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Housing and household consumption: An investigation of the wealth and collateral effects

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ABSTRACT

The macroeconomic literature has identified a robust relationship between house prices and consumption at the aggregate level. The microeconomic literature points to three possible mechanisms behind this relationship: the wealth effect, whereby households respond to changes in housing wealth by spending/saving more; the collateral effect whereby households use the main residence as collateral for consumer loans; and the common causality effect whereby one or more variables affect both house prices and consumption simultaneously. I test the implications of these mechanisms using data from a panel survey representative of the Dutch population. For that purpose, I employ measures of subjective house prices and subjective house price expectations. Results suggest that the wealth and the collateral effects play, at best, minor roles in explaining the aggregate relationship between house prices and consumption.

1. Introduction

The relationship between house prices and household saving and consumption has been largely studied in the economic literature. Macroeconomic studies (*e.g.* Skinner, 1996; Case et al., 2005; Carroll et al., 2011) have often reported a strong association between the evolution of house prices and household consumption. The microeconomic literature has explored several mechanisms that may explain this relationship. These are the *wealth effect* according to which households adjust their consumption and saving patterns when the housing component of their lifetime income unexpectedly changes; the *collateral effect* according to which there is a transmission mechanism from house prices to consumption via the use of home equity loans; and the *common causality effect*, which suggests that there may be one or more variables, for instance economic expectations, that affect both house prices and consumption simultaneously. These could be variables at the household level or at a higher level of aggregation.

The early microeconomic literature (*e.g.* Skinner, 1989, 1996; Attanasio and Weber, 1994; Engelhardt, 1996) reports associations between house prices and consumption that are smaller than those found in the macroeconomic literature. In addition, this literature points to the complexity of the different mechanisms involved even if it is unable to identify them separately. In the present study, I use a more recent stream of microeconomic literature as a benchmark (*e.g.* Campbell and Cocco, 2007; Attanasio et al., 2009; Disney et al., 2010a; Browning et al., 2013). This literature makes an effort to identify the different above-mentioned mechanisms using the life cycle-model as a theoretical framework. This model generates different predictions for the wealth and the collateral effects depending on the stage of the life cycle. The main strategy in this literature thus consists of estimating the effect of house prices on consumption for different age groups.

Following the insights of the above-mentioned microeconomic literature, in the present study I use a large Dutch household panel, covering the period between 2004 and 2018, to investigate the relative

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[2] Between 2008 and 2013 house prices declined approximately 20% in the Netherlands.

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importance of the wealth effect, the collateral effect, and the common causality explanation. Fig. 1.1 plots the evolution of the changes in house prices and household consumption for the period 1996–2018 in the Netherlands, clearly showing how these two variables follow a common pattern. The large variation in Fig. 1.1 is due mainly to the boom-and-bust cycle in the Dutch housing market occasioned in large part by the global financial crisis that broke out in 2008. According to Engsted et al. (2016), previous to the financial crisis, the Netherlands experienced one of the most pronounced housing bubbles among OECD countries. The bursting of the bubble subsequently lead to a strong decline in house prices followed by a recovery that has been occurring since 2014.[2] This makes the Netherlands a very interesting case in point for the question at hand and adds the analysis of a different country to a literature extensively dominated by studies based on the UK and the USA.

Different from most previous literature, I base the empirical analysis on a formal theoretical model. To do so, I construct a very stylized version of the life-cycle model to study the wealth and the collateral effects, while making explicit the theoretical assumptions that are necessary for these effects to take place. Making these assumptions explicit allows for a better interpretation and discussion of the empirical results. Regarding the wealth effect, the model predicts that, if households are planning to downsize their housing asset in the future, they will respond to an unexpected increase (decrease) in the price of housing by decreasing (increasing) their saving. Conversely, it predicts the effect will go in the opposite direction for households that are planning to upsize their housing. Regarding the collateral effect, the model predicts that liquidity constrained households will increase their consumption through mortgage borrowing as a response to positive house price changes.

This study contributes to the existing literature in three main ways. First, instead of using regional house price indices to measure house price changes, I use self-reported data on the change in the market price of the main residence and compare it with a regional house price index. In addition, I use self-reported house price expectations to isolate the unexpected component of house price changes, while previous literature has mostly used fitted values from an estimated house price process at the regional level to impute house price expectations. In this study I compare both approaches. Second, I make use of the recent sharp changes in the Dutch housing market reported in Fig. 1.1. These changes derive from one of the most pronounced boom-and-bust cycles in house prices among OECD countries, and have been, to a large extent, unexpected by households. Third, the data I employ allow separating the wealth and the collateral effects. That is because I use active saving as a dependent variable to estimate the wealth effect, and I use information on remaining mortgage debt to estimate the collateral effect. Even though this is not the first study to use these outcome variables to measure the wealth and the collateral effects,[3] it is the first study to estimate these two effects in this way using the same data source. This allows for a better assessment of their relative importance.

The results of the wealth effect estimation yield a negative marginal propensity to consume (MPC) of 0.02%, *i.e.* when house prices increase by one euro, consumption (saving) decreases (increases) by 0.2 cents. This estimate is very small, not significantly different from zero, and the precision of the estimate allows ruling out any large wealth effects. This result is in contrast with the macroeconomic literature and some of the early microeconomic literature. However, it is in accordance with Disney et al. (2010a) and Browning et al. (2013), who also estimate negligible wealth effects using micro data. With the aid of descriptive statistics, I argue that the limited evidence for a wealth effect may be due to three main reasons. First, the data show that very few households are planning to liquidate their housing wealth in the future, which is a necessary condition for a wealth effect; second, households do not appear to perceive house price shocks as permanent; and, third, recent literature (*i.e.* Nakajima and Telyukova, 2017; Suari-Andreu et al., 2019a) points to the presence of a bequest motive linked to housing that would mitigate potential wealth effects.

Regarding the collateral effect, the estimation results surprisingly also show a very small effect that is statistically indistinguishable from zero. When using the change in remaining mortgage debt as a dependent variable, the estimated effect is negligible and does not significantly change when focusing only on credit constrained households. As described by Ebner (2013), the Netherlands has a highly developed mortgage market that allows access to secured debt by increasing the amount of the current mortgage, by taking out a second mortgage, and/or by refinancing with a higher principal. It is therefore somewhat surprising to not find an effect. However, descriptive statistics show that only approximately 5% of households every year in the Netherlands report having increased their mortgage debt. Out of these, only 7% report having done so to increase non-durable consumption. This evidence suggests that, in the Netherlands, there is little if any transmission mechanism from house prices to consumption via mortgage debt. Even if the conclusions of the present study are based on results that are not significantly different from zero, they are still relevant. That is because they point to an absence of clear evidence for two popular explanations for the correlation observed in Fig. 1.1, specifically, the wealth effect and the collateral effect.

The remainder of the document is structured as follows. Section 2 details the empirical strategy; Section 3 presents the data and provides a number of descriptive statistics; Section 4 presents the results; and Section 5 concludes. The appendices provide summary statistics, additional descriptive statistics and results, and the theoretical model.

2. Empirical strategy

The strategy that I present is based on the model provided in Appendix F. The latter is a very stylized version of the life-cycle model with housing that predicts that households will adjust their saving as a response to house price shocks via a wealth effect. In accordance with the work by Buiter (2008), the model predicts that if a household plans to upsize housing in the future, it will increase (decrease) saving if house prices unexpectedly increase (decrease); and, conversely, if it is planning to downsize housing, then it will decrease (increase) saving if house prices unexpectedly increase (decrease). This holds under the assumptions that house price shocks are permanent, households are willing and able to trade their house in the future, and that there is no bequest motive linked to housing. Making these assumptions explicit is important since it allows for a better interpretation and discussion of the empirical results.

To test for the presence of a housing wealth effect I set up the following empirical implementation of Eq. (F.6) in the theoretical model:

$$\begin{aligned}\Delta \ln s_{it} = \beta_0 + \beta_1 \left(\Delta \ln hp_{it} - E_{it-1}\Delta \ln hp_{it}\right) + \beta_2 \Delta \ln y_{it} \\ + \beta_3 \Delta e_{it} + \Delta \mathbf{Z}'_{it}\boldsymbol{\beta}_4 + \mathbf{t}'_t\boldsymbol{\beta}_5 + \epsilon_{it},\end{aligned} \tag{2.1}$$

where s_{it} is active saving of household i in period t; hp_{it} is the price of the owner-occupied residence; $\left(\Delta \ln hp_{it} - E_{it-1}\Delta \ln hp_{it}\right)$ is the unexpected component of house price growth, *i.e.* the house price shock; y_{it} is total household income, thus including both labor income and capital income[4]; e_{it} is the expectation of the household about its future economic situation; $\mathbf{Z}_{it}$ is a vector of control variables containing information on household structure, labor market status, a dummy variable

[3] For studies using active saving to measure wealth effects, see Disney et al. (2010a) and Juster et al. (2006). For studies using mortgage debt to measure collateral effects, see Disney et al. (2010b) and Leth-Petersen (2010).

[4] It is very important here to include as a control variable a measure of income that captures both labor and capital income. That is because otherwise changes in active saving will not be equivalent to changes in consumption with the opposite sign.

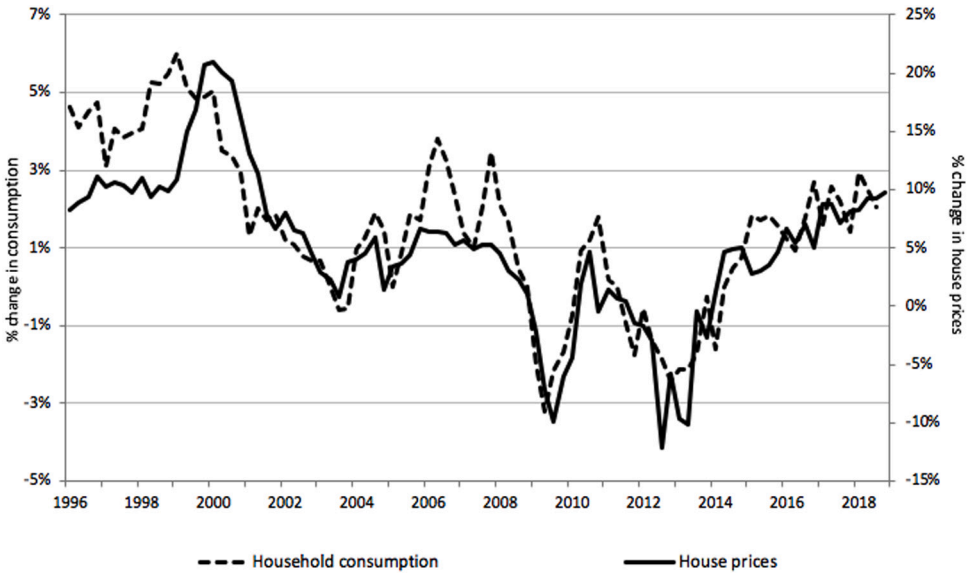

Fig. 1.1. House prices and household consumption. *Notes:* The change in household consumption is based on total nominal value of goods and services consumed by households in accordance with the National Accounts. House price changes are based on the price index of existing own homes, put together by Statistics Netherlands and the Dutch Land Registry Office. Changes are yearly and are given per quarter.
Source: Statistics Netherlands (CBS).

indicating whether the household moved since the previous wave, and a dummy variable indicating whether it spent any amount on house maintenance, improvement or adaptation since the previous wave; $\mathbf{t}_t$ is a vector of year dummies; and ϵ_{it} is the error term. The coefficient of interest is β_1, which captures the effect of the unexpected component of house price growth. Note that β_1 captures the contemporaneous effect of house price shocks since all variables in Eq. (2.1) are considered at time t.

Following Disney et al. (2010a), I define active saving as non-negative transfers from current income to financial wealth. Using this variable allows ruling out the collateral effect as an explanation for the result of the estimation of β_1. That is because increases in consumption through collateralized borrowing will not be captured by changes in saving out of income. Additionally, I include the change in economic expectations in the model to account for the argument by Attanasio and Weber (1994) and Attanasio et al. (2009). These authors state that this variable could play an important role in the common causality mechanism. That is because economic expectations could affect both house prices and consumption simultaneously. For that reason, I estimate Eq. (2.1) with and without including expectations and compare the results. The theoretical model predicts that the direction of the wealth effect is conditional on the household's current and future housing needs. These will determine whether the household plans to upsize or downsize housing. It is reasonable to assume that younger households are more likely to upsize while older households are more likely to downsize. For that reason, in the empirical analysis I condition the wealth effect on the age of the household head.

As a second step in the analysis, I study the collateral effect by employing the same specification as in Eq. (2.1) but using mortgage debt as a dependent variable. According to the theoretical model, the necessary assumptions for there to be a collateral effect are that households are borrowing constrained and that there are channels available for them to borrow for consumption against the housing asset. Note that in this case it is not required that house price changes are unexpected and permanent to have an effect on consumption. That is because, even if the household is able to foresee the house price change, it will not be able to borrow against the new value of the house until the change actually takes place. Therefore, following the model, in this part of the analysis I exclude house price expectations from the specification.

When estimating the collateral effect, it is important to take into account that, as described by Ebner (2013), in the Netherlands, homeowners have a high level of flexibility in adjusting their mortgage, *i.e.* they can change their mortgage debt either by increasing/decreasing their current mortgage amount, by taking out a second mortgage, or by refinancing with a higher principal.[5] To capture this, I use as a dependent variable a dummy indicating whether a homeowner has taken out a second mortgage between periods $t-1$ and t. This approach is appealing due to its simplicity; however, it only captures one of the three channels through which homeowners can influence their mortgage debt. Therefore, following Disney et al. (2010b), I perform an additional set of estimations using the change in remaining mortgage debt as a dependent variable.

3. Data and descriptive statistics

To implement the empirical strategy outlined in Section 2, I employ data from the Dutch National Bank Household Survey (DHS). This is an internet based panel survey that provides extensive information on economic, financial, and psychological aspects of household behavior.[6] Most importantly for the present study, the DHS features a section on accommodation and mortgages, including information on self-reported house prices and house price expectations. It does not contain information on consumption. However, it does include information on income, wealth, and active saving. In this section I describe the measurement of the most important variables in this study and provide some descriptive statistics. For the full summary statistics of all variables employed in the analysis, see Appendix A.

The DHS provides data for approximately 2000 Dutch households every year since 1993. However, since the data on self-reported house price expectations are only available since 2004, I restrict the sample

[5] For a detailed account of the Dutch mortgage market, see Ebner (2013) and van Ooijen and van Rooij (2016).

[6] The DHS is operated by CentERdata, a data collection institute based at Tilburg University. Households without a computer and/or access to internet are provided with a basic computer and internet connection to complete the survey. The sample is refreshed every two years to compensate attrition and keep the sample representative of the Dutch population. For a thorough description of the data and its representativeness, see Teppa and Vis (2012).

to the years 2004–2018, which is a long enough period to capture the boom-and-bust cycle in the Dutch housing market. For that period, there are 3106 households in the DHS who are homeowners and are observed for at least two periods. I select only the household heads and keep in the sample only those without missing values for active saving, self-reported house price changes, and house price expectations. This selection leaves me with 1981 homeowners that are observed for 4.51 waves on average. Therefore, the sample of homeowners is composed of 8939 household-year observations.

3.1. Saving and mortgage debt

To capture active saving, I use a DHS question asking respondents whether they have put any money aside in the past twelve months. Those who respond affirmatively, are provided with seven intervals ranging from "less than 1500 euro" to "more than 75 000 euro".[7] To deal with the interval structure of the variable I take the midpoint of each interval. Fig. 3.1 depicts the yearly averages in active saving over the sample period. These averages are conditional on active saving being above zero. Fig. 3.1 also shows the percentage of zeros in active saving, which remains at approximately 30% throughout the entire sample period. Out of all homeowners included in Fig. 3.1, 73% experience at least one change during the sample period. This means that they experience at least one change in active saving while being observed in the periods before and after the change.

