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

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Abstract

This paper employs Dutch administrative population data to test the "housing lock hypothesis": the conjecture that homeowners with negative home equity, low levels of financial assets and restricted opportunities to borrow reduce their mobility. We exploit variation in home equity solely driven by the timing of home purchase within a municipality and the harshness of Dutch recourse laws, which allow us to isolate the housing lock channel. Instrumented negative home equity is associated with a 74-79% decline in mobility, and the effects are substantially larger for households with low financial asset holdings or moves over longer distances.

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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 about 30% in the US and by 35% in the Netherlands.[1] 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. "Housing lock" may also be important for reasons unrelated to the labor market, including the quality of housing matches, the ability to smooth income shocks (Ejarque and Leth-Petersen (2014)), take entrepreneurial (Bracke et al. (2014)) or investment risk (Chetty and Szeidl (2014)) as well as the level of consumer spending (Best and Kleven (2013)).

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. We can cleanly isolate the housing lock channel, given the quasi-absence of defaults in the Netherlands. We construct an instrument for negative home equity based on the variation in home equity driven only by the timing of purchase within a given municipality. Our estimates– effectively based on the comparison of mobility rates of different purchase cohorts in the same year and in the same municipality– suggests that negative home equity is associated with a 74-79% decline in mobility, and the effects of falling home equity are substantially larger for households with low financial asset holdings or moves over longer distances. These results support the "balance sheet channel", where households with sufficient liquid assets and low opportunity costs of capital, can reduce the effect of housing lock. These results also suggest that housing lock is likely of significant economic importance since the effect is larger as the distance increases, rather than just preventing short distance moves that may be of less economic significance.

The existing literature investigating the relationship between home equity and mobility in the United States typically finds conflicting results. While Ferreira et al. (2010) and Gopalan et al. (2017) find lower mobility for underwater homeowners, Schulhofer-Wohl (2012), Coulson and Grieco (2013), and Demyanyk

[1] Mobility data among homeowners are from the Current Population Survey for the US and from the WoON survey for the Netherlands.

et al. (2017) detect higher mobility for underwater owners. These conflicting findings likely reflect the challenges of (1) isolating the housing lock channel in the US–where negative home equity increases the incentives to relocate through strategic default–, (2) the endogeneity of home equity, and (3) data availability. This paper is able to address these concerns by examining the role of housing lock in the Netherlands. The Netherlands–where home prices and mobility also fell sharply during the Great Recession– offers the institutional set-up that allows isolating housing lock, and the benefit of unique administrative data on household mobility, housing, balance sheets and family structure.

It is often argued that home equity affects household mobility through at least two channels. The balance sheet or housing lock channel suggests that credit market imperfections can cause lower mobility rates for households with limited or negative home equity. Mortgage lenders on a new property typically demand a larger downpayment than underwater households have available, so households with limited home equity may be unable to move.[2] 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.[3] These countervailing forces might offer part of the explanation for why authors Demyanyk et al. (2017) find some evidence that negative home equity increases moving among predominantly subprime U.S. borrowers, while Gopalan et al. (2017) find the opposite relationship among a higher credit quality pool of U.S. borrowers. In the Netherlands though, strategic default incentives are very limited since under Dutch civil law mortgage lenders have strong protection relative to borrowers. When Moody's ranked countries in terms of both the legal right for recourse and the practical application of recourse, the U.S. ranked as the weakest on both counts, while the Netherlands was ranked as "very strong" on the legal right of recourse and its application in practice, the highest ranking in either category. The result is that foreclosure rates in the U.S. at their peak were almost a hundred times higher than in the Netherlands, even though a higher proportion of households had negative equity in the Netherlands. In this strictly enforced full-recourse setting, the quasi-absence of defaults permits us to isolate the housing lock channel and shut down the strategic default channel.

Since moving rates and home equity are likely to be co-determined, the identification 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

[2]Imperfections in the rental market may exacerbate the housing lock by making it difficult to rent their existing property.

[3]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.

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, our empirical model eliminates local business-cycle effects by including fixed effects for the interaction between the calendar year and the municipality, and fixed effects for the loan age. To pick-up only variation in home equity driven by the timing of purchase within a given municipality, we instrument for the odds of negative home equity with a "synthetic" LTV ratio (SLTV). The synthetic LTV approach–introduced by Bernstein (2017) in the context of labor supply and mortgage modifications and subsequently also used by Gopalan et al. (2017)–eliminates variation in home equity arising from differences in downpayments, pre-payments, or time-varying local economic conditions. Consistent with Stein (1995)'s model we find that high SLTV ratios are associated with reduced mobility. In a flexible estimation of the effect of the SLTV ratio on mobility, we uncover a non-linear but monotone pattern of mobility, which declines in the SLTV ratio.

This variation in instrumented 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, we first show that households who have different levels of synthetic LTV are observationally equivalent in terms of interest rate, income, family size, months till rate reset, loan-to-value, and house price at origination. This finding suggests it is unlikely that our instrument is correlated with observable characteristics at origination that could affect sensitivity to local demand shocks. Second, we complement our general instrumental IV approach with an analysis of life-event driven moves based on the timing of divorces or co-habitating splits. The unique Dutch administrative data allow us not only to track the household addresses, and balance sheets, but also family structures. The family structure data allows to use life events as exogenous shifters in the timing of purchase, and therefore home equity. We exploi**t** 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 the large housing lock effects associated with negative home equity. In a battery of additional robustness and placebo tests, we show that the housing lock finding is not driven by a correlation between timing and location of house purchase by including fixed effects for the interaction of time and more than 12,000 granular neighborhoods. We also show that there is no relationship between negative SLTV and mobility among the placebo sub-group of cash-buyers, again suggesting that the observed results are driven by housing lock, and not by any overall trends in home buying and subsequent moving probabilities.

The Dutch administrative balance sheet data also allow us to test an additional prediction of the theoretical model of Stein (1995), that high LTV ratios hamper mobility more severely for households with low levels of liquid financial assets, which would not be feasible with data available in the United States.[4] While a SLTV ratio in excess of 100% is associated with a substantial reduction in mobility, about half the reduction is negated by the presence of substantial levels of liquid assets. These results are consistent with the predictions of Stein (1995), but tightening the link to the balance sheet theory more clearly we also show that the presence of liquid assets sufficient to overcome the household's specific negative home equity plus average additional moving costs causes an even larger attenuation of the overall effects of housing lock on mobility.[5] This last finding highlights the importance of an integrated view of household balance sheets in understanding household mobility.

The population addresses available in this Dutch dataset also makes it possible to define the destination of the move, to distinguish moves within and across local labor markets, and to examine the relationship between housing lock and moving distance. The Stein (1995)'s balance sheet model does not explicitly predict whether housing lock is less or more severe for long-distance moves, but does still provide a framework to analyze this question. We show that the estimated percent decline in annual mobility becomes larger in magnitude monotonically in distance of the move. Through the lens of our Stein (1995)-based toy model, this is consistent with higher upfront pecuniary costs (e.g. trucks, new furniture, time away from job) or larger desired precautionary liquidity buffers for longer-distance moves. Since these effects increase in distance, the impact of housing lock is likely to be of important economic significance[6] including in larger countries.[7]

Overall, this paper makes three contributions. First, we cleanly isolate the housing lock channel exploiting the unique Dutch institutional setting. Second, our identification strategy–based on SLTV instruments and the novel life-event approach–allows quantifying the causal lock-in effect. Third, exploiting the unique wealth data, we directly test the balance sheet channel. In terms of the external validity of our findings, the increase in distance of the effects suggests that the housing lock channel is also likely to be of important economic

[4]While existing studies using survey data may have access to some self-reported information on financial assets, they 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)) confounding attempts at clean causal identification and reliance on self-reported assets in an instance where households are distressed are unlikely to yield reliable figures. By constrast the data in this paper features more than 580,000 underwater person-year observations with adminstrative information on assets with mandated reporting and documentation by financial instutitions, rather than estimated by individuals.

[5]Even in markets where mortgage lenders have full recourse to non-home equity, the share of home equity in total liquid net worth can affect mobility as the mortgage is collateralized by the attached house, which cannot be sold without the lender's permission, in contrast to financial assets which can easily be converted in consumption.

[6]Based on the 2014 U.S. Census 57.6% of housing-related moves (such as wanting a new or better house) and 29.9% of family-related moves are intracounty, while only 10.5% of job-related moves are intracounty. This is consistent with long moves tending to be overrepresented by moves of significant economic importance, such as job search, and highlights the significant for potential pecuniary or non-pecuinary costs caused by housing lock. A detailed exploration of these costs is beyond the scope of this paper, but an important area for future work.

[7]Acccording to the 2010 National Association of Realtors annual survey the median move in the U.S. was approximately 12 miles or ~19.3km, but according to the 2010 U.S. census 45% of intercounty movers moved at least 50 miles or ~80.4km.

significance in larger countries.

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 describes the Dutch institutions and how they allow isolating housing lock. Section 4 describes the data. Section 5 lays out the empirical strategy. Section 6 first reports the IV results based on house price trajectory variation across purchase cohorts, then addresses potential remaining identification concerns by showing the absence of selection on observables and the housing lock estimates for life-event buyers, and finally demonstrates the balance sheet effects. Section 7 concludes.

2 Aggregate House Price and Mobility Patterns

This section presents aggregate information on Dutch housing pricing trends and mobility. Figure 1 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. National nominal house prices fell by 20% from the peak to the trough.

We start by presenting visual evidence for the housing lock hypothesis by comparing mobility rates of (1) buyers vs. renters, (2) various purchase cohorts, and (3) mortgage buyers vs. cash buyers.

Mobility patterns of buyers and renters Figure 2 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 share of homeowners that would like to move rises by 30%, while moving intentions of renters are flat (see Supplementary Exhibit 8.1). Both the large decline in household mobility as well as the rise in mobility intentions are thus concentrated among home-owners.

Home equity and mobility patterns across purchase cohorts We now graphically present our main empirical strategy, 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 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.[8] 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.

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 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 decline in 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.

Mobility patterns of mortgage borrowers and cash buyers Figure 8.2 presents mobility patterns across purchase cohorts for the subset of cash buyers. While early and peak cash buyers are differentially exposed to home prices, the housing lock hypothesis relies on borrowing constraints on borrowers with negative levels of home equity. And as predicted by the housing lock hypothesis, the mobility rates of early and peak cash buyers–who all have positive home equity–are remarkably similar.

Overall, Figures 2, 4 and 8.2 provide compelling, suggestive evidence of the housing lock. But, one could imagine various reasons why mobility rates of peak mortgage borrowers fall more than those of renters, early mortgage borrowers and peak cash-buyers. Our econometric analysis will therefore more formally instrument

[8]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.

for the odds of negative home equity by using synthetic LTV ratios that vary only at the cohort-municipality-time level. To inform the "external validity" of our findings, the next section puts the Dutch housing and mortgage institutions in an international perspective and argues that the Dutch institutions allow isolating the "housing lock" channel.

3 Dutch Institutions and Housing Lock

This section describes the Dutch mortgage, housing and labor market institutions. We first point out that the Dutch full recourse mortgage regime allows isolating the housing lock channel, while research on mobility in the US arguably confounds additional channels, including the impact of home equity on default incentives. We describe other important Dutch institutional factors beyond default incentives that likely influence the effects of negative home equity on mobility. For more discussion on Dutch mortgage characteristics and the costs of housing lock in international perspective see appendix section 10.

Isolating "housing lock" from "default channel" In the US, households with underwater mortgage can typically relocate by defaulting "strategically". In the Netherlands, however, mortgages are originated in an environment that provides low incentives to default at a given LTV ratio, mostly because lenders have full recourse. Therefore**,** like in most countries, the defaulting Dutch 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)).

While several US states are sometimes classified as "full recourse", the degree of recourse–and more broadly the incentives to strategically default–are in practice a continuous rather than a binary variable. When Moody's analyzed both the legal rights and practical enforcement of recourse across developed mortgage markets, the United States was ranked as the weakest of all countries considered for both legal rights for recourse and enforcement, while the Netherlands was rated as the strongest in both categories. Perhaps not surprisingly, 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 very low Dutch institutional incentives to default strategically–even on a very high LTV mortgage–allows us to isolate and focus instead on the "housing lock" channel.

Other channels influencing the effect of negative home equity on mobility In principle, besides strategic default or accessing personal savings a household with an underwater mortgage could relocate to relax the "housing lock" constraint in three ways: (1) carrying over the shortfall to a new mortgage, (2) subletting its property, or (3) borrowing the shortfall through personal loans.

Carrying over negative equity to a new mortgage is rare to find in any country and the Dutch mortgage market is no exception. In theory, there are exceptions that allow for this transferrability of the liability, but survey evidence suggests that this 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. LTV norms from the Code of Conduct for Mortgages (CCM)–which cap charges (including the cost of carry-over debt) given income– contribute to the rare nature of negative equity carry-overs (Conijn and Schilder (2013a), de Vries (2014)). Even for underwater households with high income- and financial assets levels in this full recourse market, carrying over negative equity is relatively rare as financial assets are not collateral attached to the home.

Frictions in the Dutch rental market make it difficult for an underwater household to sublet the property it owns and simultaneously rent another. In practice, the subletting and simultaneous renting occurs very rarely, possibly reflecting these frictions, including the limitation of the mortgage interest deduction to owner-occupied homes, mortgage clauses forbidding subleases, and rental supply competition from the public sector.While public sector involvement in other countries, such as the U.S., is typically more limited, most markets include tax benefits for owner-occupied housing and some degree of geographic heterogeneity in the ability to sublease, suggesting that this friction is likely to be prevalent even outside the Netherlands, and especially during periods when segmented market rental search frictions are high, such as during periods of economic distress.

