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The Impact of House Price Shocks on the Savings of Dutch Homeowners and Renters

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Abstract

We study the impact of changes in house prices on savings using administrative panel data on Dutch owner-occupying and renting households over the period 2006-2013. We analyze the immediate response as well as the response aggregated over several years. We find a marginal propensity to save (MPS) out of housing wealth in the short-run between 0 and -0.05, while the long-run effect ranges from -0.02 to -0.13. Younger homeowners consistently respond more strongly both in the short and the long-run, while pre-crisis leverage has a non-homogeneous effect in the short-run and no effect in the long-run. We only find a small, significant, and positive short-run effect for old renters and no effect for all other groups of renters, suggesting that our results are not driven by common causality.

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1 Introduction

The financial crisis has put the relation between house prices and the real economy in the spotlight. Policymakers are concerned that large drops in

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housing prices hit the economy by triggering large drops in consumption, especially amongst households with high leverage ratios. Indeed, IMF (2012) finds that house price drops went hand in hand with a decrease in household consumption expenditures in 24 OECD countries during 1980-2011, while Mian, Rao & Sufi (2013) find larger effects of house price drops for high-leverage households in the US.

Although there seems to be a strong correlation between house price changes and household consumption or savings at the macroeconomic level, this does not imply that changes in house prices were the main driving factor of the drop in consumption in the period 2008-2013. The correlation may be driven by a common factor. For example, revisions to households' current or expected future income may simultaneously increase or decrease consumption and demand for housing (Attanasio, Blow, Hamilton & Leicester, 2009). In particular, worsening job prospects may both impact savings and house prices at the same time, even though local economic conditions may be less relevant for job prospects in a small country such as the Netherlands with low cost of commuting.

Our paper assesses the importance of the direct impact of house prices on consumption using administrative panel data on Dutch home owning and renting households and renters over the period 2006-2013. Our final dataset is a 10% random sample including about 125,000 home owners and 50,000 renting households and includes data on savings, mortgage levels, and home values. Because consumption data is not available, we focus on the mirror of consumption: savings including mortgage payoffs.

The Netherlands offers a unique testing ground to study the relation between a drop in house prices and savings. Home ownership is high, while house prices exhibited a sharp increase in the years leading up to the crisis, followed by a large drop after 2008. Also, at a macro level the correlation between house prices and consumption is very strong. If the relationship between house prices and consumption runs through adjusted savings behavior in response to deteriorating household balance sheets, we should be able to explain a large fraction of the drop in consumption by this mechanism.

We identify the effect of house price declines on savings by using variation in the drop in the house price experienced by households. We control for income and for characteristics such as age, household composition, stock holdings, initial year of occupancy, the loan-to-income ratio and marital status at the household level. We address the problem of common causality, that is, unobserved factors that impact both house prices and savings, in two ways. First, we control for changing local macroeconomic circumstances through regional time dummies. Also, we include regional unemployment data as explanatory variables. Second, and more importantly, we compare the effect of a drop in house prices on consumption for home owners with the effect for renters in the social renting sector who rent for the entire period 2006-2013, whose wealth is not affected by a drop in house prices.[1]

We do this in two ways. First, in a year-by-year analysis that is standard in the literature that looks at the immediate, short-run, response of a change in house prices. Second, however, we use a model that aggregates changes in savings and house prices over multiple years to determine the long-run response. In particular, we aggregate data over the period 2008-2013. This way, we account for lagged effects of house price drops that would increase the response of households, but are not included in the panel model. Indeed, Carroll, Otsuka & Slacalek (2011), studying regional data on consumption and house prices, find that the short-run response of households to a shock in house prices is significantly smaller than the long-run response.

The use of micro-data also allows us to test the predictions of two different mechanisms that house price changes and household savings by studying how the effect varies across different subgroups of the population.

First, the life-cycle hypothesis states that individuals smooth consumption over their life-cycle by accumulating savings during earning years and spending savings during retirement (Modigliani, 1966). If consumers treat their house as part of their wealth, they will decrease consumption in case of capital losses. Because young homeowners have a longer period to even out fluctuations in consumption, they will react less strongly to a given shock compare to older households.

Second, the collateral (or credit-constrained) hypothesis states that a fall in house prices reduces the collateral available to finance consumption. Because young households have lower total wealth and are therefore more likely to be credit constrained than old households, this mechanism hits young households harder. Also, a drop in house prices will lower the creditworthiness of highly leveraged households more as compared to households with low leverage.

In the short-run, we find a marginal propensity to save out of housing wealth in the range 0 to -0.05 for owner-occupiers, depending on age and

[1]Rental prices in the social renting sector are relatively constant in the period 2006-2013. When house prices drop, this could effectively raise the wealth of renters who are planning to buy a house. People who rent in the social sector for the entire period are unlikely to plan to move to a house.

LTV ratio.[2] This is comparable to pre-crisis estimates for the US (Lehnert, 2004; Bostic, Gabriel & Painter, 2009) , and somewhat smaller than estimates that include the crisis period (Mian et al., 2013). We find larger effects in the long-run aggregated model, in the range -0.02 to -0.013, depending on age and LTV ratio, suggesting that lagged-response is important.

Both in the short-run and the long-run, our point estimates show that the response of young homeowners is stronger than the response of older homeowners, that is, we find a positive significant effect of age, pointing to the collateral hypothesis. However, we do not find a clear effect of leverage on the response, as might have been expected from the collateral hypothesis. In the short-run, the effect of leverage is non-homogeneous, with households with intermediate leverage responding more strongly compared to households with very high or very low leverage, while in the long-run leverage does not have a significant impact on the response to changes in house prices.

For renters we only find a small and significant effect of house price shocks on savings only for older households in the short-run, while we do not find any effect of house prices on savings for renters in the long-run. This shows that our findings for homeowners are not driven by common causality.

Our long-run estimates indicate that the drop in house prices resulted in additional savings of, on average, 1.5% of the disposable household income. In the period 2009-2013 the real per capita consumption in the Netherlands decreased by about 9% or 1,600 euro compared to the level in 2008. At the macroeconomic level this amounts to an aggregate decline of 63 billion euro.[3] Our conservative estimates indicate an aggregated drop in real consumption of 3.2 billion, while the upper bound of our estimates indicates an aggregated drop of 8.4 billion.[4] In other words, our estimates

[2] In our earlier analysis, which did not include 2012 and 2013, we found a smaller effect, roughly half our current estimates.

[3] This number is based on the assumption of zero population growth during the period 2009-2013 to make a fair comparison.

[4] We made buckets of households based on LTV class and age of the household head and calculate the corresponding marginal effects of a house price decline on savings for each bucket from our estimates. From Statistics Netherlands we obtained macroeconomic data on homeownership per age class, which is unfortunately not further disaggregated per LTV class. For the conservative estimate, we take the smallest price decline and the smallest point estimate of the marginal effect per age class and over LTV classes. We multiply these two numbers to get the minimum effect of the price decline on savings in euro's. Finally we multiply this number with the total number of homeowners per age class in the Netherlands. The upper bound is calculated similarly, but then we take the

explain roughly 5-13% of the total drop in consumption in the Netherlands. This suggests that, although increased savings play an important role, other mechanisms are also important in explaining the strong correlation between consumption and house prices. These other mechanisms could also be related to the decline in house prices. For instance, one could think of the decline in housing-related consumption due to the sharp decline in the number of transactions on the housing market. However, our estimates suggest that other factors play a role as well. Changes in (expected) income are an important candidate as the significance and size of changes in income as a determinant of changes in savings shows.

2 Related Literature

Our paper relates to a growing number of studies using household level data to study the relation between house prices and savings or consumption.

A number of contributions focus on the role of leverage. Some of these look at the pre-crisis period. Bostic et al. (2009) match disjunct survey data and find no evidence of an effect of high LTV ratio's, defined as an LTV higher than 90%. Cooper (2013), using US survey data, finds that house price changes affect low-wealth households, while high-wealth households do not respond to changes in house prices. Others include the crisis period. Mian & Sufi (2010) find that areas with a larger pre-crisis increase in leverage, experience a more severe recession in the years 2007-2009. Mian et al. (2013) use the elasticity of housing supply as an instrument and find stronger effects for low net-worth and high-leverage households. Both studies use aggregated US county-level data for spending per county and the housing stock. Similarly, Dynan (2012), using survey data, finds that highly leveraged US homeowners showed larger declines in consumption levels than other homeowners, even after controlling for wealth effects. Bun & Rostom (2014) also document a larger effect of a house price decline on spending among UK households with higher leverage, using a pseudo panel created from a repeated cross-section survey. Closest to our paper is Andersen, Duus & Jensen (2016), who use Danish administrative data from 2003 to 2011. They find a negative relation between pre-crisis leverage and spending during the crisis. However, once they condition on the pre-crisis change in debt levels, the relation disappears. They argue that households with abnormal spending patterns

largest price decline and the largest point estimate of the marginal effect per age class and over LTV classes.

prior to the crisis are returning to normal instead of suffering from collateral constraints.