An important disadvantage of this measure is that it will only capture changes in saving as long as the household's level of saving crosses an interval boundary which is likely to induce a bias in the measurement.[8] However, this must be weighed against two important advantages of this measure. First, the measurement of active saving allows separating the wealth effect from the collateral effect since, as argued by Disney et al. (2010a), active saving should not be affected by consumption financed by collateralized borrowing. This is an important advantage with respect to any variable that measures consumption directly. Second, this measure is not contaminated by changes in wealth due to capital gains and losses, *i.e.* passive saving. This is a relevant advantage with respect to measures of consumption based on subtracting the change in wealth from the flow of income. This is a strategy often employed in the literature given that direct measures of consumption are rarely available (*e.g.* Cooper, 2013; Browning et al., 2013; Crawley and Kuchler, 2018).

Regarding mortgage debt, the DHS features a question asking homeowners how many mortgages they have on their current accommodation and whether they took out a new mortgage since the previous wave. Around 5.4% of homeowners in the sample report taking out a new mortgage conditional on already being a homeowner in the previous wave. For approximately 50% of these cases, the new mortgage does not imply a change in the total number of mortgages which suggests that it reflects mortgage refinancing. With this information, I construct a dummy variable that takes value one if a household takes out a new mortgage that implies an increase in the total number of mortgages on the house and zero otherwise.

This dummy variable approach to measure mortgage borrowing has advantages due to its simplicity, however, as mentioned in Section 2, it does not capture all of the channels through which homeowners can influence their mortgage amount. For that reason, I use an additional question featured in the DHS that asks homeowners how much remaining mortgage debt they still have on their current accommodation. Respondents are queried about a maximum of five mortgages. I measure remaining mortgage debt by adding the self-reported amount still left to pay for each of these. Fig. 3.2 illustrates how the average remaining mortgage debt in the sample increases over time, especially between 2004 and 2009, while the percentage of homeowners without a mortgage remains rather constant between 30% and 40%. This increase in the total mortgage stock partially reflects the entry of new homeowners in the market during a period of economic growth and house price increases.

Regarding the within-household variation in mortgage debt, 58% of the households included in the sample experience a change at least once during the period that is considered. The reason why there are many households experiencing no changes in mortgage debt is twofold. First, as Fig. 3.2 indicates, every year there are about 30% of homeowners with no mortgage debt. Even though they could take a new mortgage at any given period, the data show that they rarely do so. Second, the capacity for households to change their mortgage debt is conditioned by the type of mortgage that they have. As explained by Ebner (2013), mortgages that do not require a payment of the principal until the end of the loan period are very popular in the Netherlands. However, even these households can always refinance their current mortgage, take out an additional mortgage, and/or choose to (partially) pay off the mortgage in advance upon the payment of a penalty that is tax deductible.[9]

The descriptive statistics on the number of mortgages and remaining mortgage debt suggest that there is little home equity extraction in the Netherlands. This is in accordance with the evidence shown by Ebner (2013) who uses a data module on home equity extraction provided by the DHS only for the period 2004–2007. Ebner (2013) shows that during that period only about 5% of households report having withdrawn housing equity by either increasing their current mortgage, refinancing with a higher principal, or taking out an extra mortgage.[10] Regardless of the fact that there is little home equity extraction in the Netherlands, it is still interesting to investigate to what extent it responds to changes in house prices. Ebner (2013) investigates what are the main correlates of home equity extraction using the mentioned 2004–2007 data module. Therefore, conducting a detailed analysis of the effect of house prices adds to the analysis by Ebner (2013) in addition to further clarifying the potential role of the collateral effect in explaining the correlation between house prices and consumption shown in Fig. 1.1.

3.2. House prices

Fig. 1.1 in the introduction shows that average house prices in the Netherlands experienced considerable variation between 1996 and 2018. After a long period of positive yearly house price increases reaching close to 20% in the early 2000s, there was a remarkable turning point in 2008 with house price growth turning negative and reaching rates as low as −10% in 2013. Since 2014, growth has returned to positive with an increase in 2018 similar to those in the early 2000s. This large variation over time makes a very interesting case for the question at hand. To measure house prices, the existing literature uses regional indices at different levels of aggregation. One of the main contributions of the present study consists of employing household-level self-reported data on the market value of the main residence.

Using self-reported data on house prices at the household level has several advantages compared to using aggregate measures. First, it entails a smaller unit of analysis, thus implying the use of richer

[7] The intervals are "less than 1500", "between 1500 and 5000", "between 5000 and 12 500", "between 12 500 and 20 000", "between 20 000 and 37 500", "between 37 500 and 75 000", and "more than 75 000".

[8] For every particular case the direction of the mismeasurement will depend on the distance between the actual level of saving and the closest interval midpoints and interval boundaries. Assuming these distances are uncorrelated with house price changes, there will not be a problem for the estimation as long as the measure captures enough variation in saving.

[9] For a description of the types of mortgages available in the Netherlands and their frequency in the sample, see Appendix B.

[10] I refer more in detail to this data module in the results section to further clarify relevant aspects of home equity extraction in the Netherlands.

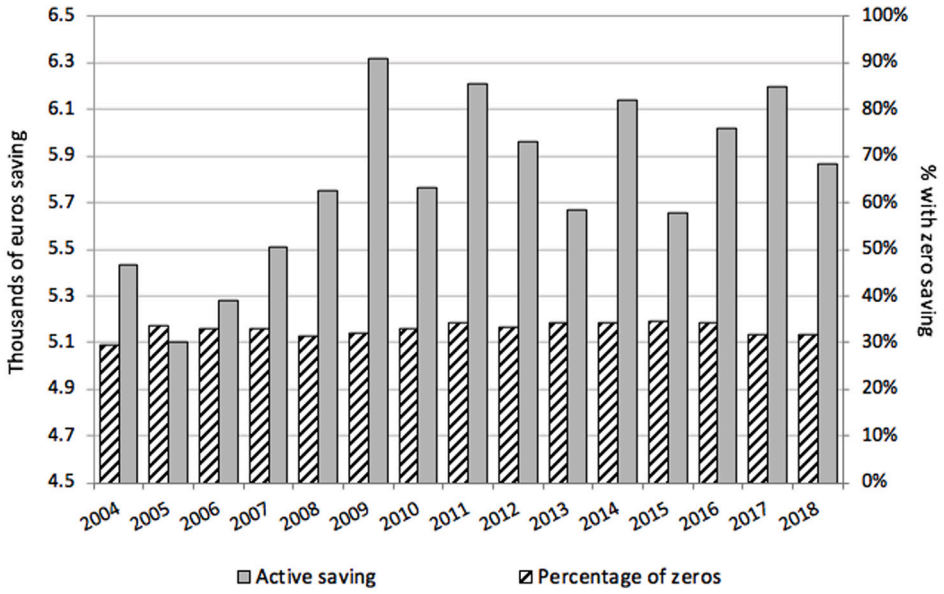

Fig. 3.1. Average active saving. *Notes:* Active saving is measured in thousands of euro. Averages are computed conditional on active saving being greater than zero. For more information on how active saving is measured, see main text.

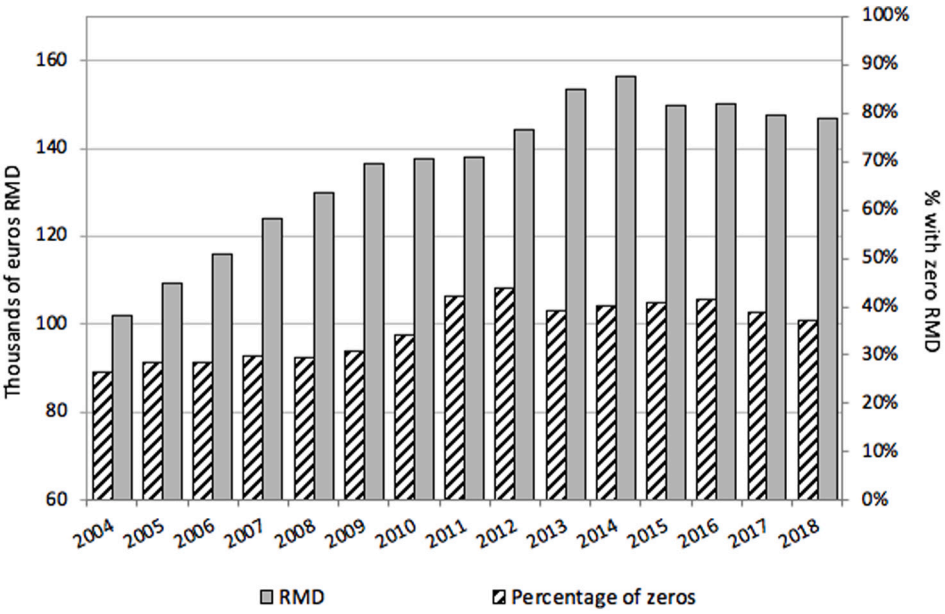

Fig. 3.2. Average remaining mortgage debt (RMD). *Notes:* Remaining mortgage debt is measured in thousands of euro. Averages are computed conditional on remaining mortgage debt being greater than zero. For more information on how remaining mortgage debt is measured, see main text.

information. Second, it avoids relying on indices constructed from average purchase prices that are conditioned by the composition of the pool of houses being sold in a particular period. Third, it accounts for any bias that individuals may have when assessing the market value of their own residence. Regarding the third point there is a stream of literature, initiated by Goodman and Ittner (1992), among others, showing that, on average, homeowners report house prices that are 2% to 15% above market estimates. This literature shows as well that homeowners tend to report house price changes with a delay of a few years.[11] van der Cruijsen et al. (2018) confirm these results using the DHS data. Therefore it is important to investigate to what extent individuals react to their own perception of house price and compare that to the effect of regional house price indices.

In the DHS, homeowners are asked about the current price of their main residence. In addition, they are asked about the percentage change in the price since the last year. Fig. 3.3 shows that average self-reported prices are consistently above the average of prices reported by municipalities (WOZ prices in Dutch).[12] Fig. 3.4 shows average self-reported house price changes along with changes in the

[11] For a thorough review of this literature, see Choi and Painter (2018).

[12] Dutch municipalities are required by law to appraise the market value of all houses in their premises, which they do based on purchase prices of similar houses in the market. This appraisal is used to levy property taxes and for other legal purposes. Since 2005, WOZ prices are updated every year. For more information on WOZ appraisals, see van der Cruijsen et al. (2018).

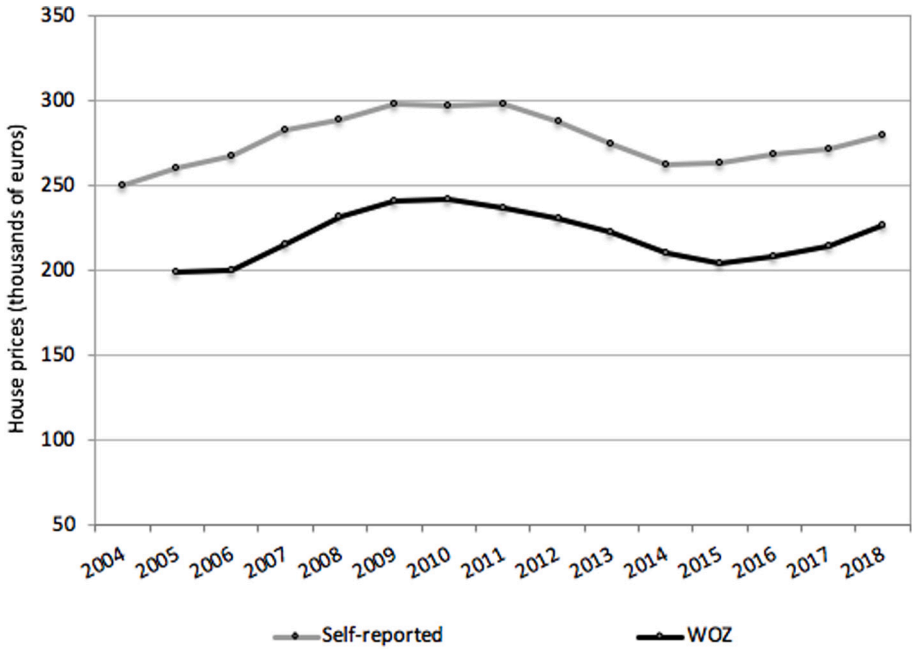

Fig. 3.3. Average house price level. *Notes:* WOZ stands for *waardering onroerende zaken*. For more information on the house price measures in this figure, see main text. For the regional distribution of WOZ prices, see Table C.1 in Appendix C. For the sample distribution of self-reported house price levels, see Fig. C.1 in Appendix C.

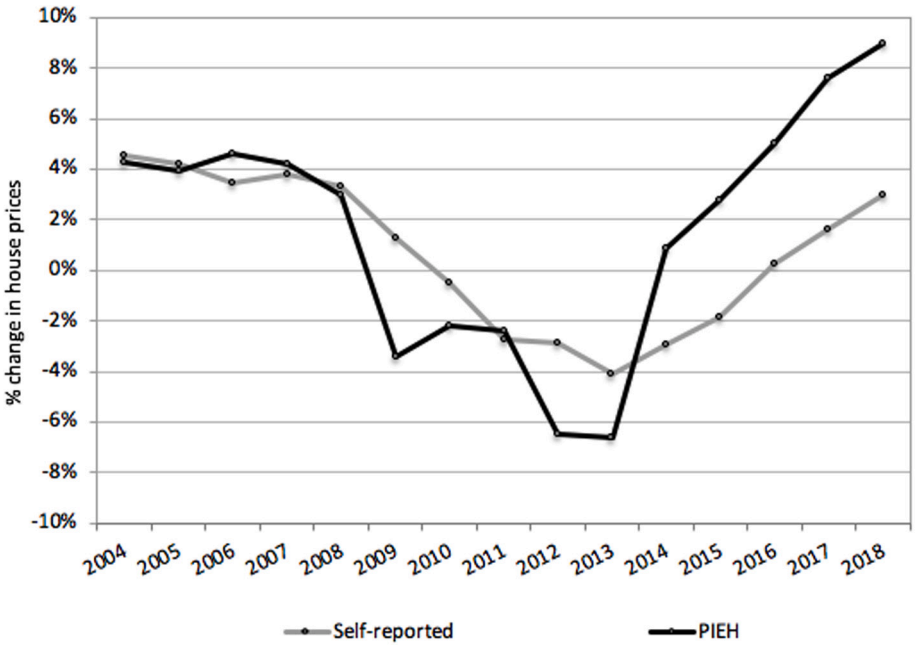

Fig. 3.4. Average house price change. *Notes:* PIEH stands for*price index of existing own homes*. For more information on the house price measures in this figure, see main text. For the regional distribution of the changes in the PIEH, see Table C.1 in Appendix C. For the sample distribution of self-reported house price changes, see Fig. C.2 in Appendix C.

price index of existing own homes (PIEH). This index is compiled by Statistics Netherlands (CBS) and consists of average purchase prices in the market corrected by the most recent WOZ prices of the houses that are sold.[13] Both WOZ prices and the PIEH are provided at the provincial level by CBS. Fig. 3.4 shows that individuals are generally aware of fluctuations in house prices even though they report the sharpest changes with a slight delay. The main takeaways of Figs. 3.3 and 3.4. are in accordance with the above-mentioned literature on self-reported house prices which states that homeowners tend to overestimate the price of their residence and that they have a delay in processing new information about house price fluctuations.

Regarding house price expectations, the existing literature has relied on parametric estimations using models of the evolution of house prices at the regional level. For instance, Disney et al. (2010a) estimate an AR(2) process while Browning et al. (2013) estimate an AR(1) process. In both cases, the house price model is used to predict house price

[13] By dividing the average purchase prices by the most recent WOZ average price, this house price index accounts for the fact that the characteristics of the pool of houses that are sold may change from one year to the next in a particular region. Since it is the result of a ratio, it can be used to measure changes in house prices but not levels. For a detailed account of how the PIEH is computed, see de Haan et al. (2009).