While access to personal loans could help alleviate the effects of housing lock, the Dutch market of consumer credit is less deep, with smaller markets for credit card debt, personal debt, and payday loans than in the U.S. This would suggest that on average, for the same level of liquid financial assets, a U.S. household would have access to more funds to overcome their constraints by increasing their utilization of personal loans, especially credit cards. On average though Dutch households tend to have more in liquid savings than U.S. households. In our sample the median household with a mortgage has about 20k USD in liquid savings, while the median U.S. household with a mortgage has around 7,500 USD in savings according to the 2010 Survey of Consumer Finances. A 2017 report by credit reporting agency Experian found that U.S. households have on average about 13k USD in available balance on their credit cards, which suggests that with a cash advance on their credit card and savings a U.S household likely has the ability to generate around 21K USD in liquid assets on short notice, almost exactly the same as the average Dutch resident.

So while the Dutch access to credit cards is quite limited, this appears to be offset by increased savings, and likely suggests a similar average effect coming from access to liquid assets. Of course households in other countries are likely to have very different degrees of access to liquidity, which we examine in detail by examining explicitly in our analysis how liquid savings affect the relationship between home equity and mobility[9].

4 Empirical Strategy

The main strategy to identify the impact of housing lock on residential mobility is an instrumental variables (IV) regression that uses variation in the likelihood of negative equity across purchase cohorts. Consider first the following naive OLS regression:

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

where the dependent variable of interest is an annual mobility indicator y_{it} equal to 1 when a buyer i–who has not moved until year t from a given property– moves in year t. The term $\mathbf{1}\left[l_k < LTV_{icrt} \leq h_k\right]$ corresponds to various indicator variables for different household LTV ratio categories, and the OLS model also includes a number of time-varying socio-demographic covariates controlling for the multiple factors determining moving risk, including gender, and person age.. The loan age indicators $\sum_a \mathbf{1}\left[a = t - c\right]$ in years flexibly control for the effect of the length of time a that individual i has lived in that home, on residential mobility. Since we compute changes in house prices at the level of 382 regions ("gemeentes" or municipalities), the inclusion of municipality x time fixed effects λ_{tr} precludes the possibility that results are driven by variation in local demand shocks, or individual variation in home investment.

Despite the inclusion of all these controls, time-varying household level variation in LTV still has the potential to confound casual interpretation. We decompose the current household's LTV into three distinct components; (1) house prices changes, (2) changes in the balance of the mortgage, and (3) origination LTV:

$$LTV_{it} = \frac{1}{\%\triangle HP_{crt}} \cdot \%\triangle Loan_{it} \cdot LTV_{ic} \tag{2}$$

Our instrument will eliminate endogenous variation in the last two components. Declines in the mortgage balance through prepayment can alter mobility while differences in future income prospects arguably both

[9]While the effect of institutional differences between the Netherlands and other countries, on the relationship between home equity and mobility, are likely to be of interest for future researchers, it appears that most of the conclusions drawn from this paper are likely to be valid in situations with non-transferrable liabilities for households with negative home equity and rental market frictions. As we show in our analysis of financial assets, the conclusions are likely to vary substantially with the liquidity available to the average household in a country. In countries with more limited recourse we would also expect the net effect of home equity on mobility to be the difference between the effects of housing lock and those caused by default incentives.

affect origination LTVs and mobility patterns. Instead, our new measure assumes that all mortgages have an LTV at origination of 108.65, which was the national average over all time periods in our sample, and no amortization. Our synthetic LTV, or SLTV, varies only at the cohort-municipality-time level, and, controlling for all previously mentioned fixed effects, provides a plausible instrument for the probability of negative home equity:

$$SLTV_{crt} = \frac{1}{\%\triangle HP_{crt}} \cdot NatAvgLTV \tag{3}$$

Variation in SLTV, after including all controls in equation (1), will be driven entirely by the timing of house purchase within a given municipality. Buyers that purchased homes around the local price peak have higher SLTV ratios than do their peers who bought homes just a few years earlier. More formally, we run a 2SLS regression where the 1st stage is:

$$U_{it} = \lambda_{tr} + X_{it}^{'}\beta + \lambda_a + \delta_1 \mathbf{1}\left[SLTV_{crt} \geq 100\right] + \epsilon_{icrt} \tag{4}$$

, where the term $U_{it} \equiv Pr\left[LTV_{it} \geq 100\right]$ equals one when the household has a 100% chance of having negative home equity[10]. The 2nd stage is:

$$y_{icrt} = \delta_2 \hat{U_{it}} + \lambda_{tr} + X_{it}^{'}\beta + \lambda_a + \epsilon_{icrt} \tag{5}$$

The exclusion restriction is that the synthetic LTV–after controlling for all the fixed effects–only affects mobility via the probability that the house has negative home equity. To the extent that all the remaining variation in SLTV after all controls is driven by the timing of home purchases, the exclusion restriction requires that the timing of home purchases is unrelated to other factors that could alter future mobility changes.

This still leaves one possible confounding factor; the timing of house purchases within a municipality could violate the exclusion restriction. For example, if house price purchases by households with mobility more sensitive to local demand shocks could predict future house price declines, then this could be potentially problematic.[11] Bijlsma and Mocking (2017) have shown that during this time in the Netherlands there is

[10]Since a significant number of mortgages in the Netherlands include linked savings accounts with amortiziations we cannot observe, we cannot actually determine if mortgages are underwater with certainty. Instead we compute the probability that a mortgage is underwater using the observed aggregate disribution of amortization types from Mastrogiacomo and Van der Molen (2015).

[11]The inclusion of very granular time-municipality fixed effects for 382 regions flexibly controls for distance to major cities and precludes the possibility that the results are driven by concentration of purchases in booms at the fringes of major cities. As a robustness check we also include fixed effects for each of 12,302 neighborhoods interacted with time. The average size of these neighborhoods is about 1.3 square miles or about 44 times smaller than a Census tract. This level of granularity diminishes plausible concerns regarding the correlation of timing and location of home purchases and subsequent mobility sensitivity to local housing shocks. We also show that our results are robust to the inclusion of cohort fixed effects, so overall differences in

no evidence of a relationship, even non-linear, between municipal house price changes since origination and initial house value, lending some initial credibility to the research design in this setting, but still leaves the potential for other omitted variables to confound interpetation. To alleviate these concerns we take two approaches. First, we show that households who have different levels of synthetic LTV are observationally equivalent in terms of interest rate, income, family size, months till rate reset, loan-to-value, and house price at origination, suggesting it is unlikely that our instrument is correlated with observable characteristics at origination that could effect sensitivity to local demand shocks. Second, we complement our general instrumental IV approach with an analysis of life-event driven moves based on the timing of divorces or co-habitating splits. In particular, we restrict our analysis to the subset of households who purchased a home in the same year they also split from their partner.

5 Data

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.[12] Appendix Figure 8.5 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.

We 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*). From the Household Spell Registry, we 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 defining shocks to family structure and home purchase dates.

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 current Loan-To-Value ratio in a given year is the ratio between the assessed net

cohorts are unlikely to be confounding interpetation.

[12] 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 60,000 per year), the Registry covers approximately 75% of the moves into owner-occupied homes.

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[13]. The current market value of the property is estimated using the administrative purchase price multiplied by the appreciation of a municipal house price index[14]. 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 checking and savings accounts and the values of equity and bond holdings. We 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[15]. 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. The data Appendix 9 provides further details on the construction of the buyer panel dataset.

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 5.3%, of which approximately 26% are moves of at least 50km and likely to be across labor markets. The middle panel presents summary statistics for the 2007-2012 panel of buyers with balance sheet data. As balance sheet data are not available prior to 2007, we do not observe the downpayment, but our identification does not use variation in downpayments. The average mobility rate is equal to 4.3% of which, again, 26% are moves across labor markets. The average and median LTV are respectively equal to 75 and 81%. 30% of the person-years have negative home equity. The mean home equity amounts to €74,000. Among the owners with negative home equity, the average home equity is - €29,000. Financial asset holdings are on average equal to €77,000, while the median of €17,000 is significantly smaller. 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 median value of 8% and a mean of 23%.

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, and lives in a household of 2.4 individuals. 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. [16]

[13]As the household balance sheets do not include the capital built up in associated mortgage accounts, we use the actual aggregate probability of an associated amortizing account to compute the probability that a mortgage has negative home equity given its observable LTV.

[14]We 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. Results are qualitatively unchanged keeping the trimmed observations in the sample and available upon request from the authors.

[15]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.

[16]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

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 rising population 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 share 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 transactions share of first-time home buyers relative to trade-up buyers during the Great Recession (Conijn and Schilder (2013b)), as first-time home buyers are not directly affected by the housing lock and may even benefit from lower house prices. 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.

Home Price data To estimate the value of each property we use the actual transaction price at origination and then index this price by annual changes in a municipal house price index. We use the OrtaX house price index, which to the best of our knowledge is the only Dutch repeat sales house price index with indices available at the municipal-level of granularity. The index relies on repeat sales from the Land Registry Office (*Kadaster*) of all Dutch housing transactions and a variety of adjustments for non-random selection of transacting properties to control for housing quality changes over time (Francke et al. (2009)). [17]

Mortgage data To test if households who purchase houses at different times are systematically different in ways that make their moving decisions more sensitive to local house price changes, we also use the Network of Mortgage Data or Hypotheken Data Netwerk (HDN) dataset of mortgage offers. Our HDN data covers 560,439 mortgage offer requests from September 2009 to December 2013 HDN. Coverage improves over time from accounting for around 50% all Dutch mortgage requests in January 2008 to around 75% by December 2014. The dataset contains detailed information on borrower characteristics (e.g. age, household size, income, home value) and loan characteristics (e.g. interest, loan amount, interest reset time).

the UK and Ireland, 31 in France, 34 in the US and 36 in Germany.

[17] The resulting price index has a >98% correlation at the national annual level with the other major Dutch house price indices that use the full sample of Kadaster housing transactions such as those produced by ABF Research and Centraal Bureau voor de Statistiek (CBS).

6 Results

6.1 Housing Lock and Mobility - IV Approach

We estimate the relationship between annual mobility and LTV ratios from equation (1) in the sample of buyer-years during the period 2007-2012. Table 3 presents both reduced form and two-stage least squares estimates of the effect of negative home equity, instrumented by negative synthetic home equity, on mobility rates. Column 1 of Table 3 presents the reduced-form regression of mobility on a dummy variable equal to one if the synthetic LTV (SLTV) is greater than 100%, after including municipality x year, gender, loan age, and person age fixed effects. We find that negative synethic home equity is associated with a decline in the household moving rate of 0.89 percentage points (pp). As we control for municipality-time fixed effects and the house price used is calculated at the municipal level, the variation that yields this relationship is differential loan-to-value based on the timing of home purchase among households in the same municipality at the same time. This suggests a causal link between house price declines driven by timing of purchase and subsequent mobility rates, and that in particular negative home equity reduces mobility rates.

The pattern in Figure 5 strengthens the evidence. We estimate equation (1) and plot the non-linear relationship between categorical SLTV bucket dummies and mobility, controlling for the same fixed effects used in Table 3. For low levels of SLTV, changes in SLTV do not significantly alter mobility. However, once SLTV rises above 100%–when the probability of being underwater rises significantly–the effect on mobility becomes large and negative. The larger response as home equity becomes more negative is consistent with the housing lock model of Stein (1995)–where liquidity constraints limit mobility more as home equity becomes more negative–as opposed to general housing wealth changes. SLTVs below 85% provide a placebo test for violations of the exclusion restriction[18], similar to analyzing renters or cash buyers, but even more credible, as home owners with mortgages are more similar than renters and cash buyers. These lower STLV households all bought houses, just at different times, which caused large variations in home equity, but are unlikely to be underwater. The absence of variation in mobility across low SLTVs provides plausibility for our instrument and suggests that the results are not driven by housing wealth, independent of the "housing lock" associated with negative home equity.

To interpret the economic magnitude of our findings, Column 2 estimates the first-stage effect of synthetic negative home equity on actual negative home equity. Controlling for the same fixed effects as in Column 1, households with negative synthetic home equity are 18.1 pp more likely to be actually underwater. As less than one third of mortgages have negative home equity, this corresponds to a more than 50% rise in the

[18] Van Ommeren and Van Leuvensteijn (2005) estimate that transaction costs for buyers in the Netherlands account for 6-12% of the purchase price of the property. Therefore, households with at least 15% of house value in home equity (i.e. a LTV below 85%) are unlikely to be directly constrained by housing lock.

probability of negative home equity. This large first-stage effect is intuitive as variation in house prices driven by the timing of home purchase is the primary source of variation in synthetic LTVs and also a large driver of variation in actual LTV ratios. Column 3 presents the formal 2SLS procedure and finds that instrumented negative home equity is associated with a 4.87 pp reduction in the household annual moving probability. As a large share of the total population is "treated" with negative home equity, we use our model estimates to compute that the counterfactual moving rate without the constraint would have been 6.19% in the absence of negative home equity. Combining the counterfactual estimate with the treatment effect suggests a 78.7% reduction in mobility caused by negative home equity. In column 4 we re-run the same analysis, but instead assume a uniform distribution of partial amortization from none to full. We obtain a 74.3% reduction in mobility caused by negative home equity, which is not statistically significantly different from those obtained in column 3 and suggest the results are not particularly sensitive to the amortization assumptions[19].

