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The Effect of Declining House Prices on Household Savings

A Theoretical and Empirical Study of the Dutch Case

DP 12/2014-056

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- A Theoretical and Empirical Study of the Dutch Case -

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December 2014

Abstract

In this paper I analyse the effect of a decrease in house prices on the savings of households. The life cycle model predicts that homeowners compensate an unexpected decrease in home equity by increasing their savings, and that the effect becomes stronger as the age of the household increases. To test these hypotheses I use panel data from the Dutch Central Bank Household Survey (DHS) for the period between 2003 and 2013. The results of the econometric analysis show a negative and significant effect on the savings of homeowners of the yearly price change in the second hand housing market. The effect becomes stronger with age and it appears to be asymmetric between positive and negative changes in house prices. However, homeowners do not appear to react neither to self-reported measures of house price changes nor to their own one-year expectations about future house prices. This might be because, on the one hand, households are not consistent in the way they report changes in the price of the own house, and, on the other hand, longer term expectations may be more important than one-year expectations.

*JEL Classification:*D9, D11, D12, D14.
Keywords: House Prices, Expected House Prices, Savings.

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1 Introduction

During the last years of the 20th century, the Dutch housing market experienced continued increases in prices which came to an end in 2008. Figure 1 shows a clear turning point in that year, which coincided with a downturn in economic growth marking the start of the economic crisis. During the years of house price increases, different actors (consumers, private business, financial sector and government) contributed to one of the most prominent housing bubbles in Europe.[1] The convincement that house prices would not stop increasing, gradually diverted resources towards the housing sector. As a consequence, there was a considerable surge in housing construction and homeownership, and, by 2008, the Netherlands had become one of the countries in Europe with the highest mortgage debt-to-GDP ratio.

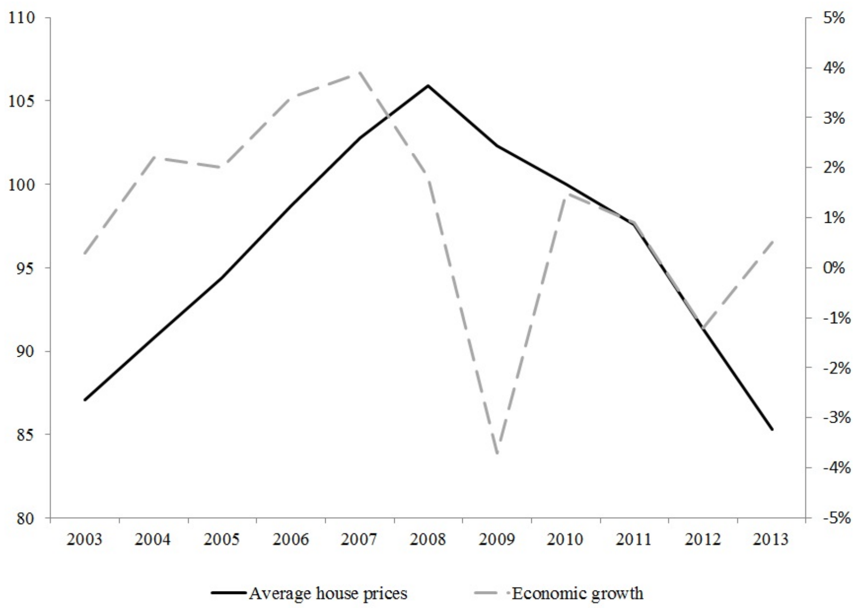

Figure 1 Evolution of House Prices and Economic Growth

Source: CBS; *Notes:* The solid line depicts the evolution of average nominal house prices in the second hand Dutch housing market, with the year 2010 taken as a reference. The dashed line depicts the evolution of the real rate of GDP growth, in terms of 2005 prices. The left axis measures house prices while the right axis measures economic growth.

The burst of the housing bubble has had consequences at many levels. In this paper I focus especifically on the consequences for household finances. I am interested in studying how the saving behaviour of Dutch households has reacted to the decline in house prices. Studying the reaction of households to these changes is relevant because it sheds light on the role that housing plays in their portfolio decisions. It gives an idea about whether individuals rely on home equity as an instrument to save for the future. Futhermore, it contributes to understanding the consequences for households of the burst of the housing bubble and for the economy as a whole. The interesting aspect about housing is that it is both a consumption good and an investment

[1] Relevant housing bubbles have been observed with the same timing as in the Netherlands in other European countries such as Spain and Ireland, as well as in the United States.

good. When a household decides to purchase a house for living porpuses, it is at the same time investing a big share of its wealth in a single and rather illiquid asset. That makes this decision one of the most important in the life of many individuals. The decision is easier if one expects house prices to increase in the future. However, the recent changes have made evident that there is a risk involved.