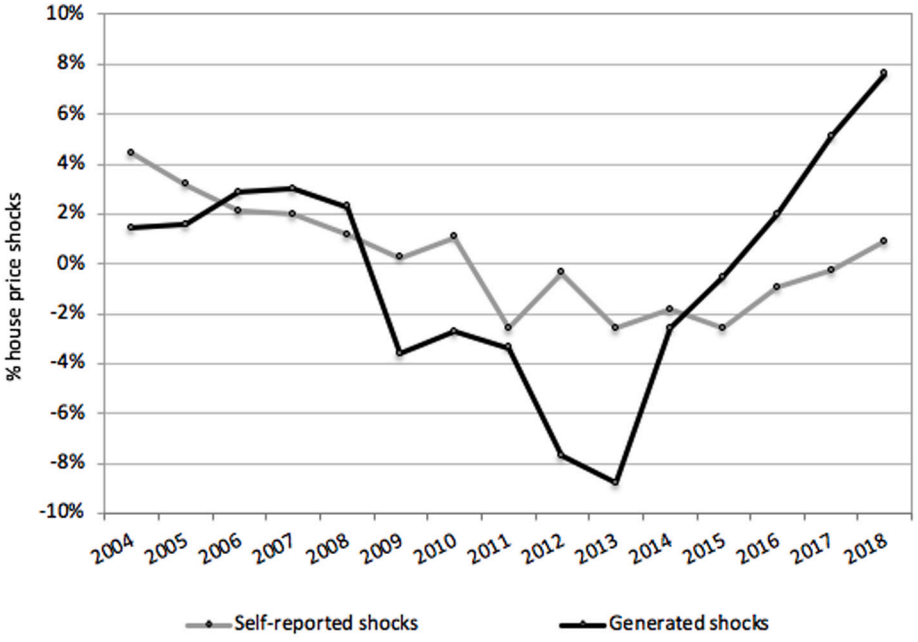

Fig. 3.5. Self-reported vs. generated shocks. *Notes:* For more information on the house price measures in this figure, see main text. For the regional distribution of the house price shocks generated using regional house prices, see Table C.2 in Appendix C.

levels conditional on previous realizations. These predictions are then used as a measure for house price expectations. This method assumes that individuals base their expectations about future house price levels on past house prices within their region. In the present study, I use a DHS question asking individuals by how many percentage points they expect the price of their primary residence will change during the following year. This non-parametric approach employs richer variation and accounts for biases that individuals may have when reporting expectations. Niu and van Soest (2014) conduct a panel data analysis of house price expectations at the individual level for the USA. They show that these expectations are dependent on past housing returns and perceived economic conditions as well as on socioeconomic, demographic, and unobserved heterogeneity at the individual level.[14] Therefore, it is relevant to take into account individual expectations and compare the outcome with an approach relying on expectations that are generated using regional house price indices.

Fig. C.3 in Appendix C shows average house price changes as self-reported by homeowners in the DHS for every particular year together with the average reported house price expectation for that same year.[15] Fig. C.4 compares average changes for every particular year as measured by the PIEH with expectations generated via an AR(1) process estimated using the PIEH itself.[16] The yearly averages of the shocks computed with the data in Fig. C.3 and C.4 are reported in Fig. 3.5. These shocks are constructed simply by subtracting the expected change for a particular year from the actual change in that same year as indicated in Eq. (2.1). Fig. C.3 shows that individuals underestimate house price changes during boom years and overestimate them during bust years. This translates into positive shocks during boom years and negative shocks during bust years. Even though the expectations generated with an AR(1) seem to somewhat capture this feature, overall, they predict much larger shocks, both positive and negative, compared to those computed with subjective data, as can be seen in Fig. 3.5.

Following the caveats of the above-mentioned literature (*i.e.* Niu and van Soest, 2014; van der Cruijsen et al., 2018), the difference between shocks computed with self-reported data and shocks computed using the regional house price index are likely to be due to individual-level characteristics that condition how individuals report current and expected house prices. Fig. 3.6 shows that, according to the measure of shocks based on self-reported data, the largest positive shocks occur between 2004 and 2007 while the largest negative shocks occur between 2011 and 2015. In addition, Fig. 3.6 reports considerable variation in the size of the shocks for all of the years in the sample. This household-level variation is not captured with the measure based on expectations generated with an AR(1) since these only vary at the provincial level. Therefore, it is important to use self-reported (unexpected) house price changes and compare the results obtained with the measures often employed in the literature.

3.3. Economic expectations

As mentioned in Section 2, Attanasio and Weber (1994) and Attanasio et al. (2009) contend that economic and financial expectations may be an important driver of the common causality between house prices and consumption. They argue that if individuals expect a better economic situation in the future, for instance due to forecasted increases in productivity, they will increase both housing and non-housing consumption which will result in a correlation between house prices and consumption. Attanasio et al. (2009) find a stronger effect of house prices on consumption for younger households compared to older households. They contend that this result is due to younger individuals being the most likely to benefit from increases in productivity in the future. If that is the case, it then means that the common causality

[14] Different from the literature on self-reported prices of own homes, summarized by Choi and Painter (2018), the literature on self-reported house price expectations is rather small. There is, however, a significant amount of literature on how individuals form expectations in other domains, *e.g.* stock market indices, inflation, etc. For a review of this literature, see Niu and van Soest (2014).

[15] At every wave, DHS respondents are asked about the change in the price of their house since last year while they are asked about the expected change in the coming year. I align the timing of these two variables to compute house price shocks as defined in Eq. (2.1).

[16] The generated expectations correspond to the fitted values of the AR(1) estimated at the provincial level, following the method in Disney et al. (2010a) and Browning et al. (2013). See Appendix D for details on how these expectations are generated.

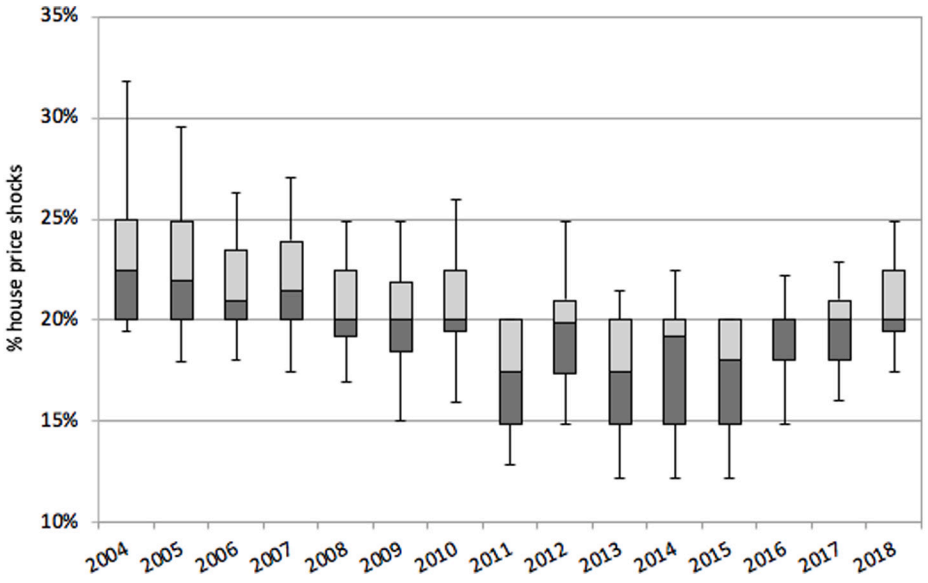

Fig. 3.6. Box plot self reported shocks. *Notes:* For more information on the house price measures in this figure, see main text. The upper and lower bounds of the intervals in this figure show the 90th and the 10th percentiles for every year, while the boxes indicate the 25th, the 50th, and the 75th percentiles.

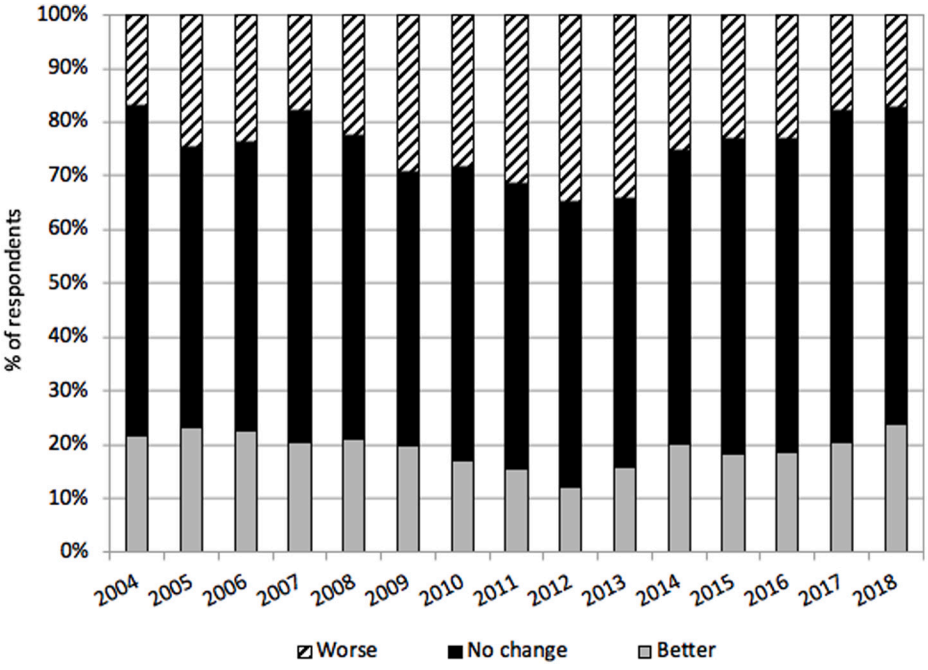

Fig. 3.7. Five-year-ahead economic expectations. *Notes:* This figure displays the answers to the DHS question "How do you think the economic situation of your household will be in five years time in comparison to the current situation?". For further information on how the variable is created, see main text.

mechanism is driven by economic expectations and this is manifested by finding a stronger effect for younger individuals.

The DHS measures individuals' economic expectations with the question "how do you think the economic situation of your household will be in five years time in comparison to the current situation?". Individuals can answer "much worse", "worse", "about the same", "better", or "much better". Using this question, I create a variable that can take three values indicating whether individuals expect their economic situation to worsen, to stay the same, or to improve. I use this variable as a measure for e_{it} in Eq. (2.1). In that way, I follow a similar strategy as Disney et al. (2010a) who also include economic expectations in their specification. They measure this variable using a similar question that, instead of five-year-ahead expectations, asks individuals about their one-year-ahead expectations about their financial situation. Fig. 3.7 shows that most individuals expect no changes in their economic situation, and that economic expectations do not substantially change over time. However, it does demonstrate that the share of individuals reporting negative expectations increases during the years of the economic crisis, up to approximately 34% in 2012 and 2013, and then decreases again to below 20% by the end of the sample period.

4. Results

This section presents the results obtained with the methodology and the data outlined in Sections 2 and 3. First, I present the results of the

Table 4.1
Effect of self-reported house price changes on active saving.

Variable	Dependent variable: Change in log active saving			
	(1)	(2)	(3)	(4)
House price change	0.009			
	(0.008)			
House price shock		0.005	0.004	
		(0.007)	(0.007)	
House price shock				−0.008
younger owner				(0.013)
House price shock				0.008
older owner				(0.008)
Positive change			−0.192*	−0.193*
economic expectations			(0.108)	(0.108)
Negative change			0.157	0.153
economic expectations			(0.104)	(0.105)
Change log income	0.211***	0.222***	0.209***	0.207***
	(0.072)	(0.072)	(0.072)	(0.071)
Number of observations	8939	8939	8939	8939
R^2	0.020	0.017	0.018	0.018

Notes: Standard errors (clustered at the household level) are reported in parenthesis. All regressions include the change in the number of children in the household, the change in the number of children outside of the household, a set of dummies indicating all possible marital transitions, a set of dummies indicating all possible labor market status transitions, a dummy indicating whether a household moved since the previous wave, a dummy indicating whether the household spent money on house renovation since the previous wave, and a set of year dummies. See main text for further details. *Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level.

wealth effect estimation and then the results of the collateral effect estimation. In both cases, I also present several extensions and robustness checks to further clarify the results of the baseline estimations. For the baseline analyses, I provide first the results when using the self-reported data to measure house price changes, and then the results when using the data provided by Statistics Netherlands (CBS). For the extended analyses, I report only the results obtained using self-reported house prices. That is because the difference in the results obtained with the two house price measures is already clear from the baseline analyses and does not significantly change with the extensions thereof.

4.1. Wealth effect

4.1.1. Baseline

Table 4.1 presents the results of the baseline estimation of the wealth effect when using self-reported data to measure house price changes. The point estimate in Column (1) shows that a 1% increase in house prices leads to a 0.009% increase in active saving, which is a very small effect and not significantly different from zero. Column (2) shows that the point estimate is halved, and again not significantly different from zero, when using the unexpected house price change (*i.e.* the house price shock) as explanatory variable. Column (3) shows that, when introducing the change in economic expectations, the point estimate of the main effect becomes even closer to zero. The point estimate in Column (3), *i.e.* 0.004, implies that, taking the average house price value in the sample (282 thousand euro as reported in Table A.1 in Appendix A) and average saving (5005 euro), when house prices increase by 1% (2820 euro) saving increases by 16 euro. This results in a negative marginal propensity to consume (MPC) out of an additional euro of housing wealth of approximately 0.5%, which is among the smallest MPCs compared to those reported in the existing literature.

Column (4) in Table 4.1 shows that the effect remains insignificantly different from zero when split between younger (below 45) and older homeowners (45 or older). To define older and younger homeowners I follow the distinction made by Disney et al. (2010a). If I follow the alternative definition by Attanasio et al. (2009) who consider younger (below 35), middle aged (between 35 and 60), and older homeowners (60 or older), Column (1) of Table 4.2 shows that the results do not significantly change. In addition, all columns in Table 4.1 show that changes in income have a strong effect on saving. In all cases, a 1% increase in income results in an increase of about 0.2% in saving. Regarding the effect of economic expectations, Column (3) shows that a positive change in economic expectations decreases saving. Even though this effect is marginally significant, it is in line with the precautionary saving motive. Together with the significant effect of income, this gives credit to the dependent variable as capturing relevant changes in active saving despite its interval structure described in Section 3.1.

Table E.1 in Appendix E shows the results obtained when using the PIEH to compute house price changes and house price shocks. The estimated effects are again not significantly different from zero, even though the point estimates are considerably larger.[17] Comparing the estimation results in Tables 4.1 and E.1 shows that using data on house prices at the household level provides a higher degree of precision.[18] That is clear from the fact that the standard errors of the estimates in Table 4.1 are smaller and thus allow ruling out a wealth effect that would be economically significant. The standard errors in Table E.1 are larger and do not allow ruling out elasticities of approximately 0.05%. This is in line with the results in the literature which yield more precisely estimated and smaller MPCs the smaller is the regional unit employed to measure house prices (*e.g.*, see Campbell and Cocco, 2007; Attanasio et al., 2009; Disney et al., 2010a; Browning et al., 2013). In addition, the caveats mentioned in Section 3.2, *i.e.* the fact that individuals tend to overvalue their house with respect to market prices and that they process house price changes with a delay, may play a role in explaining the differences between the results in Tables 4.1 and E.1.

The analyses reported in Table 4.1 assume that the effect of interest is the same for the entire sample period. However, the period of analysis is rather long and, as shown in Fig. 3.6, the sample contains years with mostly positive shocks and years with mostly negative shocks. This is an advantage with respect to previous literature which has mostly analyzed periods characterized by positive house price shocks. Therefore, it is interesting to test if the effect differs depending on whether the shock is positive or negative.[19] This is almost equivalent to testing for a structural break between the years 2011 and 2015 which is the sub-period in the sample that contains most of the negative shocks. To that end, I generate a dummy variable that takes value one if the house price shock is negative and interact it with the shock itself. The share of negative shocks in the sample is around 40%. The results in Column (2) of Table 4.2 show that there is neither a statistically nor economically significant difference between the estimated effects of positive and negative shocks, which does not give support to the hypothesis of an asymmetric effect.