Table 4 reports the same specification as column 3 of Table 3, but for mobility across farther distances[20]. The theoretical effect of distance on housing lock is ambiguous as distance could tighten or relax the liquidity constraint. If the upfront pecuniary costs (e.g. trucks, new furniture, time away from job) or the desired precautionary liquidity buffer (e.g. in response to larger uncertainty in a newer environment) associated with moves rise with distance, then a tighter constraint predicts larger housing lock effects for long-distance moves. On the other hand, if the gross benefits–including access to higher expected wages–rise in distance and can be borrowed against, then a laxer constraint predicts smaller lock-in. The toy-model in Appendix 11 develops this condition more formally.

The dependent dummy variable in Column 1 of Table 3 equals one if the household moves more than 25km. We show in column 1 of Table 4 that negative synthetic home equity is associated with a statistically significant reduction in mobility even across this farther distance, suggesting that housing lock also appears to reduce longer-distance mobility and is thus more likely to be driven by labor market conditions. The 2SLS estimates in Column 2 show that instrumented negative home equity is associated with a negative 2.45pp decline in >25km mobility, which relative to the counterfactual constitutes a 91.4% decline. The percent treatment effect is thus even larger than for all moves. Columns 3 and 4 focus on moves of at least 50km. Such moves are likely between different labor markets given the 50/km hour default speed limit in the built-up Netherlands. Our results are robust to including comparisons across statistical labor market regions known as COROPs instead[21]. We find that instrumented negative home equity is associated with a 1.93pp

[19]Results in table 3 are qualitatively similar if the analysis is rerun on just mortgages which regardless of amortization schedule are definitively either underwater are not and are available from the authors upon request.

[20]Distance is measured as the goedesic distance between the centroids of the neighborhood of the original and new property.

[21]The Netherlands consists of 12 provinces, 40 so-called COROP local labor markets and approximately 400 municipalities. 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

or 94.2% decline relative to the counterfactual annual move rates of at least 50km. Just as was the case with all moves, Figure 6 show the non-linearity of the treatment effect of SLTV on intermarket mobility, with no statistically significant effects for low SLTVs, but falling mobility as SLTVs rise above 100%. Figure 7 generalizes the relationship between the percent treatment effect of negative equity on mobility and distance. The estimated percent decline in annual mobility becomes larger in magnitude monotonically in distance of the move. This is consistent with higher upfront pecuniary costs and/or higher desired precautionary liquidity buffers for longer-distance moves and significant costs of housing lock.

6.2 Addressing Identification Concerns

We have shown that variation in home equity driven by the timing of home purchase leads to non-linear changes in mobility, consistent with housing lock for households with negative home equity. One possible explanation remains that could confound causal interpretation of these findings. The exclusion restriction would be violated if households more likely to move when house prices decline are also more likely to buy their house prior to a local house price decline. We address this concern by verifying placebo tests for selection on observables and with life-events as shifters of the timing of home purchase.

Selection on Observables We now test if households who purchase houses at different times are systematically different at origination in ways that make their moving decisions more sensitive to local house price changes. We examine if SLTV is correlated with observable differences at origination, after controlling for region-time, loan age (or cohort), and person age fixed effects. In particular, one concern could be that some cohorts face a higher initial interest rate or one that resets more frequently. The increase in market rates could disincentivize earlier buyers with fixed rate mortgages to move (Campbell (2013)). Table 5 uses HDN mortgage data and reveals no such evidence. It documents a precisely estimated null relationship between high SLTV (above the overall sample mean) and either origination interest rates or the months until a mortgage resets in columns 2 and 3, even though column 1 indicates a statistically significant negative relationship between SLTV and mobility under the same specification[22]. Column 1 shows that our results are also robust to the inclusion of cohort fixed effects, so overall differences in cohorts are unlikely to be confounding interpetation.

Metropolitan Statistical Areas (MSAs) constitute the US analogue. We focus our primary analysis on moves of farther than 25km, rather than across COROPs since we actually observed the true distance of the move. Many moves between COROPs constitute short distance moves, that happen to cross a border into a different COROP.

[22]We rely on data from HDN since loan-specific information is not available for households in the primary Statistics Netherlands micro dataset. In the HDN dataset we do not have access to gender of household head so do not include it is a control, but primary results in the main sample are unchanged by exclusion of this control and available upon request. Since the HDN data has a systematic increase in listings over time we rely on specification that adjusts for that by including cohort, instead of just loan age fixed effects. For our analysis we focus on the period where we have matching house price indices and HDN data from 2009-2013, but results are robust to considering only the sub-period prior to 2012 to match the CBS data.

One potential concern with this comparison is that the analysises rely on different underlying datasets. While we don't have mortgage contract details in the CBS data, we observe origination loan-to-value and household balance sheet and family structure charactericis for mortgages originated after 2007. In table 5 columns 4-7 we re-run the analysis, but restrict ourselves to CBS data, and mortgages originated between 70 and 130% LTVs to preclude outliers. We include average loan-to-value at origination by cohort when computing SLTV to improve power given the restricted sample. If STLV households have lower loan-to-values at origination, savings, or different family structures their mobility could be more sensitive to local demand shocks which could confound our causal interpretation. We again show in column 4 that a synthetic LTV above 100% predicts reduced mobility, but find a very precise null relationship between negative SLTV and loan-to-value, financial assets, and family size at the time of mortgage origination. Taken together, these provide evidence that SLTV and variation in home equity–driven by the timing of home purchase–alters mobility, but does not correlate with any observable variation in mortgage characteristics at origination or household characteristics for a broad set of variables.

Life-event driven buyers Even with a lack of observable differences across a large set of characteristics between these home buyers it is possible there exists some unobservable factor driving the timing of home purchase, subsequent house price changes, and sensitivities of mobility rates to home price declines. To address this concern, we take advantage of home purchases driven by life-events unlikely to provide a correlation between future house price movements and local demand sensitivity. In particular, we restrict our analysis to the subset of households who move in the same year they also split from their partner. In figure 8 we show that moving probabilities jump dramatically in the year of a divorce or partner split. In fact, the moving rate in the year of a divorce more than quadruples relative to the prior year and rises even further when considering the likelihood that at least one member of the household moves in that year. While divorce appears somewhat cyclical in the US (Amato and Beattie (2011)), appendix figure 8.3 reveals no apparent aggregate relationship between the divorce rate, the unemployment rate, and the number of housing transactions during this time period in the Netherlands, suggesting we are unlikely to pick-up macro-economic trends with this measure.

We start by presenting aggregate evidence based on cohorts like we did with all buyers. Focusing on life-event buyers, Figure 9 shows that the 2007-2008 peak life-event buyers–who are likely to be underwater–experience lower mobility rates than earlier buyers. In contrast, the 1996-2001 life-event purchase cohorts–that were exposed to rising home prices–experienced remarkably similar mobility. Appendix Figure 8.2 shows that even the more recent 2004-2008 life-event cash buyers[23] feature remarkably similar mobility

[23]The period is slightly shorter since it is restricted to the subset for who we can see loan levels at origination as well as

rates. These facts suggests that the decline in mobility is likely driven by by changes in home equity and in particular housing lock.

We test this explicitly in table 6 where we re-run the analysis of the main table, but focus on just life-event driven buyers[24]. Column 1 finds that negative synthetic home equity is associated with a statistically significant decline in annual mobility, even after restricting ourselves to life-event driven buyers and including municipality-time, gender, and person age fixed effects. Column 2 shows the validity of the first stage among just these life-event buyers and subsequently in column 3 we estimate the 2SLS effects. We find that instrumented negative home equity is associated with a 5.44 p decline in mobility among life-event driven buyers. In column 4 we confirm that this also leads to a 1.27 pp drop in intermarket mobility. Since these are life-event driven movers based on family splits, they tend to have higher subsequent baseline mobility rates. The slightly weaker percent effect from the housing lock for this subgroup is therefore intuitive. This could be consistent with this group having lower costs for moving, such as fewer ties to local family, higher benefits to moving, such as re-marriage or lower precautionary cash buffers. Generally though, the results are consistent with a decline mobility rates driven by home equity and in particular housing lock.

6.3 Additional Robustness Tests

While we believe most major concerns are addressed by the identification strategy and major robustness tests in section 6.2, a few minor concerns in causal interpretation of our results remain, which we examine in table 7. In particular, if the timing of home purchase and subsequent house declines are correlated with the geographic choice of the household, then this could lead to differential exposure to local demand shocks. One approach would be to include a host of local controls, but in column 1 of table 7 we go one step further. Rather than guessing the functional form of any relationship between geographic and timing sorting and local demand sensitivity, we instead use an incredible granular set of geographic controls. In particular, we run the initial specification, but instead of including municipality-time fixed effects (there are 408 municipalities in 2013) we include neighborhood-time fixed effects. Neighborhoods are an officially defined granular geographic unit in the Netherlands. There are 12,302 neighborhoods in our data that average about 1.3 square miles per neighborhood. These regions are larger in more rural and even smaller in urban areas. By comparison there are about 65,443 census tracts in the United States, which cover approximately 58 square miles per tract or

current outstanding balances, which start in 2007, so for the 2004 cohort the earliest we can see is 3 years into the life of the mortgage.

[24]The first stages in table 6 are not valid when also including loan age fixed effects or including all divorcing or splitting co-habitating partners and using that as an intent to treat. Absent sufficient power in the 1st stage with these weaker methods, running the IV in these cases would not be valid and so they have been excluded from the analysis. Since half of partners in a split are likely to not move (while the other does) the latter methodology is naturally weak, while in general it is almost always the case that at least one partner moves soon before/after the split and constitute the vast majority of all reasons for moving adding plausibility to this methodology even absent the additional variants.

about 44.5 times larger than the average neighborhood. In column 1 we obtain nearly identical results even with this huge set of additional controls providing compelling evidence that our results are not driven by a correlation between timing and location of house purchase.

Another concern could be that most of the variation occurs at the municipality level and so clustering at the municipality-cohort level biases down our standard errors. We show in column 2 that this is not the case and that our results are still highly statistically significant. In column 3 we show results are unchanged by excluding predicted probabilities of negative equity below 0 or above 1, since that can occasionally cause issues with linear probability models. In column 4 we also include the log of household financial assets as a control. Since savings are considered jointly with moving decisions it is likely to attenuate our estimated effects, which is exactly what we observe, but they remain qualitatively unchanged by their inclusion even if it is not our preferred specification.

Finally, in column 4 we show that there is no relationship between negative SLTV and mobility among the sub-group of buyers we can identify as cash only, even if as in column 6 we exclude loan age fixed effects to try and improve the likelihood of observing a relationship. These placebo tests with cash buyers complement the aggregate cohort placebo tests shown in figure 8.2 and again suggest that the observed results are driven by housing lock, and not by any overall trends in home buying and subsequent moving probabilities. Overall, we take the results of this section as compelling evidence that our findings of a negative relationship between mobility and negative home equity are robust and are driven by housing lock.

6.4 Balance Sheet Channel

We conclude by testing 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. In table 8 we run the primary specification in reduced form, but then interact negative synthetic home equity with dummy variables equal to one if the amount of financial assets available at the beginning of that calendar year would be sufficient to relax the housing lock constraint.

Column 1 shows that the availability of more than €80k in financial assets causes a significant decline in the sensitivity of mobility to synthetic home equity. We chose €80k since that was the approximate amount of liquid assets necessary for 90% of underwater households to overcome their housing lock, by paying the associated housing transaction costs and the full negative home equity. But as long as the amount of liquid savings are sufficiently large, the results are not sensitive to the specific cut-off. For example, column 2 shows that a cut-off of €100k leads to a similar, and slightly larger, reduction in housing lock. The intuition is that a dollar of liquidity facilitates paying for moving and, unless households are subject to mental accounting

or other frictions disturb the home sale process or important differences in terms of collateralizability and attachability exist across asset classes, it should not matter too much whether this marginal dollar comes out of home equity or out of other household savings. To make the channel even more apparent, in column 3 we interact a dummy variable equal to one if a household's available liquid financial assets would be sufficient to pay off the remaining balance on their mortgage after selling the house, while also including 7 categorical fixed effects for varying levels of financial assets to control non-linearly for their effect. We find again that the key factor in reducing the effect of housing lock is sufficient assets to relax the negative home equity constraint just as would be predicted by Stein (1995). In column 4 we replicate the analysis in column 3, but for intermarket moves and again document that even in the presence of longer moves, financial assets play an important role in dampening the affect of housing lock on mobility.

7 Conclusion

In this paper we are able to overcome the challenges typically faced by researchers trying to cleanly identify the effects of housing lock on mobility. In countries with weakly enforced recourse laws, such as the US, negative home equity has countervailing forces as housing lock decreases mobility while strategic default incentives likely increase mobility. We focus our analysis instead on Dutch mortgages–where recourse laws are very strictly enforced– and leverage novel administrative population data on household location, home-ownership, family structure, and balance sheets. We then exploit variation in home equity instrumented by the timing of home purchase, relative to other households in the same region and time, as a plausible source of exogenous variation. To support this we show the absence of correlation between observable covariates and our instrument and even restrict our robust analysis to moves driven by life-events.

We find a substantial effect of negative home equity on mobility. Instrumented negative home equity is associated with a 74-79% decline in overall mobility. Since over 30% of all households in our sample have negative home equity this likely means not only large partial equilibrium effects for each household, but also likely explain a significant portion of the overall reduction in recent mobility among homeowners in the Netherlands[25]. We also find that the effects of falling home equity are substantially larger for households with low financial asset holdings or moves over longer distances. This suggests that even in countries like the United States, which typically have farther moves and lower household asset holdings, housing lock is likely to play a significant role in mobility patterns, especially among the significant number of U.S.