Several other studies focus on how the effect of changes in house prices on consumption varies with age. Some papers also distinguish between renters and home-owners and allow for an asymmetric response to gains and losses, like we do. All of these papers study the pre-crisis period. Campbell & Cocco (2007) study the effect of regional house price changes in the UK. They find a large and significant effect of changes in house prices on consumption for older homeowners and insignificant results for younger homeowners. However, using the same data, Attanasio et al. (2009) find larger effects for young households. They argue the relation between consumption and housing prices is largely due to common causality. Both studies use a pseudo-panel. Disney, Gathergood & Henley (2010) study the effect of county-level house-price changes in the UK using household level panel data. They find little evidence of heterogeneity in the response of home-owner with respect to age and no evidence of asymmetry with respect to gains and losses. They do find a larger effect for households with negative housing equity at the start of the period and increased savings by young renters in response to a housing shock. Lehnert (2004), using US household-level survey data, finds the young and late middle aged to be most sensitive to housing wealth gains, and the middle aged and elderly the least responsive. Browning, Gørtz & Leth-Petersen (2013), using Danish administrative data, study a shift in 1992 from a regime where housing equity could not be used as collateral to a regime where it could. Using Danish administrative data for the period 1987-1996, they find that, while old households are unaffected by the shift, after the shift young homeowners with low levels of liquidity react to house price changes, whereas they did not before.

We add to this literature in several ways. First, most studies, with the exception of Browning et al. (2013) and Andersen et al. (2016), use either pseudo-panels, panels with self-reported wealth data, aggregated data, or county-level house prices. Instead, we use a representative sample of Dutch administrative data including matched house prices. In addition, we compare renters with owner-occupiers, which addresses the issue of common causality. Finally, we explicitly study the period 2006-2013 before, including and after the crisis, for a country that experienced a significant drop in housing prices, allowing us to treat the drop in house prices as an unexpected event.

3 Data

We use comprehensive administrative household level data from Statistics Netherlands covering wealth components, income, and demographics over the period 2006-2013. A file containing all Dutch addresses with information on the type of usage (owner-occupied or rent) and value of the building, the so-called WOZ-values, on each address is the backbone of our analysis. We remove non-residential buildings, such as institutional buildings, trailers, and holiday homes from the dataset. The WOZ-values are reassessed by municipalities every year based on sales prices of nearby comparable properties. The WOZ-values are used for tax purposes both nationally as well as at the municipality level and represent the value of the house in the year before the assessment year. Dutch home-owning households receive their WOZ-value by mail every year, which increases awareness of the estimated current value of their properties.

For computational reasons we randomly select 10 percent of the addresses in the year 2006. Note that, by applying this strategy, we obtain a random sample of Dutch households if every address corresponds to exactly one household and each corresponding house can be either owner-occupied or rented. In about 1 percent of the cases we found that two or more households were living on the same address. These households are removed from our sample.

We include the addresses that we selected in 2006 in all subsequent years in our dataset, which means that we created a balanced panel of addresses.

For about 20 percent of the resulting sample the mortgage amount in one or more years was missing due to administrative errors in this variable. We imputed these values by linear extrapolation.

To the random sample of addresses we match individual demographic characteristics, such as age and marital status. This individual data also includes the time span that individuals spent living on a particular address. [5] We classify a group of individuals living on the same address at the same point in time as a household. [6]

We next add data on wealth and income at the household level that originate from tax return forms. On the asset side we add information on the savings on bank accounts, the value of stocks and bonds, and en-

[5] From 1995 onwards we know the exact date at which individual started to live on a particular address. Before 1995 this information is not available.

[6] Statistics Netherlands indicates, for data merging purposes, one of the individuals as the main person in a household. We count the number of "main persons" per address to identify addresses with two or more households.

trepreneurial wealth. On the liabilities side we add information on the outstanding mortgage amount linked to the prime residence, other mortgage debt, and other types of household debt. The income data consists of disposable households income, the main income source, and information on the size and composition of the household.

In line with the literature we make several additional selections. The most important selection criteria is that households should not move during our sample period, because moving directly affects both the house value and household savings. For a small fraction of the non-moving households we do not know the status on the housing market (owner or renter). These households are also removed from our sample. We identify the oldest adult as the household head and remove households with a household head who turns 65 or older during the sample period. We also drop households with a member that divorces or becomes widowed, as well as households with major changes in household composition. All these events may lead to significant changes in savings behavior around retirement.

Finally, to correct for outliers and errors in the administrative data, we drop (i) households in the top and bottom 1% of our savings variable[7], (ii) households who live in houses with a value below 50,000 and above 1,000,000 euro, and (iii) households with an LTV above 180%[8]. Appendix C gives an overview of the data cleaning process and its effect on the number of observations.

4 Descriptives

We have about 114,000 home-owning households and 47,000 renting households in our sample. About 84% of these renting households lives in a house in the rent-control segment.

In Figure 4 in Appendix A we plot the median of yearly savings for

[7]Outliers in the top 1% of the savings distribution may be related to bequests. In our data, we also observe very large reductions in the amount on savings accounts. These dissavings may be related to administrative errors or large investments, such as home improvements. For those reasons we decided to delete both the top and bottom 1% of the savings distribution. Including the top and bottom 1% makes our estimates less precise, but does not change the conclusions.

[8]Very high LTVs are either explained by administrative errors in the mortgage variable or by the fact that mortgages of the new house are sometimes added to the current mortgage when households are close to moving. We tried to correct for administrative errors in the mortgage variable as much as possible by comparing mortgage amounts over several years and check whether strange patterns occur.

owner-occupiers, renters in the private sector, and renters in the rent-control segment. The figure reveals that owner-occupiers have the highest median savings in the years before 2011, followed by private renters and renters in the rent-control segment. From 2011 onwards this ordering is less clear and median savings seem to be on a slightly lower level for all groups. Figure 5 shows that the pattern is similar when we limit the sample to owner-occupiers and renters with an income below 50,000 euro. We find no clear effect visible of the house price shock in the raw data.

Figure 6 shows the average house price shock for the three groups of households according to housing tenure. We observe a very similar pattern for these three groups with price increases before 2010 and price decreases from 2010 onwards. Note that market prices started to decrease in 2009, which is captured in our data by the WOZ-values of 2010. The aggregate shock over the period 2010-2013 is about 38,000 euro for owner-occupiers and 26,000 euro for all renters. Compared to the average house price, this amounts to about 15% for both groups. In 2013 house prices declined for close to 100% of the Dutch households. Again, when we limit the sample to homeowners and renters with an income below 50,000 euro we find very similar results.

The averages of our most important control variables are displayed in Table 1 (owner-occupiers) and Table 2 (renters).[9] To limit the table size we only show averages for the odd years. The average real disposable income of both owners and renters starts to decline after 2009, which is most likely related to the sharp increase in unemployment. The main differences between owner-occupiers and renters are the level of disposable income (owner-occupiers earn more), the household size (owner-occupiers have larger families), and the main income source (renters are about ten times more likely to have social benefits as their main income source).

For owner-occupiers we obtained information on their LTV ratio by dividing the outstanding mortgage amount by the WOZ-value of the house. We divide the home-owning households in our sample into seven groups according to their LTV in 2006. Table 1 shows that almost 70% of the households has an LTV below 80% in 2006. Of the remaining 30% of the households a large fraction is probably in negative equity in 2013 as a result of the house price decline. Note that our sample is in this respect not representative for the Dutch population. Because moving households and households with major changes in family composition are excluded, young households, who are more likely to have high LTVs, are underrep-

[9]Besides the controls shown in the tables, we include dummies for household composition and marital status.

resented in the sample.

5 Econometric specification

We separately estimate the relation between house price changes and savings for owner-occupiers and renters, using two models. The first includes only the immediate effect of house prices on savings, in line with much of the existing literature.

$$\Delta S_{it} = \alpha_i + \theta_t + \beta \Delta H_{it} + \gamma \Delta H_{it} \times Z_{it} + \delta Z_{it} + \phi X_{it} + \epsilon_{it} \qquad (1)$$

Here, ΔS_{it} denotes the year-to-year change in real savings for household i in year t. For owner-occupiers we define ΔS_{it} as the difference between real savings on bank accounts SA_{it} and the real change in the outstanding mortgage amount ΔM_{it} of household i in year t, that is, $\Delta S_{it} = \Delta SA_{it} - \Delta M_{it}$. Thus, we consider mortgage payoffs as savings whereas mortgage increases are considered as dis-savings. For renters, savings are simply defined as the real savings on bank accounts: $\Delta S_{it} = \Delta SA_{it}$.

ΔH_{it} represents the year-to-year change in the real price of the property that the household is living in. To allow for heterogeneity in the effect of house-price changes, we include ΔH_{it} interacted with the variables Z_{it} that consist of age in 2006 (we include age in 2006 because including the actual age would imply including a time effect in the interaction), loan-to-value categories in 2006 (loan-to-value ratios for later years are endogenous), and an indicator for house price declines. The vector X_{it} includes background characteristics of the household and year dummies θ_t capture year-specific effects. The intercept α_i denotes a constant in our OLS specifications, whereas it denotes an individual fixed effect or random effect in our panel specifications.

In Equation 1 we assume that a house price shock between $t-1$ and t affects savings in the same period. This does not allow for a lagged savings response. To deal with this we also estimate an aggregated model, where we regress the aggregated savings between year t and some base year τ on the aggregated house price shock between t and τ.

$$\Delta S_{i,t-\tau} = \alpha_i + \beta \Delta H_{i,t-\tau} + \gamma \Delta H_{i,t-\tau} \times Z_{it} + \delta Z_{it} + \phi X_{i,t-\tau} + \epsilon_{it} \qquad (2)$$

We estimate this model for different years t holding the base year τ constant. Since we focus on house price declines we set $\tau = 2009$ and estimate the model for a period where virtually all households experienced price declines. Again, we estimate Equation 2 for owner-occupiers and renters separately.