In Section 3.1, I mention the presence of a potential bias due to active saving being measured with an interval variable. Even though the estimated effects of income and economic expectations suggest otherwise, the results obtained could be interpreted as a consequence of such bias. To further explore this, I rerun the regression analyses reported in Table 4.1 using only households that experience a change in active saving during the sample period (*i.e.*, approximately 73% of

[17] The estimation sample in Table E.1 is the same as in Table 4.1. However, in this case renters can also be included in the sample. In Table 4.1 that is not possible since self-reported house prices are only provided by respondents who are homeowners. If I include renters in the sample, the point estimates in Table E.1 become slightly closer to zero. However, they are not significantly different from those already reported in that table.

[18] When comparing results in Tables 4.1 and E.1, note that the two different measures of the house price shock have very different distributions, *i.e.* see Fig. 3.6 and Table C.2 respectively. This comes from the fact that in the first case, the unit of measurement is the household while, in the second case, the unit of measurement is the province.

[19] A few previous studies (*e.g.* Engelhardt, 1996; Campbell and Cocco, 2007) have already considered the possibility of an asymmetric wealth effect.

Table 4.2
Effect of self-reported house price changes on active saving — Extensions.

Variable	Age interaction (1)	Symmetry (2)	Long term exp. (3)	Willing to buy (4)
House price shock	−0.009			
younger owner	(0.020)			
House price shock	0.009			
middle aged owner	(0.010)			
House price shock	0.003			
older owner	(0.010)			
Positive house price shock		0.017		
		(0.017)		
Negative house price shock		−0.007		
		(0.009)		
Long term expectation			0.004	
			(0.008)	
House price shock				0.007
willing to buy				(0.007)
House price shock				0.017
not willing to buy				(0.028)
Number of observations	8939	8939	8939	8939
R-squared	0.012	0.013	0.014	0.013

Notes: Standard errors (clustered at the household level) are reported in parenthesis. All results reported here are obtained based the same specification as in Column (3) of Table 4.1. Regressions include thus the change in the log of income, the change in economic expectations, the change in the number of children in the household, the change in the number of children outside of the household, a set of dummies indicating all possible marital transitions, a set of dummies indicating all possible labor market status transitions, a dummy indicating whether a household moved since the previous wave, a dummy indicating whether the household spent money on house renovation since the previous wave, and a set of year dummies. See main text for further details on each of the specifications used to obtain the results in this table. *Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level.

all households observed). The only noticeable change in the results is a slight decrease in the precision of the estimates that is most likely due to the smaller sample size.[20]

To further explore the validity of the saving measure, I re-estimate the regressions in Table 4.1 using a dummy variable that takes the value one if the level of saving is above zero and zero otherwise. This analysis answers a much simpler question, *i.e.* whether house price shocks affect the probability of saving. The advantage is that, for this question, there is no possibility of mismeasurement in the dependent variable while it still gives an indication of the presence of a wealth effect. The resulting estimates are very small and not significantly different from zero.[21] This indicates that house price changes have either a very small or no effect on the probability of saving, which is in line with the results in Table 4.1.

4.1.2. Long-term expectations

The results in Section 4.1.1 strongly suggest the absence of a noticeable wealth effect. This is in accordance with the results by Disney et al. (2010a) and Browning et al. (2013), both of whom estimate almost negligible wealth effects. Following the reasoning of the theoretical model in Appendix F, it may be that the lack of an effect is because at least one of the necessary assumptions does not hold. For instance, it may be that households perceive house price shocks as transitory instead of permanent. If individuals are willing to stay in the house where they live for a long period of time, then they will not consider transitory shocks in house prices in their decision making. The DHS offers an interesting possibility to explore this argument since it asks individuals what would they consider to be a normal yearly change in the general level of house prices ten years into the future.[22]

Fig. 4.1 shows the evolution of the average self-reported expectation about the one-year-ahead change in the price of the individual's own house. This is the same statistic reported by the dark line in Fig. C.3. In addition, it shows the average of the expected one-year-ahead change in the general market price level and the average of the expected yearly change in that same price ten years ahead from the survey moment. The first thing to note is that the average short-term expectation about the price of the own house and the average short-term expectation about the market price follow each other very closely. To a large extent, they both follow the evolution of house prices as reported by the CBS as depicted in Fig. 1.1. However, and most importantly, the long-term expectation about the change in market prices is always positive, rather flat, and does not seem to follow contemporaneous changes in house prices. This suggests that individuals expect house prices to always increase in the longer term regardless of the fluctuations in the short term. Therefore, it is fair to state that households expect the effect of current house price shocks to fade out in a period of maximum ten years.

Nevertheless, when closely examining Fig. 4.1, it appears to be the case that the average long-term expectation does follow the evolution of short-term expectations to a small extent. The former shows an increase from 3% to 4% in 2008, several small decreases right after that and, by the end of the sample, there is a slight increase. The bivariate correlation between short- and long-term expectations is, in fact, 0.095, *i.e.* small but still positive. However, when rerunning the same regressions as in Column (3) of Table 4.1 but using long-term expectations as explanatory variable instead of house price shocks, the coefficient that I obtain is still very small and not significantly different from zero. This result is provided in Column (3) of Table 4.2.

4.1.3. Intention to buy

Even if individuals do not perceive house price shocks as permanent, it might be that these shocks have an effect for those households that are planning to move in the short term. For instance, if a household is planning to upsize its current residence in the short term because of family formation, then, according to the model in Appendix F, a positive house price shock should, *ceteris paribus*, increase saving and decrease consumption even if the shock will fade out in the longer term. The DHS offers an interesting possibility to further investigate this argument since it asks households whether they are intending to move by buying a house, whether they intend to do it in the short term, and whether they are currently saving for that purpose.

Fig. 4.2 shows the yearly share of homeowners and renters in the sample who report to be intending to buy a house in the short term.

[20] Results are provided in Table E.3 in Appendix E.
[21] Results are provided in Table E.4 in Appendix E.
[22] The exact wording of the question is "what do you consider to be a normal increase percentage per year for houses in ten years?".

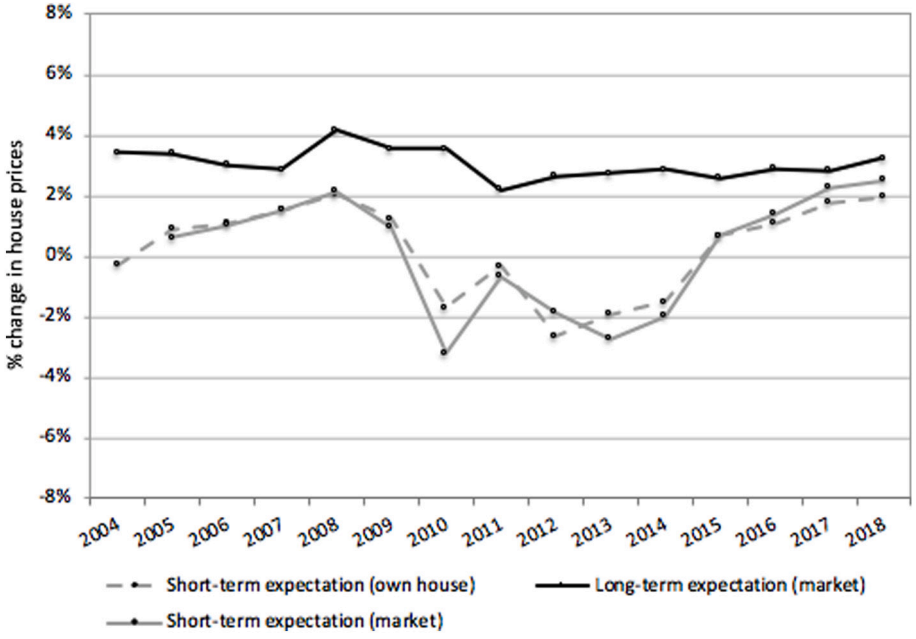

Fig. 4.1. Short-term vs. long-term house price expectations. *Notes:* Short-term expectations refer to the change one year ahead. Long-term expectations refer to the yearly change ten years ahead. All expectations are self-reported. For further information on these variables, see main text.

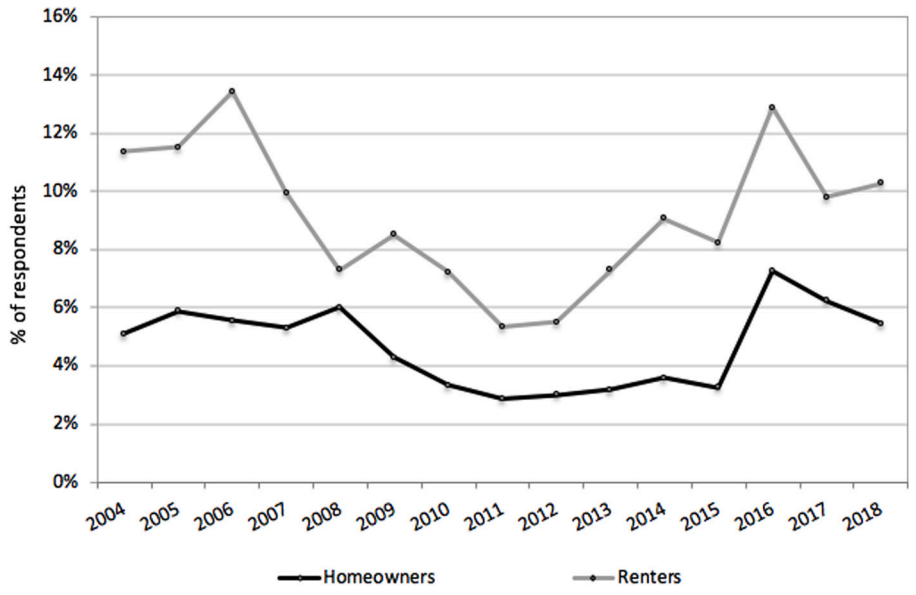

Fig. 4.2. Intention to buy a house in the short term. *Notes:* The short term refers here to two years since the moment of the interview. For further information on this variable, see main text.

The survey question specifies the short term as a maximum of two years since the moment of the interview. There are three relevant features to note in Fig. 4.2. The first is that the share of households intending to buy is always larger for renters than for homeowners. The second is that the share of households intending to buy significantly decreases during the years of the economic crisis. The third feature, and perhaps the most important, is that the share of households intending to buy in the short term is rather small throughout the entire sample, especially among homeowners. Out of those households that report to be intending to buy, approximately 50% in the case of homeowners and approximately 60% in the case of renters report to be actively saving for the purchase of the house.

Fig. 4.2 indicates that the sub-sample of households intending to purchase a house in the short term is likely to not be large enough to have reasonable statistical power to perform estimations for that particular group. Nevertheless, I test this by estimating the same specification as in Column (3) of Table 4.1 but interacting the main effect with a dummy indicating the intention to move by buying in the short term. Column (4) of Table 4.2 shows that the result does not significantly change *vis-à-vis* the one in Table 4.1 and stays not significantly different from zero. This may indeed be because the sub-sample of households that are intending to buy is not large enough. However, it may also be that households adjust to the change in house prices by purchasing a smaller/larger house and thus keeping their non-housing consumption patterns unchanged. Furthermore, it may also be that, in the event of upsizing, households do not change their consumption because they rely on the bank providing a larger mortgage to cover the increased housing costs.

Table 4.3
Effect of self-reported house price changes on mortgage debt.

Variable	New mortgage			Change in log mortgage debt		
	(1)	(2)	(3)	(4)	(5)	(6)
House price change	0.001	0.001		−0.004	−0.004	
	(0.001)	(0.001)		(0.003)	(0.003)	
House price change			0.002*			−0.004
younger owner			(0.001)			(0.007)
House price change			0.001			−0.004
older owner			(0.001)			(0.003)
Positive change		−0.002	−0.001		0.046	0.046
economic expectations		(0.007)	(0.006)		(0.039)	(0.039)
Negative change		0.001	0.005		−0.026	−0.026
economic expectations		(0.014)	(0.006)		(0.038)	(0.038)
Change log income	−0.001	−0.001	−0.001	−0.068**	−0.067**	−0.068**
	(0.004)	(0.004)	(0.003)	(0.029)	(0.029)	(0.028)
Number of observations	8133	8133	8133	8925	8925	8925
R^2	0.015	0.016	0.020	0.076	0.076	0.076

Notes: Standard errors (clustered at the household level) are reported in parenthesis. All regressions include the change in the number of children in the household, the change in the number of children outside of the household, a set of dummies indicating all possible marital transitions, a set of dummies indicating all possible labor market status transitions, a dummy indicating whether a household moved since the previous wave, an additional dummy indicating whether the household spent money on house renovation since the previous wave, and a set of year dummies. See main text for further details. *Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level.

4.1.4. Bequest motive linked to housing

Another important assumption that is necessary for the theoretical model to predict a wealth effect is that households do not intend to leave their main residence as a bequest to their descendants. There is a large literature that points to the bequest motive as an important driver of wealth accumulation throughout the life cycle (*e.g.* Kopczuk and Lupton, 2007; Lockwood, 2018; Suari-Andreu et al., 2019b). In addition, there are a few recent contributions that point to an association between the bequest motive and housing. For instance, Nakajima and Telyukova (2017) use survey data for the USA to show that households are unlikely to draw down their housing wealth during retirement. To explain this phenomenon, they build a structural model of retirement savings with housing. Their main finding is that the bequest motive and the utility benefits of homeownership are very important factors in explaining low withdrawal of housing wealth towards the end of the life cycle.[23]

In addition to Nakajima and Telyukova (2017), Suari-Andreu et al. (2019a) use the DHS data and show that housing wealth does not significantly decrease during retirement and that housing moves in older ages are rare. Furthermore, they show that the self-reported willingness to leave a bequest increases with age and is significantly higher for homeowners compared to renters. The correlation between homeownership and the intention to leave a bequest still remains even after they control for wealth, income, and a range of demographic variables. The results in Nakajima and Telyukova (2017) and Suari-Andreu et al. (2019a) strongly suggest that the intention to leave a bequest in the form of a house may be an important driver behind the lack of a wealth effect. Therefore, the bequest motive is a relevant element to take into account in future research on this effect.

4.2. Collateral effect

4.2.1. Baseline

Table 4.3 provides the results of the collateral effect estimation when using self-reported data provided by the DHS respondents to measure house price changes. As explained in Section 3.1, I use a dummy variable to indicate whether the household took out an additional mortgage since the previous period as well as the change in the log of remaining mortgage debt. In this case, the sample of homeowners becomes slightly smaller due to missing data. The dummy indicating the presence of a new mortgage has 806 missing observations while there are 14 missing for the change in mortgage debt. Therefore, the sample sizes become 8133 and 8925, respectively.

Columns (1) to (3) of Table 4.3 show the results obtained when estimating the effect of self-reported house prices changes on taking out a new mortgage using a linear probability model. Column (1) shows that the increase in probability of taking out a new mortgage when house prices increase by 1% is 0.001, *i.e.* very close to zero and almost negligible. Column (2) shows that the effect literally does not change when including economic expectations into the model while Column (3) shows a small effect, but significant at the 10% level, for the group of younger homeowners. Columns (4) to (6) show that, when using the change in the log of remaining mortgage debt, the estimated effects remain small, not significantly different from zero, and they do not change across the different specifications.

Table E.2 in Appendix E confirms these results when using the CBS measure to calculate house price changes. Columns (1) to (3) show estimates very similar to those in Table 4.3 while Columns (4) to (5) again show very small effects, although less precisely estimated. These results suggest that the collateral effect is not likely to explain the bulk of the correlation between house prices and consumption observed in Fig. 1.1 in the introduction. Similar to the case of the wealth effect, Columns (1) and (4) of Table 4.4 show that using an alternative definition of the age groups based on Attanasio et al. (2009) does not significantly change the results. In addition, it may also be in this case that positive and negative house price changes do not have a symmetrical effect. However, as shown in Columns (2) and (5) of Table 4.4, I find again that the effects of positive and negative changes are not significantly different from each other and that they are both not significantly different from zero.

A relevant aspect to take into account when investigating the collateral effect is that, given the transaction costs associated with taking out a new mortgage or increasing mortgage debt, individuals are likely to respond to lagged house price changes rather than to contemporaneous changes. This is not accounted for in the baseline analysis since in Eq. (2.1) all variables are considered at time t. To investigate this I re-estimate the baseline results but using house price changes lagged by one period as explanatory variable. As shown in Columns (3) and (6) of Table 4.4, the results I obtain are not significantly different from those reported in Table 4.3.