One of the first studies to look at the relation between house prices and household savings was conducted by Engelhardt (1996), who, employing US data finds that housing wealth gains have a negative effect on the savings of homeowners.[2] This result implies that homeowners regard housing as a saving instrument, and that housing wealth and liquid savings are to some extent substitutable. Rouwendal and Alessie (2002) confirm this result using data from the Dutch socioeconomic panel for the period 1987-1994. The problem with these two studies is that to measure savings they use the yearly change in household wealth, which makes it very difficult to disentangle active (dis)saving from capital gains or losses. Furthermore, they do not consider the role of house price expectations. Thanks to the richness of the data I employ, in this paper I introduce a new measure of savings and I give some insight on how to take house price expectations into account. In addition, I exploit the recent changes in house prices in the Netherlands which provide an interesting case to study the relationship of interest.

More recently there has been a variety of studies looking at the relationship between house price changes and household consumption. Campbell and Cocco (2007) employ the UK's Family Expenditure Survey and find a large positive effect of house price changes on consumption for old homeowners, and an effect that is close to zero for the younger ones. In contrast, Attanasio *et al.* (2009) employ the same survey for a larger period and find that the relationship is stronger for younger than for older homeowners. Disney *et al.* (2010) perform a similar study using the British Household Panel Survey and find a very small positive effect. However, they do not find any age heterogeneity. Browning *et al.* (2013) use Danish panel data and find no evidence of an effect of house price changes on household consumption. Due to this variety in the results, it is hard to establish a general relation at the micro level between house prices and household savings and consumption. Therefore, if policy recommendations are to be prescribed, every country and period deserves its own detailed analysis.

To conduct the present study, I start by analyzing the relationship of interest at the theoretical level. Following Artle and Varaiya (1978) and Li and Yao (2007), I include the housing asset into a stripped down version of the life cycle model. The model predicts that households will react to an unexpected loss in home equity by increasing their savings. The intuition is that households increase savings to smooth the drop in consumption implied by the shock to lifetime income. In addition, the model predicts that the effect increases with age since older households have a shorter lifetime horizon and thus less time to smooth the shock. To test these hypotheses I employ data from the Dutch National Bank Household Survey (DHS). The DHS dataset follows Dutch households between 1993 and 2013 and contains information on economic

[2] Studies using aggregate data, *e.g.* Peek (1983), Bhatia (1987), Skinner (1989), Case *et al.* (2005) and Carroll *et al.* (2011), have consistently shown evidence of a strong positive link between house prices and consumption. However, it seems difficult to account for all variables affecting aggregate consumption and house prices at the same time. Therefore, it is questionable to take a stand on a causal relationship between these two variables at the aggregate level.

and psychological aspects of their behaviour. It provides an interesting measure of savings by asking respondents how much money they have put aside in a given year. Even though it is still not perfect, this measure is better than those employed in the literature so far. For the change in house prices I use data from Statistic Netherlands (CBS), which are available at the national and provincial level. Additionally, the DHS dataset contains data on self-reported house price changes and on house price expectations, which allows me to compute measures of the unexpected change in house prices. I do so by subtracting the expected house price change for a particular year from the self-reported actual house price change for that same year. After performing the subtraction, only the unexpected part of the change is left.

The results show a statistically and economically significant negative effect on savings of the house price change as observed by CBS. I find that the effect increases with age and that it is asymmetrical between negative and positive changes. This result implies that, at least to some extent, individuals view home equity as an instrument to save for the future. The conditionality on age has important implications since it means that, as population ages, the economy-wide effect of house prices on savings becomes stronger. The results show as well that households do not react neither to self-reported measures of the change in house prices nor to the unexpected change in house prices. This might be because the data are on one-year expectations while longer term expectations might be more important, especially for households who expect to stay in the current residence still for a long time. The rest of the document is structured as follows. Section 2 presents the model. Section 3 provides a description of the dataset and some preliminary evidence. Section 4 explains the methodology I employ to test the hypothesis derived from the model. Section 5 presents the results of the empirical analysis. Section 6 sheds some light on how to treat house price expectations. Section 7 rounds up the paper by means of a conclusion and some discussion. The appendices provide additional data description, summary statistics and a more detailed version of the theoretical model.

2 Life Cycle Model With Housing

In this section I introduce a formal description of life cycle savings and consumption in the presence of housing.[3] I consider the rate of change in house prices as the only source of uncertainty in the model. According to Engelhardt (1996), in the case of a household that owns the house it occupies, the effect of house price changes on savings crucially relies on four assumptions. First, the change must be unanticipated and perceived as permanent. Expected changes would have no effect at the time of occurrence. Second, households must view housing wealth as substite with respect to other forms of wealth. That means households should not treat housing differently from other more liquid assets such as stocks or bonds. Third, households must be able to somehow liquidate housing wealth so it can actually be substituted by other forms of wealth. Fourth, the household must not regard the house as an asset to be bequeathed. If a bequest motive is present, changes in housing wealth will lead to changes in the bequest itself, rather than on savings and consumption of the household.