In both model 1 and 2, the marginal propensity to save out of housing wealth (MPS) is given by $\beta + \gamma Z_{it}$, the partial derivative of ΔS_{it} with respect to ΔH_{it}. It is intuitive that the relation between house prices and savings runs from house prices to savings and not the other way around. However, to interpret the MPS as the causal effect of house price shocks on savings, the house price shock should be unexpected and we need to take seriously the issue of common causality.

A relevant assumption is that the shock to house prices due to the financial crisis that hit the world in 2008 was largely unexpected. This seems uncontroversial. In 2006, no one expected a price decline of 20 percent within eight years.[10] Therefore, we do not estimate a time-series model for house price changes and use the unexplained variation as our exogenous house-price shock as in Campbell & Cocco (2007), Browning et al. (2013), or Disney et al. (2010).

Common causality arises when, the shock to house prices is driven by other factors that affect both house prices and savings at the same time. For instance, some areas may be hit harder by the crisis than other areas, which might affect both house prices and household savings. To address this we should in principle include all variables in our model that affect both ΔH_{it} and ΔS_{it} at the same time, otherwise estimates will be biased. Because we do not have a credible instrument, we control for omitted variables by including the regional unemployment percentage and region-year fixed effects in our regressions. [11] This means that our estimates are identified on variation in house price shocks within regions.

In addition, we include the following control variables in the vector X_{it}: number of household members and household composition, aggregate household income, main income source, mortgage-to-income ratio in 2006, marital status, first year on address dummies, and regional unemployment. Together with the region-year fixed effects and the year dummies this substantially limits the scope of omitted variables. Besides that, we estimate our model with individual fixed effects, which means that we

[10] Note that we allow for an asymmetric effect of house price increases and decreases. However, price increases in years before 2008 were probably not unexpected as house prices were increasing for at least 15 years before the house price bust. In our interpretation of the results we therefore focus on the effect of house price decreases.

[11] We include region-year fixed effects at the COROP-level. The Netherlands is divided in 40 COROP-areas. We also experimented with municipality-year effects (there are about 400 municipalities in the Netherlands), but this yields virtually identical results. For computational reasons we prefer to include COROP-year effects in most of our specifications.

control for time-invariant household characteristics.

To further strengthen the belief of a causal interpretation, we investigate differences in the response of owner-occupiers and renters. Because renters are not affected by house price changes, there is no reason to believe that a house price shock would impact their savings.[12] Therefore, we hypothesize that renters in the rent-control segment do not adjust their savings following a house price shock.

If we found similar effects of changes in house prices for owner-occupiers and renters in rent-controlled houses, this would indicate that common causality is at play and we are missing an important variable that affects both property prices and household savings. On the other hand, if we found no effect for renters and a significant effect for owner-occupiers, this would make a causal interpretation more credible.

6 Results

We first discuss the result for owner-occupiers in the short run. The estimated coefficients of equation 1, measuring the immediate response to a house price shock, are presented for owner-occupiers in Table 3.

For owner-occupiers, we find a negative significant coefficient on ΔH_{it}. This indicates that a house price decline results in an increase in savings. We find a positive significant coefficient on the interaction with age. This means that the negative relationship between house price shocks and savings is weaker for older households. This is in line with the collateral constraints hypothesis. The size of the coefficient for owner-occupiers is such that an increase in age of 10 years reduces the MPS by roughly 0.01. However, in contrast to what one would expect if the collateral constraint hypothesis held, we find a non-homogeneous effect of the 2006 LTV class. We find the strongest response for LTV ratios of 80-90 percent and 100-110 percent, and a weaker response for high or low LTV ratios. Finally,

[12] It is possible that savings of renters are affected by house price changes, for instance when price shocks translate in rent changes or when renters are planning to buy a house in the near future. In the Netherlands a large group of renters is living in rent controlled houses. Households in the rent-control segment are more likely to be low-educated and have, on average, lower incomes. Therefore we expect that mobility from the rent-control segment to the owner-occupied segment is relatively low. Moreover, rents in the rent-control segment are not affected by the large price fluctuations of owner-occupied houses. For renters in the private rent segment it is less clear whether the same line of reasoning holds, since these households are probably more likely to move to an owner-occupied house. For that reason we estimate our models for all renters together as well as for the group of renters in the rent-control segment.

we get a positive significant coefficient on the interaction with the decline dummy in all specifications. This implies that the relationship between a change in house prices and savings is asymmetric and less strong for a house price decline compared to a house price increase. The MPS for a decline is roughly 0.03 smaller than for an increase. In general, our FE estimates are very similar to the OLS and RE estimates in terms of signs, but the FE estimates are somewhat smaller and slightly less significant.

We briefly discuss the effects of the control variables (not shown in the table). Income has a positive and significant effect on savings in all specifications. The coefficient varies between 0.09 and 0.13, indicating that households save about 10 percent of each additional euro of income. The regional unemployment rate has a negative effect on savings, but the coefficient is not significant in the FE model. Other controls that we include in the FE model, such as household size and composition, and marital status, have very low within variation resulting in switching signs and large differences in order of magnitude.

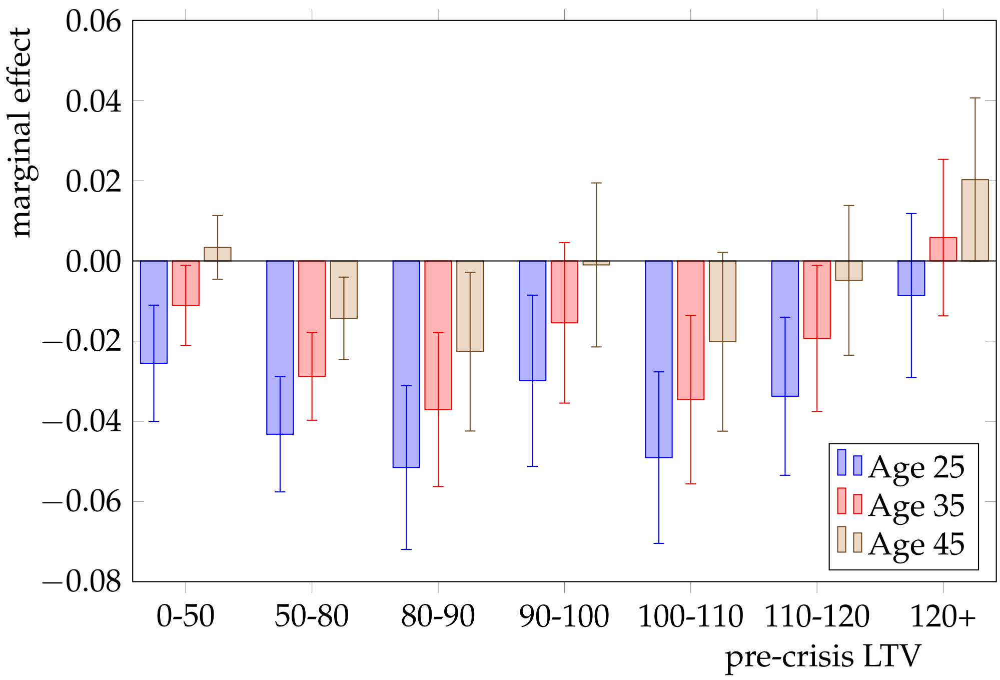
Table 4 presents our results for all renters, while Table 5 shows the results for renters in the rent-controlled segment. For renters, the coefficient for ΔH_{it} is much smaller. They are significant for OLS and RE estimates and insignificant in case of FE estimates. We still find an age effect, which is again insignificant in case of FE estimates. We do not find any asymmetry in the response.

Similar to what we found for owner occupiers, disposable income has a positive and highly significant effect on savings of renters. The order of magnitude is also similar to what we found for home owners and the effects do not differ between the group of all renters and the group of renters in the rent-control segment. Next, the regional unemployment rate has a negative and significant effect on household savings in both the OLS models and the panel data models.

Due the presence of interaction terms with age, decline, and leverage, the size of the coefficients can not be directly interpreted in terms of the MPS. To assess the impact for a particular group and compare the size and significance across groups, for example, households aged 45 with a leverage between 100-110 and the group aged 45 with a leverage between 50-80, we need to calculate the mean effect and its standard deviation for those particular groups.