[23] According the Nakajima and Telyukova (2017), the utility benefits of homeownership capture factors such as attachment to a house and neighborhood, the ability to adapt the house to individual preferences, tax exemption of imputed rents, the tax deduction of mortgage interest payments, and insurance against rental rate fluctuation.

Table 4.4
Effect of self-reported house price changes on mortgage debt — Extensions.

Variable	New mortgage			Change in log mortgage debt		
	Age int. (1)	Symmetry (2)	Lagged (3)	Age int. (4)	Symmetry (5)	Lagged (6)
House price change	0.005*			−0.019		
younger owner	(0.003)			(0.013)		
House price change	0.000			−0.005		
middle aged owner	(0.001)			(0.004)		
House price change	−0.000			−0.001		
older owner	(0.001)			(0.004)		
Positive house price change		0.001			−0.003	
		(0.001)			(0.004)	
Negative house price change		0.000			−0.006	
		(0.001)			(0.005)	
House price change (t − 1)			−0.000			0.005
			(0.000)			(0.004)
Number of observations	7254	8133	8133	7932	8925	8925
R-squared	0.014	0.017	0.016	0.076	0.076	0.076

Notes: Standard errors (clustered at the household level) are reported in parenthesis. All results reported here are obtained based on the same specification as in Columns (2) and (5) of Table 4.3. Regressions include thus the change in the log of income, the change in economic expectations, the change in the number of children in the household, the change in the number of children outside of the household, a set of dummies indicating all possible marital transitions, a set of dummies indicating all possible labor market status transitions, a dummy indicating whether a household moved since the previous wave, a dummy indicating whether the household spent money on house renovation since the previous wave, and a set of year dummies. See main text for further details on each of the specifications used to obtain the results in this table. *Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level.

4.2.2. Borrowing constraints

Following the theoretical model and previous literature by Disney et al. (2010b), Leth-Petersen (2010), Agarwal and Qian (2017), and Defusco (2018), the collateral effect should only be relevant for households that are credit constrained. In the literature, there are several definitions of credit constraints. For instance, Disney et al. (2010b) take households for whom the loan-to-value (LTV) ratio corresponding to their main residence is 80% or higher while Leth-Petersen (2010) consider households for whom financial assets are worth less than one month of disposable income. The rationale behind using the level of financial assets as an indicator is that households will probably first resort to their liquid savings to increase consumption before choosing to increase their mortgage debt. However, as argued by Leth-Petersen (2010), it may be that the presence of financial assets reflects the preference to hold on to a buffer of savings for precautionary reasons regardless of how large the LTV is. For that reason, and given the relative importance of mortgage debt out of total household debt in the Netherlands, I use a definition of credit constraints similar to that in Disney et al. (2010b).[24]

Fig. 4.3 provides the evolution of average LTVs for younger and older homeowners as well as the evolution of the share of homeowners who are under water for both groups. A household is under water if its LTV exceeds 100%, implying negative net housing wealth. As explained by Ebner (2013), credit conditions in the Netherlands allow households to borrow 100% or more of the market value of their residence. Fig. 4.3 shows that younger homeowners have higher LTVs and are more often under water than older homeowners. This implies that credit constraints are already to some extent controlled for in Tables 4.3 and 4.4 and when splitting the results by age group.

For younger households (household head below 45), the average LTV fluctuates at around 60%. The share who are under water remains at approximately 15% for the first half of the sample while reaching a high of nearly 40% in 2014. This is likely due to the accumulation of house price declines between 2009 and 2014. For older households, the LTVs are much lower (around 30% on average) and the share who are under water is always very close to zero. Even though liquidity constraints seem to be relatively important, Table 4.5 shows that when interacting house price changes with a dummy variable indicating being under water in the previous period, the results are not significantly different from those in Table 4.3. As shown by the different columns in Table 4.5, this is the case even when considering different LTV thresholds to identify liquidity constrained households, *i.e.* 100%, 90%, and 80%.[25]

The limited evidence for a collateral effect in the Netherlands is somewhat surprising given the facility with which households can access mortgage borrowing. It contrasts with the findings by Disney et al. (2010b) and Leth-Petersen (2010), both of whom estimate positive collateral effects, albeit small, for the UK and Denmark, respectively. Even stronger is the contrast with Mian and Sufi (2011) who find a very large collateral effect for the USA using a methodology similar to that employed in the present study. The latter find that, for the years previous to the 2008 financial crisis, American homeowners increased borrowing by 25 cents for every dollar gain in home equity which is, by all standards, is a very large effect. According to Mian and Sufi (2011), consumption financed through mortgage borrowing experienced a very significant increase in the USA during the years leading up to the financial crisis which likely contributed to the large number of mortgage defaults observed in the aftermath of the crisis. The present study together with the results by Disney et al. (2010b) and Leth-Petersen (2010) show that, in the Netherlands, UK, and Denmark, home equity borrowing did not increase as much prior to the financial crisis and did not respond as much to house price increases relative to the USA.[26] This may explain a generally smaller rise in mortgage defaults as a consequence of the crisis in these countries.

4.2.3. Uses of housing equity loans

Considering the results in Sections 4.2.1 and 4.2.2, it is relevant to investigate further whether homeowners in the Netherlands actually

[24] For statistics on the relative share of mortgage and non-mortgage debt out of total debt in the Netherlands, see Ebner (2013).

[25] Disney et al. (2010b) consider only the 80% threshold since borrowing conditions are more restrictive in the UK. I consider a wider range of thresholds since, as explained by Ebner (2013), in the Netherlands it is possible to borrow up to a 100% of the value of the property.

[26] To investigate this further, I rerun the estimations in Table 4.3 for the years previous to the financial crisis, *i.e.* the 2004–2007 period. The difference with the results in Table 4.3 is negligible and not statistically significant. These results are reported in Table E.5 in Appendix E.

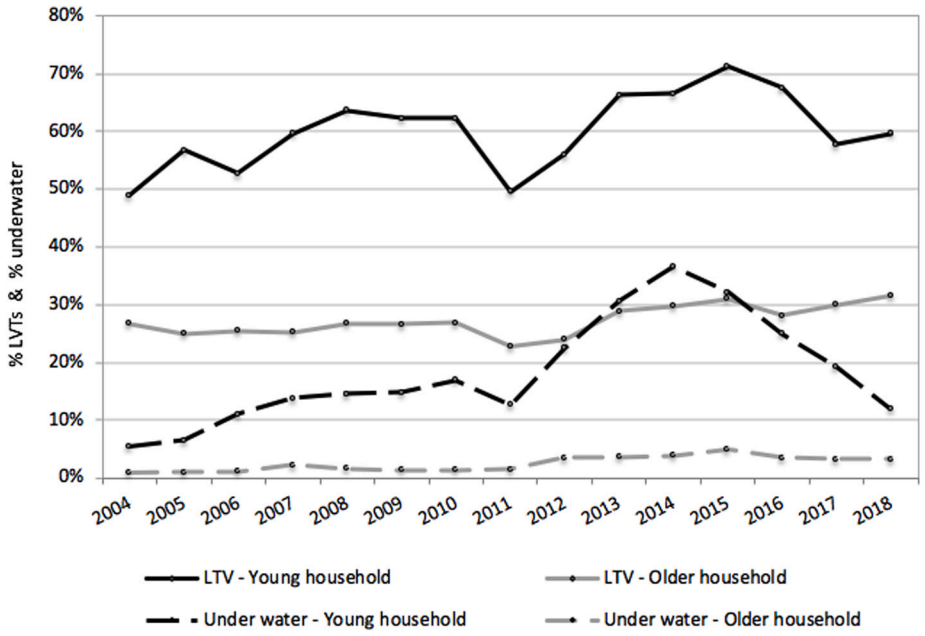

Fig. 4.3. Credit constraints for younger and older households. *Notes:* Under water means that the LTV is above 100%, *i.e.* the household has negative net housing wealth. The younger and older groups are defined following Disney et al. (2010a), *i.e.* younger means that the household head is younger than 45.

Table 4.5
Effect of house price changes on mortgage debt — Borrowing constraints.

Variable	New mortgage			Change in log mortgage debt		
	(1)	(2)	(3)	(4)	(5)	(6)
House price change	0.001			−0.001		
not borrowing constrained (100%)	(0.001)			(0.003)		
House price change	0.001			−0.018		
borrowing constrained (100%)	(0.002)			(0.021)		
House price change		0.000			0.000	
not borrowing constrained (90%)		(0.001)			(0.003)	
House price change		0.001			−0.009	
borrowing constrained (90%)		(0.001)			(0.013)	
House price change			0.000			−0.000
not borrowing constrained (80%)			(0.001)			(0.003)
House price change			0.002			−0.008
borrowing constrained (80%)			(0.002)			(0.009)
Number of observations	8133	8133	8133	8925	8925	8925
R2	0.017	0.016	0.017	0.021	0.024	0.026

Notes: Standard errors (clustered at the household level) are reported in parenthesis. Percentages indicate the LTV levels used to define borrowing constrained households. All regressions include the change in the log of income, the change in economic expectations, the change in the number of children in the household, the change in the number of children outside of the household, a set of dummies indicating all possible marital transitions, a set of dummies indicating all possible labor market status transitions, a dummy indicating whether a household moved since the previous wave, a dummy indicating whether the household spent money on house renovation since the previous wave, and a set of year dummies. See main text for further details. *Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level.

ever consider tapping their housing wealth by increasing their mortgage debt or by taking out a second mortgage. In addition, it is relevant to ask to what extent a new mortgage responds to refinancing to take advantage of better borrowing conditions or it responds to a true preference for a higher consumption level. As mentioned in the introduction, the Netherlands has a highly developed mortgage market that offers the possibility of increasing the amount of the current mortgage, taking out a second mortgage, and/or mortgage refinancing. In addition, tax deductibility of mortgage interest payments, the absence of down payment requirements, and the presence of a national mortgage guarantee imply that households have facilities and incentives to borrow against their housing wealth if they consider it necessary.[27] Given this context, it is reasonable to expect households will access home equity borrowing when necessary.

As I mention in Section 3.1, the DHS provides a battery of detailed questions on housing equity borrowing which are unfortunately only available for the period 2004–2007.[28] However, these data can still be used to further investigate home equity borrowing in the Netherlands and thus complement the results in Sections 4.2.1 and 4.2.2. Within this 2004–2007 data module, the DHS asks homeowners whether and how they have increased the amount of their mortgage debt. In addition, they are also asked about the quantity borrowed and its use as well as about whether they are planning to withdraw housing equity within

[27] For thorough descriptions of the Dutch mortgage market, see Ebner (2013) and van Ooijen and van Rooij (2016). For a list of the types of mortgage available and their frequency in the sample, see Appendix B.

[28] These data are used by Ebner (2013) to investigate the correlates of home equity extraction. Table E.5 in Appendix E provides the results of the same estimations as in Table 4.3 but only for the 2004–2007 sub-period.

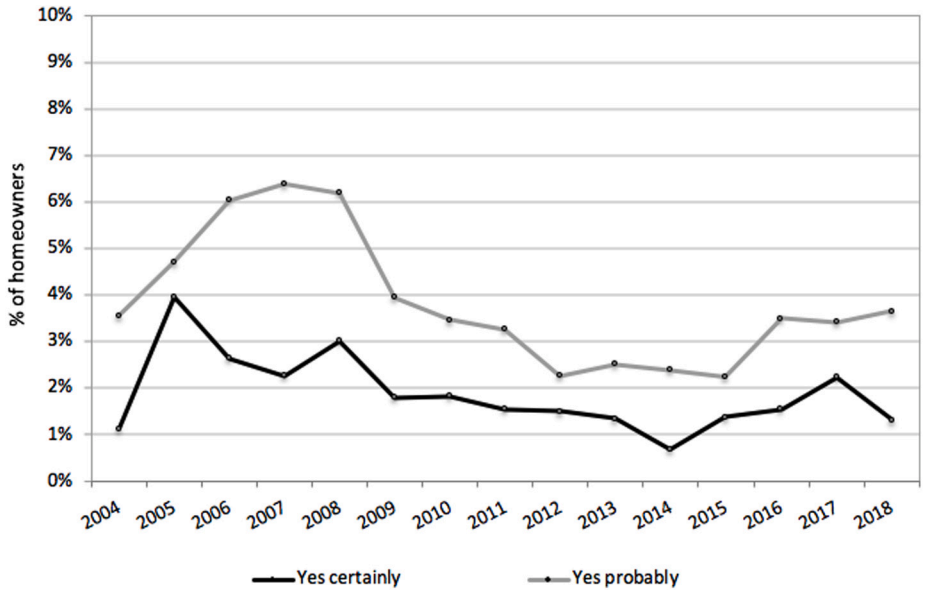

Fig. 4.4. Willingness to use housing equity. *Notes:* Homeowners are asked "are you planning on using the surplus value of your property in the next two years (by taking out an extra mortgage, by increasing your mortgage amount or by moving)?" They can respond "yes, certainly", "yes, probably", "probably not", "certainly not", or "don't know". Only the two first responses are reported here. The percentage of homeowners who report not knowing the answer is always below 2% for all years. The sample used here corresponds with that one used in Table 4.4.

the next two years.[29] The intention to withdraw within the next two years is the only question that is available in all waves.

Fig. 4.4 shows the yearly share of homeowners who report to be either probably or certainly willing to use their housing equity within the next two years. Both percentages remain low throughout the sample period, especially the percentage of households reporting to be certainly willing to do it which, for most years, remains at approximately 2%. Both percentages seem to move along to some extent with the evolution of house prices shown in Fig. 1.1, *i.e.* in the years with house price decreases (increases) individuals are more (less) willing to use their housing equity. Nevertheless, the percentages are still very low in all years, and the correlation with house prices could be due to other factors not accounted for here.

Fig. 4.4 only provides information on intentions and not on the actual use of housing wealth which, of course, need not be the same. The data only available for the 2004–2007 period show that the average yearly share of individuals who report having withdrawn housing equity (by increasing their current mortgage, refinancing with a higher principal, or taking out an extra mortgage) is between 5% and 6% which coincides, to some extent, with the share of households taking out a new mortgage as reported in Section 3.1. Conditional on having withdrawn housing equity through any of these three channels, 75% of respondents report having used it for improvement of their main residence, 17% for the purchase of durable goods, 14% to pay off other loans, while only 7% report having used it for non-durable consumption.[30]

This evidence proves once again that the share of households increasing their mortgage debt is rather low which might explain the lack of a significant effect in the results provided in Sections 4.2.1 and 4.2.2. In addition, out of the households who increase their mortgage debt, only a very small fraction use it to increase non-durable consumption. Therefore, changes in consumption due to increased mortgage debt seem unlikely to have a strong effect on the evolution of aggregate consumption. This indicates that it is improbable that the collateral effect is a relevant explanation for the strong correlation between house prices and consumption observed in Fig. 1.1. Ebner (2013) finds that there are several variables that are correlated with housing equity withdrawal. For instance, he finds that homeowners who have low income but are optimistic about their future economic situation are more likely to increase their mortgage debt. However, he does not investigate the effect of house price changes on housing equity withdrawal which, according to the evidence presented in this study, appears to not be significantly different from zero.

5. Conclusion

This study investigates the mechanisms behind the correlation between house prices and consumption reported in Fig. 1.1 in the introduction. While the macroeconomic literature usually estimates strong marginal propensities to consume (MPC), the microeconomic literature has often reported smaller MPCs. In addition, the microeconomic literature has put relevant effort into disentangling the different potential mechanisms behind this relationship, *i.e.* the wealth effect and the collateral effect, from the common causality hypothesis. This study contributes to previous literature by introducing the use of data on subjective house prices and house price expectations, by exploiting the recent sharp house price swings in the Netherlands, and by clearly separating the wealth and the collateral effects using panel survey data. When introducing subjective house prices and expectations, I compare the results with those obtained using a regional house price index, which is of the type most often used in the literature.