[25]Since reduced mobility could feedback into local economic conditions and house prices an analysis of the general equilibrium effects is not trivial. Absent any feedback effects though since 30% of households are underwater and the reduction in mobility per household is 74-79% the aggregated partial equilibrium shock at the national level would be a 22-24 percent reduction in aggregate mobility among homeowners which is more than 2/3rds of the total observed reduction in mobility of homeowners in the Netherlands during this time period. General equilibrium effects could either amplify or dampen such aggregated partial equilibrium effects, but it is clear that this is likely to be a shock of first order macroeconomic importance.

households morally averse to strategic default Guiso et al. (2013). The use of Dutch adminstrative data on both households asssets and home equity provides the first direct evidence of the importance of the integrated household balance sheet view, consistent with Stein (1995). While it appears that most of the conclusions drawn from this paper are likely to be valid in situations with non-transferrable liabilities for households with negative home equity and rental market frictions, the effect of institutional differences between the Netherlands and other countries, on the relationship between home equity and mobility, is likely to be an interesting area for future work.

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Table 1: Buyer summary statistics

	Mean	median	sd	*N*
CBS 1995-2012 panel of buyers				
Annual Mobility (%)	5.31	0	N/A	3,783,286
Annual Inter labor market mobility (%)	1.39	0	N/A	3,781,227
CBS 2007-2012 panel of buyers with balance sheet data				
Annual Mobility(%)	4.31	0	N/A	1,956,183
LTV ratio (%)	75	81	37	1,969,905
Synthetic LTV ratio (%)	92	101	25	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
CBS Buyers in the year of the move into the property				
Distance of move (km)	16	3	33.35	574,337
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
HDN Data on Mortgage Offers 2009-2013				
Origination LTV (%)	96.9	112	34	556,613
Mortgage Initial Interest Rate (%)	4.50	4.55	0.67	541,656
Months till ARM Mortgage Reset at Orig	115.7	120.0	66.6	557,996

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 home equity related variables rely on an amortization method using the observed aggregate distribution of amortization types and assumes a linear interpolation within buckets. The second panel gives summary statistics regarding mobility and balance sheet variables for the 2007-2012 person-years. The variables in the third 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. The bottom panel gives summary statistics on the loan characteristics for mortgages in the HDN dataset. See section 5 in the text for more details on the CBS data on buyers and HDN data on mortgage offers.

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 5 in the text for more details on the CBS data on buyers.

Table 3: Impact of home equity on mobility

	Reduced Form	1st Stage	2SLS	
	(1)	(2)	(3)	(4)
	Mobility	$Pr[LTV > 100]$	Mobility	Mobility
$Pr[LTV > 100]$			-4.87	-4.54
(IV:$SLTV > 100$)			(0.38)	(0.36)
$SLTV > 100$	-0.887	0.181		
	(0.008)	(0.005)		
Time × municipality FE	Yes	Yes	Yes	Yes
Gender FE	Yes	Yes	Yes	Yes
Loan age FE	Yes	Yes	Yes	Yes
Person age category FE	Yes	Yes	Yes	Yes
Amortization method	N/A	1	1	2
Counterfactual Dep. Variable Mean	N/A	N/A	6.19	6.11
Adjusted R^2	0.033	0.331	0.027	0.028
Observations	1,956,003	1,956,003	1,956,003	1,956,003

Notes: This table shows the effect of negative home equity on annual mobility rates using a two-stage least squares (2SLS) methodology. The first stage regresses the probability of negative home equity on a household's synthetic loan-to-value ratio (SLTV) after controlling for municipality x time, gender, age, and loan age fixed effects. The second stage regresses a dummy variable equal to one if a person changes addresses by the end of that year on the instrumented probability of negative home equity. SLTV is defined as the overall average origination loan-to-value ratio of 108.65 divided by the change in the house price index in that municipality since the month of origination. Column 1 is a reduced form regression of mobility on negative STLV after including all the aforementioned controls. Column 2 includes the same methodology but regresses the probability of having negative home equity on negative STLV. In this case the amortization method chosen uses the observed aggregate distribution of amortization types and assumes a linear interpolation within buckets. Column 3 is the same as column 2, but we run the full 2SLS procedure with mobility on the left-hand side and instrument for the probability of negative home equity with an indicator for negative SLTV. Column 4 is the same as column 3, but instead of using the observed distribution of amortization schedules, we assume a uniform distribution of partial amortization from none to full. All standard errors are clustered at the municipality x Cohort level.

Table 4: Home equity and distance of move

	(1)	(2)	(3)	(4)
	Move >25km	Move >25km	Move >50km	Move >50km
$Pr[LTV > 100]$		-2.45		-1.93
(IV:$SLTV > 100$)		(0.30)		(0.27)
$SLTV > 100$	-0.443		-0.349	
	(0.059)		(0.052)	
Time × municipality FE	Yes	Yes	Yes	Yes
Gender FE	Yes	Yes	Yes	Yes
Loan age FE	Yes	Yes	Yes	Yes
Person age category FE	Yes	Yes	Yes	Yes
Counterfactual Dep. Variable Mean	N/A	2.68	N/A	2.05
Adjusted R^2	0.029	0.025	0.030	0.027
Observations	1,955,294	1,955,294	1,955,294	1,955,294

Notes: This table shows the effect of negative home equity on annual market mobility rates by distance using a two-stage least squares (2SLS) methodology. The first stage regresses the probability of negative home equity on a household's synthetic loan-to-value ratio (SLTV) after controlling for municipality x time, gender, age, and loan age fixed effects. The second stage regresses a dummy variable equal to one if a person changes addresses by the end of that year on the instrumented probability of negative home equity. SLTV is defined as the overall average origination loan-to-value ratio of 108.65 divided by the change in the house price index in that municipality since the month of origination. Column 1 is a reduced form regression of the probability of move of farther than 25km on negative STLV after including all the aforementioned controls. Column 2 includes the same methodology but we run the full 2SLS procedure with mobility on the left-hand side and instrument for the probability of negative home equity with an indicator for negative SLTV. The amortization method chosen uses the observed aggregate distribution of amortization types and assumes a linear interpolation within buckets. Column 3 is the same as column 1, but restricted to moves of at least 50km. Column 4 is the same as column 2, but restricted to moves of at least 50km. All standard errors are clustered at the municipality x Cohort level.

Table 5: Validity of IV

	(1) Current Mobility (%)	(2) Orig Int. Rate (%)	(3) Orig Mos to Reset	(4) Current Mobility (%)	(5) Orig LTV (%)	(6) Orig ln(Fin Assets)	(7) Orig Fam. Size
$SLTV > 100$	-1.029	0.0015	-0.255	-0.344	-0.00071	0.0014	0.0099
	(0.108)	(0.0040)	(0.388)	(0.0823)	(0.00066)	(0.0095)	(0.0064)
Time × municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan age FE	No	No	No	Yes	Yes	Yes	Yes
Person age category FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	No	No	No	No
$SLTV_0$	Overall avg	Overall avg	Overall avg	Cohort avg	Cohort avg	Cohort avg	Cohort avg
Dataset	CBS	HDN	HDN	CBS	CBS	CBS	CBS
Orig LTV Constraints	N/A	N/A	N/A	[70,130]%	[70,130]%	[70,130]%	[70,130]%
Adjusted R^2	0.030	0.065	0.076	0.034	0.085	0.181	0.239
Observations	1,712,797	896,275	912,856	1,173,585	1,173,585	426,192	462,392

Notes: This table shows that the effect of negative home equity on annual mobility rates is not driven by confounding correlation with observable co-variates. The reduced form regressions regresses a dummy variable equal to one if a person changes addresses by the end of that year on household's synthetic loan-to-value ratio (SLTV) after controlling for municipality x time, gender, and age fixed effects. SLTV is defined as the average origination LTV divided by the change in the house price index in that region since the month of origination and after including the aforementioned controls and is an instrument for the negative home equity. In Columns 1-3 the average LTV is defined as the average origination LTV for each cohort and includes cohort fixed effects. In Columns 4-7 overall average origination is the average over the whole sample which is 108.65 and includes loan age fixed effects. Columns 2-3 use information from the Network of Mortgage Data (HDN) dataset of mortgage offers, since it includes mortgage contract details, while Columns 1 and 4-7 use data provided by CBS. Column 1 is a reduced form regression of mobility on negative STLV after including all the aforementioned controls. Column 2 is the same as column 1, but the dependent variable is origination interest rate in percentage terms. Column 3 is the same as column 1, but the dependent variable is months till reset of an adjustable rate mortgage. Column 4 is a reduced form regression of mobility on negative STLV after including all the aforementioned controls, but where the sample has been restricted to properties with origination loan-to-value ratios between 70 and 130%, to avoid outliers, and uses loan age instead of cohort fixed effects and origination LTV by cohort to boost power in the restricted sample of observations with detailed household information available at the time of origination (2007 and later). Column 5 is the same as column 4 but the dependent variable is the origination loan-to-value ratio. Column 6 is the same as column 4, but the dependent variable is the log of the households non-housing financial assets at the time of origination, where available. Column 7 is the same as column 4, but includes family size at the time of origination as the depedent variable. All standard errors are clustered at the municipality x cohort level.

Table 6: Life-event Buyers

	Reduced Form	1st Stage	2SLS	
	(1)	(2)	(3)	(4)
	Mobility	$Pr[LTV > 100]$	Mobility	Intermarket mobility
$Pr[LTV > 100]$			-5.44	-1.66
(IV:$SLTV > 100$)			(0.66)	(0.46)
$SLTV > 100$	-1.66	0.305		
	(0.21)	(0.007)		
Time × municipality FE	Yes	Yes	Yes	Yes
Gender FE	Yes	Yes	Yes	Yes
Loan age FE	No	No	No	No
Person age category FE	Yes	Yes	Yes	Yes
Distance of Move	All	All	All	>50km
Counterfactual Dep. Variable Mean	N/A	N/A	9.20	2.85
Adjusted R^2	0.0269	0.0235	0.0411	0.0418
Observations	133,539	133,539	133,539	133,539

Notes: This table shows the effect of negative home equity on annual mobility rates using a two-stage least squares (2SLS) methodology, but restricted to the subset of life-event driven buyers. In particular, we take the sample of 1.956 million buyer-years in the 2007-2012 period with balance sheet data and only include those individuals who move in the same year they divorce or split from their partner. The first stage regresses the probability of negative home equity on a household's synthetic loan-to-value ratio (SLTV) after controlling for municipality x time, gender, and age fixed effects. The second stage regresses a dummy variable equal to one if a person changes addresses by the end of that year on the instrumented probability of negative home equity. SLTV is defined as the overall average origination loan-to-value ratio of 108.65 divided by the change in the house price index in that municipality since the month of origination. Column 1 is a reduced form regression of mobility on negative STLV after including all the aforementioned controls. Column 2 includes the same methodology but regresses the probability of having negative home equity on negative STLV. Column 3 is the same as column 2, but we run the full 2SLS procedure with mobility on the left-hand side and instrument for the probability of negative home equity with an indicator for negative SLTV. Column 4 is the same as column 3, but restrict moves to those of at least 50km. All standard errors are clustered at the municipality x cohort level.

Table 7: Impacts of home equity on annual mobility: Robustness

	Nghbrhd FEs	Clustering	Outliers	Assets	Cash Buyers	Cash Buyers No Loan FEs
	(1)	(2)	(3)	(4)	(5)	(6)
	Mobility	Mobility	Mobility	Mobility	Mobility	Mobility
$Pr[LTV > 100]$	-5.02	-4.87	-4.92	-3.39		
(IV:$SLTV > 100$)	(0.38)	(0.48)	(0.41)	(0.44)		
$SLTV > 100$					-0.396	-0.106
					(0.361)	(0.198)
Time × region FE	Yes	Yes	Yes	Yes	Yes	Yes
Gender FE	Yes	Yes	Yes	Yes	Yes	Yes
Loan age FE	Yes	Yes	Yes	Yes	Yes	No
Person age category FE	Yes	Yes	Yes	Yes	Yes	Yes
Log(Fin Assets) Control	No	No	No	Yes	No	No
Region for FE	Neighborhood	Muni	Muni	Muni	Muni	Muni
Number of regions	12,302	382	382	382	382	382
Cluster	region-coh	region	region-coh	region-coh	region-coh	region-coh
Buyers	All	All	$Pr[\hat{LTV} > 100] \in [0, 1]$	All	Cash	Cash
Adjusted R^2	0.0483	0.0270	0.0257	0.0293	0.0344	0.0343
Observations	1,956,003	1,956,003	1,869,412	1,956,003	299,043	299,043

Notes: This table shows the effect of negative home equity on annual mobility rates is driven by the causal relationship between these and is robust to alternative specifications. The first stage regresses the probability of negative home equity on a household's synthetic loan-to-value ratio (SLTV) after controlling for region x time, gender, and age fixed effects. The second stage regresses a dummy variable equal to one if a person changes addresses by the end of that year on the instrumented probability of negative home equity. SLTV is defined as the overall average origination loan-to-value ratio of 108.65 divided by the change in the house price index in that region since the month of origination. In column 1 we run the full 2SLS procedure with mobility on the left-hand side and instrument for the probability of negative home equity with an indicator for negative SLTV and include extremely granular neighborhood FEs. Unlike in the previous tables in this case standard errors are clustered at the region (gemeente) level. Column 2 is the same as column 1, but standard errors are clustered at the Gem x Cohort level and excluding any cases of predicted probabilities in the 1st stage less than 0 or greater than 1. Column 3 is the same as column 1, but includes the log value of financial assets as a control variable. Column 4 runs a reduced form version of the regression, but restricts it to the subset of cash only buyers. Column 5 is the same as column 4, but does not includes loan age fixed effects.