Figure 1 therefore graphically presents our OLS estimates of the MPS out of housing wealth for different subgroups of the population. It clearly shows the largest MPS for young households with a 2006 LTV of 80-90 percent and 100-110 percent. For the latter group, the MPS is estimated to be -0.049 with a 95% confidence interval of $[-0.070; -0.028]$. With an av-

Figure 1: Marginal effects of a house price decline and 95% confidence intervals (OLS, owner-occupiers)



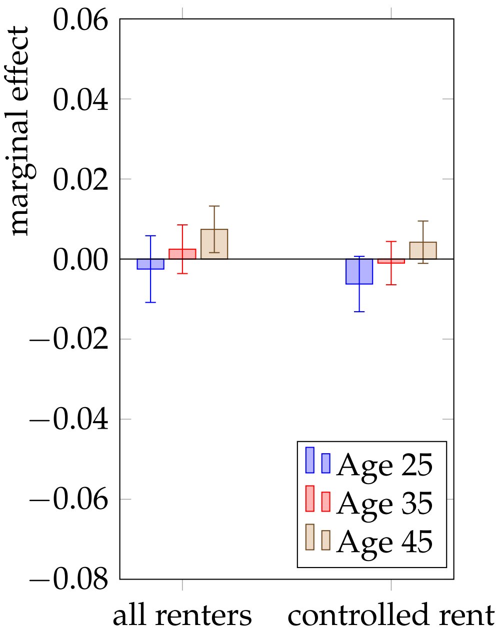
erage house price decline of 10,300 euro in 2013 (for this group of owner-occupiers), this would lead to yearly additional savings (including mortgage payoffs of 505 euro. This is about 1.5% of the average disposable income for this group of homeowners. In the years before 2013, price declines were smaller resulting in average yearly additional savings of 305 euro during 2009-2013 for this group of homeowners.

Figure 2 presents the corresponding estimates of the MPS out of housing wealth for all renters and the renters in the rent-control segment. To facilitate comparison we fixed the scale of the y-axis. The graphs shows that the effects are hardly different from zero for both groups of renters and for all ages. This shows that, in line with our expectations, the renters in our sample do not adjust their savings following a price decline of the house they are living in.

We next discuss the result for owner-occupiers in the aggregated model. The estimated coefficients of equation 2, measuring the aggregated effect of a house price shock for various periods, are presented for owner-occupiers in Table 6.

First note that the income level in 2009 and the income increase compared to 2009 are highly significant and enter the model with the expected

Figure 2: Marginal effects of a house price decline and 95% confidence intervals (OLS, renters)

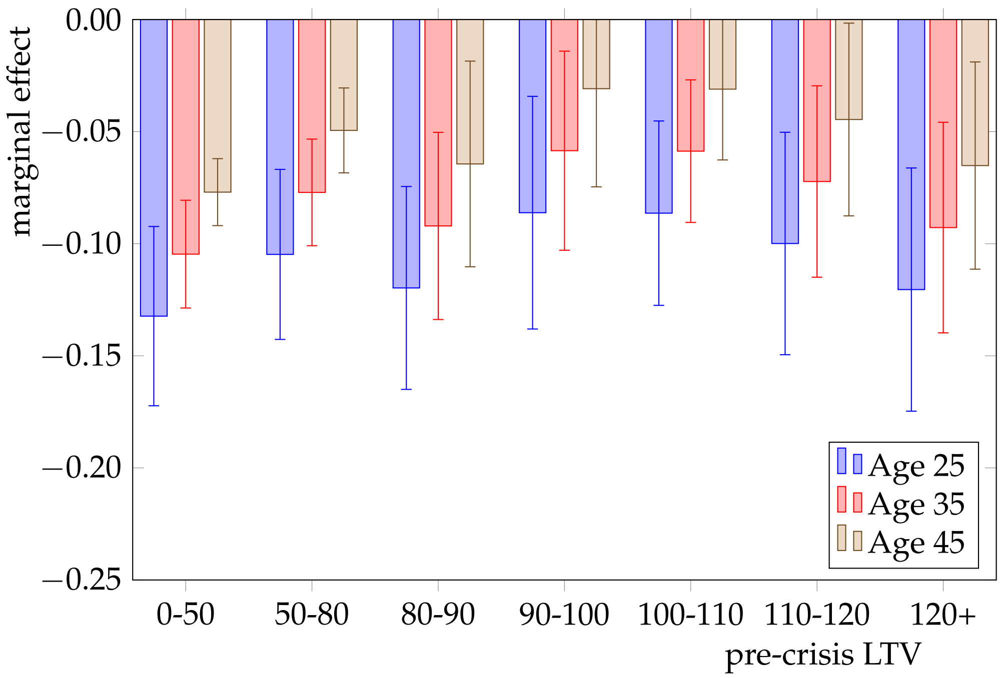


signs. Next, the explanatory power of our model, as measured by the R^2, increases compared to our baseline model. This may be due to the fact that we aggregate savings over multiple years in this model, which partly eliminate the effect of measurement error and lagged response to shocks to household savings.

The signs of the coefficients on ΔH_{it} and $\Delta H_{it} \times AGE2006$ are similar to what we found in our baseline model. We still find a stronger response among young households. As in the baseline model, we do not find a homogeneous effect of 2006 LTV level on the savings response of owner-occupiers. The interaction with the price decline indicator has the same sign in the first two columns, but it becomes insignificant (and negative) once we aggregate over more years. This is probably due to the fact that almost all households in our dataset experienced a house price decline in the period 2009-2013.

The resulting marginal effects are presented in Figure 3. Note that, compared to our baseline estimates, we find relatively high point estimates for the marginal effect for all age and LTV-categories. For young owner-occupiers with a 2006 LTV of 100-110 percent we find an MPS of -0.086 with a 95% confidence interval of $[-0.127; -0.045]$. For this group of homeowners, the average house price decline between 2009 and 2013 was about 24.900 euro. This would imply additional savings of 24.900 $\times$ $-0.086 = 2.141$ euro, or 535 euro per year. This number is 230 euro higher than the average yearly number obtained from our baseline estimates.

Figure 3: Marginal effects of the 2009-2013 house price decline and 95% confidence intervals (OLS, owner-occupiers, aggregated model)



The estimated coefficients of the aggregated model for all renters are presented in Table 7 and for renters in the rent-control segment in Table 8. The insignificance of all coefficients relating to ΔH_{it} confirms our previous finding that renters do not adjust their savings following a house price shock.[13] Note that the coefficients on baseline income and the income change compared to 2009 are again highly significant with a magnitude that is comparable to what we found for owner-occupiers.

6.1 Robustness

We do a number of robustness checks: (1) on the imputation of the mortgage amount, (2) controlling for financial assets, and (3) existence of non-linear effects.

[13]We also calculated the MPS for the same three age groups as in Figure 3. The point estimates vary between -0.011 and 0.003 and are not statistically different from zero.

For about 20% of the homeowners in our sample we imputed the mortgage amount in one or more years due to administrative errors in this variable. Since the mortgage variable is important for the computation of our dependent variable we want to check whether this imputation influences our results. Therefore we remove households for which we adjusted the mortgage variable in one or more years from our sample. The results are presented in Table 9. The estimates are highly comparable to our baseline estimates in Table 3 indicating that the imputation of mortgage amounts does not influence our results.

So far we did not control for total financial assets in our regressions, because financial assets are part of our dependent variable. Potentially, households with low financial assets respond different to house price shock than households with high financial assets. To test this hypothesis we divide the sample in four quartiles according to financial assets in 2006. The results are presented in Table 10.

The coefficients have the same signs and orders of magnitude as in our main results. One difference is that we find less significant coefficients on the interactions with the pre-crisis LTV categories. Only for the LTV categories below 90 percent we find some significant negative effects, indicating that households with an LTV between 50 and 90 percent adjust their savings more after a house price shock than households with an LTV of 0-50 percent. The most remarkable difference between the wealth categories is that we find a significant coefficient of -0.07 on the interaction term with the LTV class 80-90 percent in the fourth wealth quartile. This could indicate that especially the more wealthy households with relatively high pre-crisis LTVs started to save extra in response to the house price drop.

In all our previous regression we assumed a linear effect of age on the MPS out of house price shocks. This is a rather strict assumption and therefore we estimate a more flexible specification where we interact ΔH_{it} with dummies for all possible combinations of the price decline indicator, age categories, and pre-crisis LTV categories. The full results for owner-occupiers, renters, and renters in the rent-control segment are presented in Table 11. Note that estimating this specification requires a lot from our data: we have for instance only 772 observations in our dataset in the age category < 30 with a pre-crisis LTV of 0-50 percent who experience a price increase. In the other cells we have a higher number of observations, but the numbers can still be relatively low.

In our interpretation of the results we focus on the effect of price declines. We mostly find negative or close to zero effects. Only for the youngest group of households (below age 30 and with pre-crisis LTVs between 50 and 120) we find some negative estimates that are in line with what we found in earlier specifications. For renters, especially in the rent-control segment, we find small and mostly non-significant effects.

7 Conclusion and Discussion

In this study we investigate the impact of the house price decline in the period 2008-2013 on the savings of Dutch households using administrative household level data for both home-owning and renting households.

We estimate two models. First, we estimate a model where we relate the short-run response of the savings by household i in year t to the house price shock experienced by that household in that year. Second, we estimate an aggregated model where we relate the house price shock during the period 2009-2013 to the aggregate savings during that period. This measures the long-run response by accounting for lagged effects of house price drops that would increase the response of households, but are not included in the panel model. We find a marginal propensity to save (MPS) out of housing wealth in the short-run between 0 and -0.05, while the long-run effect ranges from -0.02 to -0.13.

In both models we find a negative impact of house price shocks on savings, indicating that a house price decline induces additional savings. We consequently find a higher MPS for young households, which is in line with the collateral hypothesis. Besides that, we find a non-homogeneous effect of the pre-crisis LTV in the short-run: households with intermediate leverage respond more strongly than households with very high or very low leverage according to our estimates. We do not have a clear explanation for this non-homogeneous effect, and this result is not confirmed in the long-run model where we do not find a significant effect of pre-crisis leverage on the savings response of households. The effects of pre-crisis LTV ratios are not in line with the collateral hypothesis.

