 7% of the owners have zero outstanding mortgage balance. Financial asset holdings are on average equal to €77,000, while the median of €17,000 is significantly smaller. The bottom 37% of the households own less than €10,000 of financial assets, and the top 36% have financial asset holdings above €30,000. The net liquid assets after a potential house sale are on average equal to €151,000 and the median value is €74,000. The Financial-Assets-To-Value ratio features a mean value of 8% and a median of 23%. More than

[13] As the household balance sheets do not include the capital built up in associated mortgage accounts, I randomly select 55% of the mortgages, which corresponds to the market share of mortgages with associated accounts, for which I estimate the capital built up applying the standard amortization formula with a 4% interest rate.

two-thirds of the observations have a Financial-Assets-To-Value ratio below 15, while 15% of the observations have a Financial- Assets-To-Value ratio above 35.

The bottom panel of Table 1 shows descriptive statistics for buyer variables measured when they move into the property. A buyer is on average approximately 37 years old, lives in a household of 2.4 individuals and 86% of the buyer household heads are male. Fewer than half of the buyers are married and around a third have children. Respectively 3% and 7% of the moves into the selected properties occur in years of, respectively, a divorce and a cohabiting-couple split. According to American Housing Survey (AHS) 2001-2011 data, the typical American buyer is on average 4 years older, belongs to a household with 0.4 more members and is 10% more likely to be married than his Dutch counterpart (Taylor (2013)). The average age of Dutch first-time homebuyers of 28 is low from an international perspective relative to approximately 29 in the UK and Ireland, 31 in France, 34 in the US and 36 in Germany.

Table 2 reports descriptive statistics for buyers by purchase cohort. The distribution of buyer characteristics is quite stable across cohorts. The increase (decrease) of the average age (household size) from 1995 until 2007 is slow, small and continuous and consistent with secular population demographic trends. The continuous reduction in the fraction of married buyers is consistent with a population-wide increase in the average age at marriage. When we zoom in on pairs of cohorts such as 2004 and 2007 or 2003 and 2006, we observe small differences in buyer observables relative to the much larger differences in the fraction with high LTV ratios in the 2009-2012 bust, as shown in Figure 3. The drop of the average age since 2008 is driven by an increasing share of first-time home buyers relative to trade-up buyers in the transaction volume during the Great Recession (Conijn and Schilder (2013b)), as first-time home buyers are not directly affected by the housing lock. The number of transactions by cohort in the sample rises gradually from approximately 30,000 in the late 1990s to a peak in 2006 at around 41,000 and a drop back to approximately 23,000 in 2011.

Other data. To estimate house value appreciation, I use the Statistics Netherlands price index of existing purchase dwellings for the 12 provinces. Statistics Netherlands (CBS) and the Land Registry Office (*Kadaster*) construct the Sales Price Appraisal Ratio index using assessed values of the universe of transacted proprerties to control for differences between the properties and obtain a constant quality price index.

5 Results

5.1 Estimates based on house price trajectory variation across purchase cohorts

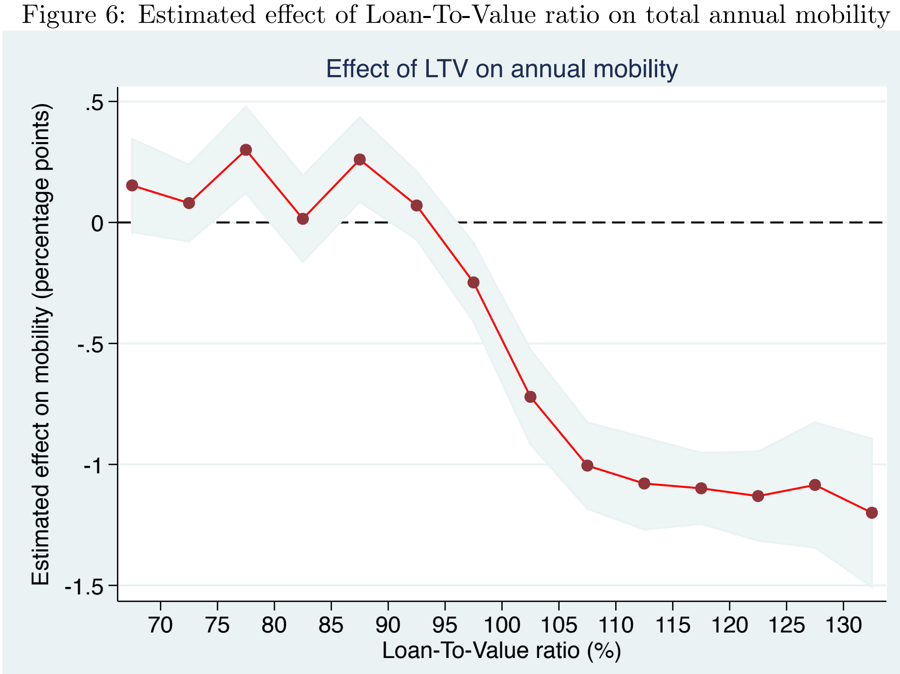
The relationship between annual mobility and LTV ratios from equation (1) is now estimated in the sample of buyer-years during the period 2007-2012. Table 3 presents the effects of the LTV ratio, grouped in 5 categories, on annual total mobility and on annual mobility across labor markets. Column 1 of Table 3 presents the results for total annual mobility by including the minimal set of controls: only loan age year- as well as five person age category fixed effects. In particular, this specification in Column 1 excludes time fixed effects. The estimates in Column 1 suggest a negative, large and monotone association between mobility and LTV ratios. The coefficient of -1.57 percentage points on the $100 < LTV \leq 110$- indicator in Column 1 can be interpreted as the annual mobility rate of 100-110 LTV owners relative to the reference group with a LTV ratio below 50, controlling for the person age category and the loan age year.

While Column 1 of Table 3 exploits time-series variation in home equity, Columns 2-4 exploit variation in home equity across purchase cohorts within a calendar year-region by including time-region interaction fixed effects. Standard errrors are clustered at the region-year level in Table 3 (except for Column 1) to account for any local shocks to moving risk. Column 2 also indicates a pattern of negative, large and monotone effects of high LTV ratios on mobility. The decline in absolute value of the high-LTV ratio category coefficients in Column 2 as compared to Column 1 is intuive, as pro-cyclical mobility declines in less favourable economic times (and areas) for other reasons than the housing lock, such as more uncertainty and fewer income opportunities. Column 3 adds all the remaining controls, namely fixed effects for household sizes, financial asset holdings categories and indicators for gender, marital status, migration status and changes in family size. Column 3 provides evidence for the housing lock hypothesis in the pattern of large, negative and monotone effects of LTV on mobility. LTV ratios do not alter mobility in a significant way in the 50-90 category. The negative, small and significant coefficient of -0.24 on the 90-100 category is fully consistent with the housing lock hypothesis as moving costs, downpayment requirements or the cost of mobilizing non-home equity can be positive. The housing lock effect becomes large in the 100-110 category, which features a coefficient of -1.01. With an average annual mobility of 4.31 percentage points, the decline in the coefficient by 0.77 percentage points from the 90-100 to the 100-110 category, which corresponds to 18% (=0.77/4.31), is large. The coefficient on the LTV ratio indicator declines further in the 110-150 category, consistent with the balance sheet channel. Relative to Column 2, the addition of the observable controls in Column 3 leaves the coefficients on the LTV ratios materially unaffected. For instance, the coefficient on the LTV above 110 indicator remains identical and is equal to -1.22 percentage points. The stability of these coefficients makes it also less plausible that the housing lock hypothesis is confounded by the selection of different mobility types on unobservables into different purchase cohorts.

The tables in this study mostly present the results by distinguishing 5 categories for LTV ratios, using as maximum LTV values for each category respectively 50, 90, 100 and 110. Figure 6 reports the estimated coefficients of the model from equation (1) with even more granular LTV ratio categories of size 5. We observe a “hockey-stick pattern” consistent with the housing lock predictions. Mobility is initially quite flat for various LTV ratios in the non-critical regions and then declines steeply in LTV ratio, starting in the 90-95 category.

In contrast with the fully flexible estimation of the effects of the LTV ratio on mobility from Figure 6, I also estimate models which solely distinguish “underwater” and “abovewater” owners, an approach that has been used in a number of previous studies. When estimating the binary version of equation (1), I obtain a coefficient of -1.02 on the $LTV > 100$ indicator and a standard error of 0.07. The binary effect of -24% (=-1.02/4.31) is comparable but somewhat smaller in absolute value than the effect of -30% found by Ferreira et al. (2011) in the different US setting. Abstracting from all other institutional differences, one may *a priori* expect effects of negative home equity on mobility which are larger in absolute value in full recourse markets such as the Netherlands. While the Dutch full-recourse setting allows me to isolate balance sheet housing lock effects, negative housing lock effects of high LTV ratios on mobility in non-recourse markets such as the United States can be diluted or overturned by the positive effects of high LTV ratios on mobility through the strategic default channel.

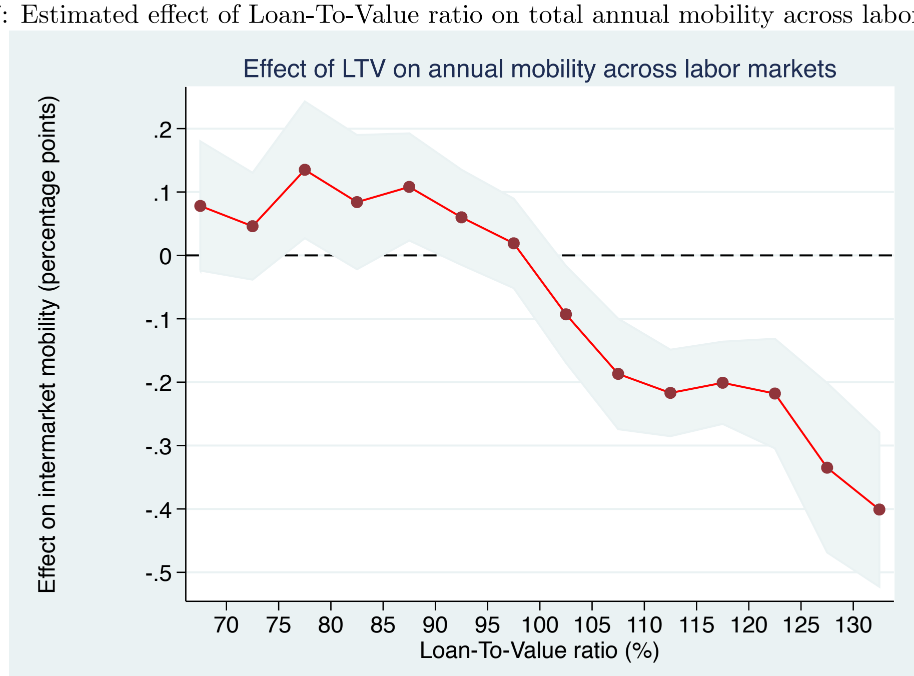
Figure 6: Estimated effect of Loan-To-Value ratio on total annual mobility



Notes: This figure visualizes the 95% confidence intervals around the coefficients on LTV ratio categories $\mathbf{1}\left[l_k < LTV_{it} \leq h_k\right]$ from the following equation estimating the effects of LTV ratios on annual mobility indicators:
$y_{icrt} = \lambda_{tr} + \sum_k \delta_{1k}\mathbf{1}\left[l_k < LTV_{icrt} \leq h_k\right] + X_{it}^{'}\beta + \epsilon_{icrt}$. The model is estimated in the sample of 1,956,003 buyer-years in the 2007-2012 period with balance sheet data.

Table 3 also reports the estimation of the model of mobility across local labor markets. Column 4 estimates equation (1), where the dependent variable is an annual indicator for mobility across local labor markets. Column 4 illustrates that the mobility rate across local labor markets also declines monotonically in LTV ratios, with a large decline from the 90-100 category to the 100-110 category. To facilitate comparisons of results across outcomes and other studies, I also estimate a binary model of mobility across labor markets and obtain a coefficient of -0.24 percentage points (and a standard error of 0.03) on negative home equity, which corresponds to a -21% effect given the 1.12 percentage points intermarket mobility mean. The binary effect of -21% for mobility across labor markets is somewhat smaller but of a similar order of magnitude as the binary effect on total mobility. The relative importance of negative home equity for local versus non-local mobility is theoretically ambiguous, and is an empirical question this study sheds light on. Both moving costs (monetary, psychological and time opportunity costs) and mean benefits (e.g. better job in another market) are arguably higher for longer-distance moves than for local moves. In some cases, the household may want to borrow more, for instance, through a personal loan or mobilize more non-home liquidity to realize the potentially higher benefits of the intermarket move. Figure 7 presents fully flexible estimations of the cross market mobility model and confirms the lock-in pattern of mobility, which declines monotonically in LTV ratios. Overall, the findings in Table 3 and Figures 6 and 7, which exploit variation in home equity across purchase cohorts, provide compelling evidence for the housing lock, both for total mobility as well as for mobility across local labor markets.