[3] I borrow modelling aspects from Artle and Varaiya (1978), Attanasio and Brugiavini (2003), Li and Yao (2007) and Campbell and Cocco (2007). For a more detailed description of the model which also considers the case of a renter, see appendix 2.

Bearing these assumptions in mind, consider a household that lives for four periods and maximizes the following CRRA utility function

$$U(C_t^\tau, H) = \sum_{t=1}^{4} \frac{1}{(1+\rho)^{t-1}} \left(\frac{(C_t^\tau)^{1-\gamma}}{1-\gamma} + \theta \frac{(H(1+\lambda))^{1-\gamma}}{1-\gamma} \right), \tag{1}$$

where C_t^τ is consumption in period t as planned in period τ, H is constant housing, ρ is the rate of time preference, γ is the rate of realtive risk aversion, θ is the preference for housing and λ is the utility gain from owning the occupied house. $\lambda = 0$ for a renter and $\lambda \geq 0$ for an owner. In the case of a homeowner, I assume the house is purchased by taking out a mortgage. The purchase takes place at the beginning of the second period since it is required to have previous income to obtain a mortgage. In the Netherlands households can borrow close to 100% of the value of a house and hence there is no downpayment restriction. Since there is no bequest motive, the house is sold at the beginning of the last period and the proceeds are used for consumption. Therefore, the household is a renter in the first and fourth periods.

The intertemporal budget constraint for a homeowner is given in the first period by

$$\Omega + E_1 \frac{\alpha_4 H(1-\phi)}{(1+r)^3} = \Theta + K_1 + E_1 \left(\frac{M r^M}{(1+r)} + \frac{M(1+r^M)}{(1+r)^2} + \frac{K_4}{(1+r)^3} \right), \tag{2}$$

where Ω and Θ are lifetime income and consumption, α_t is the real price of housing, ϕ is the transaction cost incurred to sell the house, K_t is the cost of renting in period t, M is the mortgage loan, r^M is the interest rate on the mortgage, r is the interest rate determining the return on savings and E_t is the expectations operator. I assume the rental price to be a function of the house price given by $K_t = \kappa + \delta\alpha_t H$, where κ is a constant and δ is the sensitivity to the house price. The household borrows 100% of the value of the house, hence $M = \alpha_2 H$. The expectation is due to the uncertainty related to the rate of change in house prices, which, in turn, implies uncertainty in future house prices, mortgage payments and rental prices.[4] I assume the household expects the rate of change in house prices to be positive and constant. The second term on the left hand side of (2) denotes the amount the household is expecting to receive when the house is sold at the beginning of the fourth period.

At the beginning of period one the household sets an optimal plan by maximizing (1) subject to (2). A closed form solution for planned consumption can be found by combining (2) with the first order conditions derived from the maximization problem, which yields

$$C_t^1 = \frac{\Omega + E_1 \Xi}{\Lambda_t}, \tag{3}$$

where Λ_t is the factor containing ρ and r that distributes lifetime income among the four periods of life and Ξ is what I call the owning factor. The owning factor contains the expected value of the house at the selling period minus all the lifetime housing related expenses. Any change in the owning factor that is known in the planning period will be incorportaed in the maximization problem and distributed among the four periods according to the Λ_t factors.

[4] I employ point expectations which implies that the household takes into account the expected value of the rate of change in house prices but not the variance.

If the expectation regarding the rate of change in house prices is fulfilled in all periods, the house will be sold at the beginning of the fourth period at the expected price. I consider now the event of a one period negative surprise in the house price rate of change that can take place in periods either two, three or four. I assume the information about the realized rate of house price change becomes available at the beginning of each period. In addition, I assume the negative surprise takes place only in a particular period, while in the rest of periods the initial expectation is fulfilled. Realized consumption in a period with a negative surprise is given by

$$C_t = C_t^1 + \eta_t, \tag{4}$$

where η_t is the forecast error equal to the difference between actual consumption, C_t, and the consumption plan set in period one, C_t^1. The forecast error occurs as a direct consequence of the lower-than-expected rate of change in house prices, which implies that the expected value of η_t is zero. Realized consumption is the result of the reoptimization the household undertakes when the new information is available. As can be seen in (4), a negative forecast error implies a reduction in consumption. That is because the household realizes that the house will be sold in the last period for a lower price compared to what was originally planned. For a given size of the shock, the contemporaneous effect on consumption will be higher the closer the household is to selling the house. If the surprise takes place in period two, the are still two more periods to smooth the shock, whereas if it happens in period four the whole shock to lifetime income has to be absorbed in just one period. Therefore, the contemporaneous effect on consumption will be higher the older the household is.