To further strengthen the belief of a causal interpretation of our estimates, we estimate similar models for the group of renting households in the Netherlands. For the group of renters we find virtually no effect of the house price decline on savings. This finding rules out common causality as an explanation for our results. If some unobserved factor influenced both house prices and savings at the same time, we would have expected to find similar results for owner-occupiers and renters.

Our study can be used to tentatively answer the question how much the house price decline in the Netherlands contributed to the overall decrease in consumption. The estimates from our long-run model suggest that the drop in house prices resulted in additional savings of, on average, 1.5% of disposable household income. Compared to the consumption level in 2008, the aggregated consumption in the Netherlands over the period 2009-2013 declined by about 63 billion. Our estimates explain between 5 and 13 percent of this aggregated consumption decline.

When interpreting this number one should take into account that we only estimate the direct effect of the house price decline on savings. Any indirect effects, such as declining housing-related consumption due to the decrease in the number of transactions on the housing market are not taking into account. In addition, for identification purposes we excluded households who planned to move during the sample period from our sample. These households are probably most vulnerable to house price shocks, since they need to sell their devalued properties and, in some cases, refinance their residual mortgage debt. Therefore these households have a clear incentive to start saving extra money when house prices drop.

Nevertheless, our estimates suggest that other effects besides the direct effect on consumption are probably important in explaining the macroeconomic correlation between house prices and consumption. An important candidate for an alternative channel is drops in (expected) income that are correlated with house price movements. Our estimates show that changes in income are significant in explaining variations in savings and thus probably also in consumption.

References

Andersen, A. L., Duus, C., & Jensen, T. L. (2016). Household debt and spending during the financial crisis: Evidence from danish micro data. *European Economic Review*, *89*, 96 – 115.

Attanasio, O. P., Blow, L., Hamilton, R., & Leicester, A. (2009). Booms and busts: Consumption, house prices and expectations. *Economica*, *76*(301), 20–50.

Bostic, R., Gabriel, S., & Painter, G. (2009). Housing wealth, financial wealth, and consumption: New evidence from micro data. *Regional Science and Urban Economics*, *39*(1), 79 – 89.

Browning, M., Gørtz, M., & Leth-Petersen, S. (2013). Housing wealth and consumption: A micro panel study. *The Economic Journal*, *123*(568), 401–428.

Bun, P. & Rostom, M. (2014). Household debt and spending. *Bank of England Quarterly Bulletin*, *Q3*.

Campbell, J. Y. & Cocco, J. F. (2007). How do house prices affect consumption? evidence from micro data. *Journal of Monetary Economics*, *54*(3), 591 – 621.

Carroll, C. D., Otsuka, M., & Slacalek, J. (2011). How large are housing and financial wealth effects? a new approach. *Journal of Money, Credit and Banking*, *43*(1), 55–79.

Cooper, D. (2013). House price fluctuations: the role of housing wealth as borrowing collateral. *The Review of Economics and Statistics*, *95*(4), 1183–1197.

Disney, R., Gathergood, J., & Henley, A. (2010). House price shocks, negative equity, and household consumption in the united kingdom4. *Journal of the European Economic Association*, *8*(6), 1179–1207.

Dynan, K. (2012). Is a household debt overhang holding back consumption? *Brookings Papers on Economic Activity*, *1*, 299–362.

Lehnert, A. (2004). Housing consumption and credit constraints. Federal Reserve Working Paper Series.

Mian, A., Rao, K., & Sufi, A. (2013). Household balance sheets, consumption, and the economic slump. *The Quarterly Journal of Economics*, *128*(4), 1687–1726.

Mian, A. & Sufi, A. (2010). Household leverage and the recession of 2007-09. *IMF Economic Review*, *58*(1), 74–117.

Modigliani, F. (1966). The life cycle hypothesis of saving, the demand for wealth and the supply of capital. *Social Research: An International Quarterly*, *33*, 160–217. Essays in Economic Theory in Honor of Adolph Lowe and Hans Neisser.

van Beers, N., Bijlsma, M., & Mocking, R. (2015). House price shocks and savings: Evidence from dutch administrative data. *CPB Discussion Paper*, (299).

Appendix A Descriptive Statistics

Figure 4: Median savings of owners and renters

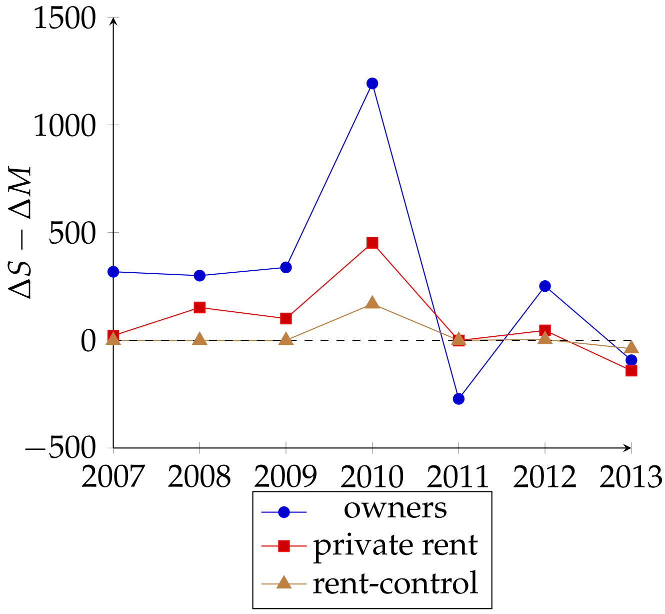


Figure 5: Median savings of owners and renters with comparable incomes ($\leq 50,000$)

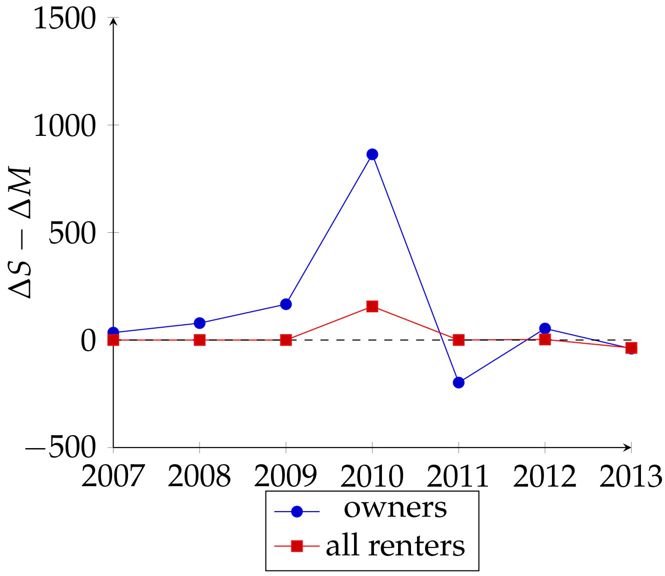


Figure 6: Average house price shocks of owners and renters

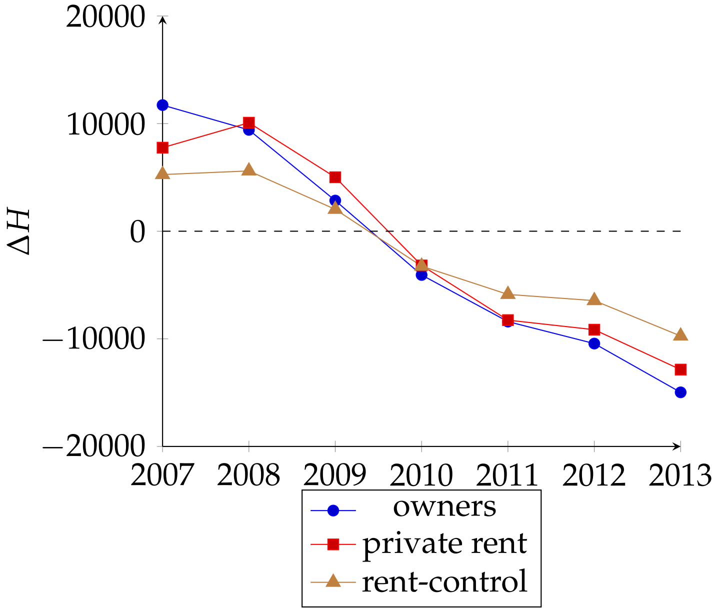


Figure 7: Average house price shocks of owners and renters with comparable incomes ($\leq 50,000$)