The estimates of the wealth effect and the collateral effect I obtain suggest that these two effects play, at best, a very small role in explaining the strong correlation observed in Fig. 1.1. In the case of the wealth effect, the estimates I obtain have lower standard errors when employing self-reported data to measure house price changes and house price expectations compared to the results obtained using the regional data provided by Statistics Netherlands (CBS). This shows that using house price data at the household level provides the analysis with a higher level of precision. This is in accordance with the results

[29] Respondents are asked whether they are willing to withdraw housing equity within the next two years by increasing the amount of the current mortgage, by taking out an additional mortgage, or by moving.

[30] Respondents are also asked whether they have used it for purchase of real estate, business investment, savings account, purchase of stocks, pension arrangements, and education of children. The share of affirmative responses for these categories is below 5% in all cases.

in the literature that studies the wealth effect using methods similar to the one I employ (*e.g.*, see Campbell and Cocco, 2007; Attanasio et al., 2009; Disney et al., 2010a; Browning et al., 2013). This literature reports MPCs that are smaller and more precisely estimated the smaller is the regional unit employed to measure house prices. In addition, self-reported data has the advantages that it does not rely on the pool of houses that are on the market in a particular year and that it accounts for any bias in individuals' perception of house price levels.

Following the assumptions made explicit by the theoretical model, the limited evidence for a wealth effect may be due to several reasons. First, it may be that households do not perceive house price shocks as permanent. Second, the share of households that plan to move in the short term may not be large enough for consumption to be affected by short-term house price shocks. Third, it may be that households do not plan to liquidate their housing wealth in the future and that they actually would like to use it as a bequest. Fourth, it is possible that households adjust to house price shocks by changing their housing consumption instead of their non-housing consumption. The first three of these explanations appear to be plausible given that they are in line with the (mostly descriptive) evidence presented in Sections 4.1.2 to 4.1.4. They are all very interesting venues for future research related to the housing wealth effect and/or to the role of housing within the households' portfolio in general.

Regarding the collateral effect, the results remain insignificant even when conditioning the effect on being borrowing constrained. In addition, descriptive evidence suggests that, regardless of house price changes, the number of homeowners who access mortgage borrowing to finance regular consumption in the Netherlands is very small. This is a surprising result given the facilities and the incentives households have for accessing mortgage borrowing in the Netherlands (Ebner, 2013). It contrasts with the results in literature employing similar methods, such as Disney et al. (2010b) and Leth-Petersen (2010), who find evidence for small collateral effects in the UK and Denmark, respectively, and Mian and Sufi (2011) who find a strong collateral effect in the USA. Among other reasons, this could be because of differences in social norms and/or due to Dutch households more easily reaching optimal consumption without the need for additional borrowing.

Even if the conclusions of the present study are based on results that are not significantly different from zero, they are still relevant because they point to the finding of an absence. Specifically, they point to the absence of clear evidence for strong wealth and collateral effects. As an implication of this, common causality appears as the most plausible explanation for the correlation observed in Fig. 1.1. However, my results suggest that economic expectations do not play a major role in the common causality mechanism. That is because all of the estimates of the wealth and collateral effects do not change once I include economic expectations as a control variable. Therefore, both observed and unobserved mechanisms remain as potential explanations for common causality. These could take place at the household level and/or at a higher level of aggregation. For instance, an additional potential reason for common causality can be macroeconomic factors such as financial liberalization which, according to Iacoviello and Minetti (2003) could affect both house prices and consumption simultaneously. Future research could focus on further studying the common causality mechanism as well as the reasons why the wealth and the collateral effect may not be as important as could be expected.

As an additional venue for future research, it would be particularly interesting to investigate why, especially in comparison with the USA, Dutch households generally do not choose to finance consumption by increasing mortgage debt despite relatively liberal lending standards. Furthermore, for any study that deals with house prices as a central variable, additional comparisons between self-reported measures of house prices and regional house prices indices remain an interesting contribution to the literature.

Table A.1
Summary statistics.

	Mean	Median	St. Dev.	Min.	Max.
Active saving	5005	3250	7471	0	75 000
Remaining mortgage debt	91 978	67 500	106 833	0	1 400 000
New mortgage	0.05	–	–	0	1
House price	282 040	250 000	148 028.4	75 000	5 500 000
House price change	0.52%	0.00%	5.28%	−29.17%	41.67%
Exp. house price change	0.32%	0.00%	3.61%	−50.00%	25.00%
Long term exp.	3.07%	2.00%	4.14%	−40.00%	90.00%
House price change (PIEH)	1.80%	3.00%	4.74%	−7.30%	11.20%
Loan to value	35.51%	26.68%	37.07%	0.00%	712.00%
Under water	0.06	–	–	0	1
Intention to buy	0.05	–	–	0	1
Future economic situation					
Worse	0.25	–	–	0	1
No Change	0.57	–	–	0	1
Better	0.19	–	–	0	1
Household income	36 304	31 405	31 914	211	2 197 469
Age	57.79	59.00	14.02	24	93
Marital status					
Married	0.78	–	–	0	1
Divorced	0.06	–	–	0	1
Widowed	0.06	–	–	0	1
Never married	0.11	–	–	0	1
Children inside	0.6	0.00	1.01	0	6
Children outside	1.18	1.00	1.40	0	9
Labor market status					
Employee	0.52	–	–	0	1
Self-employed	0.04	–	–	0	1
Unemployed	0.02	–	–	0	1
Not active	0.03	–	–	0	1
Retired	0.37	–	–	0	1
Disabled	0.02	–	–	0	1
Other	0.00	–	–	0	1
Moved	0.02	–	–	0	1
Renovate	0.32	–	–	0	1

Notes: All variables are provided by Dutch National Bank Household Survey except for the PIEH (price index of existing own homes) which is provided by Statistics Netherlands (CBS). All summary statistics refer to the sample used for the analyses reported in Table 4.1. For definitions of all variables in this table, see Table A.2.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Summary statistics

See Tables A.1 and A.2.

Appendix B. Types of mortgage available

See Tables B.1 and B.2.

Appendix C. Descriptive statistics (extensions)

See Figs. C.1–C.4, Tables C.1 and C.2.

Appendix D. Estimation of the house price process

Most literature using similar methods as in the present study (*e.g.* Campbell and Cocco, 2007; Attanasio et al., 2009; Disney et al., 2010a; Browning et al., 2013) relies on the estimation of time series models to generate house price expectations. The latter are then used to generate a measure of house price shocks by separating unexpected from expected house price innovations. For instance, Campbell and Cocco (2007) regress log house prices on their second lag, while Attanasio et al. (2009) regress regional log house prices against log real household income while controlling for a set of regional dummies.

Table A.2
Variable definitions.

Variable	Definition
Active saving	Money put aside in the past 12 months. Respondents are provided with seven intervals: "less than 1500", "between 1500 and 5000", "between 5000 and 12 500", "between 12 500 and 20 000", "between 20 000 and 37 500", "between 37 500 and 75 000", and "more than 75 000". To construct the variable I take the midpoint of each interval.
Remaining mortgage debt	Mortgage debt outstanding on the main residence. Up to five mortgages are considered.
New mortgage	Dummy variable taking value one if the household took out a mortgage since the previous wave.
House price	Self-reported market price of the own house.
House price change	Self-reported percentage change in the price of the own house since the previous year.
Exp. house price change	Self-reported expectation about the percentage change in the price of the own house in the coming year.
Long term exp.	Self-reported expectation about the yearly percentage change in the price of the own house ten years ahead.
House price change (PIEH)	Percentage change in the regional house price index *price of existing own homes* provided by Statistics Netherlands (CBS).
Loan to value	Ratio of the outstanding mortgage over the self-reported house price.
Under water	Dummy taking value one if the loan-to-value ratio is above 100%.
Intention to buy	Dummy variable taking value one if the household is intending to buy a house within the coming two years.
Future economic situation	Categorical variable indicating whether individuals expect their economic situation will be the same, better or worse in five years time.
Household income	Total income of the household.
Age	Age of the household head.
Marital status	Categorical variable indicating the marital status of the household head.
Children inside	Number of children in the household.
Children outside	Number of children outside the household.
Labor market status	Categorical variable indicating the labor market status of the household head.
Moved	Dummy variable taking value one if the household moved since the previous wave.
Renovate	Dummy variable taking value one if the household spent any money on house maintenance, improvement or adaptation since the previous wave.

Table B.1
Types of mortgage.

Type	Definition
Annuity mortgage	With an annuity mortgage, the total amount of the periodic payments on interest and repayment remains the same (at least) during the period for which the interest rate was fixed. During the first part of this period, the amount due consists of a relatively large part of interest and a relatively small part of repayment. In later years, it is the other way around.
Traditional life-insurance mortgage	This sort of mortgage consists of a loan and a life-insurance policy. The idea is that there is no repayment, but only paying interest on the loan, and paying a premium for the life-insurance policy. There is no direct relation between the interest rate of the mortgage loan and the savings interest rate of the life-insurance policy (in contrast with an improved life-insurance mortgage, where there is a relation between those two interest rates).
Improved life-insurance mortgage	This is a certain type of a traditional life-insurance mortgage. An improved life-insurance mortgage consists of a loan and a life-insurance policy. The idea is that there is no repayment, but only paying interest on the loan, and paying a premium for the life-insurance policy. In this case, the interest rate of the mortgage-loan and the savings interest rate of the life-insurance policy are related, which causes monthly net-costs to be rather stable.
Linear mortgage	With this sort of mortgage, the periodic payments include paying off a fixed percentage of the total mortgage loan, and paying interest on the loan that is left at that moment. Over time, the amount paid on interest becomes less and less, such that total monthly costs go down through the years. In the first period of the term of the mortgage, the costs of a linear mortgage are higher than the costs of an annuity mortgage.
Endowment mortgage	With an endowment mortgage it is possible, during the term of the mortgage, to get a new loan on (part of) the amount that is already paid off.
Investment mortgage	This is a variation on the (traditional) life-insurance mortgage. As is the case with the other life-insurance mortgages, also for most of the investment mortgages the loan is paid off out of the benefits of a whole life-insurance policy linked to the mortgage at the end of the mortgage period. Contrary to a(n improved) life-insurance mortgage, the returns of the life-insurance policy are based on the returns of an investment portfolio.
Interest-only mortgage	With this mortgage one only pays interest during the term of the mortgage with a balloon payment due at the end.
Annuity construction mortgage	During the term of the mortgage one pays interest only, but at the same time one contributes to an annuity, which becomes available at the end of the mortgage period. The annuity does not have to be used to pay off the mortgage at the end of the mortgage period. It can be used as a supplementary pension provision.
Life-insurance mortgage	The lifelong mortgage with life-insurance is a variation on the interest only mortgage. This mortgage is taken out for an indefinite period. To be sure that the mortgage is paid off after death (at the latest), the mortgage holds a term life-insurance policy.
Bank-savings mortgage	Compared with a traditional improved life insurance mortgage the bank savings mortgage uses no life insurance. One uses a blocked savings account or an escrow investment account that is linked to the mortgage.

Notes: All types of mortgage and the corresponding definitions are taken form the documentation of the Dutch National Bank Household Survey.

However, both Campbell and Cocco (2007) and Attanasio et al. (2009) only consider the effect of unexpected house price changes as an extension of their main results and do not explain in detail how the latter are computed.

Disney et al. (2010a) and Browning et al. (2013) distinguish between expected and unexpected house price changes in all their estimations and are more explicit about how they estimate the house price process. Disney et al. (2010a) estimate an AR(2) process while Browning et al. (2013) estimate an AR(1) process. Both include regional dummies in the specification and Browning et al. (2013) also include the regional average house size and the average number of rooms per house. In addition, Browning et al. (2013) perform a series of unit root test to establish whether the house price process is stationary or non-stationary. They conclude that the process has a high degree of persistence but clearly reject the unit root hypothesis.

Following the above mentioned-literature, in the present study I estimate the unexpected component of the house price change, *i.e.* $\left(\Delta \ln hp_{it} - E_{it-1}\Delta \ln hp_{it}\right)$, which, introducing the province identifier k,

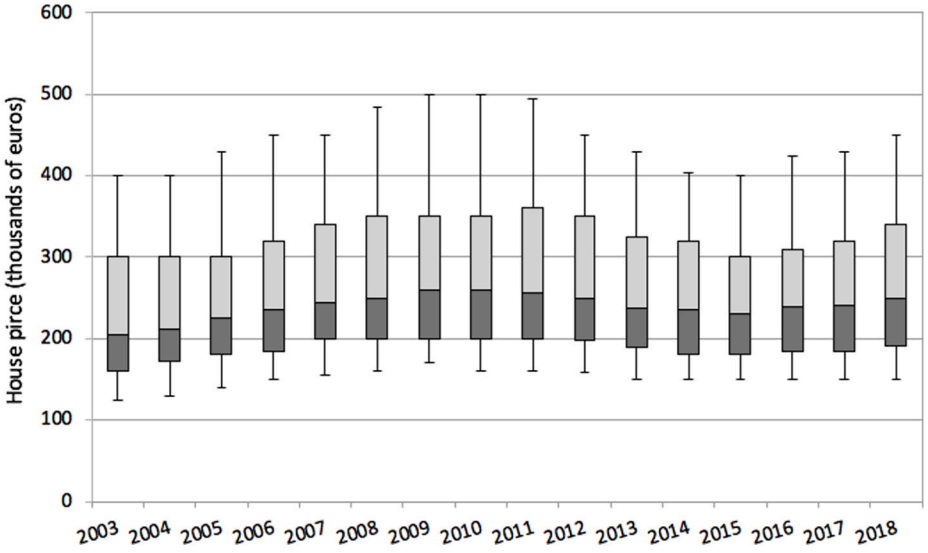

Fig. C.1. Sample variation self-reported house prices. *Notes:* The upper and lower bounds show the 90th and 10th percentiles for every year, while the boxes indicate the 25th, the 50th, and the 75th percentiles. For more information on self-reported house prices, see Section 3.2 in the main text.

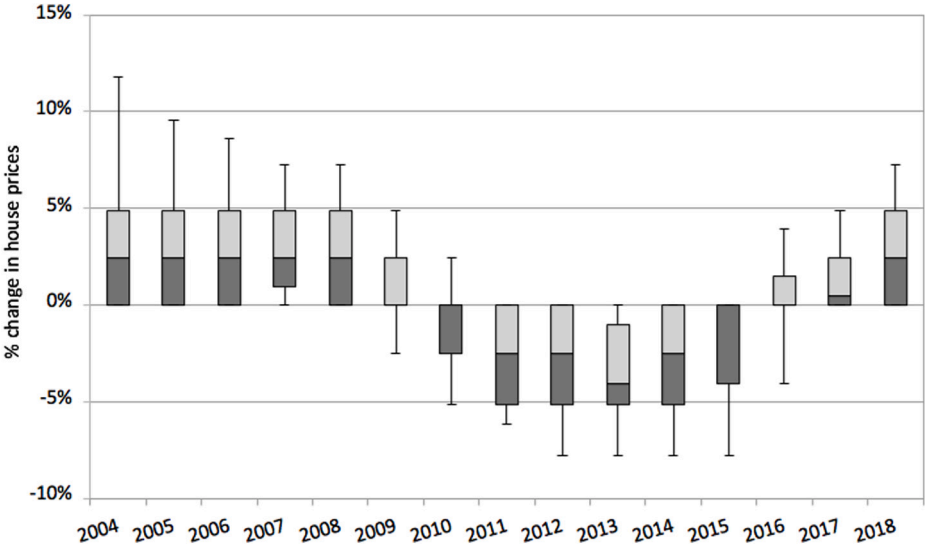

Fig. C.2. Sample variation self-reported house price changes. *Notes:* The upper and lower bounds show the 90th and 10th percentiles for every year, while the boxes indicate the 25th, the 50th, and the 75th percentiles. For more information on self-reported house prices, see Section 3.2 in the main text.

Table B.2
Types of mortgage — Frequency.