The result for consumption in (4) can be easily given in terms of savings. The contemporaneous effect on the stock of savings of a change in house prices in periods two and three is given by

$$S_2 = S_1(1 + r) + Y_2 - C_2^1 - Mr^M - \eta_2 \tag{5}$$

and

$$S_3 = S_2(1 + r) + Y_3 - C_3^1 - M(1 + r^M) - \eta_3 \tag{6}$$

respectively, where S_t is the stock of savings at the end of period t. The negative sign in front of the forecast error implies that a negative surprise in house prices will have a positive effect on savings. The intuition is that households increase savings to be able to smooth over time the drop in consumption implied by the shock to lifetime income. The later in life, the less periods there are to smooth consumption so the higher has to be the compensatory increase in savings. Therefore, the contemporaneous effect on savings of the negative housing surprise is higher (in absolute value) the older the household is.

3 Data and Preliminary Evidence

To estimate the relations that derive from (5) and (6) I use data from the Dutch National Bank Household Survey (DHS). This panel survey contains yearly information on a variety of topics (e.g. work, income, pensions, demographics, etc.) between 1993 and 2013 for around

2000 households every year.[5] Attrition is dealt with by biannually refreshing the sample to keep the panel representative of the Dutch population. Since I want to focus the analysis on the years before and after the 2008 turning point in house prices, I only use data for the eleven years running from 2003 until 2013, both included. To construct my sample I take only the responses from household heads and I exclude those households that have moved during the sample period. The advantage of this dataset is that it contains an interesting measure of savings, which I explain further below in this section. Furthermore, it contains an extensive section on accommodation and mortgages including questions about self-reported house prices and house price expectations. In section 6, I explain how I use these variables to compute measures of the unexpected change in house prices.

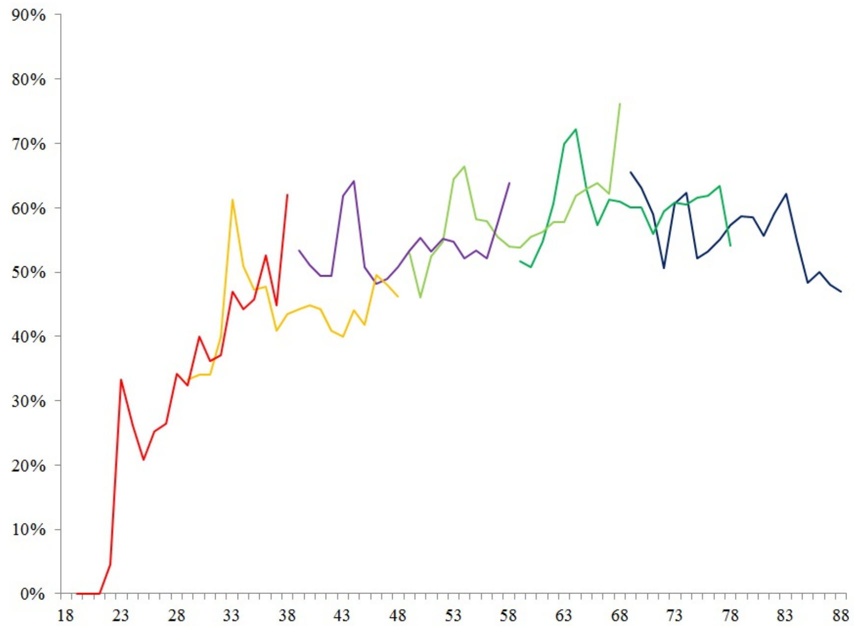

Figure 2 Evolution of Homeownership Through Life

Source: DHS; *Notes:* Data between 2003 and 2013 are employed. Each one of the lines depicts a particular cohort. There are six ten year cohorts born between 1925 and 1984. The vertical axis measures cohort specific homeownership rate, while to horizontal axis measures age.

Figure 2 shows the relation between homeownership and age as found in the DHS dataset. The data are divided in six cohorts of ten years. Each line corresponds to a particular cohort. The figure shows a clear increase in homeownership rates for younger cohorts. For the middle aged cohorts the increase is more moderate and for the last two cohorts there is a slight decrease in homeownership over time. In light of this graph, the assumption stating that homeowners sell their house towards the end of their life seems far fetched.[6] However, the idea behind this assumption is not generating a realistic prediction but more capturing the financial security that households obtain by possessing an asset that can eventually be sold later in life.

[5]For variable definitions, sources and summary statistics, see tables A2 and A3 in appendix 1.

[6]It can still be that the elderly use other means to liquidate part of their housing equity. Rouwendal and Alessie (2002) find that second mortgages are quite popular in the Netherlands.