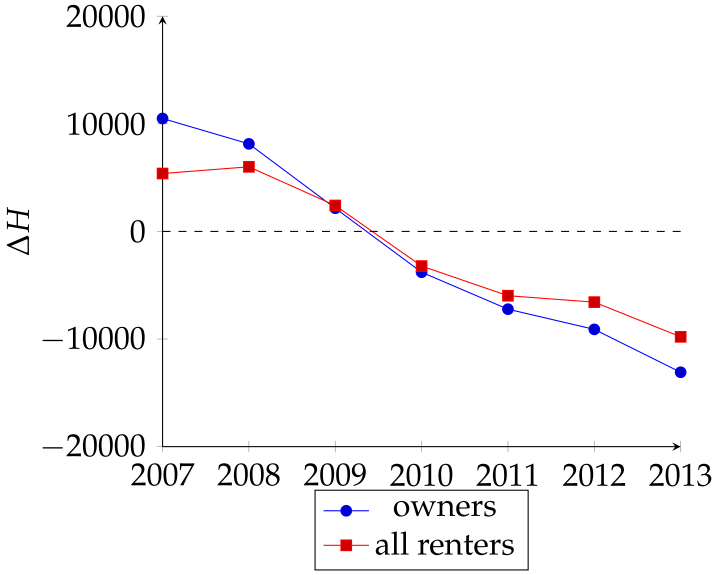


Table 1: Control variables owner-occupiers

	2007	2009	2011	2013
Disposable income	39299	42001	42089	41017
Mortgage-to-income	3.8	3.8	3.8	3.8
Household size	3.2	3.2	3.2	3.1
Age	43.8	45.8	47.8	49.8
Unemployment	4.5	4.8	5.4	8.2
Main income source				
Labor	0.82	0.80	0.78	0.75
Entrpreneurship	0.15	0.17	0.18	0.19
Wealth	0.00	0.00	0.00	0.00
Social benefits	0.02	0.02	0.03	0.04
Pension	0.01	0.01	0.01	0.01
Other	0.00	0.00	0.00	0.00
LTV class 2006				
0-50	0.41	0.41	0.41	0.41
50-80	0.26	0.26	0.26	0.26
80-90	0.07	0.07	0.07	0.07
90-100	0.07	0.07	0.07	0.07
100-110	0.07	0.08	0.07	0.08
110-120	0.06	0.06	0.06	0.06
120+	0.05	0.05	0.05	0.05
First year	1998	1998	1998	1998
Observations	114708	114695	114714	114706

Table 2: Control variables renters

	2007	2009	2011	2013
Disposable income	24771	25979	25644	24481
Household size	2.3	2.3	2.2	2.1
Age	44.5	46.5	48.5	50.5
Unemployment	4.5	4.8	5.4	8.3
Main income source				
Labor	0.64	0.66	0.62	0.59
Entrpreneurship	0.07	0.08	0.09	0.09
Wealth	0.00	0.00	0.00	0.00
Social benefits	0.26	0.24	0.27	0.29
Pension	0.01	0.01	0.02	0.02
Other	0.01	0.01	0.01	0.01
First year	1998	1998	1998	1998
Observations	47284	47273	47290	47286

Appendix B Results

Table 3: Main specification owner-occupiers

	OLS	RE	FE
ΔH_{it}	-0.0957***	-0.0957***	-0.0565***
	(0.0152)	(0.0152)	(0.0157)
$\Delta H_{it} \times AGE2006_i$	0.0014***	0.0014***	0.0006
	(0.0003)	(0.0003)	(0.0003)
$\Delta H_{it} \times DECLINE_{it}$	0.0341***	0.0341***	0.0336***
	(0.0055)	(0.0055)	(0.0065)
$\Delta H_{it} \times 2006LTV_i = 50 - 80$	-0.0177***	-0.0177***	-0.0164**
	(0.0051)	(0.0051)	(0.0052)
$\Delta H_{it} \times 2006LTV_i = 80 - 90$	-0.0260*	-0.0260*	-0.0234*
	(0.0102)	(0.0102)	(0.0092)
$\Delta H_{it} \times 2006LTV_i = 90 - 100$	-0.0044	-0.0044	-0.0029
	(0.0101)	(0.0101)	(0.0106)
$\Delta H_{it} \times 2006LTV_i = 100 - 110$	-0.0235*	-0.0235*	-0.0205
	(0.0108)	(0.0108)	(0.0113)
$\Delta H_{it} \times 2006LTV_i = 110 - 120$	-0.0082	-0.0082	-0.0019
	(0.0093)	(0.0093)	(0.0094)
$\Delta H_{it} \times 2006LTV_i = 120+$	0.0169	0.0169	0.0295**
	(0.0102)	(0.0102)	(0.0111)
corop x year effects	Yes	Yes	Yes
N	802922	802922	802922
Adjusted R^2	0.0093		0.0072

Note: The dependent variable is $\Delta S_{it} - \Delta M_{it}$. We control for income (source), household characteristics, first year on address, mortgage-to-income ratio in 2006, and regional unemployment. The interaction terms are also included separately. The standard errors are clustered at the household level. Legend: * p<0.05, ** p<0.01, and *** p<0.001.

Table 4: Main specification all renters

	OLS	RE	FE
ΔH_{it}	-0.0211*	-0.0211*	-0.0061
	(0.0088)	(0.0088)	(0.0090)
$\Delta H_{it} \times AGE2006_i$	0.0005*	0.0005*	0.0001
	(0.0002)	(0.0002)	(0.0002)
$\Delta H_{it} \times DECLINE_{it}$	0.0062	0.0062	0.0094
	(0.0043)	(0.0043)	(0.0052)
corop x year effects	Yes	Yes	Yes
N	330988	330988	330988
Adjusted R^2	0.0172		0.0155

Note: The dependent variable is ΔS_{it}. We control for income (source), household characteristics, first year on address, and regional unemployment. The interaction terms are also included separately. The standard errors are clustered at the household level. Legend: * p<0.05, ** p<0.01, and *** p<0.001.

Table 5: Main specification renters in rent-control segment

	OLS	RE	FE
ΔH_{it}	-0.0207**	-0.0207**	-0.0000
	(0.0065)	(0.0065)	(0.0068)
$\Delta H_{it} \times AGE2006_i$	0.0005***	0.0005***	0.0001
	(0.0002)	(0.0002)	(0.0002)
$\Delta H_{it} \times DECLINE_{it}$	0.0014	0.0014	-0.0008
	(0.0038)	(0.0038)	(0.0044)
corop x year effects	Yes	Yes	Yes
N	279206	279206	279206
Adjusted R^2	0.0166		0.0179

Note: The dependent variable is ΔS_{it}. We control for income (source), household characteristics, first year on address, and regional unemployment. The interaction terms are also included separately. The standard errors are clustered at the household level. Legend: * p<0.05, ** p<0.01, and *** p<0.001.

Table 6: Owner-occupiers - Aggregated effect

	t=2010	t=2011	t=2012	t=2013
$\Delta H_{i,t-2009}$	-0.1457*	-0.2037***	-0.2736***	-0.1510***
	(0.0690)	(0.0552)	(0.0494)	(0.0416)
$\Delta H_{i,t-2009} \times AGE2006_i$	0.0017	0.0030**	0.0040***	0.0028**
	(0.0013)	(0.0010)	(0.0010)	(0.0009)
$\Delta H_{i,t-2009} \times DECLINE_{it}$	0.0518*	0.0415*	0.0185	-0.0504
	(0.0208)	(0.0199)	(0.0229)	(0.0296)
$\Delta H_{i,t-2009} \times 2006LTV_i = 50-80$	0.0021	-0.0060	0.0391***	0.0275**
	(0.0213)	(0.0148)	(0.0114)	(0.0090)
$\Delta H_{i,t-2009} \times 2006LTV_i = 80-90$	-0.0137	0.0134	0.0645**	0.0126
	(0.0311)	(0.0208)	(0.0207)	(0.0244)
$\Delta H_{i,t-2009} \times 2006LTV_i = 90-100$	0.0010	0.0343	0.0900***	0.0461*
	(0.0253)	(0.0264)	(0.0248)	(0.0216)
$\Delta H_{i,t-2009} \times 2006LTV_i = 100-110$	-0.0724	0.0180	0.0687***	0.0459**
	(0.0642)	(0.0325)	(0.0207)	(0.0161)
$\Delta H_{i,t-2009} \times 2006LTV_i = 110-120$	0.0083	0.0460	0.0673**	0.0324
	(0.0263)	(0.0269)	(0.0238)	(0.0216)
$\Delta H_{i,t-2009} \times 2006LTV_i = 120+$	0.0477	0.0546	0.0530	0.0118
	(0.0267)	(0.0361)	(0.0280)	(0.0234)
$INCOME2009$	0.0831***	0.1218***	0.2151***	0.2300***
	(0.0067)	(0.0098)	(0.0129)	(0.0159)
$\Delta INCOME_{t-2009}$	0.1437***	0.2392***	0.3111***	0.3453***
	(0.0121)	(0.0154)	(0.0177)	(0.0196)
municipality FE	Yes	Yes	Yes	Yes
N	114684	114714	114713	114706
Adjusted R^2	0.0136	0.0184	0.0249	0.0238

Note: The dependent variable is $\Delta S_{it} - \Delta M_{it}$. We control for income (source), household characteristics, first year on address, mortgage-to-income ratio in 2006, and regional unemployment. The interaction terms are also included separately. The standard errors are clustered at the household level. Legend: * p<0.05, ** p<0.01, and *** p<0.001.