Figure 7: Estimated effect of Loan-To-Value ratio on total annual mobility across labor markets



Notes: This figure visualizes the 95% confidence intervals around the coefficients on LTV ratio categories $\mathbf{1}[l_k < LTV_{it} \leq h_k]$ from the following equation estimating the effects of LTV ratios on annual mobility indicators across local labor markets:
$y_{icrt} = \lambda_{tr} + \sum_k \delta_{1k}\mathbf{1}[l_k < LTV_{icrt} \leq h_k] + X_{it}'\beta + \epsilon_{icrt}$. The model is estimated in the sample of 1,955,2940 buyer-years in the 2007-2012 period with balance sheet data.

5.2 Estimating balance sheet effects

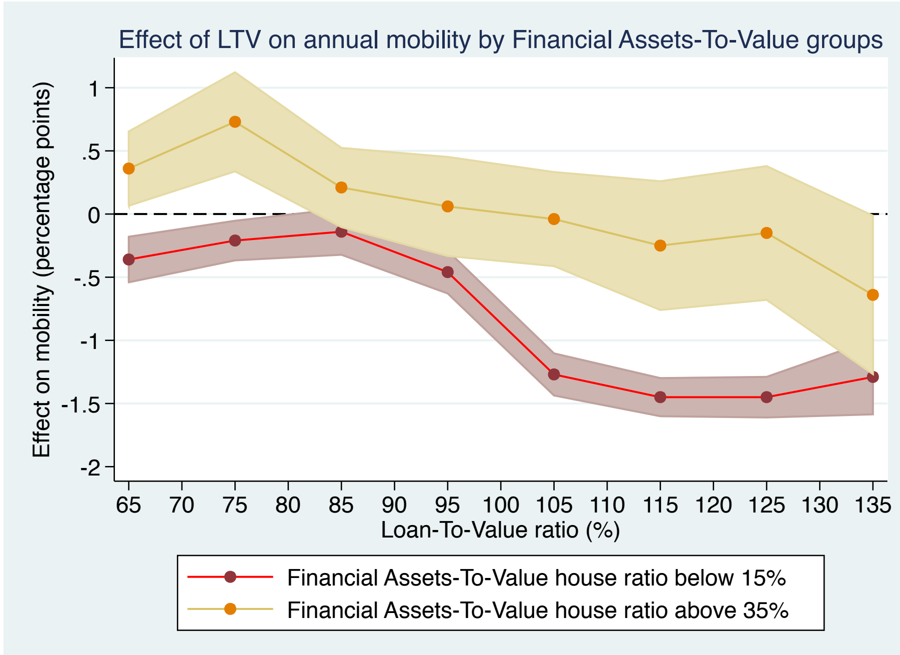
I now test the prediction of the Stein (1995) balance sheet channel according to which both home equity as well as household financial assets are critical factors in permitting moves. Tables 4 and 5 study the heterogeneous effects of home equity on mobility as a function of the Financial-Assets-To-Value (FATV) ratio. The prediction is that high-LTV ratios will hamper mobility more for households with low Financial-Assets-To-Value ratios. I distinguish 3 categories of Financial-Assets-To-Value ratios: low FATV ratios (below 15), medium FATV ratios (between 15 and 35) and high FATV ratios (above 35). The 15- and 35 thresholds correspond to, respectively, the percentiles 68 and 85 of Financial-Assets-To-Value ratios in the estimation sample. Household financial asset holdings, the numerator in the Financial-Assets-To-Value ratio, include checkings and savings accounts, equity holdings and bond holdings. Future pension rights are not included; Dutch households cannot borrow against their pensions. The definition of the Financial-Assets-To-Value ratio therefore captures the liquid savings that can be mobilized by underwater households to pay off the remaining mortgage balance relative to the value of the property.

Table 4 studies balance sheet effects for total annual mobility by estimating equation (1) for the full sample in Column 1 and for the 3 subsamples of high, medium and low Financial-Assets-To-Value ratio observations in, respectively, Columns 2, 3 and 4.[14] Table 4 reveals a striking double monotonicity of the housing lock effects consistent with the Stein (1995) model. First, for each household category, displayed vertically in a column, mobility declines monotonically in the LTV ratio. Second, for each LTV category, shown horizontally, the housing lock effects of high LTV ratios become much more pronounced when households become asset poorer relative to the value of the house. For instance, the coefficient on the $LTV > 110$ category indicator is equal to -0.22 and not significant in Column 2 for the high FATV ratio observations but quite large, negative and significant and equal to -1.64 for the low FATV ratio observations in Column 4. Given the average mobility levels of those two FATV groups, these coefficients can be interpreted as follows. While a LTV ratio above 110 is associated with an insignificant and small decline in mobility of 5% for the high FATV owners, a LTV ratio above 110 is associated with a very large and significant drop in mobility of 40% for low FATV owners. The estimated effects are thus approximately eight times larger for low FATV owners than for high FATV owners.

Figure 8 reports the point estimates and 95% confidence intervals for the coefficients from the same model in equation (1) but with more flexible LTV bins for the subsamples of high and low Financial-Assets-to-Value Ratios. On the one hand, high LTV ratios are not associated with significant declines in mobility for the high FATV ratio (above 35) subsample (except for very high LTV ratios above 130). On the other hand, the rise of LTV ratios is associated with an important reduction in mobility for the low FATV ratio subsample.

[14] The only difference between Column 1 of Table 4 and Column 3 of Table 3 is that the model in Table 4 does not include fixed effects for financial asset holdings categories. The housing lock effects in Column 1 of Table 4 are a bit larger in absolute value than the housing lock effects in Column 3 of Table 3, as underwater households with high LTV ratios are more likely to have limited financial asset holdings.

Figure 8: Estimated effect of LTV on annual mobility by Financial-Assets-To-Value ratio groups



Notes: This figure visualizes the 95% confidence intervals around the coefficients on LTV ratio categories $\mathbf{1}\left[l_k < LTV_{it} \leq h_k\right]$ from the following equation estimating the effects of LTV ratios on annual mobility indicators:
$y_{icrt} = \lambda_{tr} + \sum_k \delta_{1k} \mathbf{1}\left[l_k < LTV_{icrt} \leq h_k\right] + X_{it}^{'} \beta + \epsilon_{icrt}$. This figure shows the coefficients for models estimated in the subsamples of respectively low Financial-Assets-To-Value (below 15) and high Financial-Assets-To-Value (above 35) buyer-years.

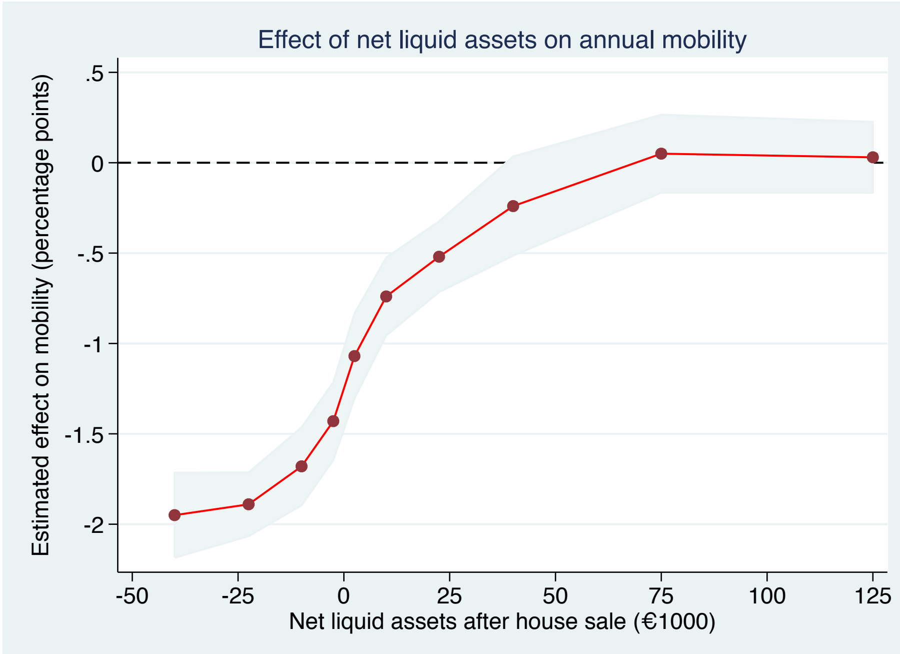
Table 5 reports the effects of LTV ratios on mobility across local labor markets by estimating equation (1) for the full sample in Column 1 and for the 3 subsamples of Financial-Assets-To-Value ratio observations in Columns 2 (high FATV), 3 (medium FATV ratio) and 4 (low FATV ratio). The cross-market mobility-LTV pattern is quite flat for the high FTA subsample in Column 2. For the medium FTV ratio subsample in Column 3, the coefficients on the LTV category indicators decline a bit for high LTV ratios, and the coefficient turns negative and significant for the $LTV > 110$ category and is equal to -0.16. Finally, the effects of high LTV ratios become much more prounounced in Column 4 for the low FATV ratio category with a coefficient on the $LTV > 110$ category indicator equal to -0.37 percentage points per year. Table 5 thus shows that high LTV ratios hamper mobility across local labor markets more for households with low Financial Assets-To-Value ratios.

Tables 4 and 5 document important interaction effects between home equity and household financial asset holdings. This finding as well as the Stein (1995) model call for an investigation of the importance of total liquid assets for mobility. In addition to downpayment constraints and other moving costs, the critical variable in the Stein (1995) model to predict whether a household can move is the net liquid assets level a household has after having sold the house. I thus define net liquid assets after a potential house sale as the sum of home equity and household financial assets. The intuition is that a dollar of liquidity facilites paying for moving. And, unless households are subject to mental accounting or other frictions disturb the home sale process, it should not matter too much whether this marginal dollar comes out of home equity or out of other household savings.

Figure 9 investigates the effects of net liquid assets on mobility. This figure reports point estimates and 95% confidence intervals for the coefficients δ_{2j} on net liquid assets after house sale categories from the model in equation (2). The only two differences with the model in equation (1) are: (i) the inclusion of net liquid asset levels, instead of Loan-To-Value ratio categories, and (ii) the absence of financial asset holdings group indicators in equation (2). In addition, the inclusion of household financial assets in the net liquid assets after a house sale as a variable of interest as opposed to Loan-To-Value ratios makes it arguably less likely that the conditional independence assumption is verified. In addition to exploiting relatively exogenous factors such as the timing of purchase, these regressions *de facto* compare asset-rich to asset-poor households and will provide descriptive evidence of the balance sheet mechanism driving the lock-in.

The relationship between mobility and net liquid assets in Figure 9 is S-shaped, consisting of four regions, consistent with a Stein (1995) balance sheet model. In the first region, for very negative net liquid assets after a house sale (or shortened as net liquid assets) below approximately -€25,000, a marginal euro of net liquid assets does foster mobility only to a limited extent, as the owner is relatively far away from filling the funding gap. Then, in the second region, when we are closer to the zero net liquid assets point, the curve starts to rise very quickly and becomes almost vertical around zero. In this second, steep region, extra liquidity provides a "big moving bang for the buck." In the third region, between approximately €0 and €25,000, extra liquidity still contributes to higher mobility, even if the owner already has positive net liquid assets. This is consistent with models with positive moving costs and/or borrowing constraints where a euro of savings has a precautionary value above and beyond its current consumption value. This seems plausible in the Netherlands, where there is almost no credit card or consumption credit. This finding is consistent with models of precautionary savings to insure against near-term fluctuations in income (Zeldes (1989), Deaton (1991), Carroll (1997)) or models of credit constraints (Bernanke and Gertler (1989), Kiyotaki and Moore (1997)), where agents with relatively positive but small net worth can also be constrained in their behavior. Finally, in the fourth region, once total liquid assets exceed approximately €75,000, then the marginal mobility value of a euro of liquidity converges to zero as the curve flattens out.