The mesure of savings I employ is obtained by asking respondents how much money they have put aside in a given year. This measure of savings is much less noisy and more accurate than other measures employed in the literature.[7] First, the questionnaire asks respondents if they have put any money aside in a given year, and then, those who respond affirmatively are provided with seven intervals that range from "Less than 1500 Euros" to "More than 75000". Figure 3 plots the average reponse over time. To compute yearly averages, I take the midpoint of each interval. The solid line shows a clear increase in average savings between 2005 and 2009. After 2009, average savings experience some fluctiations but they stay at a higher level compared to the first years in the sample. The percentage of respondents reporting zero money put aside stays rather constant over time at a value between 30% and 40 %. These responses are excluded from the computation of the average.

Figure 4 shows how different measures of the change in house prices evolve over time. The solid black line shows the evolution of the average change in house prices at the national level as observed by CBS. This measure refers to the second hand housing market. Before 2008 there are stable positive changes in house prices, but after that year the CBS measure shows a clear downward trend. Additionaly, the dashed grey lines show the evolution of the average change in house prices as reported by DHS respondents. The light grey line refers to the change in the self-reported price of the own house. Every year homeowners are asked how much they think they would get for their house in the second hand market. The light grey line shows the yearly average change in that self-reported price. The dark grey line refers to the self-reported change in the price of the own house. Every year homeowners are asked to give in percentage what they think is the yearly change in the price of their house. In principle, both measures should yield the same outcome. However, figure 4 shows that there is a discrepancy between these two measures, which increases after 2008.

Figures 3 and 4 suggest a negative correlation between house price changes and household savings. Actually the correlation over time between the CBS measure and average savings in the sample is as high as -0.86. However, this correlation does not exploit the variation that takes place at the household level. Furthermore, the increase in average savings takes place at around the time the Dutch economy was hit by the financial crisis. Hence there might be other factors that drive the evolution of savings other than the change in house prices. Attanasio *et al.* (2009) point that, especially at the aggregate level, both house prices and savings may be driven by common factors. With this caveat in mind, I separate average savings of homeowners and renters to see if a negative correlation is still observed. Figures A1 and A2 in appendix 1 plot respectively average savings for homeowners and for renters, each of them together with the change in house prices as observed by CBS. The correlation between average savings of homeowners and the CBS measure of house price changes is of -0.91. In the case of renters the correlation is less strong, which makes sense since average savings of renters do not show a clear increasing time pattern like the savings of homeowners do.

Even though the preliminary evidence presented in this section is suggestive, it is only based

[7] Engelhardt (1996) and Rouwendal and Alessie (2002) employ the change in assets as a measure of savings. This measure is very noisy and it is very easily contaminated since it is difficult to disentangle active savings from capital gains and losses.

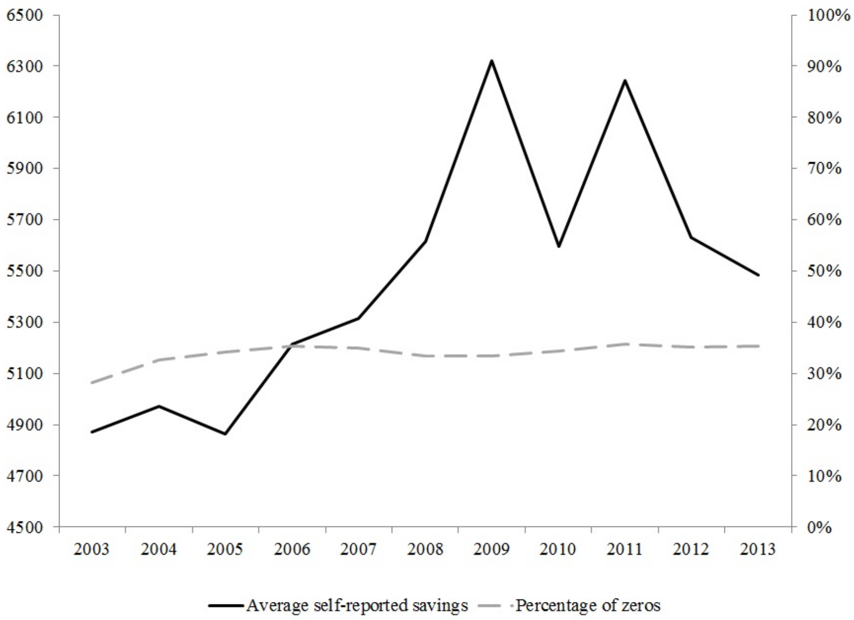

Figure 3 Average Savings

Source: DHS; *Notes:* The question asks how much money the household put aside in a given year. Respondents are provided with a series of intervals. To compute the average I take the midpoint of each interval. The dashed line reports the percentage of households who report zero money put aside. The zeros are not included in the average. The left axis measures savings, while the right axis measures the percentage of zeros.