Table 8: Balance Sheet Effects

	(1) Mobility	(2) Mobility	(3) Mobility	(4) Intermarket Mobility
$SLTV > 100$	-0.923	-0.931	-1.511	-0.508
	(0.078)	(0.078)	(0.132)	(0.078)
>€80k Fin Assets	0.800			
	(0.076)			
$[SLTV > 100] \times [> €80k Fin Assets]$	0.355			
	(0.095)			
>€100k Fin Assets		0.716		
		(0.078)		
$[SLTV > 100]$×[>€100k Fin Assets]		0.491		
		(0.102)		
$[SLTV > 100]$×[Fin Assets>Neg Eq]			0.838	0.232
			(0.128)	(0.072)
Time × municipality FE	Yes	Yes	Yes	Yes
Gender FE	Yes	Yes	Yes	Yes
Loan age FE	Yes	Yes	Yes	Yes
Person age category FE	Yes	Yes	Yes	Yes
Fin Asset Bucket FEs	No	No	Yes	Yes
Distance of Move	All	All	All	>50km
Adjusted R^2	0.0335	0.0335	0.0344	0.0307
Observations	1,956,003	1,956,003	1,956,003	1,956,003

Notes: This table shows how the effect of negative home equity on annual mobility rates varies depending on the amount of liquid financial assets available. The reduced form regressions regresses a dummy variable equal to one if a person changes addresses by the end of that year on household's synthetic loan-to-value ratio (SLTV) after controlling for municipality x time, gender, and age fixed effects. SLTV is defined as the overall average origination loan-to-value ratio of 108.65 divided by the change in the house price index in that region since the month of origination and after including the aforementioned controls and is an instrument for the negative home equity. Column 1 is a reduced form regression of mobility on negative STLV after including all the aforementioned controls, but also includes interactions with a dummy variable equal to 1 if beginning of the year financial assets are greater than €80k. Column 2 is the same as column 1, but includes interactions with a dummy variable equal to 1 if beginning of the year financial assets are greater than €100k. Column 3 is the same as column 1, but includes categorical dummies for beginning of the year financial assets from 0 to €1k, €1k to €3k, €3k to €5k, €5k to €10k, €10k to €30k, €30k to €80k, and greater than €80k, as well as a dummy variable equal to 1 if a person's financial assets exceed the negative equity in the house. Column 4 is the same as column 3, but the left hand side variable is a dummy variable equal to 1 if a person moves at least 50km. All standard errors are clustered at the municipality x cohort level.

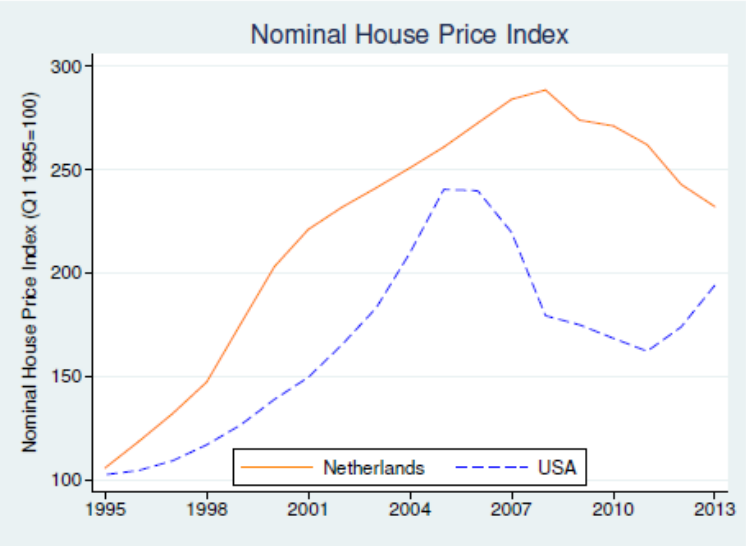


Figure 1: Nominal house price index for the US and the Netherlands

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

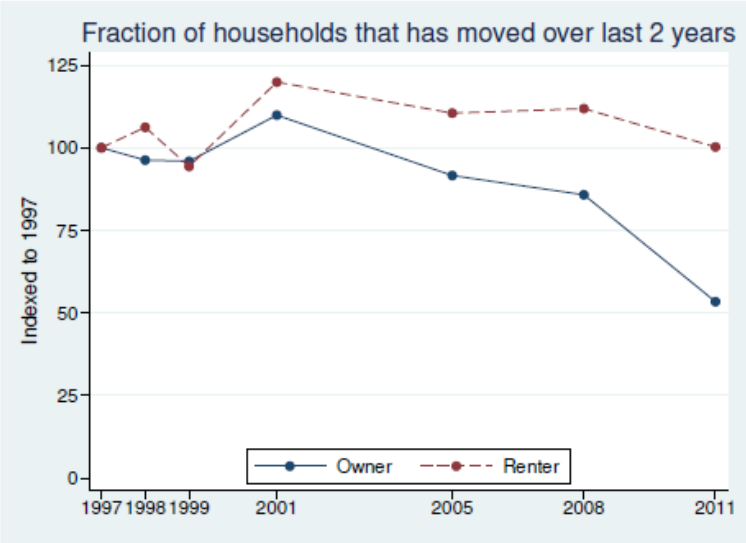


Figure 2: Mobility intentions of owners and renters over time

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.

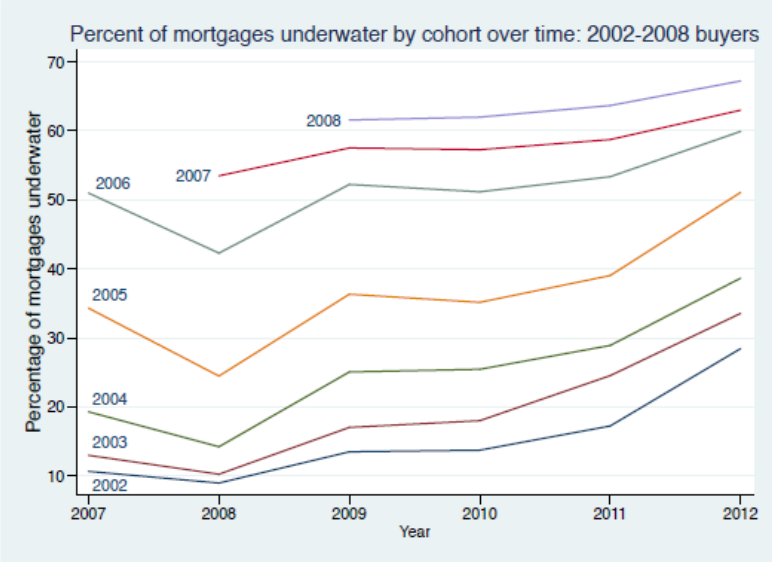
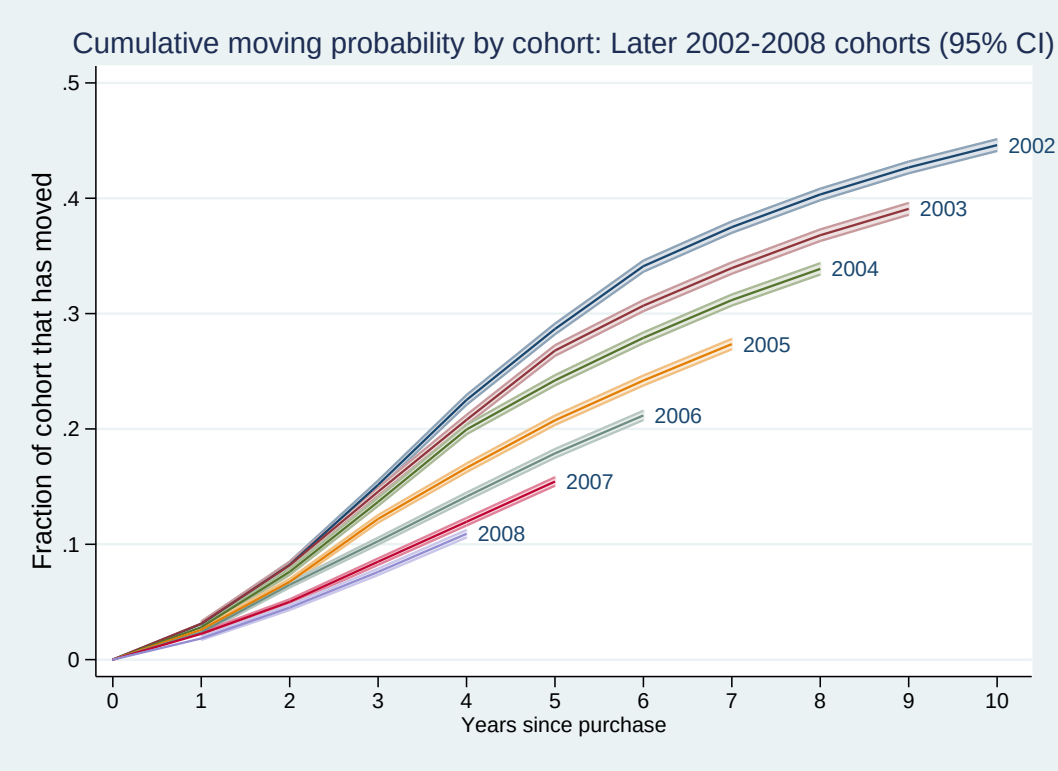


Figure 3: Percentage of mortgages underwater by purchase cohort over time

Notes: The percentage of mortgages underwater within a purchase cohort by year is based on CBS household balance sheet, transaction price and municipal house price index data. See section 5 of the text for more details.



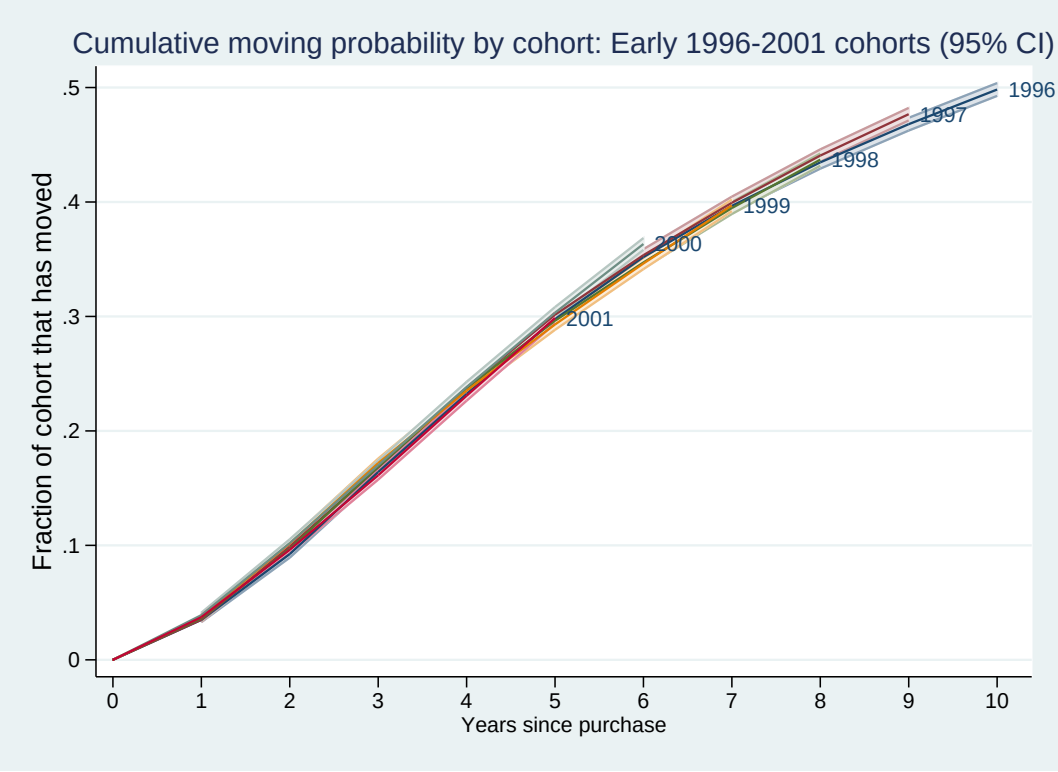


Figure 4: Mobility of purchase cohorts given the years since purchase

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 Statistics Netherlands (CBS). See section 5 of the text for more details.