Figure 9: Estimated effect of net liquid assets on total annual mobility



Notes: This figure visualizes the 95% confidence intervals around the coefficients on "net liquid assets after house sale (NLAS)" categories $\mathbf{1}\left[l_k < NLAS_{it} \leq h_k\right]$ from the following equation estimating the effects of net liquid assets on annual mobility indicators: $y_{icrt} = \lambda_{tr} + \sum_j \delta_{2j}\mathbf{1}\left[l_j < NLAS_{icrt} \leq h_j\right] + X_{it}^{'}\beta + \epsilon_{icrt}$. Net liquid assets after a house sale are defined as the sum of home equity and household financial assets. The model is estimated using the full sample of 1,956,003 buyer-years with balance sheet data.

5.3 Estimates for life-event buyers using quasi-exogenous purchase dates

The main empirical strategy in this paper has been to exploit variation across purchase cohorts in home equity and net liquid assets by estimating respectively equations (1) and (2). To address the possibility that house buyers near the peak were somehow different from those who bought homes at other times, this section refines and restricts the analysis to buyers who bought in a given year because of a divorce or a cohabiting-couple split. The goal is to rule out alternative hypotheses based on differential sorting of individuals of high- and low-future-mobility types across purchase cohorts. Peak buyers may, for instance, be financially less sophisticated (if the timing of house price busts can be anticipated by earlier buyers) or less creditworthy (if credit market conditions are relaxed over time). While the direction of this potential bias seems to lead to an understatement of the housing lock estimates (less sophisticated people and less creditworthy buyers may be more likely to be laid off during the Great Recession and therefore be forced to move), other stories of sorting across cohorts may be possible. To show the validity of divorces as a source of exogenous variation in purchase dates, I will first document that the divorce rate is actually relatively unaffected by the state of housing and labor markets. I will then demonstrate that divorces and cohabiting-couple splits shift the timing of purchase.

Figures 10 and 11 show that the annual Dutch divorce rate of approximately 9 divorces per thousand married people is quite stable over time. The largest annual change in the divorce rate from 0.93% to 1.00% occurred in 2001 when a faster divorce procedure was introduced. While the economic cycle may in principle alter the benefits of marriage such as production complementarities or risk-sharing (Becker (1981), Stevenson and Wolfers (2007)) or the affordability of divorce, the stable Dutch aggregate divorce rate is also almost uncorrelated with cyclical movements in the housing and labor markets. Figure 10 shows that the aggregate divorce rate remains relatively stable, both when housing transaction volumes rise and when they drop over time. Figure 11 visualizes the absence of any clear comovement between the divorce rate and the unemployment rate. The lack of any economically-significant relationship between the divorce rate and housing markets or labor market dynamics is also confirmed in simple regressions.[15]

The US literature on the cyclicality of divorces typically finds zero or very small business cycle effects. Using state-level data on unemployment and divorce rates from 1960 to 2005, Amato and Beattie (2011) find zero association between unemployment and divorce rates in models as soon as state and year fixed effects are included. Hellerstein, Morrill and Zou (2013) use micro-data from retrospective marital histories in the Survey of Income and Program Participation (SIPP). These authors document a small pro-cyclicality of divorce rates. When the unemployment rate rises by one percentage point (e.g. from 6 to 7%), the divorce rate is estimated to decline by 0.34 divorces per 1000 married women. As the mean unemployment and annual divorce rates are equal to respectively 6 and 1.8%, this corresponds to a small elasticity of the divorce rate with respect to unemployment rates of approximately -0.1. Hellerstein et al. (2013) also show that divorce rates are a-cyclical for women who married after the age of 24. The divorce rate is also found to be a-cyclical for women with college degrees. Nothing guarantees a full extrapolation of these US relationships to the specific Dutch setting. However, the general finding that the pro-cyclicality of divorce rates is limited to individuals with lower levels of education or who married at a younger age is encouraging for the exogeneity of the timing of purchase in my sample of homeowners (who are typically more educated than renters) in the Netherlands (a country with relatively high ages of first marriage). Finally, suggestive international surveys typically find that only approximately 5% of the respondents report economic factors such as financial or employment problems as the cause of divorce, while the vast majority perceives idiosyncratic, affective issues to be the main reason for marriage breakdown (Wolcott and Hughes (1999), Amato and Previti (2003)). The stability of the aggregate divorce rate, its independence from housing and labor-market-cycle indicators and the literature on the relationship between divorce and the general economic environment, all suggest that the timing of divorce is largely driven by idiosyncratic shocks.

[15]The R^2 - and adjusted R^2- values of simple regressions of the aggregate divorce rate are respectively equal to 0.02 and -0.4 for the transaction volume, 0.05 and -0.02 for the growth rate of the CBS house price index and 0.05 and 0.06 and -0.06 for the unemployment rate.

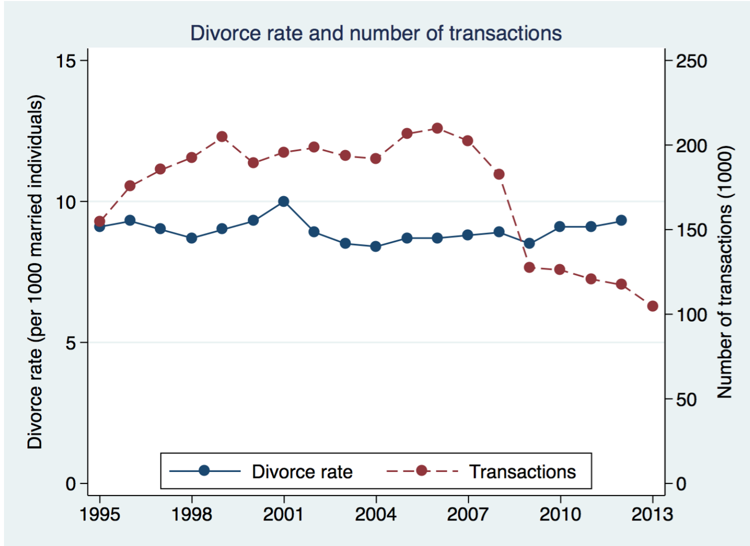


Figure 10: Divorce rate and number of transactions

Notes: The divorce rate is from Statistics Netherlands Statline (CBS). The number of transactions of existing owner-occupied homes is from the Transactions Registry.

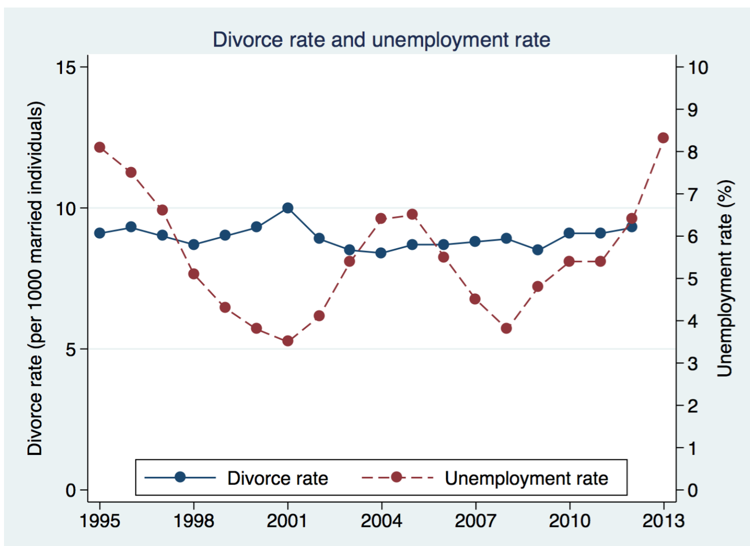
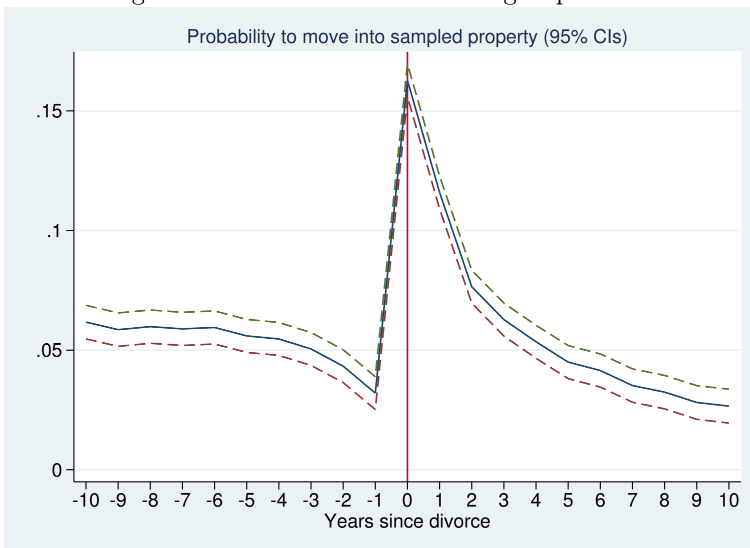


Figure 11: Divorce rate and unemployment rate

Notes: The divorce- and unemployment rate series are from from Statistics Netherlands Statline (CBS).

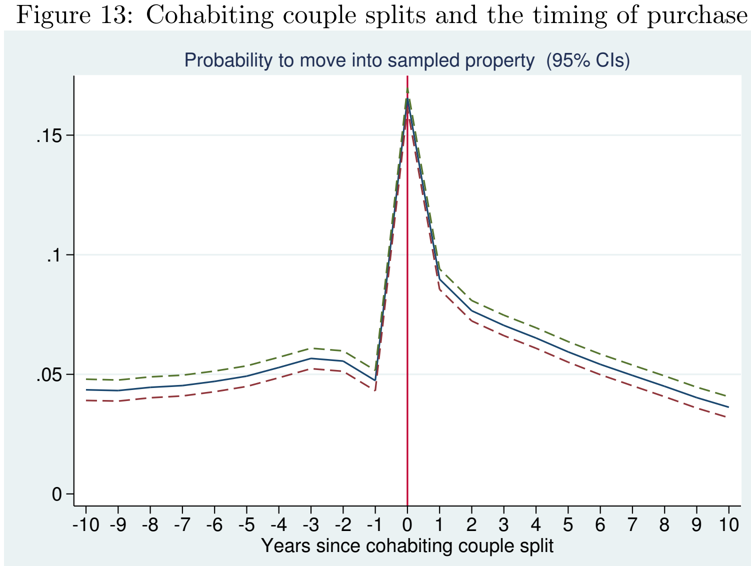
How does the occurrence of a divorce impact the probability of buying a property in my sample of buyers? Figure 12 plots the probability of moving into a sampled purchased property as a function of the timing of the divorce for the individuals in the sample, who were divorced during the period 1996-2011. The probability of purchasing a sampled property quadruples in the year of the divorce relative to the previous year and then drops again relatively quickly. Given the sampling procedure which samples 25% of sold existing homes, the probability of a move into a sampled property is a lower bound on the probability for individuals in the sample of purchasing a home in a given year. Figure 13 plots the probability of purchasing a sampled property as a function of the timing of the cohabiting couple split for the individuals in the sample, who split as cohabiting couples in the period 1996-2011. The probability of purchasing a property also peaks strongly in the year of the split. Figures 12 and 13 thus provide compelling evidence that life-events shift the timing of purchase.

Figure 12: Divorces and the timing of purchase



Notes: The probability of purchasing a property from the sample of selected transactions is plotted for all household heads in the sample of buyers who divorced during the sample period.