Mortgage type	Frequency	Percentage
Annuity	669	7.48%
Traditional life insurance	301	3.37%
Improved life insurance	1360	15.21%
Linear	108	1.21%
Endowment	64	0.72%
Investment	475	5.31%
Interest only	3156	35.31%
Annuity construction	39	0.44%
Life insurance	38	0.43%
Bank savings	163	1.82%
Unknown type	102	1.14%
No mortgage	2464	27.56%
Total	8939	100%

Notes: Frequencies refer to the sample used for the analyses reported in Table 4.3.

can be written as

$$\begin{aligned}\Delta \ln hp_{ikt} - E_{it-1}\Delta \ln hp_{ikt} &= (\ln hp_{ikt} - \ln hp_{ikt-1}) \\ &\quad -(E_{kt-1} \ln hp_{ikt} - \ln hp_{ikt-1}) \\ &= \ln hp_{ikt} - E_{t-1} \ln hp_{ikt},\end{aligned}$$

and can be approximated using the residuals from the estimation of a house price process. Consider for example the AR(1) process

$$\begin{aligned}\ln hp_{ikt} &= \gamma_0 + \gamma_1 \ln hp_{ikt-1} + u_{ikt} \\ &= E_{kt-1}(\ln hp_{ikt} | \ln hp_{ikt-1}) + u_{ikt},\end{aligned} \tag{D.1}$$

then

$$u_{ikt} = \ln hp_{ikt} - E_{kt-1}(\ln hp_{ikt} | \ln hp_{ikt-1}). \tag{D.2}$$

Eqs. (D.1) and (D.2) make explicit the assumption stating that individuals base their house price expectations for period t on the house price level within their region at period $t-1$, which is a necessary assumption for this strategy.

As mentioned in Section 3.2, I use the *price index of existing own homes* (PIEH) to measure house price changes at the provincial level

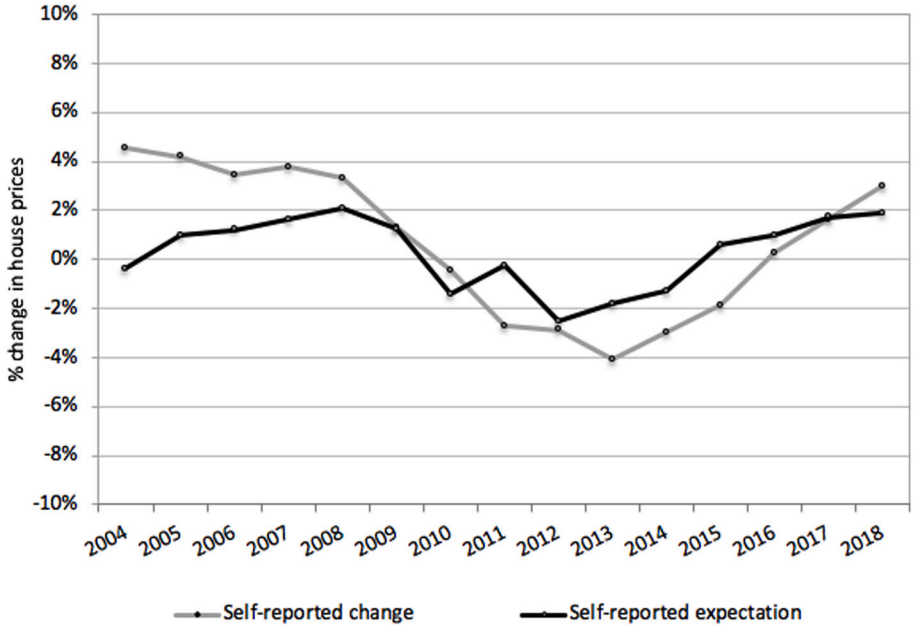

Fig. C.3. Actual vs. expected changes (self-reported). *Notes:* For more information on the house price measures in this figure, see main text. For the sample distribution of self-reported house price changes, see Fig. C.2.

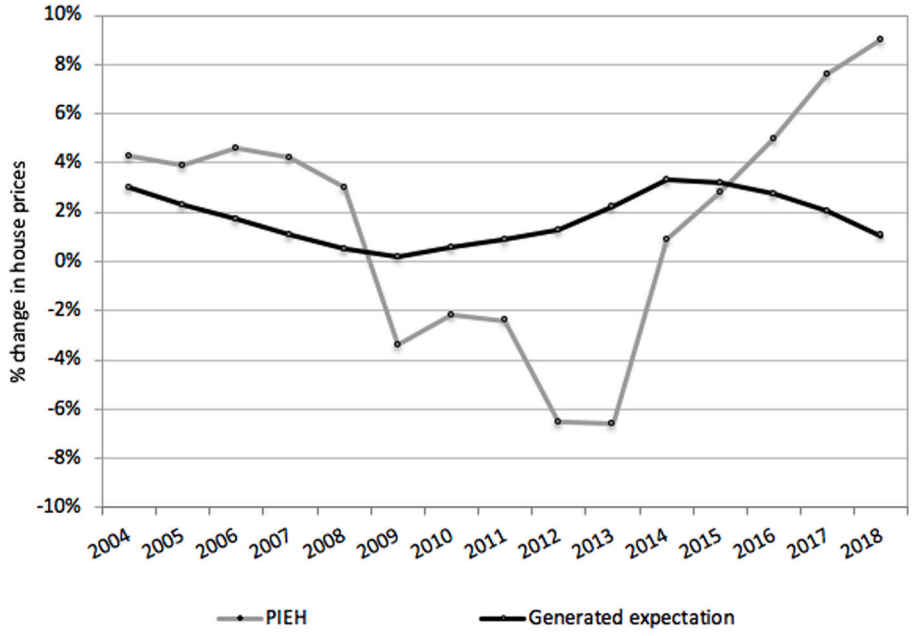

Fig. C.4. Actual vs. expected changes (generated). *Notes:* PIEH stands for *price index of existing own homes*. For more information on the house price measures in this figure, see main text. For the regional distribution of the expectations generated using an AR(1), see Table C.2.

in the Netherlands. Table D.1 shows the results obtained when using this index to estimate an AR(1) and an AR(2) process including a set of provincial dummies in the specification. The estimates I obtain for the AR(1) and the AR(2) processes are very similar to those obtained by Disney et al. (2010a) and Browning et al. (2013). Browning et al. (2013) obtain an estimate of 0.819 for their AR(1) process, while Disney et al. (2010a) obtain estimates of 1.41 and −0.35 for the first and second lags respectively in their AR(2) process. The R^2s I obtain are also very similar to those obtained by these authors. In the present study I use the results of the AR(1) process to generate house price expectations and compute unexpected house price changes.[31] Table D.1 shows that the AR(1) structure is able to explain 67% of the variation in house prices. Which implies that shocks are identified from the remaining 33% of the variation.[32]

[31] When using the AR(2) process, the house price shocks become smaller but the final results do not change significantly. Results obtained using the AR(2) process are available on request.

[32] See Fig. 3.5 in the main text and Table C.2 in Appendix C for further information on the fitted values and house price shocks obtained using the AR(1) estimates.

Table C.1
Regional variation in average WOZ prices and average changes in the PIEH.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Groningen	–	141	141	158	174	179	180	178	174	168	159	154	155	157	165
	5.6%	7.5%	5.9%	3.3%	2.0%	−4.0%	−1.2%	−3.1%	−6.4%	−5.4%	−0.8%	2.7%	4.7%	5.7%	7.1%
Friesland	–	158	159	177	191	197	197	195	190	180	169	163	164	169	176
	6.3%	4.9%	5.6%	3.6%	2.5%	−4.3%	−0.6%	−4.3%	−6.4%	−7.2%	−1.2%	2.0%	3.9%	6.0%	7.6%
Drenthe	–	176	177	193	206	214	215	211	207	198	186	181	182	185	190
	4.7%	4.6%	4.8%	4.5%	1.9%	−2.8%	−2.1%	−2.7%	−5.7%	−7.3%	−0.2%	1.6%	2.1%	5.4%	6.7%
Overijssel	–	185	186	201	214	220	222	218	213	207	195	191	193	196	204
	4.5%	3.6%	4.4%	2.1%	2.0%	−2.9%	−1.9%	−2.9%	−5.1%	−6.4%	0.6%	0.9%	3.9%	5.8%	7.5%
Flevoland	–	180	180	191	199	203	203	201	197	191	183	179	180	185	194
	1.7%	2.5%	2.4%	2.3%	0.4%	−3.1%	−2.7%	−2.7%	−5.3%	−5.1%	0.9%	1.4%	4.8%	8.3%	11.2%
Gelderland	–	220	220	236	251	259	260	252	245	235	220	214	214	218	227
	4.6%	3.2%	4.6%	3.8%	2.1%	−3.9%	−2.1%	−3.2%	−6.9%	−6.9%	−0.3%	2.0%	3.5%	6.6%	8.4%
Utrecht	–	231	232	249	269	283	286	279	274	264	248	240	243	252	274
	4.8%	4.5%	5.1%	6.2%	4.0%	−2.9%	−2.3%	−2.5%	−6.6%	−6.6%	1.9%	3.9%	6.3%	9.1%	8.6%
Noord-Holland	–	220	221	230	251	267	269	262	258	248	235	232	240	259	288
	3.6%	3.8%	5.6%	6.9%	5.1%	−3.6%	−2.8%	−1.3%	−6.4%	−7.1%	2.7%	5.3%	8.2%	10.7%	10.8%
Zuid-Holland	–	186	187	203	217	225	226	221	217	210	199	194	197	203	214
	4.2%	4.1%	3.9%	3.4%	3.1%	−3.1%	−2.2%	−1.7%	−6.4%	−6.1%	1.2%	3.0%	5.2%	8.3%	10.6%
Zeeland	–	158	159	181	194	199	200	198	198	194	188	185	186	190	194
	7.8%	6.1%	5.4%	2.4%	2.9%	−1.3%	−2.1%	−1.0%	−5.2%	−2.7%	−1.0%	0.4%	2.4%	2.8%	5.1%
Noord-Brabant	–	226	226	245	261	270	271	264	257	246	233	226	227	234	241
	4.1%	3.9%	4.5%	4.0%	2.9%	−3.4%	−2.4%	−3.2%	−7.2%	−7.3%	0.4%	2.3%	3.9%	6.1%	7.6%
Limburg	–	179	179	194	202	206	206	200	196	189	180	175	179	182	190
	4.1%	1.8%	3.1%	2.3%	0.5%	−4.5%	−2.3%	−2.2%	−6.1%	−5.9%	1.2%	1.9%	4.1%	4.8%	7.7%

Notes: Average WOZ prices are given in thousands of euro, while yearly changes in the PIEH are given in percentage terms. Both variables are given here for the twelve provinces of the Netherlands. For further information on WOZ prices and the PIEH, see Section 3.2 in the main text.

Table C.2
Regional variation in generated house price expectations and house price socks.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Groningen	3.5%	2.7%	1.6%	0.7%	0.3%	0.1%	0.6%	0.8%	1.2%	2.2%	3.0%	3.2%	2.7%	2.0%	1.2%
	2.0%	4.8%	4.4%	2.5%	1.7%	−3.9%	−1.8%	−3.9%	−7.6%	−7.5%	−3.9%	−0.4%	2.0%	3.6%	5.8%
Friesland	2.6%	1.7%	1.0%	0.2%	−0.2%	−0.5%	0.0%	0.1%	0.7%	1.6%	2.8%	3.0%	2.7%	2.1%	1.2%
	3.7%	3.3%	4.8%	3.3%	2.7%	−3.7%	−0.6%	−4.4%	−7.1%	−8.9%	−4.0%	−1.0%	1.2%	3.9%	6.4%
Drenthe	2.5%	1.8%	1.1%	0.5%	−0.1%	−0.3%	0.0%	0.3%	0.7%	1.5%	2.7%	2.6%	2.5%	2.1%	1.4%
	2.2%	2.9%	3.6%	4.0%	2.0%	−2.4%	−2.1%	−3.0%	−6.4%	−8.8%	−2.9%	−1.5%	−0.4%	3.2%	5.3%
Overijssel	2.2%	1.6%	1.1%	0.5%	0.2%	−0.1%	0.3%	0.6%	1.0%	1.7%	2.8%	2.7%	2.5%	1.9%	1.1%
	2.3%	2.0%	3.4%	1.8%	1.9%	−2.9%	−2.2%	−3.5%	−6.0%	−8.2%	−2.1%	−1.8%	1.4%	3.8%	6.3%
Flevoland	1.4%	1.2%	0.8%	0.5%	0.2%	0.1%	0.6%	0.9%	1.3%	2.1%	2.9%	2.8%	2.6%	1.8%	0.7%
	0.3%	1.3%	1.7%	1.9%	0.2%	−3.2%	−2.8%	−3.6%	−6.6%	−7.2%	−2.1%	−1.4%	2.2%	6.3%	10.5%
Gelderland	1.8%	1.1%	0.7%	0.1%	−0.4%	−0.6%	−0.1%	0.1%	0.6%	1.6%	2.7%	2.7%	2.4%	1.9%	1.0%
	2.8%	2.1%	3.8%	3.9%	2.5%	−3.2%	−1.8%	−3.4%	−7.5%	−8.5%	−2.9%	−0.8%	1.1%	4.8%	7.5%
Utrecht	4.8%	4.0%	3.2%	2.5%	1.5%	1.0%	1.4%	1.7%	2.1%	3.2%	4.3%	4.0%	3.4%	2.4%	1.1%
	0.0%	0.6%	1.9%	4.3%	2.3%	−3.8%	−3.7%	−4.2%	−8.7%	−9.8%	−2.4%	−0.2%	2.9%	6.7%	7.5%
Noord-Holland	5.3%	4.6%	4.0%	3.1%	2.0%	1.3%	1.8%	2.2%	2.5%	3.5%	4.8%	4.3%	3.5%	2.2%	0.7%
	−1.7%	−0.8%	1.5%	3.9%	3.2%	−4.8%	−4.7%	−3.7%	−8.9%	−10.7%	−2.2%	0.9%	4.7%	8.5%	10.0%
Zuid-Holland	3.4%	2.7%	2.1%	1.5%	1.0%	0.6%	1.1%	1.4%	1.6%	2.7%	3.7%	3.5%	3.0%	2.2%	1.0%
	0.9%	1.4%	2.0%	1.9%	2.0%	−3.8%	−3.2%	−3.1%	−8.1%	−8.8%	−2.4%	−0.5%	2.2%	6.1%	9.6%
Zeeland	4.4%	3.1%	2.2%	1.4%	1.0%	0.6%	0.8%	1.1%	1.3%	2.0%	2.5%	2.6%	2.6%	2.2%	1.8%
	3.4%	3.1%	3.3%	1.0%	1.9%	−2.0%	−2.9%	−2.1%	−6.5%	−4.8%	−3.5%	−2.2%	−0.2%	0.6%	3.4%
Noord-Brabant	2.3%	1.7%	1.1%	0.5%	0.0%	−0.4%	0.1%	0.4%	0.8%	1.9%	3.1%	3.0%	2.7%	2.1%	1.2%
	1.8%	2.2%	3.4%	3.5%	3.0%	−2.9%	−2.5%	−3.6%	−8.0%	−9.1%	−2.7%	−0.8%	1.2%	4.0%	6.5%
Limburg	1.0%	4.4%	0.2%	−0.2%	−0.5%	−0.6%	0.0%	0.3%	0.6%	1.5%	2.5%	2.3%	2.0%	1.4%	0.7%
	3.1%	1.4%	3.0%	2.5%	1.0%	−4.0%	−2.4%	−2.6%	−6.7%	−7.5%	−1.2%	−0.3%	2.1%	3.4%	7.0%

Notes: For every province of the Netherlands, the first row shows the generated house price expectations using an AR(1) process, while the second row shows the house price shocks generated using these expectations. For further information on how these variables are calculated and on the estimation of the AR(1) process, see Section 3.2 in the main text and Appendix D.

Table D.1
AR(1) and AR(2) estimates for the province-level PIEH.

PIEH $t-1$	0.873***	1.681***
	(0.006)	(0.006)
PIEH $t-2$		−0.958***
		(0.006)
No. observations	10 470	8844
No. groups (provinces)	12	12
R^2	0.67	0.90

Notes: All regressions include provincial dummies. Standard errors are provided in parenthesis. PIEH stands for *price index of existing own homes*. For more information on the PIEH, see Section 3.2 in the main text. ***Significant at the 10% level, **significant at the 5% level, *significant at the 1% level.