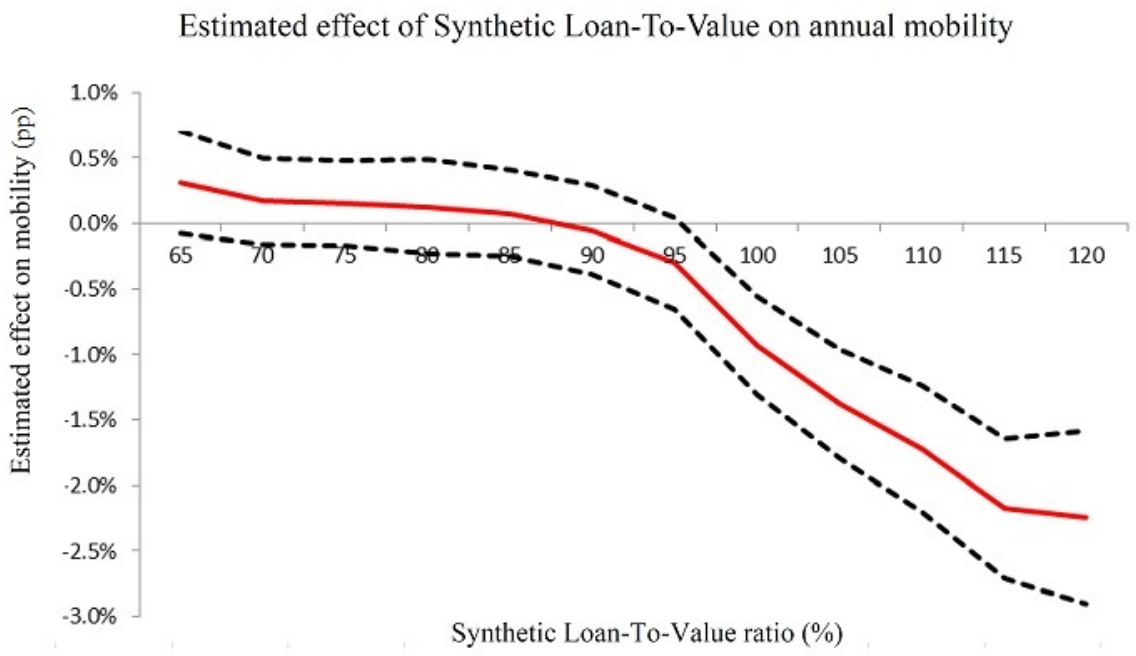


Figure 5: Effect of Synthetic Loan-to-Value Ratio on Annual Mobility

Notes: This figure visualizes the 95% confidence intervals around the coefficients on synthetic loan-to-value (STLV) ratio categories $1[l_k < SLTV_{it} < h_k]$ from the following equation estimating the effect of SLTV on annual mobility indicators: $y_{icrt} = \lambda_{tr} + \gamma_a + \sum_k \delta_{1k} 1[l_k < SLTV_{it} < h_k] + X_{it}{}' \beta + \epsilon_{icrt}$. Synthetic loan-to-value is defined as the overall average origination loan-to-value ratio of 108.65 divided by the change in the house price index in that municipality since the month of origination. The model is estimated in the sample of 1.956 million buyer-years in the 2007-2012 period with balance sheet data.

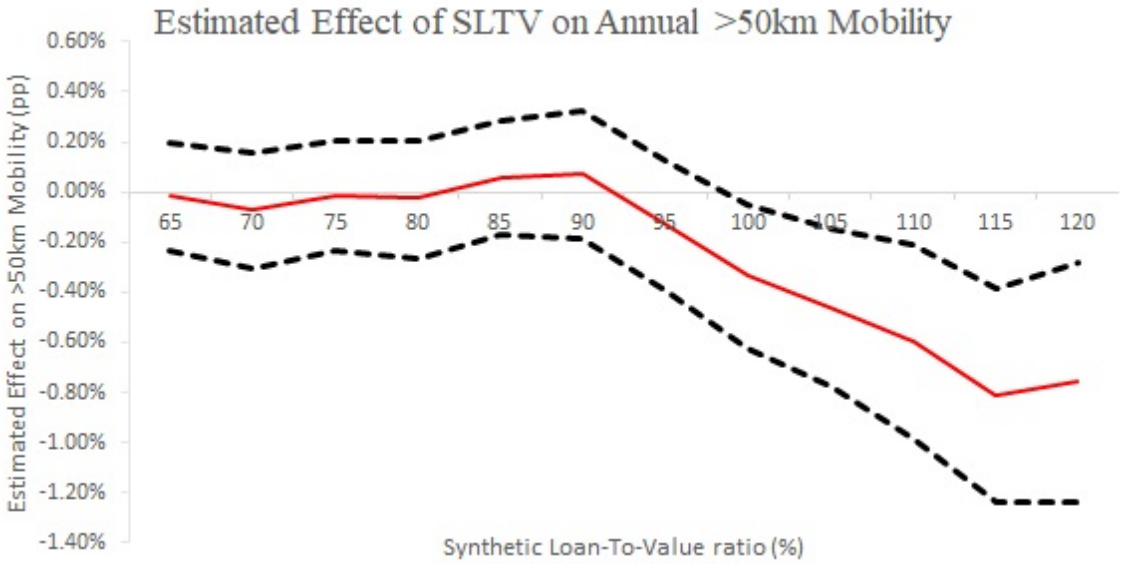


Figure 6: Effect of Synthetic Loan-to-Value Ratio on Annual Intermarket Mobility

Notes: This figure visualizes the 95% confidence intervals around the coefficients on synthetic loan-to-value (STLV) ratio categories $1[l_k < SLTV_{it} < h_k]$ from the following equation estimating the effects of SLTV ratios on annual mobility indicators for moves at least 50km away: $y_{icrt} = \lambda_{tr} + \gamma_a + \sum_k \delta_{1k} 1[l_k < SLTV_{it} < h_k] + X_{it}{}' \beta + \epsilon_{icrt}$Synthetic loan-to-value is defined as the overall average origination loan-to-value ratio of 108.65 divided by the change in the house price index in that municipality since the month of origination. The model is estimated in the sample of 1.956 million buyer-years in the 2007-2012 period with balance sheet data.

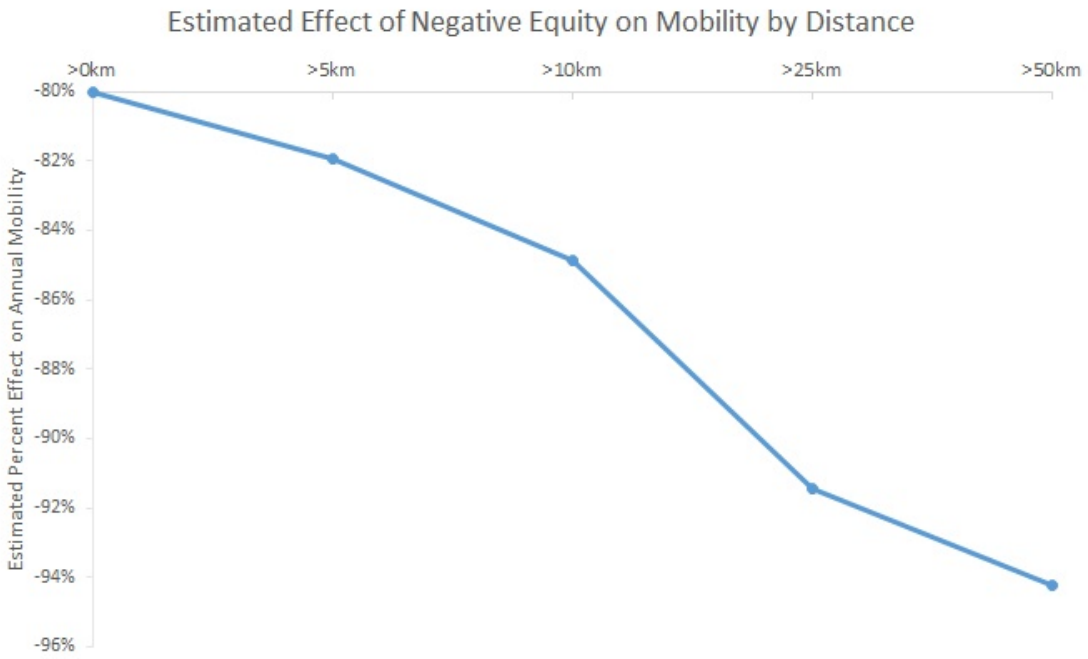
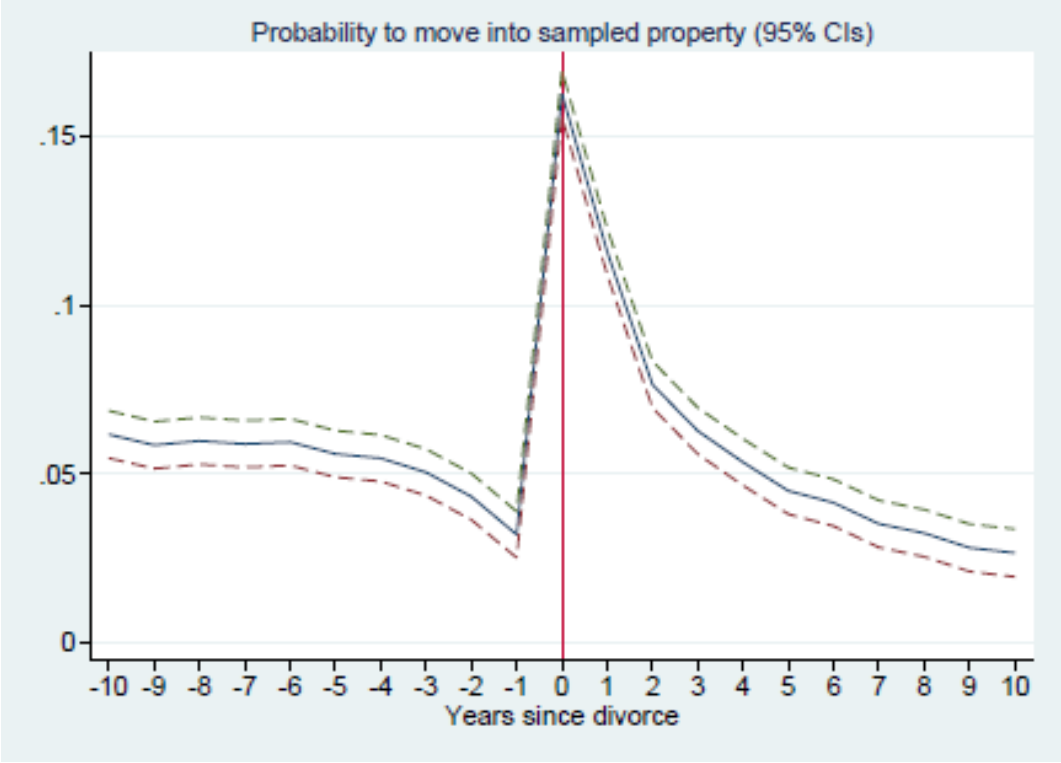


Figure 7: Effect of Negative Equity on Percent Mobility Reduction by Distance of Move

Notes: This figure visualizes the percent change in annual moving probability caused by negative home equity as a function of the distance of the move. Each point is estimated via separate 2SLS procedures using negative synthetic loan-to-value (STLV) as an instrumental variable. SLTV is defined as the overall average origination loan-to-value ratio of 108.65 divided by the change in the house price index in that municipality since the month of origination. The model is estimated in the sample of 1.956 million buyer-years in the 2007-2012 period with balance sheet data.