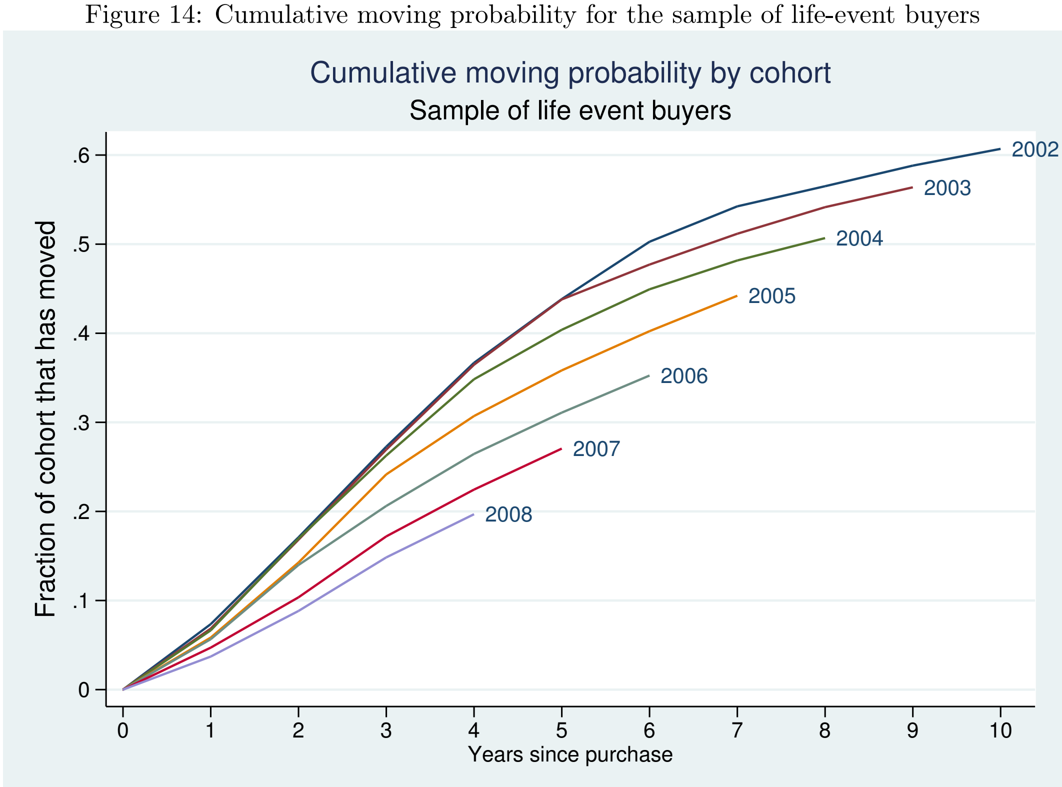
Figure 13: Cohabiting couple splits and the timing of purchase



Notes: The probability of purchasing a property from the sample of selected transactions is plotted for all household heads in the sample of buyers who were part of a cohabiting couple that split during the sample period.

Among the sampled 574,337 transactions in 1995-2011, 16,844 transactions occurred in the year of the buyer's divorce and 32,276 transactions occurred in the year of a cohabiting couple split. I now restrict the analysis to these 16,844 so-called divorce buyers as well as the 32,276 split-couple buyers. The former are on average 43 years old and 49% male, whereas the latter are on average 39 years old and 50% male. The life-event buyers are on average approximately 4 years older and more likely to be single than are the buyers in the full sample. I now analyze the effect of Loan-To-Value ratios on subsequent mobility for these life-event buyers, who started their ownership spells because of plausibly exogenous, idiosyncratic life events. This analysis estimates equation (1), which shuts down variation within calendar year-regions for this subgroup of life-event buyers. The housing lock results for these life-event buyers will turn out to be a robust feature of the compelling mobility patterns across purchase cohorts, as shown in Figure 14. The subsequent mobility patterns for the life-event buyers are consistent with the housing lock hypothesis. Early cohorts, those who were exposed to rising house prices for a longer period and less exposed to high LTV ratios, moved substantially and significantly more often than the later cohorts. The mobility patterns across purchase cohorts for the life-event buyers are remarkably similar to those in the full sample from Figure 4.

Figure 14: Cumulative moving probability for the sample of life-event buyers



Notes: The moving data are based on the Transactions Registry and Address Registry from Statisistics Netherlands (CBS). The sample is restricted to transactions of buyers who started their ownership spell at the time of the occurence of life-events (a divorce or a cohabiting-couple split).

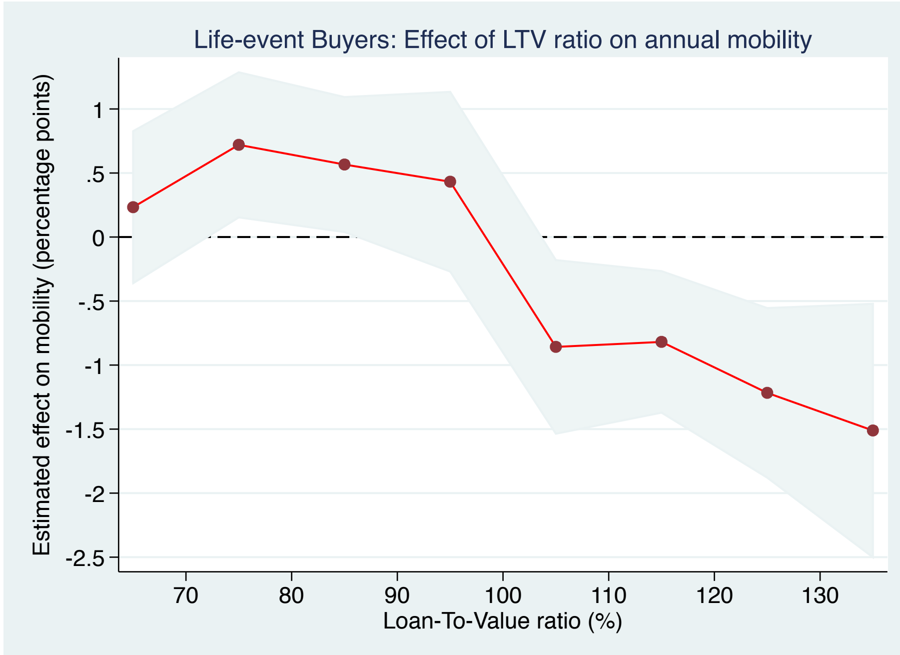
Table 6 presents the estimation of the model in equation (1) for total mobility, in Columns 1 and 2, and for mobility across labor markets, in Columns 3 and 4. The model with 5 LTV ratio categories in Column 1 finds again a pattern of mobility that declines when LTV ratios are high. The coefficient on the LTV 110-150 category indicator is precisely estimated and equal to -1.09. Given the smaller subsample and associated lower level of precision, Columns 2 and 4 also present binary models, which contrast the mobility of "underwater" and "abovewater" owners.

Column 2 reveals an estimate of -1.27 on the underwater coefficient in the binary model. Overall, the coefficients on the LTV ratios in the total mobility regressions for the life-event buyers in columns 1 and 2 are comparable in absolute terms to the coefficients in the corresponding Columns 3 and 4 of the full sample depicted in Table 3. The life-event buyer housing lock effects are somewhat smaller in relative terms, as the mean mobility hazard rate for the life-event buyers of 6.93 percentage points per year exceeds the full sample mobility mean of 4.31 percentage points. Columns 3 and 4 estimate the impact of LTV ratios on inter labor market mobility for life-event buyers in models with respectively 5 and 2 LTV ratio categories. Column 3 documents a pattern of mobility across local labor markets, which declines monotonically in LTV ratios for buyer-years with exogenous purchase dates. Given the smaller sample size, the housing lock effects are less precisely estimated for mobility across local labor markets for life-event buyers. Column 4 confirms that underwater buyers with exogenous purchase dates also move less frequently to different local labor markets.

In addition to the models with respectively 5 and 2 LTV ratio categories in Table 6, I also estimate the model for total mobility from equation (1) with smaller LTV ratio categories. Figure 15 reveals a pattern of initially flat LTV effects which then start to decline in a relatively monotone way when LTV ratios exceed approximately 95.

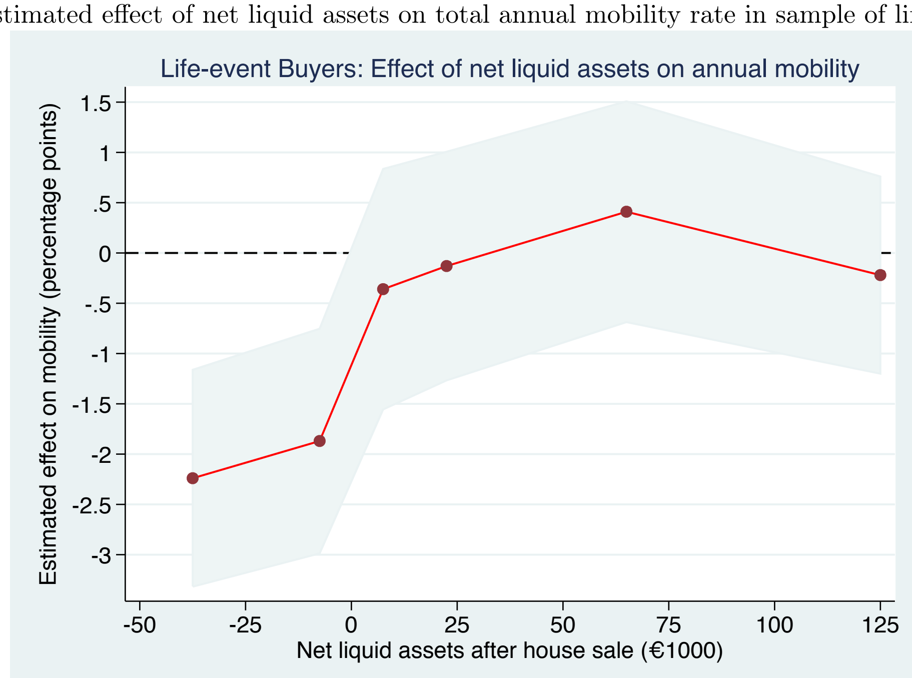
I will now test balance sheet predictions for buyers with quasi-exogenous purchase dates. I estimate the effect of net liquid assets (after a potential house sale) on mobility from equation (2) in the subgroup of life-event buyers. The curve of mobility against net liquid assets is S-shaped in Figure 16, which resembles the pattern for the full sample from Figure 9. The contribution of marginal net liquid assets to mobility is large in the critical region, around the zero-net-liquid-assets threshold, where the slope becomes quite steep. Overall Table 6 and Figures 15 and 16 show that high LTV ratios, triggered by divorces and couple splits that shift the timing of purchase, as well as low-net-liquid-asset positions, are associated with subsequent lower total mobility and lower mobility across labor markets.

Figure 15: Estimated effect of Loan-To-Value ratio on total annual mobility rate in the sample of life-event buyers



Notes: This figure visualizes the 95% confidence intervals around the coefficients on LTV ratio categories $\mathbf{1}\left[l_k < LTV_{it} \leq h_k\right]$ from the following equation estimating the effects of LTV ratio categories on annual mobility indicators:
$y_{icrt} = \lambda_{tr} + \sum_k \delta_{1k}\mathbf{1}\left[l_k < LTV_{icrt} \leq h_k\right] + X_{it}^{'}\beta + \epsilon_{icrt}$. The model is estimated from the sample of 113,539 life-event buyer-years in the 2007-2012 period with balance sheet data.

Figure 16: Estimated effect of net liquid assets on total annual mobility rate in sample of life-event buyers



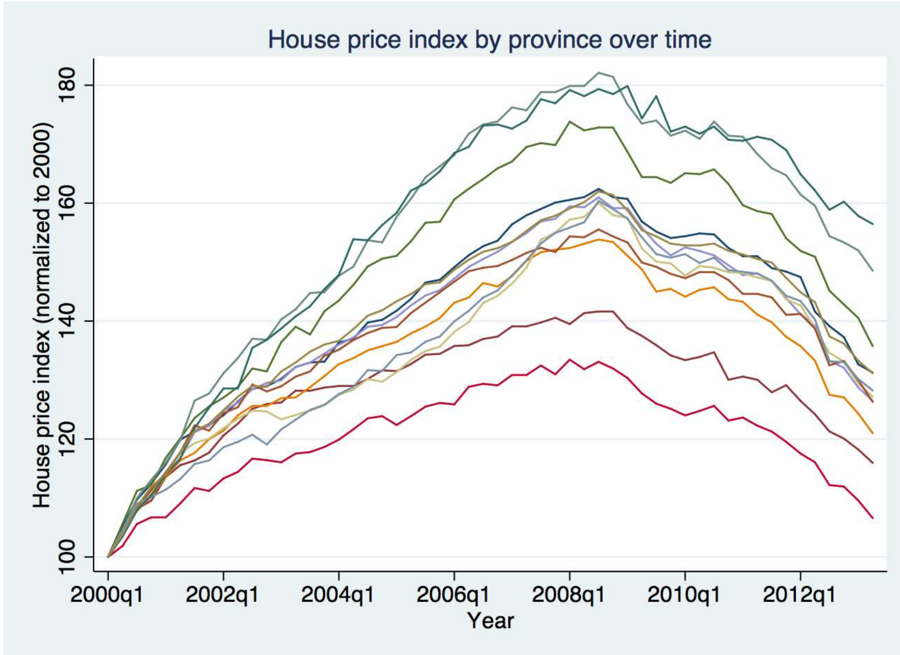
Notes: This figure visualizes the 95% confidence intervals around the coefficients on "net liquid assets after house sale (NLAS)" categories $\mathbf{1}\left[l_k < NLAS_{it} \leq h_k\right]$ from the following equation estimating the effects of net liquid assets on annual mobility indicators $y_{icrt} = \lambda_{tr} + \sum_j \delta_{2j}\mathbf{1}\left[l_j < NLAS_{icrt} \leq h_j\right] + X_{it}^{'}\beta + \epsilon_{icrt}$. Net liquid assets after a house sale are defined as the sum of home equity and household financial asset holdings. The model is estimated from the sample of 113,539 life-event buyer-years in the 2007-2012 period with balance sheet data.