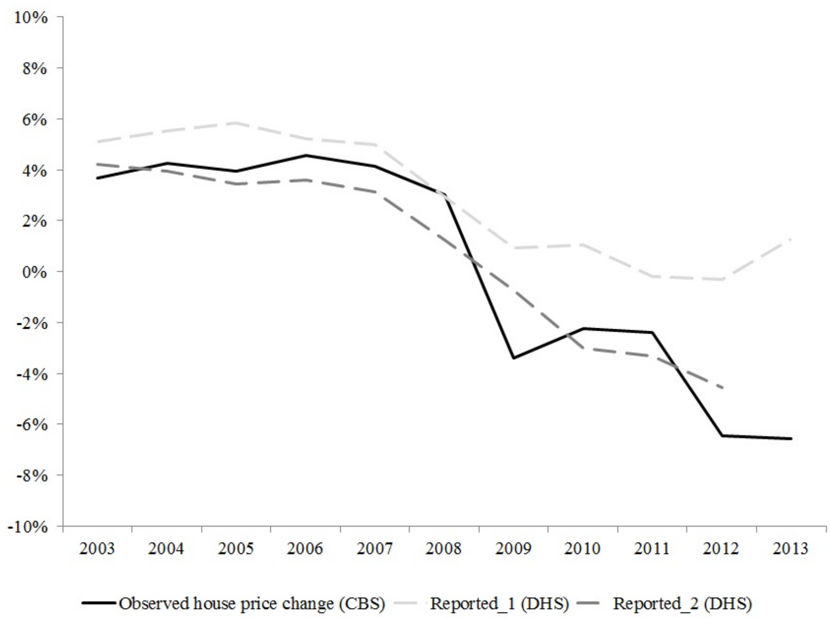

Figure 4 House Price Changes

Source: DHS and CBS; *Notes:* The solid black line reports the average change in house prices as observed by CBS at the national level. Reported_1 is the average change in the self-reported price of the own house. Reported_2 is the average self-reported change in the price of the own house.

on correlations (which, indeed, do not imply causation) at the aggregate level. The evidence has to be confirmed by the microeconometric analysis if any casual claim is to be made. It is likely that savings are conditioned by the business cycle, while the latter also conditions the evolution of house prices. Therefore, it is necessary to disentangle the effect of declining house prices from the effect of general macroeconomic conditions. In addition, there are several household level variables (income, risk aversion, family structure, etc.) that may influence savings as well as self-reported house price changes. Therefore, it is important to consider them in the analysis.

4 Methodology

To investigate the effect house price changes on the savings of homeowners and renters I follow a reduced form method. From the theoretical model I derive an equation for savings which I use as a reference to set up a regression equation. For that matter, the interesting equations from the model are those that describe the effect of the change in house prices on savings, *i.e.* (5) and (6). I focus on equation (6) since, besides mortgage interest payments, it includes the repayment of the principal and thus is more comprehensive. Moving lagged savings to the left of the equality and plugging in planned consumption allows to rewrite (6) as

$$\mathit{\Delta} S_3 = S_2 r + Y_3 - \frac{\mathit{\Omega} + E_1 \Xi}{\mathit{\Lambda}_3} - M(1 + r^M) - \eta_3, \tag{7}$$

where $\mathit{\Delta} S_3 = S_3 - S_2$ is the change in the stock of savings from one period to another. To empirically estimate the relations suggested by (7), which applies only to homeowners, I set up the following linear regression equation

$$\mathit{\Delta} S_{it} = \beta_0 + \beta_1 HPC_{it} + \mathbf{X}_{1it} \boldsymbol{\psi} + \mathbf{X}_{2it} \boldsymbol{\varphi} + c_i + \varepsilon_{it}, \tag{8}$$

where i and t are household and year indices respectively. The βs are unknown coefficients, $\mathit{\Delta} S_{it}$ is the change in the stock of savings, HPC_{it} is the house price change given in percentages, $\mathbf{X}_{1it}$ is a vector containing economic variables (*i.e.* value of the house, household income, yearly mortgage expenditures and remaining mortgage debt), $\mathbf{X}_{2it}$ is a vector containing demographic and psychological characteristics of the household (*i.e.* household structure, education and risk aversion), and $\boldsymbol{\psi}$ and $\boldsymbol{\varphi}$ are vectors of coefficients that correspond to the variables in $\mathbf{X}_{1it}$ and $\mathbf{X}_{2it}$ respectively. In addition, c_i is an unobserved individual household effect and ε_{it} is the error term. The latter captures the unobserved effects that vary across households and over time. Even though (8) does not have exactly the same form as (7), it provides an empirical strategy to estimate the relation between house price changes and savings that derives from (7). I am interested in estimating the coefficient β_1 for which, according to the model, I expect to find a negative sign.