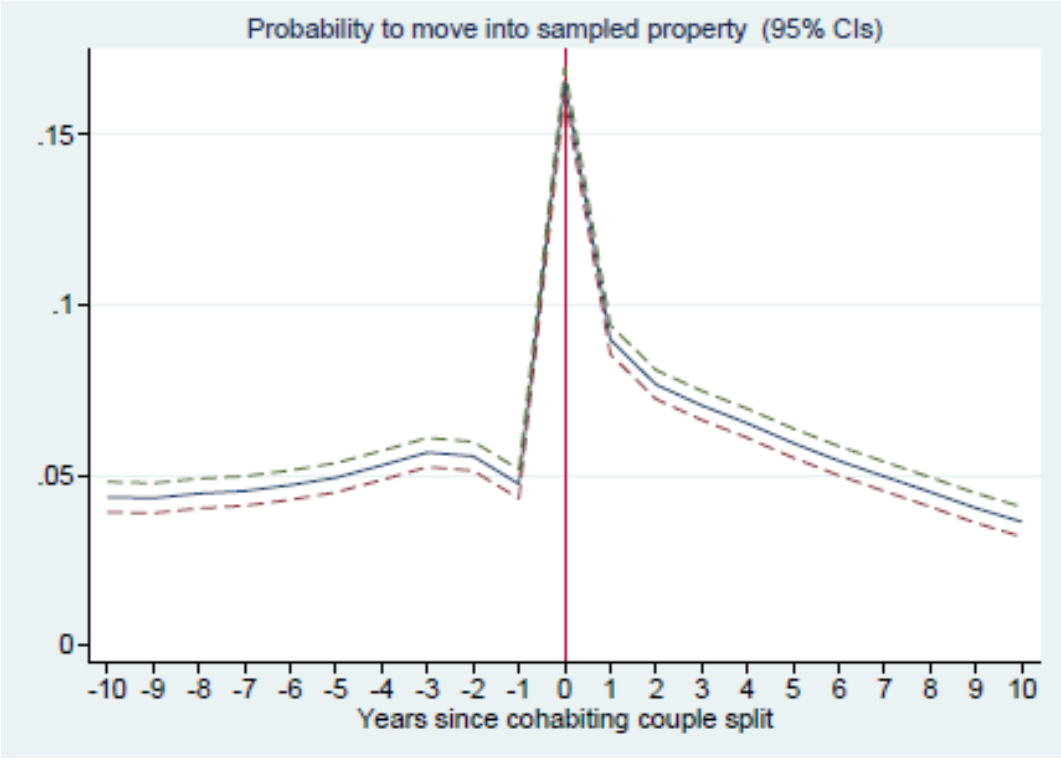


Figure 8: Moving probability for the sample of life-event buyers

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

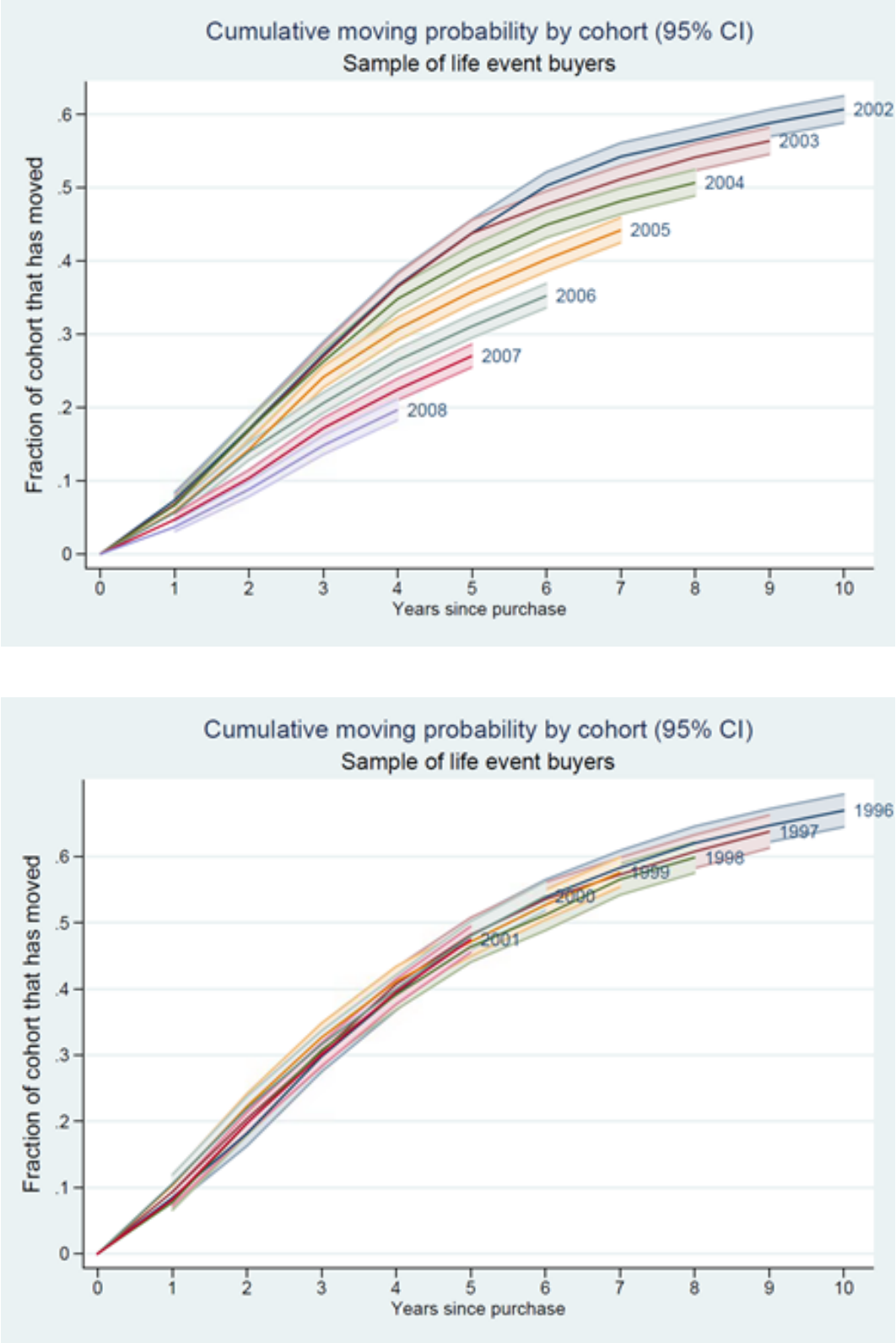


Figure 9: Mobility of purchase cohorts for life-event driven buyers

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 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 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 Statistics Netherlands (CBS). See section 5 of the text for more details. The sample is restricted to transactions of buyers who started their ownership spell at the time of the occurrence of life-events (a divorce or a cohabitating-couple split).

8 Supplementary exhibits

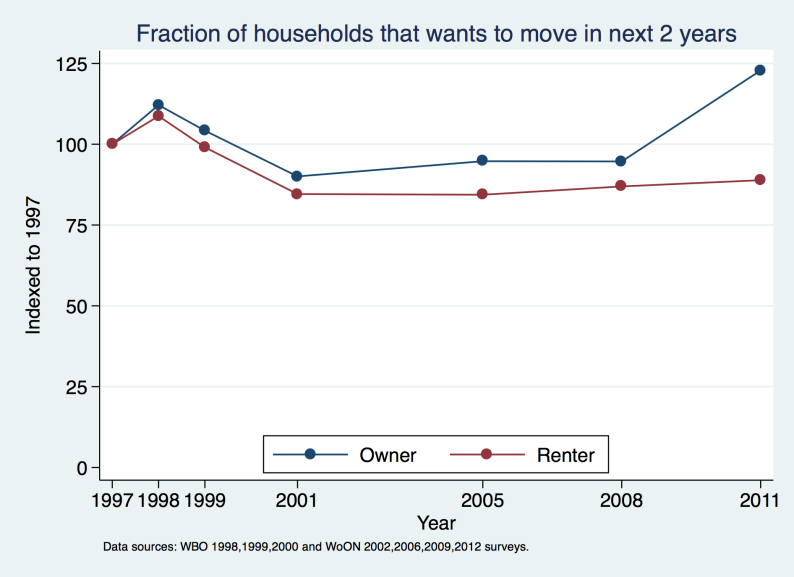


Figure 8.1: Mobility intentions of owners and renters over time

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.

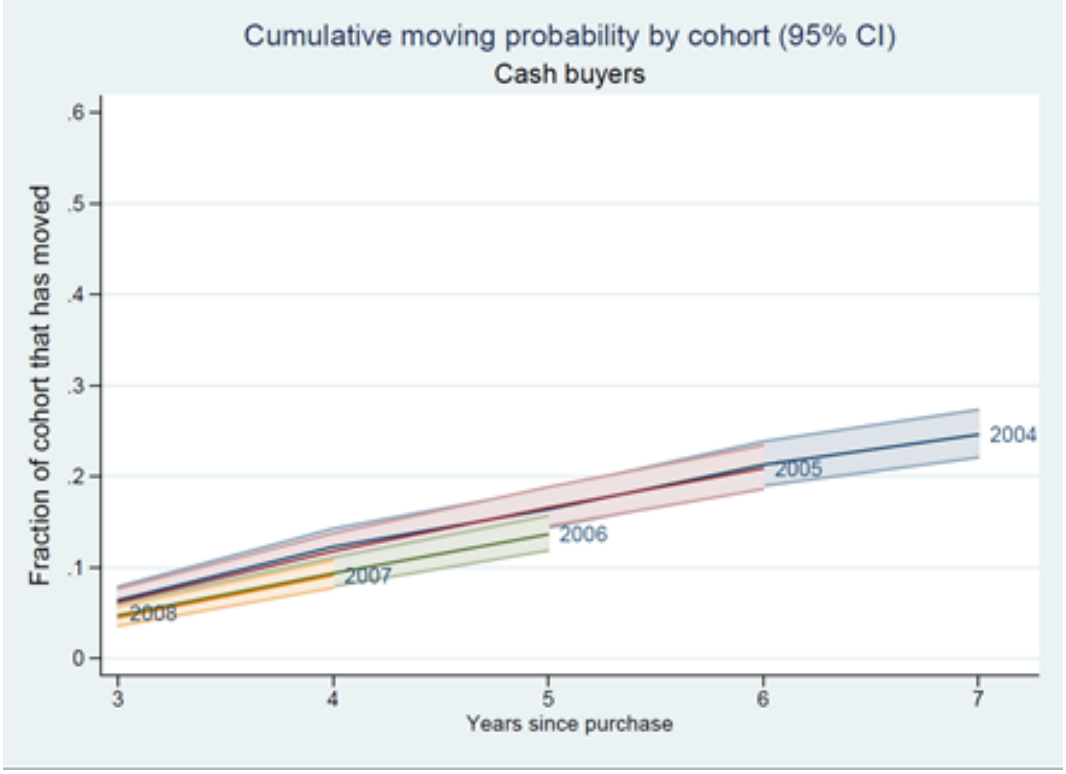
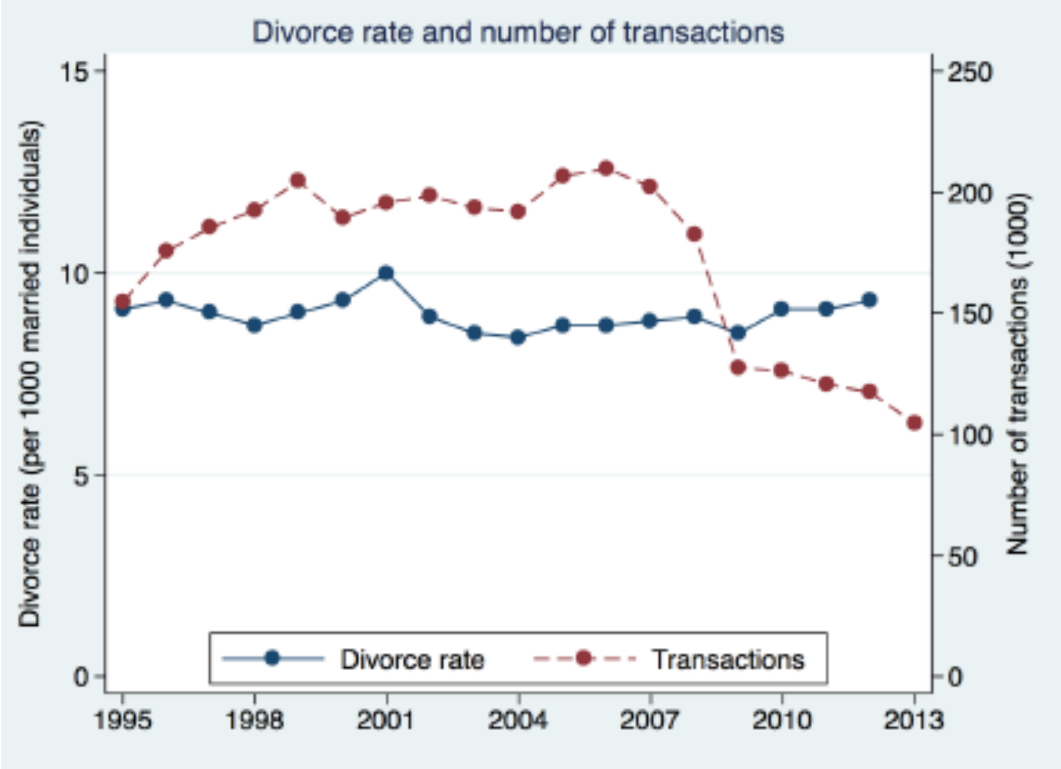


Figure 8.2: Mobility of purchase cohorts for cash buyers

Notes: This presents average cumulative moving probabilities and 95% confidence intervals for a placebo test of cash buyers which are differentially exposed to house prices, but who are not exposed to housing lock. The moving data are based on the Transactions Registry and the Address Registry from Statistics Netherlands (CBS). The sample is restricted to transactions of buyers who have no record of mortgage liabilities associated with the home purchase at any date and have balance sheet data over the time period 2007-2012.