5.4 Estimates using regional variation in house price trajectories

I will now show the robustness of the findings to shutting down any variation across cohorts. The purpose of this is to assess the endogeneity of purchase dates as a source of potential contamination, which may affect the prior results. However, the analysis of life-event buyers and the stability of the following three factors suggest that these findings, based on variation across purchase cohorts, capture the housing lock: (i) mobility as a function of loan age year patterns from Figure 4 for the early 1996-2001 purchase year cohorts, that were not affected by the decline in house prices, (ii) buyer observables across cohorts from Table 2, and (iii) coefficients in Columns 2 and 3 of Table 3, which respectively exclude and include the household observables. To overcome any remaining concerns with variation in purchase dates, this section eliminates all variation across purchase cohorts in the model from equation (3) by including a full set of fixed effects for calendar year-purchase cohort interactions λ_{tc}. This specification exploits cross-regional variation in house price trajectories as well as the distribution of LTV ratios within a given purchase cohort-year. Figure 17 shows substantial variation in house price changes across the 12 provinces. For instance, the cumulative house price appreciation between the first quarter of 2000 and the third quarter of 2008 is approximately 2.5 times higher in the province with the highest growth, Groningen (in the North of the Netherlands), relative to the province with the lowest growth, Limburg (in the South of the Netherlands).

Table 7 reports the estimation of the model in equation (3), both for total mobility and mobility across local labor markets. All columns include a full set of time-purchase cohort interaction fixed effects to soak up any variation across purchase cohorts. Columns 1 and 3 do not include region fixed effects. The inclusion of region fixed effects in Columns 2 and 4 allows for the control of time-unvarying differences in average mobility rates across regions. Columns 1 and 2 confirm the pattern of lower mobility rates for higher LTV ratios, exploiting regional variation in home equity. Similarly, Columns 3 and 4 demonstrate the housing lock for mobility across local labor markets. The effects are similar but a bit smaller when region fixed effects are included. To conclude, Table 7 demonstrates the robustness of the housing lock finding to eliminating any variation across purchase cohorts.

Figure 17: Regional house prices



Notes: The provincial house prince indices are from Statisistics Netherlands (CBS).

6 Robustness Checks

This section demonstrates the robustness of the evidence consistent with the housing lock along several dimensions. Table 8 estimates equation (1) for two subsamples to demonstrate the robustness of the housing lock to: (i) excluding Great Recession purchase year buyers, and (ii) the definition of household mobility. Columns 1 and 2 do not include the buyer-years, who started their ownership spell during the 2009-2012 recession period. The potential concern which might be associated with their inclusion is that the decision of homeownership and mortgages may be different during the Great Recession along unobservable variables, possibly correlated with future moving propensity. Nevertheless, the subsample of 1995-2008 buyers also features the housing lock pattern, as both total mobility and mobility across local labor markets decline monotonically in LTV ratios. This paper defines mobility as the mobility of the household head (as opposed to other household members). I now confirm the robustness of the housing lock to this definition of mobility. Columns 3 and 4 of Table 8 study the effects of LTV ratios on both total and inter labor market mobility in the sample of buyers who have been single for their full period of ownership. In the case of always-singles, household mobility is unambiguously defined as the mobility of the single individual. For the 12% of buyers who remain single during their home ownership, I even find somewhat larger housing lock effects than are evident in the full sample.

Table 9 estimates equation (1) to establish the robustness of the housing lock to: (i) the definition of local labor markets; (ii) the presence of mobility shocks specific to buyer-age categories, and (iii) the treatment of LTV ratio outliers. Column 1 estimates the model with an indicator for mobility across provinces as the dependent variable. While about two-thirds of the moves across local labor markets (so-called COROP areas) involve a move to a different province, one third of the moves across local labor markets occurs within the same province. The estimates for the effects of the LTV ratios on inter-province mobility in Column 1 of Table 9 are comparable in relative terms to the estimates for mobility across local labor markets in Table 3. These estimates corroborate the housing lock effects, now also for longer-distance moves across provinces. Column 2 of Table 9 includes fixed effects for the interaction between the calendar year and 5 buyer age category fixed effects. This model allows for temporary shocks to mobility for specific buyer-age categories. Young workers may be particularly vulnerable to negative labor market shocks in recessions, for instance if employers' lay-off decisions feature "last in and first out"-patterns. Nevertheless, Column 2 confirms the stability of the housing lock to such age-category shocks. Finally, Columns 3 and 4 of Table 9 present the estimation of the effects of LTV ratios on mobility when the extreme LTV ratio outliers below zero or above 150 are included. The housing lock estimates are relatively stable, when these outliers are included. Finally, in unreported regressions, I confirm the housing lock effect in a non-linear Probit model, which yields similar results to those of the linear probability models estimated in this paper.

7 Simulating Effects of Counterfactual House Price and Borrowing Trajectories on Mobility

This section uses the estimates of the effects of LTV ratios on mobility to simulate mobility under two different counterfactual trajectories of home prices as well as a counterfactual trajectory of mortgage borrowing. I simulate counterfactual mobility rates for 1995-2008 buyer cohorts in the estimation sample during the 2009-2012 period. These partial equilibrium simulations are not policy simulations. The scenarios for house price trajectories assume exogenous alternative house prices from 2009 to 2012 and keep the borrowing trajectory fixed.[16] The third scenario fixes house prices and assumes an exogenous alternative scenario for borrowing. Distributions of LTV ratios as well as mobility rates will be simulated under the three scenarios and will be compared with those in reality, the so-called baseline scenario. These simulations will generate two important insights. First, in recessions the effect of the housing lock on total owner-occupied mobility can be substantial. Second, given the highly non-linear effects of LTV ratios on mobility, small shocks to house prices or borrowing levels can have relatively large effects on aggregate mobility.

Counterfactual House Price Trajectories The parameter inputs for the various scenarios appear in the top panel of Table 10. In the baseline scenario, nominal house prices, which declined from the end of 2008 until mid

[16]This section thus ignores the arguably positive impact of house prices on refinancing. In reality, ABN AMRO data suggest that the the constant prepayment rate, where prepayment includes refinancing, curtailments and relocations, in prime Dutch mortgage loans in RMBS transactions dropped from around 12% in the 2004-2008 period to approximately 6% in 2009-2012.

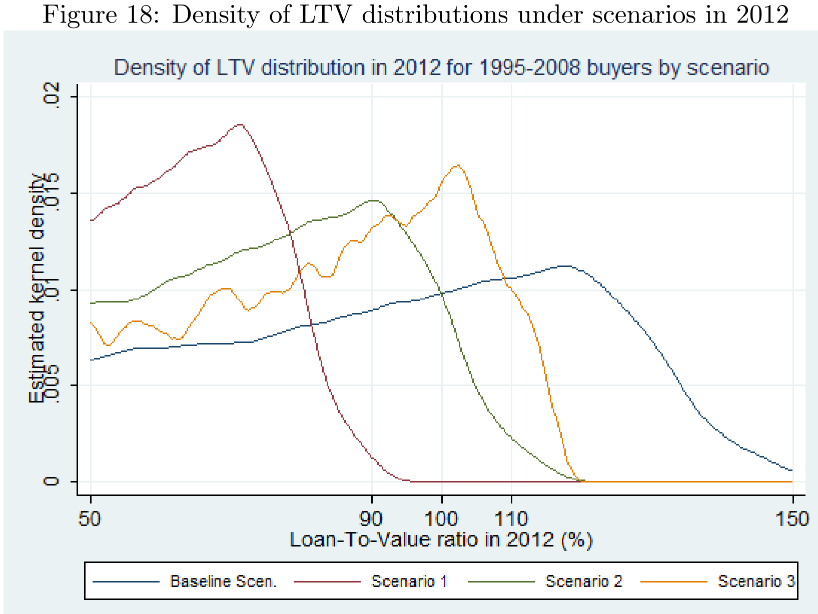
2013, declined by 16% in the simulation period 2009-2012. This decline corresponds to an average reduction of 4% per year. In scenario "Price growth as usual" 1, I assume that nominal house prices increased in 2009-2012 at their average historical annual rate of 8.5%, where the average is computed over the 1995-2007 period. In scenario "Halfway prices" 2, the trajectory of house prices in the 2009-2012 period is half way the decline of the baseline scenario and the increase in scenario 1. The "Halfway prices" scenario thus assumes that nominal house prices increased in 2009-2012 at 2.25% every year.

The methodology for the simulations consists of the following iterative steps. First, I apply the exogenous input parameters, namely, house prices in scenarios 1 and 2, to all the buyers, who live in their properties in 2009 at the beginning of the simulation period. Second, the exogenous inputs and the remaining micro-data then allow for computation of counterfactual LTV ratios at the end of 2009. Third, I then use the estimated effects of LTV ratios in the main specification of this study (i.e. Column 3 from Table 3) to simulate which buyers would have moved in 2009 under the alternative scenario. The lower LTV ratios under the counterfactual scenarios relative to the baseline scenario and the associated higher mobility cause the exit of some extra buyers in 2009. This different composition of the sample on January 1st, 2010 then affects the distribution of LTV ratios in 2010. In a fourth step, I again apply the exogenous parameters to the new micro-data sample in 2010 and compute counterfactual LTVs in 2010. I repeat this iterative "Price Shock-LTV-Mobility-Exit" procedure each year until the end of the sample period in 2012.

In the baseline scenario, a high fraction of buyers have LTV ratios above 100% and even above 110%, as shown in the blue density kernel of Figure 18. 14.2% of the buyers in the sample have moved during the 4 Great Recession years in the baseline scenario, as reported in the bottom panel of Table 10. Let us now turn to the "Price growth as usual" scenario 1. The red density in Figure 18 shows that the rapid run-up in prices in scenario 1 pushes the distribution of LTV ratios to the left. Here, almost no observation in the simulation sample, which consists of the 1995-2008 buyers, features LTV ratios in 2012 above 90%. Table 10 shows that the cumulative mobility of the simulation sample under this "Price growth as usual" scenario would have been 15.3%. Cumulative mobility would thus have been 1.1 percentage points (15.3%-14.2%) higher than in reality. Expressed in relative terms, this corresponds to a cumulative mobility rate that would have been approximately 7.5% higher in the "Price growth as usual" scenario 1. To gauge the quantitative importance of this mobility difference one can, for instance, perform an out-of-sample, back-of-the-envelope calculation of the number of involved individuals. About 10 million Dutch individuals live in an owner-occupied home. Therefore the comparison of the "Price growth as usual" scenario 1 to the baseline scenario, suggests that, *ceteribus paribus*, approximately 110,000 more individuals would have moved, if house prices had continued to increase at their historical average rate. One may also estimate the share of the decline in owner-occupied mobility that can be attributed to housing lock balance sheet effects. Owner mobility declined by 35% during the crisis relative to the pre-period. Dividing the decline of 7.5%, associated with the housing lock effects, by the total decline during the crisis period of 35%, yields a suggestive ratio of 22%. The 22% contribution of housing lock effects to the total decline in owner-occupied mobility is arguably reasonably large. Indeed, multiple other factors, such as higher uncertainty or fewer income opportunities, hamper mobility in recessions and have been absorbed by the time-region fixed effects in my model of the housing lock. While these back-of-the-envelope calculations focus on the cumulative effect on mobility in 2009-2012, Table 10 also reports the impact on the mobility rate in 2012. In the "Price growth as usual" scenario 1, mobility in 2012 would have been 11.2% higher in relative terms than the baseline mobility. Intuitively, the effect of higher house price growth rates increases over time, as declining LTV ratios reflect the cumulative impact of the full house price trajectory.