Due to the presence of c_i the different observations within a household will display serial correlation. Furthermore, considering a correlation between c_i and the explanatory variables, plain OLS estimates will be inconsistent if I do not take it into account. Therefore, it is a apporpriate to consider a technique that tackles these two issues. For that purpose, I employ the Mundlak estimator, which was introduced by Mundlak (1978) and is a usual method in panel regression analyses. This estimator assumes that c_i has the structure

$$c_i = \bar{\mathbf{X}}_i \boldsymbol{\gamma} + u_i, \tag{9}$$

where $\bar{\mathbf{X}}_i$ is a vector containing the household-specific time averages of the explanatory variables, $\boldsymbol{\gamma}$ is the corresponing vector of coefficients and u_i is a houseold-specific error component which is assumed to be uncorrelated with the regressors in (8). This assumption allows to solve the inconsistency problem by including $\bar{\mathbf{X}}_i$ in the right-hand-side of the regression equation. In $\bar{\mathbf{X}}_i$ I include only the time averages of those variables that are potentially correlated with c_i. To deal with the within household serial correlation, I combine the Mundlak method with cluter-robust estimation of the standar errors. This method of estimating the standard errors allows for both heteroskedasticity and autocorrelation (of unknown form) within households.

An important issue with methodological consequences is that the dependent variable is coded in intervals. As explained in section 3, the measure of savings I employ corresponds to the DHS question on the yearly amount of money put aside by households. Respondents are given seven intervals that range from "Less than 1500 Euros" to "More than 75000". They can also report that they put zero money aside. A possibility to deal with such a variable consists of taking the midpoint of each interval and applying linear estimation methods. This option assigns a value of zero to the observations with zero money put aside and a value of 75000 to the observations in the top interval. The problem is that those who are coded with a zero may have actually dissaved and those coded with 75000 may have actually saved more than that.

As an alternative to the linear approach, I consider interval regression estimation. As explained by Wooldridge (2010) this technique is the same as ordered probit but with known thresholds for the intervals. It consists of defining a likelihood function that depends on the coefficients in (8) and that takes into account the interval structure of the data. This is done by defining a function that gives the probability that savings fall in each one of the given intervals as well as the probability that they are below zero or above 75000. Once this function has been defined, maximum likelihood can be applied to estimate the coefficients. In contrast to binary probit, the resulting estimates are directly interpretable *as if* a continuous dependent variable had been observed. This technique can be applied in a panel data context, and it allows for the application of the above described Mundlak method. Therefore, the method I employ can be labeled as *interval regression with Mundlak terms*, where the latter refer to the household-specific time averages of the explanatory variables.

5 Results

Table 1 reports the results I obtain for homeowners when applying interval regression with Mundlak terms using both self-reported and observed measures of the change in house prices. When using self-reported measures, I include time dummies to control for macroeconomic effects. When using observed measures, time dummies cannot be included without interfering in the estimation of β_1. Therefore, in that case I use the rate of economic growth as a way to control for the business cycle. Table 1 shows that the estimate for β_1 has the expected sign only when using house price changes as observed by CBS. When national level data are employed (Observed_1) the estimate is -199.941 while, when data at the province level are employed (Observed_2) the estimate is -160.462.[8] Both are significant at the 1% level. These estimates tell by how much savings change when the change in house prices increases by one percentage point. The average house price change at the national level has gone from 4.24% to -6.57% between 2003 and 2013 (see figure 4). According to the estimate in column 3 of table 1 this implies average household savings have increased in this period by 2161.362 Euros due to changes in house prices. This amount represents close to 2/3 of the yearly average money put aside as reported in the first row of table A3 in appendix 1.

The theoretical model predicts that the effect of house price changes on savings increases with age. Table 2 reports the results I obtain when testing this hypothesis. The estimation technique is the same as in table 1 but I add interactions between age group dummies and the change in house prices. A clear and significant conditionality on age is observed only when I use the change in house prices as observed by CBS. In that case I find that indeed the coefficient estimate increases (in absolute value) with age. There is no significant effect for the young group (younger than 35), while the estimates for the middle aged group (between 35 and 65) and for the older group (above 65) are significant and close to the ones found in columns 3 and 4 of table 1. The effect of self-reported measures of the change in house prices remains insignificant when the interaction with age is included.

A relevant aspect that might affect the results is the presence of the so-called National Mortgage Guarantee (NMG).[9] This type of guarantee became quite popular in the Netherlands during the years of the housing boom. Table A3 in appendix 1 shows that 32.9% of the homeowners in the sample have an NMG. Households with an NMG may feel less pressured to increase their savings when the price of their residence in property declines. To test this, I interact house price changes with a dummy indicating the presence of an NMG. The second panel of table 2 shows that when using the house price change as observed by CBS there is indeed a much lower effect on savings for households with an NMG. Taking into account only households without guarantee, the effect of the house price change at the national level (Observed_1) and at the province level (Observed_2) are of -245.978 and -200.471 respectively. When combined with the interaction with the NMG dummy, these coefficients are roughly halved.[10] These results are significant at the 1 % level.