Table 7: All renters - Aggregated effect

	t=2010	t=2011	t=2012	t=2013
$\Delta H_{i,t-2009}$	-0.0049	0.0041	0.0247	-0.0021
	(0.0453)	(0.0285)	(0.0353)	(0.0335)
$\Delta H_{i,t-2009} \times AGE2006_i$	0.0007	0.0001	-0.0003	0.0001
	(0.0010)	(0.0007)	(0.0008)	(0.0007)
$\Delta H_{i,t-2009} \times DECLINE_{it}$	-0.0210	-0.0123	-0.0161	-0.0128
	(0.0177)	(0.0130)	(0.0172)	(0.0167)
$INCOME2009$	0.0829***	0.1253***	0.2088***	0.2124***
	(0.0094)	(0.0107)	(0.0134)	(0.0156)
$\Delta INCOME_{t-2009}$	0.1670***	0.2555***	0.3434***	0.3424***
	(0.0267)	(0.0160)	(0.0177)	(0.0187)
municipality FE	Yes	Yes	Yes	Yes
N	47279	47290	47290	47286
Adjusted R^2	0.0350	0.0368	0.0479	0.0443

Note: The dependent variable is ΔS_{it}. We control for income (source), household characteristics, first year on address, and regional unemployment. The interaction terms are also included separately. The standard errors are clustered at the household level. Legend: * $p<0.05$, ** $p<0.01$, and *** $p<0.001$.

Table 8: Renters in controlled segment - Aggregated effect

	t=2010	t=2011	t=2012	t=2013
$\Delta H_{i,t-2009}$	-0.0431	0.0377	0.0348	0.0048
	(0.0254)	(0.0297)	(0.0340)	(0.0349)
$\Delta H_{i,t-2009} \times AGE2006_i$	0.0008	-0.0008	-0.0002	0.0003
	(0.0006)	(0.0005)	(0.0006)	(0.0006)
$\Delta H_{i,t-2009} \times DECLINE_{it}$	0.0183	-0.0140	-0.0333	-0.0176
	(0.0106)	(0.0172)	(0.0208)	(0.0252)
$INCOME2009$	0.0706***	0.1045***	0.1744***	0.1839***
	(0.0084)	(0.0107)	(0.0135)	(0.0164)
$\Delta INCOME_{t-2009}$	0.2213***	0.2810***	0.3503***	0.3678***
	(0.0212)	(0.0180)	(0.0177)	(0.0191)
municipality FE	Yes	Yes	Yes	Yes
N	39882	39892	39892	39888
Adjusted R^2	0.0463	0.0455	0.0511	0.0467

Note: The dependent variable is ΔS_{it}. We control for income (source), household characteristics, first year on address, and regional unemployment. The interaction terms are also included separately. The standard errors are clustered at the household level. Legend: * p<0.05, ** p<0.01, and *** p<0.001.

Table 9: Main specification owner-occupiers: mortgage variable not corrected

	OLS	RE	FE
ΔH_{it}	-0.1019***	-0.1019***	-0.0610***
	(0.0162)	(0.0162)	(0.0164)
$\Delta H_{it} \times AGE2006_i$	0.0016***	0.0016***	0.0008*
	(0.0003)	(0.0003)	(0.0003)
$\Delta H_{it} \times DECLINE_{it}$	0.0395***	0.0395***	0.0336***
	(0.0060)	(0.0060)	(0.0070)
$\Delta H_{it} \times 2006LTV_i = 50 - 80$	-0.0207***	-0.0207***	-0.0196***
	(0.0057)	(0.0057)	(0.0057)
$\Delta H_{it} \times 2006LTV_i = 80 - 90$	-0.0302*	-0.0302*	-0.0264*
	(0.0119)	(0.0119)	(0.0103)
$\Delta H_{it} \times 2006LTV_i = 90 - 100$	-0.0079	-0.0079	-0.0077
	(0.0096)	(0.0096)	(0.0099)
$\Delta H_{it} \times 2006LTV_i = 100 - 110$	-0.0156	-0.0156	-0.0105
	(0.0106)	(0.0106)	(0.0109)
$\Delta H_{it} \times 2006LTV_i = 110 - 120$	-0.0118	-0.0118	-0.0056
	(0.0105)	(0.0105)	(0.0106)
$\Delta H_{it} \times 2006LTV_i = 120+$	0.0118	0.0118	0.0233
	(0.0116)	(0.0116)	(0.0125)
corop x year effects	Yes	Yes	Yes
N	623102	623102	623102
Adjusted R^2	0.0125		0.0082

Note: The dependent variable is $\Delta S_{it} - \Delta M_{it}$. We control for income (source), household characteristics, first year on address, mortgage-to-income ratio in 2006, and regional unemployment. The interaction terms are also included separately. The standard errors are clustered at the household level. Legend: * p<0.05, ** p<0.01, and *** p<0.001.

Table 10: Main specification owner-occupiers: financial wealth quartiles

	Fin. Assets Q1	Fin. Assets Q2	Fin. Assets Q3	Fin. Assets Q4
ΔH_{it}	-0.0614*	-0.0752**	-0.1484***	-0.0999***
	(0.0260)	(0.0287)	(0.0315)	(0.0288)
$\Delta H_{it} \times AGE2006_i$	0.0013**	0.0007	0.0023***	0.0014*
	(0.0005)	(0.0007)	(0.0006)	(0.0006)
$\Delta H_{it} \times DECLINE_{it}$	0.0061	0.0491***	0.0478***	0.0454***
	(0.0110)	(0.0101)	(0.0120)	(0.0094)
$\Delta H_{it} \times 2006LTV_i = 50 - 80$	-0.0175	-0.0237*	-0.0072	-0.0279**
	(0.0090)	(0.0114)	(0.0101)	(0.0093)
$\Delta H_{it} \times 2006LTV_i = 80 - 90$	-0.0151	-0.0111	0.0025	-0.0707**
	(0.0116)	(0.0124)	(0.0148)	(0.0258)
$\Delta H_{it} \times 2006LTV_i = 90 - 100$	-0.0074	0.0122	0.0001	-0.0246
	(0.0118)	(0.0181)	(0.0161)	(0.0234)
$\Delta H_{it} \times 2006LTV_i = 100 - 110$	-0.0336	-0.0106	-0.0083	-0.0457
	(0.0201)	(0.0150)	(0.0166)	(0.0235)
$\Delta H_{it} \times 2006LTV_i = 110 - 120$	-0.0101	-0.0258	-0.0069	-0.0106
	(0.0125)	(0.0255)	(0.0175)	(0.0174)
$\Delta H_{it} \times 2006LTV_i = 120+$	0.0228	0.0280	0.0055	0.0060
	(0.0194)	(0.0168)	(0.0182)	(0.0199)
corop x year effects	Yes	Yes	Yes	Yes
N	200723	200723	200721	200713
Adjusted R^2	0.0063	0.0074	0.0078	0.0355

Note: the dependent variable is $\Delta S_{it} - \Delta M_{it}$. We control for income (source), household characteristics, first year on address, mortgage-to-income ratio in 2006, and regional unemployment. The interaction terms are also included separately. The standard errors are clustered at the household level. Legend: * p<0.05, ** p<0.01, and *** p<0.001.

Table 11: Piecewise linear results

	owners	all renters	rent-control
$\Delta H_{it} \times DECLINE_{it} \times AGE < 30 \times 2006LTV_i = 0 - 50$	-0.0124		
	(0.0360)		
$\Delta H_{it} \times DECLINE_{it} \times AGE < 30 \times 2006LTV_i = 50 - 80$	-0.0456		
	(0.0236)		
$\Delta H_{it} \times DECLINE_{it} \times AGE < 30 \times 2006LTV_i = 80 - 90$	-0.1637**		
	(0.0569)		
$\Delta H_{it} \times DECLINE_{it} \times AGE < 30 \times 2006LTV_i = 90 - 100$	-0.0493		
	(0.0414)		
$\Delta H_{it} \times DECLINE_{it} \times AGE < 30 \times 2006LTV_i = 100 - 110$	-0.0883***		
	(0.0221)		
$\Delta H_{it} \times DECLINE_{it} \times AGE < 30 \times 2006LTV_i = 110 - 120$	-0.0542*		
	(0.0218)		
$\Delta H_{it} \times DECLINE_{it} \times AGE < 30 \times 2006LTV_i = 120+$	-0.0114		
	(0.0280)		
$\Delta H_{it} \times DECLINE_{it} \times AGE = 30 - 40 \times 2006LTV_i = 0 - 50$	-0.0266***		
	(0.0077)		
$\Delta H_{it} \times DECLINE_{it} \times AGE = 30 - 40 \times 2006LTV_i = 50 - 80$	-0.0389***		
	(0.0106)		
$\Delta H_{it} \times DECLINE_{it} \times AGE = 30 - 40 \times 2006LTV_i = 80 - 90$	-0.0233		
	(0.0136)		
$\Delta H_{it} \times DECLINE_{it} \times AGE = 30 - 40 \times 2006LTV_i = 90 - 100$	-0.0019		
	(0.0163)		
$\Delta H_{it} \times DECLINE_{it} \times AGE = 30 - 40 \times 2006LTV_i = 100 - 110$	-0.0037		
	(0.0163)		
$\Delta H_{it} \times DECLINE_{it} \times AGE = 30 - 40 \times 2006LTV_i = 110 - 120$	0.0290		
	(0.0211)		
$\Delta H_{it} \times DECLINE_{it} \times AGE = 30 - 40 \times 2006LTV_i = 120+$	0.0438*		
	(0.0205)		
$\Delta H_{it} \times DECLINE_{it} \times AGE = 40 - 50 \times 2006LTV_i = 0 - 50$	0.0178**		
	(0.0061)		
$\Delta H_{it} \times DECLINE_{it} \times AGE = 40 - 50 \times 2006LTV_i = 50 - 80$	-0.0003		
	(0.0086)		
$\Delta H_{it} \times DECLINE_{it} \times AGE = 40 - 50 \times 2006LTV_i = 80 - 90$	-0.0105		
	(0.0188)		
$\Delta H_{it} \times DECLINE_{it} \times AGE = 40 - 50 \times 2006LTV_i = 90 - 100$	0.0207		
	(0.0313)		
$\Delta H_{it} \times DECLINE_{it} \times AGE = 40 - 50 \times 2006LTV_i = 100 - 110$	0.0054		
	(0.0226)		
$\Delta H_{it} \times DECLINE_{it} \times AGE = 40 - 50 \times 2006LTV_i = 110 - 120$	-0.0321		
	(0.0256)		
$\Delta H_{it} \times DECLINE_{it} \times AGE = 40 - 50 \times 2006LTV_i = 120+$	-0.0209		
	(0.0290)		
$\Delta H_{it} \times DECLINE_{it} \times AGE > 50 \times 2006LTV_i = 0 - 50$	-0.0005		
	(0.0067)		
$\Delta H_{it} \times DECLINE_{it} \times AGE > 50 \times 2006LTV_i = 50 - 80$	-0.0166		
	(0.0124)		
$\Delta H_{it} \times DECLINE_{it} \times AGE > 50 \times 2006LTV_i = 80 - 90$	-0.0156		
	(0.0236)		
$\Delta H_{it} \times DECLINE_{it} \times AGE > 50 \times 2006LTV_i = 90 - 100$	-0.0655		
	(0.0406)		
$\Delta H_{it} \times DECLINE_{it} \times AGE > 50 \times 2006LTV_i = 100 - 110$	-0.1518		
	(0.0917)		
$\Delta H_{it} \times DECLINE_{it} \times AGE > 50 \times 2006LTV_i = 110 - 120$	-0.0218		
	(0.0439)		
$\Delta H_{it} \times DECLINE_{it} \times AGE > 50 \times 2006LTV_i = 120+$	-0.0164		
	(0.0444)		
$\Delta H_{it} \times DECLINE_{it} \times AGE < 30$		-0.0127	-0.0058