The LTV distribution in 2012 for the "Halfway prices" scenario 2 is plotted in green in Figure 18. While the rate of price growth is only halfway between the baseline scenario and scenario 1, most of the buyers with LTV ratios above 100 or 110% in the baseline scenario have positive home equity under the "Halfway Prices" scenario. Table 10 reports a cumulative mobility rate of 14.9% in the "Halfway prices" scenario 2 in the 2009-2012 period. This corresponds to an impact on cumulative mobility of 5.1%, expressed in relative terms, relative to the baseline. While the rate of price growth in the "Halfway prices" scenario 2 is the average of the growth rate in scenario 1 and the growth rate in baseline scenario, the mobility rate of 14.9% in the "Halfway prices" scenario 2 is thus closer to the mobility rate of 15.3% in the "Price Growth as usual" scenario 1 than to the baseline 14.2% mobility. This non-linearity of mobility rates in house prices growth rates reflects the highly non-linear effects of LTV ratios on mobility estimated in this paper.

Figure 18: Density of LTV distributions under scenarios in 2012



Notes: This figure visualizes the estimated Epanechnikov kernel density of the distribution of LTV ratios in 2012 for the 1995-2008 buyers in the estimation sample. The baseline scenario corresponds to the observed data in reality. Scenario "Price growth as usual" 1 assumes house prices increase in 2009-2012 at their average historical annual rate of 8.5%. In scenario "Halfway prices" 2, nominal house prices increase in 2009-2012 at 2.25% annually. In scenario "Capped borrowing" 3, mortgages are capped at 95% of the purchase value of the house for all the 1995-2008 cohorts and house prices follow the baseline scenario.

Counterfactual Borrowing Trajectory In scenario "Capped borrowing" 3, borrowing cannot exceed 95% of the value of the house at purchase for all the 1995-2008 cohorts. This third scneario also assumes that house prices follow their baseline scenario trajectory, as they did in reality. In the "Capped borrowing" scenario, I also assume that the binding borrowing maxima are countercyclical; as they are relaxed in 2009-2012. In reality, the Netherlands introduced procyclical LTV at origination norms in 2011, at relatively high levels of 112%. This exercise assumes that the alternative borrowing trajectory in scenario "Capped borrowing" 3 has no effect on i) housing demand in the 1995-2008 period or ii) the trajectory of house prices.

For the "Capped borrowing" scenario 3, the associated LTV distribution in 2012 is shown in yellow in Figure 18. As a consquence of the hard maximum cap on borrowing at 95% of a house's value at origination, only the buyers who bought close to the peak have LTV ratios above 100 or 110%. The cumulative mobility in 2009-2012 for the simulation sample would have been 15.0% under the "Capped borrowing" scenario 3, as shown in the last column in Table 10. This corresponds to an impact on the cumulative mobility rate of 5.8% in relative terms. However, the last line in this Table shows that the impact on mobility in 2012 of house price scenarios 1 and 2 is larger than the impact of the "Capped borrowing" scenario 3. Over time, as house prices continue to decline and as the cumulative, negative house price shocks become larger, the "Capped borrowing" trajectory becomes relatively less useful in terms of "preventing moves lost because of the housing lock". One potential insight for the design of borrowing regulation may be the recognition of the volatility of house price processes, and to take into account, for instance, the likelihood of 1-sigma or 2-sigma house price change events. Further implications for macro-prudential policy (e.g. LTV ratio at origination caps) are beyond the scope of this study. Policy simulations of caps on LTV ratios would require the modeling and/or measurement of the impact of these policies on subsequent changes in refinancing, house prices, housing demand and aggregate demand. The simulations in this section are primarily developed to quantify the magnitude and non-linearity of the estimated coefficients and constitute at most a first step to understand the partial equilibrium consequences of such policies for household mobility.[17]

Overall, the simulations of the effects of counterfactual house price and borrowing trajectories on mobility have led to two insights. First, the effect of the housing lock during recessions on total owner-occupied mobility can be substantial and depends on the assumed counterfactual house price scenario. Second, given the highly non-linear effects of LTV ratios on mobility, relatively small shocks to house prices or borrowing levels can have large effects on aggregate mobility.

[17] Several recent macro-prudential reforms emphasize countercylicality, as such reforms intend to dampen the business cycle. Those new macro-prudential tools often include norms or caps on LTV ratios at originations. Soft norms or hards caps have been or are being introduced in Hong Kong, Singapore, China, Norway, the UK, Israel, New Zealand and also the Netherlands. Policymakers have mentioned multiple potential costs and benefits, both *ex-ante* and *ex-post*. The *ex-post* benefits and intented consequences may, for instance, lead to more stable trajectories of credit growth and asset prices.

8 Conclusion

This paper investigated the impact of home equity and financial assets on household mobility in the Netherlands. My results suggest that a decline in home equity, particularly when the LTV ratio is near 100 percent, is associated with large and statistically significant reductions in household mobility both within and across local labor markets. The effects of falling home equity are substantially larger for households with low levels of financial assets than for those with substantial financial wealth. The simulations of counterfactual trajectories for house prices and borrowing levels suggest substantial, non-linear effects of house price shocks on the aggregate mobility rate among owner-occupiers.

The finding of substantial housing lock when house prices fall and home equity declines must be recognized as conditional on the housing and mortgage institutions in the Netherlands. One important feature of the Dutch market is the reliance on full recourse loans which eliminates the strategic default channel that may affect homeowners in the United States. The quantitative importance of the balance sheet channel that links house price fluctuations to mobility rates is likely to depend on country-specific institutions, such as downpayment requirements, the assumability of mortgage debt, moving costs, the liquidity of the rental market, and the availability of alternative borrowing opportunities, such as unsecured credit or loans from family and friends. More detailed balance sheet information for Dutch households could provide further information on this issue, and data and research from other nations could also help to calibrate both the balance sheet and strategic defaults channels.

One of the reasons "housing lock" has attracted attention is because it may be related to the functioning of the labor market and to the rate at which unemployed workers find new jobs. While this paper has shown that negative home equity can reduce the likelihood that homeowners leave their local labor market, it has not explored how house price fluctuations and variation in housing equity affect the rate at which homeowners find new jobs. The effects of housing lock on job finding rates, unemployment, and the quality of job and housing matches are important questions for future research.

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Table 1: Buyer Summary statistics

	Mean	median	sd	N
1995-2012 panel of buyers				
Annual Mobility (%)	5.31	0	22.41	3,783,286
Annual Inter labor market mobility (%)	1.39	0	11.73	3,781,227
2007-2012 panel of buyers with balance sheet data				
Annual Mobility(%)	4.31	0	20.31	1,956,183
Annual Inter labor market mobility (%)	1.12	0	10.51	1,955,474
LTV ratio (%)	75	81	37	1,969,905
LTV ratio below 50 (%)	25	0	44	1,969,905
LTV ratio btwn 50-90 (%)	33	0	47	1,969,905
LTV ratio btwn 90-100 (%)	12	0	32	1,969,905
LTV ratio btwn 100-110 (%)	12	0	33	1,969,905
LTV ratio btwn 110-150 (%)	17	0	38	1,969,905
Negative home equity dummy (%)	30	0	46	1,969,905
Home equity (€1000)	74	41	123	1,969,905
Home equity if negative (€1000)	-29	-22	31	581,158
Zero mortgage balance dummy (%)	7	0	26	1,969,905
Financial assets (€1000)	77	17	563	1,969,663
Net liquid assets if house sale (€1,000)	151	74	593	1,969,663
Financial-Assets-To-Value ratio (%)	23	8	115	1,969,663
Financial-Assets-To-Value ratio below 15 (%)	68	1	47	1,969,663
Financial-Assets-To-Value ratio btwn 15-35 (%)	18	0	38	1,969,663
Financial-Assets-To-Value ratio above 35 (%)	15	0	34	1,969,663
Buyers in the year of the move into the property				
Age	36.86	34	11.88	574,337
Household size	2.36	2	1.19	574,337
Male	0.86	1	0.35	574,337
Native to country	0.85	0	0.35	574,337
Married	0.42	0	0.49	574,337
Kids dummy	0.35	0	0.48	574,337
Divorce in year dummy	0.031	0	0.173	548,076
Cohabiting couple split dummy	0.068	0	0.252	548,076

Notes: The top panel presents annual mobility and intermarket mobility indicators measured in every year where the buyer lives at a sampled purchased property on January 1st. The middle panel gives summary statistics regarding mobility and balance sheet variables for the 2007-2012 person-years. The variables in the bottom panel are measured at the end of the year of the move into the property. Male, native to country, married and kids dummy are all indicator variables for the given characteristic of the buyer. See Section 4 in the text for more details on the CBS data on buyers.

Table 2: Buyer summary Statistics by Cohort

Cohort	Age	Household Size	Male	Married	# Transactions
1995	36.00	2.44	0.89	0.51	26261
	(11.49)	(1.19)	(0.32)	(0.50)	
1996	36.11	2.44	0.89	0.50	31916
	(11.41)	(1.20)	(0.32)	(0.50)	
1997	36.10	2.42	0.89	0.48	33271
	(11.41)	(1.19)	(0.32)	(0.50)	
1998	36.09	2.42	0.89	0.47	34331
	(11.31)	(1.20)	(0.32)	(0.50)	
1999	36.27	2.41	0.88	0.46	36540
	(11.42)	(1.20)	(0.32)	(0.50)	
2000	36.38	2.38	0.88	0.44	34431
	(11.55)	(1.19)	(0.33)	(0.50)	
2001	36.68	2.39	0.87	0.43	36482
	(11.69)	(1.19)	(0.33)	(0.50)	
2002	36.67	2.38	0.87	0.41	38001
	(11.65)	(1.19)	(0.34)	(0.49)	
2003	36.86	2.37	0.86	0.41	36634
	(11.73)	(1.20)	(0.35)	(0.49)	
2004	37.20	2.33	0.85	0.40	37217
	(11.98)	(1.19)	(0.36)	(0.49)	
2005	37.53	2.33	0.84	0.39	39387
	(12.03)	(1.19)	(0.37)	(0.49)	
2006	37.76	2.34	0.84	0.38	40933
	(12.08)	(1.20)	(0.37)	(0.49)	
2007	38.02	2.31	0.84	0.38	38757
	(12.42)	(1.18)	(0.37)	(0.48)	
2008	37.59	2.32	0.84	0.37	36472
	(12.32)	(1.18)	(0.37)	(0.48))	
2009	36.25	2.21	0.82	0.33	25933
	(12.22)	(1.14)	(0.38)	(0.47)	
2010	36.78	2.22	0.82	0.33	24538
	(12.31)	(1.15)	(0.38)	(0.47)	
2011	37.65	2.25	0.82	0.35	23233
	(12.74)	(1.16)	(0.38)	(0.48)	

Notes: Age, household size, male and married are measured on December 31st of the year of the move into the property. Male and married are indicator variables for the given characteristic of the buyer. See Section 4 in the text for more details on the CBS data on buyers.

Table 3: Impacts of home equity on annual total and interlabor market mobility

	(1) Mobility	(2) Mobility	(3) Mobility	(4) Inter lab. mkt.
$50 < LTV \leq 90$	-0.41	-0.27	-0.08	-0.02
	(0.04)	(0.07)	(0.06)	(0.03)
$90 < LTV \leq 100$	-0.59	-0.30	-0.24	-0.02
	(0.06)	(0.08)	(0.07)	(0.03)
$100 < LTV \leq 110$	-1.57	-1.02	-1.01	-0.20
	(0.06)	(0.08)	(0.08)	(0.04)
$LTV > 110$	-2.32	-1.22	-1.22	-0.29
	(0.05)	(0.06)	(0.06)	(0.03)
Person age category FE	Yes	Yes	Yes	Yes
Loan age FE	Yes	Yes	Yes	Yes
Other controls	No	No	Yes	Yes
Time · region FE	No	Yes	Yes	Yes
Observations	1,956,183	1,956,183	1,956,003	1,955,294
Mean of dep. var.	4.31	4.31	4.31	1.12

Notes: This table reports results from the estimation of linear probability models of annual mobility dummies. The models are estimated using the 2007-2012 panel. The dependent variable in Columns (1)-(3) is total annual mobility. The dependent variable in Column (4) is mobility across local labor markets. The controls are loan age fixed effects, 5 person age category fixed effects, 5 household size category fixed effects, 3 financial asset category fixed effects and indicators for male, native to the country, married and a change in familiy size. Standard errors in parentheses are clustered on region-years in Columns (2)-(4).