Table E.1
Effect of CBS house price changes on active saving.

Variable	Dependent variable: Change in log active saving			
	(1)	(2)	(3)	(4)
House price change	0.042			
	(0.030)			
House price shock		0.033	0.034	
		(0.024)	(0.024)	
House price shock				0.029
younger owner				(0.026)
House price shock				0.034
older owner				(0.024)
Positive change			−0.186*	−0.188*
economic expectations			(0.108)	(0.108)
Negative change			0.169	0.166
economic expectations			(0.106)	(0.106)
Change log income	0.214***	0.213***	0.212***	0.210***
	(0.080)	(0.080)	(0.080)	(0.080)
Number of observations	8939	8939	8939	8939
R^2	0.011	0.011	0.012	0.012

Notes: Standard errors (clustered at the household level) are reported in parenthesis. All regressions include the change in the number of children in the household, the change in the number of children outside of the household, a set of dummies indicating all possible marital transitions, a set of dummies indicating all possible labor market status transitions, and a set of year dummies. See main text for further details. *Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level.

Appendix E. Additional results

See Tables E.1–E.5

Appendix F. Life cycle model with housing

In this section I present a simple model of housing and non-durable consumption over the life cycle, loosely based on previous work by Li and Yao (2007) and Yang (2009).[33] The function of this model is to underpin the empirical analysis of the effect of house price shocks on household saving and consumption. I focus on explaining the theoretical mechanisms behind the wealth and collateral effects, which potentially explain the relationship between house prices and consumption. In that way, I make explicit the assumptions that are necessary for these effects to work. Listing these assumptions allows for a better discussion about the presence or absence of empirical evidence supporting the relevance of a wealth and/or collateral effect.

F.1. Optimization problem

Consider a household unit that owns the house it occupies and that at period s chooses an optimal path for non-durable and housing consumption with T as the planning horizon. The intertemporal utility function is expressed as

$$U(c_t, h_t) = \sum_{t=s}^{T} \frac{D_t}{(1+\rho)^{t-s}} \left(\theta \ln c_t + (1-\theta)\ln h_t\right),$$

where c_t and h_t are non-durable consumption and housing consumption respectively at period t, $\rho \geq 0$ is the rate of time preference, $0 \leq \theta \leq 1$ indicates the preference for housing relative to non-durables, and D_t is a preference shifter that scales the utility flow derived from c_t and h_t.[34] D_t can be expressed as

$$D_t = \exp(\delta_0 + \boldsymbol{\delta}'\mathbf{Z}_t),$$

where δ_0 is a household fixed effect and $\mathbf{Z}_t$ is a vector of variables capturing the time-varying demographic characteristics of the household.

For the sake of simplicity, I do not consider neither income nor lifetime uncertainty. However, the household does face uncertainty with regard to house prices. In addition, it can adjust housing consumption by moving and, without loss of generality, I assume it may choose to move maximum only once between periods s and T. Given these premises, at period s the household chooses c_t and h_t such as to maximize utility subject to

$$\sum_{t=s}^{T} \frac{c_t}{(1+r)^{t-s}} + \frac{w_T}{(1+r)^{T-s}} = \sum_{t=s}^{T} \frac{y_t}{(1+r)^{t-s}} + \frac{E_s \alpha_n (h_{n-1}\phi - h_n \mu)}{(1+r)^{n-s}} + w_{s-1}(1+r), \tag{F.1}$$

where y_t denotes labor income, $r \geq 0$ is the constant interest rate, n is the period of a potentially planned house move, E_s is an expected value operator denoting the expectation the household forms at period s about α_n, *i.e.* the unit price for housing upon moving, $\phi \leq 1$ and $\mu \geq 1$ are the transaction costs of selling and buying a house respectively, and w_t is household net financial wealth.

The second term of the summation to the right of the equality in Eq. (F.1) denotes the present value of the expected difference between the selling price of the old house and the buying price of the new house at period n, net of transaction costs. I call this term the *housing factor*. Intuitively speaking, the housing factor is the change in lifetime income that results from the future housing move. If the household plans to upsize its main residence, the housing factor will be negative, and *vice versa* if the household is planning to downsize. If the household does not plan to move, or plans to move to a house that has the same value as the current one net of the transaction costs, then the housing factor is equal to zero.

Taking housing choices as given, the solution of the optimization problem yields the optimal consumption level

$$c_t = \frac{\theta D_t}{\lambda}\left(\frac{1+r}{1+\rho}\right)^{t-s}, \tag{F.2}$$

[33] For a review of studies that include housing in the life-cycle model, see Suari-Andreu et al. (2019a).

[34] The specification of the utility function assumes that the elasticity of intertemporal substitution and the elasticity of substitution between c_t and h_t are both constant and equal to one. Note that allowing the elasticity of intertemporal substitution to differ from one results in non-separability between c_t and h_t. Allowing for non-separability does not change the predictions in the model that are tested in this study.

Table E.2
Effect of CBS house price changes on mortgage debt.

Variable	New mortgage			Change in log mortgage debt		
	(1)	(2)	(3)	(4)	(5)	(6)
House price change	−0.001	−0.001		−0.015	−0.015	
	(0.001)	(0.002)		(0.010)	(0.010)	
House price change			0.001			−0.002
younger owner			(0.002)			(0.013)
House price change			−0.001			−0.018*
older owner			(0.002)			(0.010)
Positive change		0.001	0.001		0.048	0.049
economic expectations		(0.006)	(0.005)		(0.039)	(0.039)
Negative change		0.007	0.007		−0.025	−0.024
economic expectations		(0.006)	(0.006)		(0.038)	(0.038)
Change log income	−0.001	−0.002	−0.002	−0.067**	−0.067**	−0.067**
	(0.003)	(0.003)	(0.003)	(0.029)	(0.029)	(0.030)
Number of observations	8133	8133	8133	8925	8925	8925
R^2	0.016	0.017	0.018	0.076	0.076	0.077

Notes: Standard errors (clustered at the household level) are reported in parenthesis. All regressions include the change in the number of children in the household, the change in the number of children outside of the household, a set of dummies indicating all possible marital transitions, a set of dummies indicating all possible labor market status transitions, and a set of year dummies. See main text for further details. *Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level.

Table E.3
Effect of self-reported house price changes on active saving.

Variable	Dependent variable: Non-zero change in log active saving			
	(1)	(2)	(3)	(4)
House price change	0.011			
	(0.009)			
House price shock		0.005	0.006	
		(0.008)	(0.008)	
House price shock				−0.009
younger owner				(0.013)
House price shock				0.010
older owner				(0.009)
Positive change			−0.215*	−0.216*
economic expectations			(0.123)	(0.123)
Negative change			0.185	0.183
economic expectations			(0.121)	(0.121)
Change log income	0.253***	0.253***	0.251***	0.247***
	(0.096)	(0.096)	(0.095)	(0.095)
Number of observations	7765	7765	7765	7765
R-Squared	0.013	0.013	0.014	0.014

Notes: Standard errors (clustered at the household level) are reported in parenthesis. The dependent variable is limited to non-zero values. All regressions include the change in the number of children in the household, the change in the number of children outside of the household, a set of dummies indicating all possible marital transitions, a set of dummies indicating all possible labor market status transitions, a dummy indicating whether a household moved since the previous wave, a dummy indicating whether the household spent money on house renovation since the previous wave, and a set of year dummies. See main text for further details. *Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level.

where λ is the marginal utility of lifetime income. Substituting (F.2) into the budget constraint (F.1) λ can be expressed as

$$\lambda = \left(\sum_{t=s}^{T} \frac{\theta D_t}{(1+\rho)^{t-s}}\right)\left(\sum_{t=s}^{T} \frac{y_t}{(1+r)^{t-s}} + \frac{E_s(\alpha_n)(h_{n-1}\phi - h_n\mu)}{(1+r)^{n-s}} + w_{s-1}(1+r) - \frac{w_T}{(1+r)^{T-s}}\right)^{-1}, \tag{F.3}$$

which shows how λ captures all relevant information from all periods other than t affecting c_t. Eq. (F.2) allows deriving the expression

$$\frac{c_t}{c_{t-1}} = \frac{D_t}{D_{t-1}}\left(\frac{1+r}{1+\rho}\right), \tag{F.4}$$

which shows how consumption evolves over time. Eq. (F.4) is the standard life-cycle model consumption growth equation.

F.2. Wealth effect

If house price expectations are fulfilled at every period between s and T, the level of consumption at every period is determined by the optimal plan set at period s and expressed by Eqs. (F.2) to (F.4). However, if the household is planning to move at period n and at a particular period j, given that $s < j < n$, there is an unexpected and permanent change in house prices, the budget constraint will shift and the household will reset its plans taking the new information into account.

The effect of the house price shock on consumption can be expressed as $v_j = c_j/c_j^s$, *i.e.* the ratio between the actual level of consumption at period j, which takes the new information into account, and the level of consumption that was planned for j at period s. Considering Eq. (F.4) at period j and substituting in the ratio for v_j, (F.4) can be rewritten as

$$\frac{c_j}{c_{j-1}} = \frac{D_j}{D_{j-1}}\left(\frac{1+r}{1+\rho}\right)v_j, \tag{F.5}$$

which shows that the change in consumption from period $j-1$ to period j is the same as in the absence of a house price shock, but amplified by the product with v_j. Plugging in the expression for D_t in (F.4) and (F.5) and taking the natural logarithm on both sides of the equality leads to an expression for the relative change in consumption, *i.e.*

$$\Delta \ln c_t = \ln\left(\frac{1+r}{1+\rho}\right) + \boldsymbol{\delta}'\Delta\mathbf{Z}_t + \Delta \ln v_t, \tag{F.6}$$

Table E.4
Effect of self-reported house price changes on active saving.

Variable	Dependent variable: Saving dummy			
	(1)	(2)	(3)	(4)
House price change	0.002*			
	(0.001)			
House price shock		0.001	0.001	
		(0.001)	(0.001)	
House price shock				0.001
younger owner				(0.002)
House price shock				0.002
older owner				(0.001)
Positive change			−0.049***	−0.050***
economic expectations			(0.107)	(0.013)
Negative change			−0.007	−0.009
economic expectations			(0.013)	(0.013)
Change log income	0.015**	0.012*	0.013*	0.010
	(0.007)	(0.007)	(0.007)	(0.007)
Number of observations	8939	8939	8939	8939
R-Squared	0.022	0.021	0.023	0.030

Notes: Standard errors (clustered at the household level) are reported in parenthesis. All regressions include the change in the number of children in the household, the change in the number of children outside of the household, a set of dummies indicating all possible marital transitions, a set of dummies indicating all possible labor market status transitions, a dummy indicating whether a household moved since the previous wave, a dummy indicating whether the household spent money on house renovation since the previous wave, and a set of year dummies. See main text for further details. *Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level.

where $\Delta \ln v_t$ captures the contemporaneous wealth effect of a house price shock on consumption. I assume there are no shocks other than at period j, thus $\Delta \ln v_t = \ln v_t$ if $t = j$, and $\Delta \ln v_t = 0$ if $t \neq j$. When the shock hits at period j, consumption jumps from the optimal path set at period s to the new optimal path, and it stays on that path from then on.

The consumption levels in the numerator and the denominator of $v_j = c_j / c_j^s$ are determined by Eqs. (F.2) and (F.3). These consumption levels are almost the same except for the fact that c_j accounts for the new expectation about the housing factor that results from the house price shock at j, while c_j^s is the consumption level planned at period s. Substituting in the expressions for the consumption levels yields

$$v_j = \frac{c_j}{c_j^s} = \frac{\frac{E_j H_n - E_s H_n}{(1+r)^{n-j}}}{\sum_{t=j}^{T} \frac{y_t}{(1+r)^{t-j}} + \frac{E_s H_n}{(1+r)^{n-j}} + w_{j-1}(1+r) - \frac{w_T}{(1+r)^{T-j}}} + 1, \tag{F.7}$$

where $H_n = \alpha_n(h_{n-1}\phi - h_n\mu)$ and E_s and E_j denote expectations formed in periods s and j respectively. The denominator in Eq. (F.5) shows that the wealth effect will be determined by the present value of the difference between the housing factor as expected in periods j and s respectively. This implies that if a household plans to sell the current residence and move to a larger house, it will increase (decrease) saving if house prices unexpectedly increase (decrease). Conversely, if a household is planning to move to a smaller house, then it will decrease (increase) saving if house prices unexpectedly increase (decrease). This in line with the theoretical prediction made by Buiter (2008), who shows that households for whom the value of their home exceeds the present discounted value of the housing services they plan to consume in the future, *i.e.* households who are planning to downsize, will benefit from a house price increase; while households who are planning to upsize will be made worse off by house price increase.

An important takeaway of this model is that the wealth effect crucially relies on the following assumptions: house price changes are permanent and unexpected, households are willing and able to trade their main residence in the future, there is no bequest motive linked to housing, and the adjustment to the shock does not take place through housing consumption, *i.e.* demand for housing is strongly conditioned by household structure and thus it is to a large extent price inelastic. If any of these assumptions does not hold, that will go against the presence and intensity of a housing wealth effect. These are rather strong assumptions which are in line with the caveat in the early literature by Skinner (1989, 1991, 1996). Nearly all studies that investigate the housing wealth effect rely on these assumptions even though they are very rarely made explicit. Making them explicit sets the ground for a better interpretation and discussion of the empirical results.

F.3. Collateral effect

Appendices F.1 and F.2 assume that the household is not borrowing constrained. For the collateral effect to play a role in the relation between house prices and consumption, I assume in this section that the household can only borrow by pledging the house as a collateral, and thus it is constrained by the market value of this asset. This feature can be included in the model simply by adding the constraint

$$w_t \geq -\alpha_t h_t \phi, \tag{F.8}$$

to the optimization problem in Appendix F.1. This constraint implies that at any given period the household's liabilities cannot exceed the price of the house net of the selling transaction costs.

Table E.5
Effect of self-reported house price changes on mortgage debt (2004–2007).

Variable	New mortgage			Change in log mortgage debt		
	(1)	(2)	(3)	(4)	(5)	(6)
House price change	0.001	0.001		−0.004	−0.004	
	(0.001)	(0.001)		(0.005)	(0.005)	
House price change			0.002			−0.016
younger owner			(0.001)			(0.010)
House price change			−0.000			0.003
older owner			(0.001)			(0.003)
Positive change		−0.021	−0.022		0.077	0.084
economic expectations		(0.017)	(0.017)		(0.078)	(0.077)
Negative change		0.042*	0.042*		−0.062	−0.066
economic expectations		(0.022)	(0.022)		(0.093)	(0.092)
Change log income	−0.012	−0.012	−0.013	−0.022	−0.021	−0.022
	(0.014)	(0.014)	(0.014)	(0.081)	(0.080)	(0.080)
Number of observations	1952	1952	1952	2161	2161	2161
R2	0.019	0.023	0.025	0.122	0.123	0.124

Notes: Standard errors (clustered at the household level) are reported in parenthesis. All regressions include the change in the number of children in the household, the change in the number of children outside of the household, a set of dummies indicating all possible marital transitions, a set of dummies indicating all possible labor market status transitions, a dummy indicating whether a household moved since the previous wave, a dummy indicating whether the household spent money on house renovation since the previous wave, and a set of year dummies. See main text for further details. *Significant at the 10% level, **significant at the 5% level, ***significant at the 1% level.

If the constraint in Eq. (F.8) is not binding, the result of the optimization problem is the same as in Appendix F.1. However, if the constraint is binding, that means the household is fully leveraged and is not able to achieve its optimal consumption level. In that scenario, the household will respond to a house price increase by consuming more through collateralized borrowing.

Note that, differently from the wealth effect, in this case the house price change does not have to be unexpected and permanent to have an effect on consumption. That is because, even if the household is able to foresee the house price change, the constraint is not relaxed until the change actually takes place. Therefore, the set of assumptions that have to be satisfied for there to be a collateral effect is shorter than in the case of the wealth effect. The only necessary assumptions in this case are that households are borrowing constrained, and that there are channels available for them to borrow for consumption using the housing asset as a collateral.

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