		(0.0072)	(0.0056)
$\Delta H_{it} \times DECLINE_{it} \times AGE = 30 - 40$		-0.0044	-0.0066
		(0.0041)	(0.0038)
$\Delta H_{it} \times DECLINE_{it} \times AGE = 40 - 50$		0.0128**	0.0056
		(0.0041)	(0.0038)
$\Delta H_{it} \times DECLINE_{it} \times AGE > 50$		0.0105	0.0106*
		(0.0059)	(0.0049)
$\Delta H_{it} \times INCREASE_{it} \times AGE < 30 \times 2006LTV_i = 0 - 50$	-0.1903*		
	(0.0811)		
$\Delta H_{it} \times INCREASE_{it} \times AGE < 30 \times 2006LTV_i = 50 - 80$	0.0038		
	(0.0190)		
$\Delta H_{it} \times INCREASE_{it} \times AGE < 30 \times 2006LTV_i = 80 - 90$	-0.0031		
	(0.0354)		
$\Delta H_{it} \times INCREASE_{it} \times AGE < 30 \times 2006LTV_i = 90 - 100$	0.0219		
	(0.0290)		
$\Delta H_{it} \times INCREASE_{it} \times AGE < 30 \times 2006LTV_i = 100 - 110$	-0.0095		
	(0.0251)		
$\Delta H_{it} \times INCREASE_{it} \times AGE < 30 \times 2006LTV_i = 110 - 120$	-0.0744**		
	(0.0272)		
$\Delta H_{it} \times INCREASE_{it} \times AGE < 30 \times 2006LTV_i = 120+$	-0.0385		
	(0.0203)		
$\Delta H_{it} \times INCREASE_{it} \times AGE = 30 - 40 \times 2006LTV_i = 0 - 50$	-0.0471***		
	(0.0112)		
$\Delta H_{it} \times INCREASE_{it} \times AGE = 30 - 40 \times 2006LTV_i = 50 - 80$	-0.0691***		
	(0.0125)		
$\Delta H_{it} \times INCREASE_{it} \times AGE = 30 - 40 \times 2006LTV_i = 80 - 90$	-0.0736***		
	(0.0195)		
$\Delta H_{it} \times INCREASE_{it} \times AGE = 30 - 40 \times 2006LTV_i = 90 - 100$	-0.0811**		
	(0.0248)		
$\Delta H_{it} \times INCREASE_{it} \times AGE = 30 - 40 \times 2006LTV_i = 100 - 110$	-0.1008***		
	(0.0201)		
$\Delta H_{it} \times INCREASE_{it} \times AGE = 30 - 40 \times 2006LTV_i = 110 - 120$	-0.0624**		
	(0.0213)		
$\Delta H_{it} \times INCREASE_{it} \times AGE = 30 - 40 \times 2006LTV_i = 120+$	-0.0278		
	(0.0173)		
$\Delta H_{it} \times INCREASE_{it} \times AGE = 40 - 50 \times 2006LTV_i = 0 - 50$	-0.0259***		
	(0.0077)		
$\Delta H_{it} \times INCREASE_{it} \times AGE = 40 - 50 \times 2006LTV_i = 50 - 80$	-0.0469***		
	(0.0100)		
$\Delta H_{it} \times INCREASE_{it} \times AGE = 40 - 50 \times 2006LTV_i = 80 - 90$	-0.0817*		
	(0.0319)		
$\Delta H_{it} \times INCREASE_{it} \times AGE = 40 - 50 \times 2006LTV_i = 90 - 100$	-0.0208		
	(0.0168)		
$\Delta H_{it} \times INCREASE_{it} \times AGE = 40 - 50 \times 2006LTV_i = 100 - 110$	-0.0669***		
	(0.0183)		
$\Delta H_{it} \times INCREASE_{it} \times AGE = 40 - 50 \times 2006LTV_i = 110 - 120$	-0.0465*		
	(0.0207)		
$\Delta H_{it} \times INCREASE_{it} \times AGE = 40 - 50 \times 2006LTV_i = 120+$	-0.0185		
	(0.0217)		
$\Delta H_{it} \times INCREASE_{it} \times AGE > 50 \times 2006LTV_i = 0 - 50$	-0.0210**		
	(0.0079)		
$\Delta H_{it} \times INCREASE_{it} \times AGE > 50 \times 2006LTV_i = 50 - 80$	-0.0424**		
	(0.0131)		
$\Delta H_{it} \times INCREASE_{it} \times AGE > 50 \times 2006LTV_i = 80 - 90$	-0.0172		
	(0.0241)		
$\Delta H_{it} \times INCREASE_{it} \times AGE > 50 \times 2006LTV_i = 90 - 100$	-0.0289		
	(0.0215)		
$\Delta H_{it} \times INCREASE_{it} \times AGE > 50 \times 2006LTV_i = 100 - 110$	0.0698		
	(0.0587)		
$\Delta H_{it} \times INCREASE_{it} \times AGE > 50 \times 2006LTV_i = 110 - 120$	-0.0057		
	(0.0250)		
$\Delta H_{it} \times INCREASE_{it} \times AGE > 50 \times 2006LTV_i = 120+$	0.0275		

	(0.0403)		
$\Delta H_{it} \times INCREASE_{it} \times AGE < 30$		0.0107	-0.0102*
		(0.0169)	(0.0051)
$\Delta H_{it} \times INCREASE_{it} \times AGE = 30 - 40$		-0.0056	0.0020
		(0.0035)	(0.0033)
$\Delta H_{it} \times INCREASE_{it} \times AGE = 40 - 50$		0.0021	0.0052
		(0.0045)	(0.0036)
$\Delta H_{it} \times INCREASE_{it} \times AGE > 50$		0.0020	-0.0003
		(0.0058)	(0.0050)
corop x year effects	Yes	Yes	Yes
N	802922	330988	279206
Adjusted R^2	0.0096	0.0173	0.0166

Note: the dependent variable is $\Delta S_{it} - \Delta M_{it}$ for owners and ΔS_{it} for renters. We control for income (source), household characteristics, first year on address, mortgage-to-income ratio in 2006, and regional unemployment. The standard errors are clustered at the household level. Legend: * p<0.05, ** p<0.01, and *** p<0.001.

Appendix C Data cleaning process

	Observations	Households
Raw data set	5,705,444	724,178
Drop observations with two or more household heads on one address, major changes in household composition or marital status*, and gaps of more than two consecutive years in house price data	3,220,411	430,345
Drop if house price is below 50,000 or above 1,000,000 euro	3,205,864	429,191
Drop top and bottom 1% of savings distribution	3,150,314	429,174
Drop if house price is missing	3,139,920	427,507
Drop if LTV is above 180%	3,112,109	423,286
Drop if age in 2006 is above 55	1,917,760	261,703
Drop if an address switches from owner-occupied to rent or vice versa	1,802,847	246,183
Keep households who are not moving in the period 2006-2013	1,380,372	175,266
First-differencing (calculate ΔH_{it} and ΔS_{it})	1,207,023**	175,231

*We delete household with a member that divorces or becomes widowed. Next, we drop single-person households that change to multi-person households and vice versa. We also drop observations with an unclear household composition, of which the most important category is "couple, with a third person". **In the final analysis the total number of owner-occupiers and renters is slightly smaller, because of missing values for some of the control variables.

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