Table 4: Impacts of home equity on annual mobility: Balance sheet effects

	(1) Mobility	(2) Mobility	(3) Mobility	(4) Mobility
Sample: Financial-Assets-To-Value ratio (%)	All	Above 35	15-35	Below 15
$50 < LTV \leq 90$	-0.15	0.29	0.46	-0.48
	(0.07)	(0.11)	(0.13)	(0.07)
$90 < LTV \leq 100$	-0.34	0.03	0.49	-0.67
	(0.08)	(0.20)	(0.19)	(0.09)
$100 < LTV \leq 110$	-1.11	-0.07	-0.41	-1.48
	(0.08)	(0.19)	(0.16)	(0.09)
$LTV > 110$	-1.36	-0.22	-0.67	-1.64
	(0.06)	(0.19)	(0.16)	(0.07)
Time · region FE	Yes	Yes	Yes	Yes
Financial assets FE	No	No	No	No
Controls	Yes	Yes	Yes	Yes
Observations	1,956,003	283,272	346,862	1,325,869
Mean of dep. var.	4.31	4.62	4.68	4.14

Notes: This table reports results from the estimation of linear probability models of annual total mobility indicators. The models are estimated using the 2007-2012 panel. Column (1) is estimated in the full sample of buyers. Columns (2)-(4) estimate the model in subsamples of observations grouped by the household Financial-Assets-To-Value ratio category in a given year. The ratio between financial assets and the value of the house is respectively above 35% in Column (2), between 15 and 35% in Column (3) and below 15% in Column (4). The controls are loan age fixed effects, 5 person age category fixed effects, 5 household size category fixed effects, and indicators for male, native to the country, married and a change in familiy size. The specification in this table does not include fixed effects for financial asset holdings categories. Standard errors in parentheses are clustered on region-years.

Table 5: Impacts of home equity on annual mobility across labor markets: Balance sheet effects

	(1)	(2)	(3)	(4)
	Inter lab. mkt.	Inter lab. mkt.	Inter lab. mkt.	Inter lab. mkt.
Sample: Financial-Assets-To-Value ratio (%)	All	Above 35	15-35	Below 15
$50 < LTV \leq 90$	-0.02	0.06	0.13	-0.10
	(0.03)	(0.05)	(0.06)	(0.03)
$90 < LTV \leq 100$	-0.02	0.07	0.21	-0.12
	(0.04)	(0.10)	(0.08)	(0.04)
$100 < LTV \leq 110$	-0.21	0.06	0.05	-0.31
	(0.04)	(0.08)	(0.06)	(0.05)
$LTV > 110$	-0.30	-0.04	-0.16	-0.37
	(0.03)	(0.10)	(0.07)	(0.04)
Time · region FE	Yes	Yes	Yes	Yes
Financial assets FE	No	No	No	No
Controls	Yes	Yes	Yes	Yes
Observations	1,955,380	283,180	346,735	1,325,379
Mean of dep. var.	1.12	1.13	1.10	1.12

Notes: This table reports results from the estimation of linear probability models of annual mobility across local labor markets indicators. The models are estimated using the 2007-2012 panel. Column (1) is estimated in the full sample of buyers. Columns (2)-(4) estimate the model in subsamples of observations grouped by the household Financial-Assets-To-Value ratio category in a given year. The ratio between financial assets and the value of the house is respectively above 35% in Column (2), between 15 and 35% in Column (3) and below 15% in Column (4). The controls are loan age fixed effects, 5 person age category fixed effects, 5 household size category fixed effects, and indicators for male, native to the country, married and a change in familiy size. The specification in this table does not include fixed effects for financial asset holdings categories. Standard errors in parentheses are clustered on region-years.

Table 6: Impacts of home equity on annual mobility: life-event buyers

	(1) Mobility	(2) Mobility	(3) Inter lab. mkt.	(4) Inter lab. mkt.
$LTV > 100$		-1.27		-0.14
		(0.23)		(0.13)
$50 < LTV \leq 90$	0.34		0.23	
	(0.23)		(0.11)	
$90 < LTV \leq 100$	0.36		0.13	
	(0.38)		(0.18)	
$100 < LTV \leq 110$	-0.93		0.08	
	(0.34)		(0.20)	
$LTV > 110$	-1.09		-0.06	
	(0.25)		(0.15)	
Time · region FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	113,539	113,539	113,514	113,514
Mean of dep. var.	6.93	6.93	2.13	2.13

Notes: This table reports results from the estimation of linear probability models of annual mobility dummies. The dependent variable in Columns (1)-(2) is the total annual mobility. The depedent variable in Columns (3) and (4) is the annual mobility across different local labor markets. The models are estimated using the 2007-2012 panel. The controls are loan age fixed effects, 5 person age category fixed effects, 5 household size category fixed effects, 3 financial assets category fixed effects and indicators for male, native to the country, married and a change in familiy size. Standard errors in parentheses are clustered on region-years.

Table 7: Impacts of home equity on annual mobility: Regional variation

	(1) Mobility	(2) Mobility	(3) Inter lab. mkt.	(4) Inter lab. mkt.
$50 < LTV \leq 90$	-0.14	-0.14	-0.03	-0.03
	(0.13)	(0.14)	(0.04)	(0.04)
$90 < LTV \leq 100$	-0.27	-0.27	-0.04	-0.04
	(0.16)	(0.16)	(0.05)	(0.05)
$100 < LTV \leq 110$	-0.95	-0.92	-0.21	-0.19
	(0.20)	(0.20)	(0.06)	(0.06)
$LTV > 110$	-1.26	-1.21	-0.32	-0.29
	(0.20)	(0.21)	(0.05)	(0.06)
Time · cohort FE	Yes	Yes	Yes	Yes
Time · Region FE	No	No	No	No
Region FE	No	Yes	No	Yes
Controls	Yes	Yes	Yes	Yes
Observations	1,956,003	1,956,003	1,955,294	1,955,294
Mean of dep. var.	4.31	1,956,003	1.12	1.12

Notes: This table reports results from the estimation of linear probability models of annual mobility indicators. The dependent variable in Columns (1)-(2) is total mobility and the dependent variable in Columns (3)-(4) is inter labor market mobility. The models are estimated using the 2007-2012 panel. The controls are 5 person age category fixed effects, 5 household size category fixed effects, 3 financial assets category fixed effects and indicators for male, native to the country, married and a change in familiy size. Standard errors in parentheses are clustered on cohort-years.

Table 8: Impacts of home equity on annual mobility: Robustness

	(1) Mobility	(2) Inter lab. mkt.	(3) Mobility	(4) Inter lab. mkt.
$50 < LTV \leq 90$	0.08	0.03	-1.07	-0.12
	(0.05)	(0.03)	(0.13)	(0.05)
$90 < LTV \leq 100$	-0.07	0.03	-1.61	-0.27
	(0.07)	(0.03)	(0.18)	(0.07)
$100 < LTV \leq 110$	-0.75	-0.13	-2.12	-0.49
	(0.10)	(0.04)	(0.19)	(0.09)
$LTV > 110$	-0.86	-0.22	-2.26	-0.56
	(0.08)	(0.04)	(0.19)	(0.09)
Time · region FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Sample	1995-2008 buyers	1995-2008 buyers	Always-singles	Always-singles
Observations	1,816,985	1,816,301	235,085	235,041
Mean of dep. var.	4.48	1.15	2.65	0.72

Notes: This table reports results from the estimation of linear probability models of annual mobility indicator variables. The dependent variable in Columns (1) and (3) is the total annual mobility dummy. The depedent variable in Columns (2) and (4) is the annual mobility across different local labor markets. The models are estimated using the 2007-2012 panel. The sample in Columns (1)-(2) is restricted to buyers who started their ownership spell prior to 2009. The sample in Columns (3)-(4) is restricted to buyers who are single during every year of the ownership spell. The controls are loan age fixed effects, 5 person age category fixed effects, 5 household size category fixed effects, 3 financial assets category fixed effects and indicators for male, native to the country, married and a change in familiy size. Standard errors in parentheses are clustered on region-years.

Table 9: Impacts of home equity on annual mobility: Robustness

	(1) Inter prov. mob.	(2) Mobility	(3) Mobility	(4) Inter lab. mkt.
$50 < LTV \leq 90$	-0.06	-0.14	-0.06	-0.01
	(0.02)	(0.06)	(0.07)	(0.03)
$90 < LTV \leq 100$	-0.06	-0.35	-0.19	-0.02
	(0.03)	(0.07)	(0.07)	(0.03)
$100 < LTV \leq 110$	-0.19	-1.09	-0.94	-0.18
	(0.03)	(0.09)	(0.08)	(0.04)
$LTV > 110$	-0.25	-1.15	-0.96	-0.23
	(0.03)	(0.06)	(0.07)	(0.03)
Time · region FE	Yes	Yes	Yes	Yes
Time · person age category FE	No	Yes	No	No
Other controls	Yes	Yes	Yes	Yes
Sample	Full	Full	Non-trimmed	Non-trimmed
Observations	1,955,945	1,956,003	2,004,999	2,004,280
Mean of dep. var.	0.75	4.31	4.31	1.12

Notes: This table reports results from the estimation of linear probability models of annual mobility indicator variables. The dependent variable in Column (1) is the annual mobility across provinces. The dependent variable in Columns (2)-(3) is the total annual mobility. The dependent variable in Column (4) is the mobility across local labor markets. The models are estimated using the 2007-2012 panel in Columns (1)-(2). The models are estimated using the 2007-2012 panel, including the person-years with extreme LTV ratios below 0 or above 150 in Columns (3)-(4). The controls are loan age fixed effects, 5 person age category fixed effects, 5 household size category fixed effects, 3 financial assets category fixed effects and indicators for male, native to the country, married and a change in familiy size. The controls in Column (2) also include fixed effects for the interaction between the calendar year and 5 person age category fixed effects. Standard errors in parentheses are clustered on region-years.

Table 10: Mobility simulations for 1995-2008 purchase cohort buyers during Great Recession years 2009-2012

Type of scenario	Baseline	Scenario 1	Scenario 2	Scenario 3
	LTV inputs:			
Average annual house price changes 2009-2012 (%)	-4	8.5	2.25	-4
LTV at origination maximum (%)				95
	Mobility outputs:			
Cumulative mobility rate 2009-2012 (%)	14.2	15.3	14.9	15.0
Impact on cumulative mobility 2009-2012 vs. baseline (%)	0	7.5	5.1	5.8
Impact on mobility rate in 2012 vs. baseline (%)	0	11.2	9.4	5.2

Notes: This table simulates counterfactual mobility rates in three scenearios for LTV trajectories. The scenarios are applied to the 1995-2007 buyers in my sample for the calendar years 2009-2012. From the distribution of LTV ratios in the scenarios, I simulate counterfactualy mobility using the estimated effects of loan-to-value ratios on mobility using the point estimates in Column 3 of Table 3. See section 7 of the text for more details on the assumptions formulated in each of the three scenarios.

A Supplementary exhibits

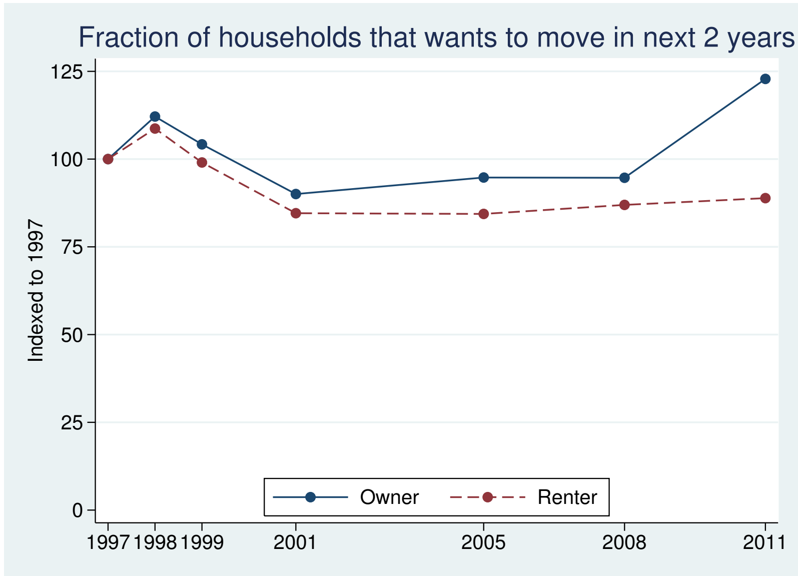

Figure A.1: Mobility intentions of owners and renters over time

Notes: The data are from the WBO 1998, 1999, 2000 and WoON 2002, 2006, 2009 and 2012 surveys. WoON (WoonOnderzoek Nederland) is a repeated cross-sectional nationally representative survey of about 70,000 individuals about their housing situations which was known as WBO (WoningBehoefteOnderzoek) until 2000.