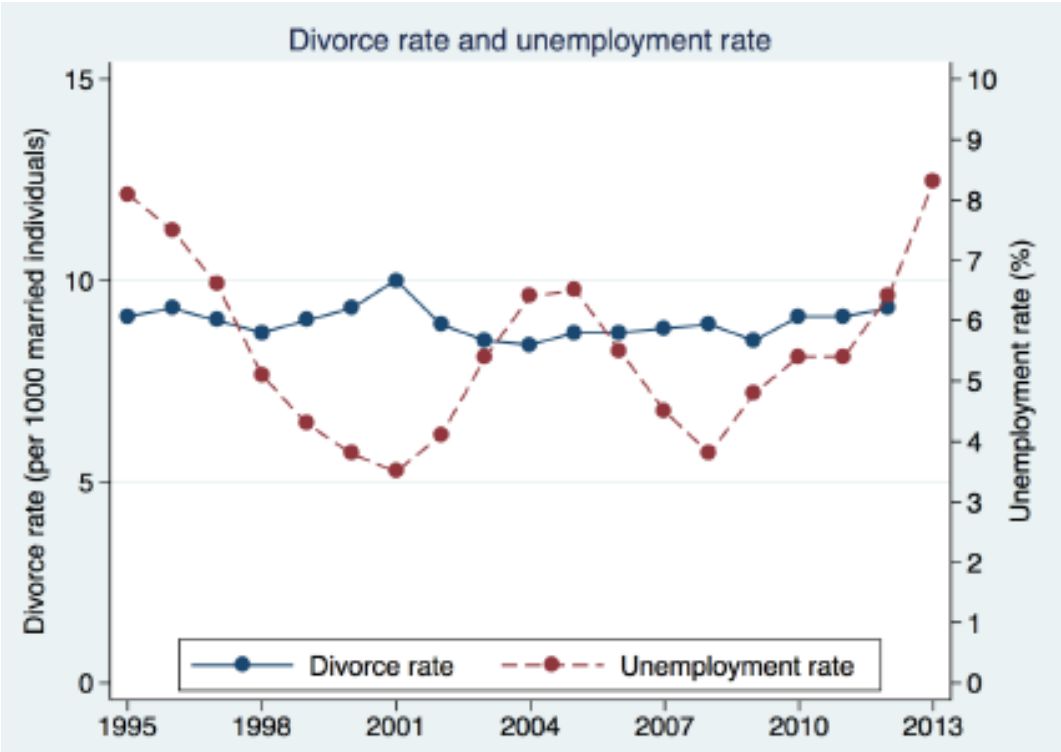


Figure 8.3: Divorce Rates, Housing Transactions, and Unemployment

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

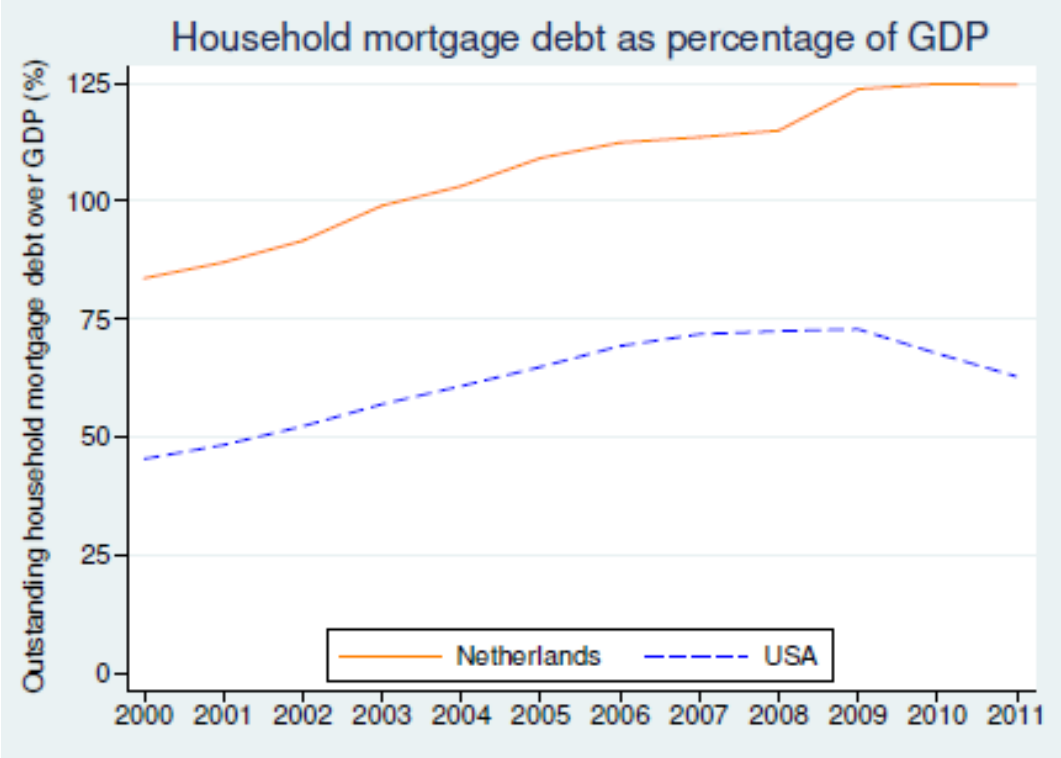
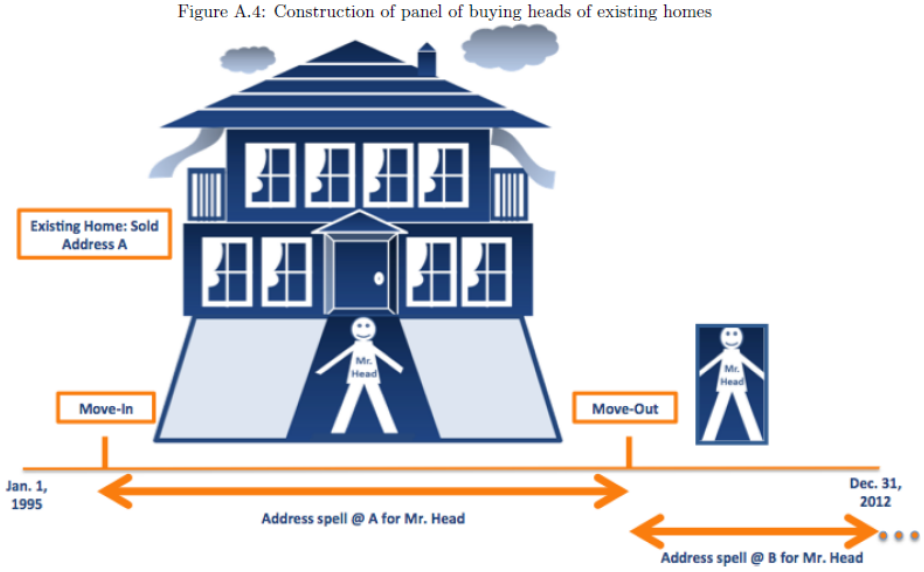


Figure 8.4: Household debt to GDP ratio for the US and the Netherlands

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

Figure 8.5: Construction of panel of buying heads of existing homes

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 5 of the text for more details.

Figure 8.6: Description of selection of transactions

Criterion	Deleted observations	Remaining 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 9 of the text for more details.

Figure 8.7: Life events and moves into owner-occupied homes by calendar year

Calendar year	# Life Events	# Moves into owned homes	Share of life events individuals moving into owned homes (%)
2003	17,021	62,807	37.1
2004	17,380	62,742	38.0
2005	17,344	66,365	40.4
2006	16,853	68,117	40.5
2007	16,087	64,188	40.9
2008	15,742	60,628	39.5
2009	14,078	45,969	37.8
2010	13,661	42,742	36.4
2011	12,669	39,908	35.7

Notes: Columns 1 and 2 in this Table count the number of life events and the number of moves into owned homes in the full sample of 549,066 buyers for the calendar years 2003-2011. The move into an owned home can but does not have to be a move into a sampled purchased existing home. Conditional on going through a life event, the percentage of person-years that moves into an owned home, is shown in Column 3 of this Table. The table starts in 2003 as the homeownership indicator variable is available since 2003, and ends in 2011, the last year for which life events can be defined.

9 Data Appendix on Construction of Sample of Buyers

We construct the 1995-2012 buyers in three steps. First, we randomly select 25% of the transactions of existing owner-occupied homes in 1995-2011. Second, we identify the unique household head among the persons moving into the selected property. Third, we build a panel following these identified buyers over the period 1995-2012. We now detail each of these three steps as well as the number of remaining observations after each step shown in Figure 8.6.

Random selection 25% of transactions in 1995-2011. We 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. We drop 35,242 transactions for which the address variable is missing and keep 3,022,286 transactions**. We** 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, we 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, we first consider all the individuals moving in during the same quarter at a given address. we 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[26]. We drop 1,198,597 individual address spells with more than 10 persons moving in[27] and obtain 34,443,817 individual address spells. We 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.

We 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, we match 630,947 of the 747,554 purchase transactions (=84.40%).[28]

To identify the household heads for the selected transactions, we use the head of household identifier

[26]We drop the 15,415,895 left-censored spells starting exactly on January 1st, 1995; the database starts on January 1st 1995.
[27]The main goal is to avoid those who moved into institutional addresses (e.g. senior citizen housing, nursing homes).
[28]For the remaining 116,607 non-matched transactions, **we** 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).

dummy on December 31st of the transaction year from household structure spells that we 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, we list all the individuals moving into the sampled transactions, and we 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, we 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, we then build a annual panel of household structures of persons moving in. We 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 we find 13,244,303 individual household structure spells for the 1,362,573 matched distinct persons. Because of insufficient disk space constraints, we 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.We then match the moving in person-years and person-years from the household structure panel. From the 1,436,642 moving in person years (629,174 transactions), we can match 1,436,459 person years (629,137 transactions) to their household structure in December of the year of the transaction. We then restrict ourselves 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. We then drop transactions for which the move starts in 2012, as we cannot observe subsequent mobility out of purchase dwellings in 2013 and later as of yet. We thus drop 6,750 moving in person years for which the moving in date occurs in 2012 (0.47%), and we obtain 1,427,955 moving in person-years (625,315 transactions). We then match transactions and heads.

From the 625,315 transactions, we 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, we 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%). We 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. we 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. We 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). We 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, we implement two minor transaction sample restrictions using the panel of addresses. First, before defining mobility, we 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. We focus on the remaining 99.44% or 574,337 transactions.

10 Dutch Mortgage Characteristics and Costs of Housing Lock

Dutch Mortgage debt stock and characteristics 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 8.4. This high mortgage-to-income ratio reflects (1) high home-price-to-income ratios, (2) a moderate homeowmership rate, and (3) high LTV ratios among homeowners.

First, the median Dutch household housing cost burden in 2014 is 23.9% of disposable income. This average housing cost among owners and renters corresponds to percentile 90 among OECD countries (vs. 18.9% OECD average and 19.5% in the US). Second, the homeownership rate in the Netherlands is 60%. Third, average Dutch LTV ratios are high, reflecting both high LTV ratios at origination and limited amortization. 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.

The vast majority of mortgages for the 1995-2011 purchase cohorts that we study are non-amortizing.

Interest-only 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 interest-only loan, combined with a second interest-only 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.[29] 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[30] 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.

The cost of housing lock Declines in residential mobility can in principle be associated with several costs, including, for instance, lower job switching and job quality, declines in the quality of housing matches, lower ability to smooth income risk, and reduced performance at existing employment. Several authors have explored such factors in the U.S. setting including Brown and Matsa (2016), Demyanyk et al. (2017),Bernstein et al. (2017) ,and Gopalan et al. (2017).The magnitude and relative importance of these costs likely also depends on policy factors. In terms of the baseline residential mobility rate, the mobility of Dutch homeowners is comparable to US levels (Emrath (2009)) with estimated times until half of the buyers move from their homes of around 12 to 13 years. First, in terms of the labor market effects, the Netherlands is of course a smaller country than the US with more synchronized local business cycles. But within 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 et al. (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. Second, the comparable baseline homeowner mobility rate suggest that the cost from foregone moves with non-labor market motives (e.g. proximity to family, change in house size) is likely of a similar order of magnitude. Third, the cost of the inability to smooth income risk by adjusting housing costs probably also depends on the availability of social insurance–perceived as relatively generous in the Netherlands–and the options to default, which are limited in the Netherlands. Overall, the Dutch institutions allow isolating the housing lock, likely imply a more negative effect of home equity on mobility than in the US, and have led to a very high mortgage-debt-to GDP ratio.

[29] As of January 2013, new mortgages have to fully amortize to benefit from interest tax deduction, which has decimated the market for non-amortizing loans (Struyven (2015)).

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

11 Toy Model on the interaction of housing lock and moving distance of buyers

The Stein (1995) model predicts that households move when (i) the life-time utility benefit of moving exceeds the life-time utility cost of moving, and (ii) the total net liquid assets are larger than the required downpayment and the pecuniary upfront moving cost (i.e. when the liquidity constraint does not bind). As both the life-time benefits (ex. income gains from job search) and costs (ex. shipping costs, distance to family, job search costs) vary with distance, it is not obvious theoretically how the effect of negative home equity on mobility should vary with distance.

In terms of the model, let us define B as the discounted present value of the gross utility benefits of moving and C as the discounted present value of the gross utility costs of moving. In turn, the discounted costs C are the sum of (1) pecuniary moving costs MC faced today (e.g. trucks, furniture, time away from job), and (2) other costs OC. Additionally, the household balance sheet consists of home equity denoted by HE , and liquid financial assets FA. Let us also assume that a moving household has to put down D but can obtain a supplementary personal loan L if it moves (by borrowing for instance against higher future expected wages). Finally, the household also keeps a minimum precautionary buffer P of cash set aside (i.e. the minimum on their cash account), that may increase in a new, riskier environment.

We can posit that a household moves if a new home opportunity arises for which (i) the life-time benefit of moving exceeds the life-time cost of moving:

$$B > C \tag{6}$$

and (ii) the total liquidity after the move exceeds the minimum precautionary buffer:

$$(HE + FA + L) - (D + MC) > P \tag{7}$$

Let us assume that the household has a short-distance moving opportunity s and long–distance opportunity l. We also assume that the discounted moving benefit $B(d)$, the pecuniary moving cost $MC(d)$, the discounted total moving cost $C(d)$, the collateral value of moving L, and the precautionary buffer $P(d)$ can all vary with the moving distance d, while home equity HE and financial assets FA–predetermined before the moving opportunity arises–do not depend on distance. Specifically, it is plausible to assume that $B(d)$ rises in distance as more job more opportunities and person-specific amenities–such as weather–become available. On the cost side, DaVanzo (1981) finds that individuals build location-specific capital, and Mulder and Wagner (2012) and Mulder and Malmberg (2011) show that moving tends to occur less frequently if a

person has family nearby and moving probability and distance are lower if the person has lived in a location for a long period of time.

How does the impact of negative home equity on mobility differ for the short and long moves? Analytically, negative home equity only affects equation 7. Negative home equity has a larger effect on the long move than on the short move if equation 7 is more often violated for long moves l than for short moves s. The two threshold conditions for this to be true are (i) $(HE(s) + FA(s) + L(s)) - (D(s) + MC(s)) > P(s)$ and (ii) $(HE(l) + FA(l) + L(l)) - (D(l) + MC(l)) = P(l)$. Combing these 2 conditions and using that home equity, financial assets, and the downpayment are equal for short and long moves gives the following condition:

$$L(l) - L(s) < [MC(l) - MC(s)] + [P(l) - P(s)] \tag{8}$$

In words, negative home equity has a more negative effect on long distance moves than on short distance moves if the extra collateral value of a long move is smaller than the sum of the extra moving costs and the extra precautionary cash buffer.