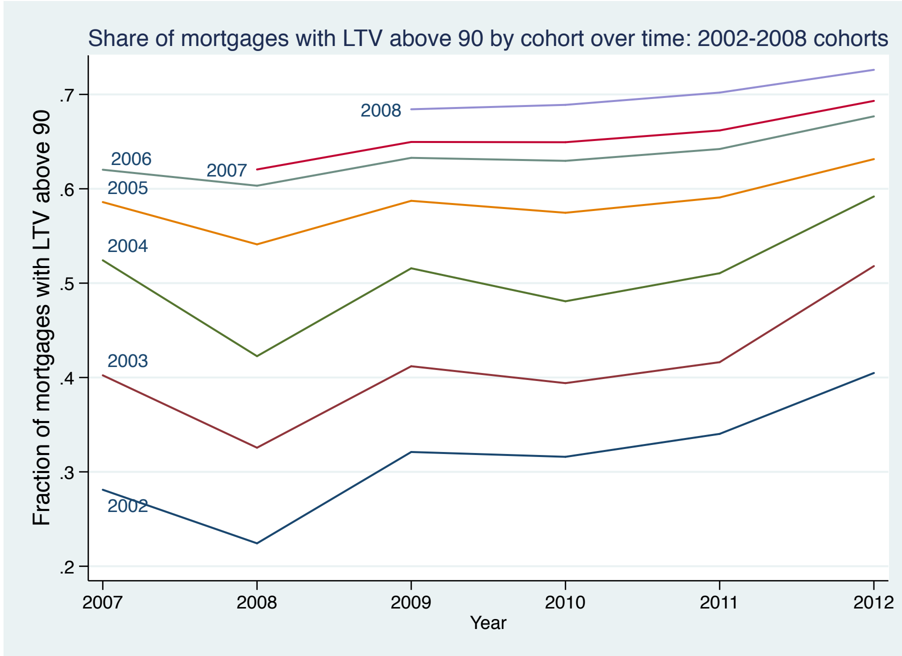

Figure A.2: Fraction of mortgages with LTV above 90 by cohort over time

Notes: The share of mortgages with a LTV ratio above 90 is based on CBS household balance sheet, transaction price and regional house price index data. See section 4 of the text for more details.

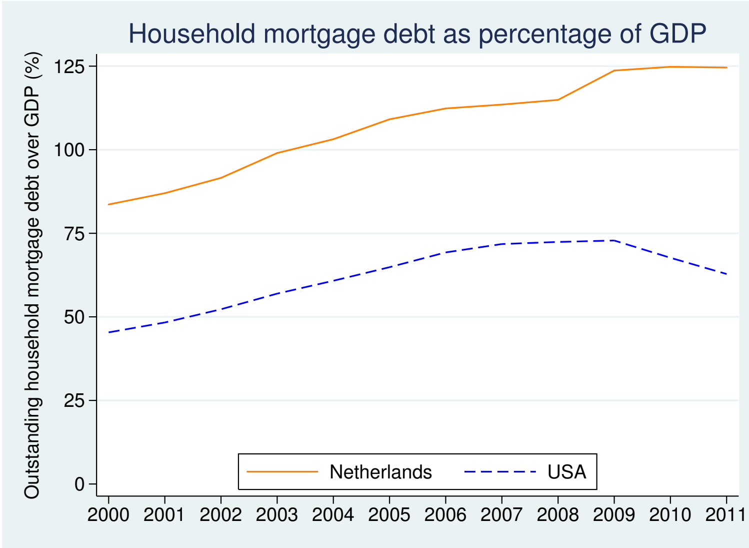

Figure A.3: Household debt to GDP ratio for the US and the Netherlands

Notes: The sources are Statline Statistics Netherlands and Federal Reserve Bank of St. Louis Economic Data.

Figure A.4: Construction of panel of buying heads of existing homes

Notes: The figure provides visual support for the explanation of the construction of the sample of buyers of transacted existing homes and the associated panel of buyer-years. See section 4 of the text for more details.

Figure A.5: Description of selection of transactions

Criterion	Deleted observations	**Remaning observations**
Initial transaction data 1995-2011		3,057,528
Missing address	35,242	3,022,286
More than one transaction at address per quarter	32,066	2,990,220
Random 25% selection	2,242,666	747,554
No match to start address spell of person moving in	116,607	630,947
More than one transaction per person per year at address	1,773	629,174
No match to household spell	37	629,137
More than one move per person at a given address in a year	825	628,349
Move after 2011 (we cannot measure subsequent mobility in 2013)	3,034	625,315
Match to exactly one household head	47,500	577,815
More than one purchase of given address by given household head	45	577,770
No match of transaction address to January address of next year	3,433	574,337
Selected transactions matched to head of household		**574,337**

Notes: This table summarizes the number of deleted and remaining observations at each step of the construction of the sample of buyers. See Appendix B of the text for more details.

B Data Appendix on Construction of Sample of Buyers

I construct the 1995-2012 buyers in three steps. First, I randomly select 25% of the transactions of existing owner-occupied homes in 1995-2011. Second, I identify the unique household head among the persons moving into the selected property. Third, I build a panel following these identified buyers over the period 1995-2012. I now detail each of these three steps as well as the number of remaining observations after each step shown in Figure A.5.

Random selection 25% of transactions in 1995-2011. I make use of the universe of 3,057,528 transactions of the existing owner-occupied dwellings file with transaction dates during the period 1995-2011. This file has as identifiers an address and a month of home purchase. I drop 35,242 transactions for which the address variable is missing and keep 3,022,286 transactions**.** I drop 32,066 transactions for which there is more than 1 transaction in a given quarter for a given address and keep 2,990,220 transactions**.** Given memory constraints, I then randomly select 25% of the purchases to obtain 747,554 purchase transactions.

Identifying unique household heads among persons moving in into sampled properties. To identify the unique household head from the persons moving into a selected property, I first consider all the individuals moving in during the same quarter at a given address. I use the universe of individual address spells with coverage January 1995-December 2012, which has as identifiers an address, an encrypted social security number, a spell start date and a spell end date. There are 35,642,414 individual address spells starting after January 1st 1995[18]. I

[18]I drop the 15,415,895 left-censored spells starting exactly on January 1st, 1995; the database starts on January 1st 1995.

drop 1,198,597 individual address spells with more than 10 persons moving in[19] and obtain 34,443,817 individual address spells. I consider all the address spells on a given address starting in a given quarter and regroup them. The 34,443,817 individual address spells correspond to 21,467,505 household address spells.

I then merge the 747,554 purchase transactions with the 21,467,505 reshaped household address spells using the addresses and quarter of purchase of spell start as keys. 398,826 transactions (=53.35% of the transactions) are matched to a spell that starts in the same quarter as the purchase date. 185,575 (=24.82%) of the transactions are matched to a spell that starts in the quarter after purchase. Finally, 46,546 (=6.23%) of the transactions are matched to a spell that starts two quarters after the purchase. Hence, I match 630,947 of the 747,554 purchase transactions (=84.40%).[20]

To identify the household heads for the selected transactions, I use the head of household identifier dummy on December 31st of the transaction year from household structure spells that I will match to transactions. The head of household dummy is created by Statistics Netherlands with a time-consistent and intuitive rule. If there is a couple in the household, then the male member of the couple is the head of household. If the couple is of the same gender, then it is the oldest person. The head of single-parent household heads is the parent. In an "other household", the head is the oldest male, 15 years or older- and if this is missing- the oldest woman, 15 years or older. In multiple-generation households (e.g. non-married pair with daughter and mother), then the partner in the couple rule dominates the parent rule in a single-parent family and in the case of two (via child-parent related) pairs, the head is chosen as the youngest pair.

To select the head of household from the persons who moved in an address, I list all the individuals moving into the sampled transactions, and I consider 1,441,087 person moving-in years corresponding to the 630,947 transactions. The 1,441,087 person moving-in years correspond to 1,364,733 distinct persons. Focusing on persons who have only 1 transaction per year per address in our 630,947 transactions, I drop 4,445 person-years and get 1,436,642 moving in person years, which corresponds to 1,362,594 distinct persons and 629,174 transactions. To identify the head in the year of the move, I then build a annual panel of household structures of persons moving in. I therefore merge the universe of 138,238,794 household spells with the list of 1,362,594 transacting distinct persons using the SSN. Household spells have as a unit of observation a SSN, a family-structure-spell start date, a family-structure-spell end date and a household number. 21 persons cannot be matched and I find 13,244,303 individual household structure spells for the 1,362,573 matched distinct persons. Because of insufficient disk space constraints, I drop the 1,576 household spells (0.01% of 13,244,303 spells) with more than 150 household spells to keep 13,242,727 spells.I then match the moving in person-years and person-years from the household structure panel. From the 1,436,642

[19]The main goal is to avoid those who moved into institutional addresses (e.g. senior citizen housing, nursing homes).

[20]For the remaining 116,607 non-matched transactions, I observe the variable "Is the buyer a current renter" (which has always been measured since 1998 and never before) for 85,732 transactions. 27,276 of those 85,732 non-matched transactions are bought by current renters (17,028 are sales by public housing corporations).

moving in person years (629,174 transactions), I can match 1,436,459 person years (629,137 transactions) to their household structure in December of the year of the transaction. I then restrict myself to the 1,434,705 moving in person years (628,349 transactions) where there is only 1 selected move in that year for that person at that address. I then drop transactions for which the move starts in 2012, as I cannot observe subsequent mobility out of purchase dwellings in 2013 and later as of yet. I thus drop 6,750 moving in person years for which the moving in date occurs in 2012 (0.47%), and I obtain 1,427,955 moving in person-years (625,315 transactions). I then match transactions and heads.

From the 625,315 transactions, I can match 577,815 transactions (=92.40%) to exactly 1 household head (as defined by SN) using the panel of household structures of persons moving in. However, 5.06% of the transactions have no household head and 2.20% of the transactions are associated to starting address spells for 2 household heads. To keep things simple and non arbitrary, I keep the 577,815 transactions associated to starting address spells with exactly one household head (which corresponds to 1,332,388 moving in person years). The 577,815 transactions- that we can match to the start of the address spell of a unique household head correspond to 552,168 distinct persons. 527,407 (95.52%) persons occur once, 23,912 persons twice (4.33%), 812 persons three times (0.15%) and 37 persons four times (0.01%). I then use the universe of 2012 time-unvarying personal characteristics file GBAPERSOONTAB and merge it with the list of 577,815 selected and matched buying heads of households using the SSN as key.

Building a 1995-2012 panel for selected buyers To know the address before and after the purchase, we build a panel of December addresses for the 552,168 distinct persons retaining the 2,175,981 address spells of the 552,168 distinct persons. I reshape the 2,175,981 address spells into 552,168 lines where we put the 1 to 40 addresses of a given person on 1 line. I then reshape the file to create 18 December addresses for the 552,168 distinct persons which corresponds to 9,939,024 person-years (=18*552,168). I then merge the 9,939,024 person-years and the list of 552,168 distinct persons using as key, the SSN and the year (where the year is the year in which the address spell associated to the transaction began). Finally, I implement two minor transaction sample restrictions using the panel of addresses. First, before defining mobility, I drop 378 person years- which corresponds to 45 transactions- if the same person buys the same address more than once to keep 9,938,646 person years (552,147 persons) and 577,770 transactions. Second, for 3,433 out of the 577,770 transactions, the January address after the move in is already different from the address where the buyer moved in. I focus on the remaining 99.44% or 574,337 transactions.