Several authors in the literature, *e.g.* Engelhardt (1996), Chen *et al.* (2009) and Disney *et al.* (2012), state that the effect of house price changes on household savings and consumption may display asymmetry between positive and negative changes. Furthermore, Mastrogiacomo (2006) shows using Dutch data that households react asymetrically to changes in stock wealth. The third panel in table 2 shows the results I obtain when I interact the house price change measures in table 1 with a dummy indicating negative changes in house prices. Once more, only Observed_1 and Observed_2 yield significant coefficient estimates, which confirms the absence

[8]Table A1 in appendix 1 shows how house prices change over time at the provincial level.

[9]The NMG applies if a homeowner, undercertain unfavourable circumstances (*e.g.* unemployment, divorce or work incapacity) must sell his/her house for a price below the ramaining mortgage debt.

[10]When using Observed_1 the estimated effect for households with a guarantee is $-245.978+124.939 = -121.039$ while when using Observed_2 it is $-200.471 + 108.580 = -91.891$.

Table 1 Savings of Homeowners: Interval Regression with Mundlak Terms

	(1)	(2)	(3)	(4)
Income	0.091***	0.083***	0.060***	0.057***
	(0.019)	(0.016)	(0.012)	(0.012)
House value	0.432	-1.356	-0.345	-0.304
	(2.572)	(2.052)	(0.990)	(0.972)
Mortgage debt	-4.034	-5.167	-3.738	-3.492
	(3.726)	(3.741)	(3.029)	(3.026)
M. expenditures	-0.048	-0.072	-0.043	-0.046
	(0.079)	(0.077)	(0.065)	(0.065)
Age2	124.178	-41.989	-1.113	40.660
	(622.224)	(558.266)	(494.254)	(495.046)
Age3	-1640.114**	-1864.21***	-1550.739**	-1478.956**
	(785.478)	(696.549)	(640.023)	(639.370)
University	869.209*	1334.338**	1078.211**	1106.960**
	-461.201	(610.322)	(537.776)	(537.263)
N. of children	-761.917***	-785.937***	-669.296***	-670.331***
	(196.257)	(190.408)	(164.775)	(165.076)
Partner	28.951	660.715	128.101	127.408
	(517.692)	(483.106)	(430.199)	(430.422)
Risk aversion	0.455	-4.471	12.562	14.628
	(92.601)	(89.610)	(72.483)	(72.759)
Growth			107.396*	59.781
			(60.610)	(57.847)
Reported_1	0.146			
	(2.512)			
Reported_2		27.483		
		(28.117)		
Observed_1			-199.941***	
			(49.659)	
Observed_2				-160.462***
				(46.707)
Constant	-5639.33***	-5858.26***	-4906.88***	-4797.945***
	(1536.352)	(1392.308)	(1271.226)	(1271.126)
Year dummies	Yes	Yes	No	No
Observations	3551	3346	4557	4556
Households	909	893	1171	1171

Notes: Standard errors, clustered by household, are reported in parentheses. Time averages are included for all variables except for Age2, Age3, University, Partner, Growth, Observed_1 and Observed_2. *** significant at the 1 % level, ** significant at the 5 % level, * significant at the 10 %level. For variable definitions and summary statistics, refer to tables A2 and A3 in appendix 1.

Table 2 Interaction Effects

Age

	Coefficient Estimate	p-value		Coefficient Estimate	p-value
Reported_1	-8.491	0.708	Reported_2	55.614	0.187
Reported_1×Age2	8.804	0.984	Reported_2×Age2	-46.541	0.406
Reported_1×Age3	8.564		Reported_2×Age3	-20.315	
Observed_1	-73.316	0.780	Observed_2	9.250	0.963
Observed_1×Age2	-127.439	0.001	Observed_2×Age2	-160.416	0.006
Observed_1×Age3	-129.030		Observed_2×Age3	-205.911	

National Mortgage Guarantee (NMG)

	Coefficient Estimate	p-value		Coefficient Estimate	p-value
Reported_1	-0.215	0.947	Reported_2	64.293	0.026
Reported_1×NMG	0.819	0.993	Reported_2×NMG	-75.962	0.077
Observed_1	-245.978	0.000	Observed_2	-200.471	0.000
Observed_1×NMG	124.939	0.000	Observed_2×NMG	108.580	0.000

Symmetry of the House Price Effect

	Coefficient Estimate	p-value		Coefficient Estimate	p-value
Reported_1	-1.644	0.588	Reported_2	18.625	0.507
Reported_1×neg	14.797	0.754	Reported_2×neg	212.987	0.172
Observed_1	-268.935	0.344	Observed_2	59.748	0.563
Observed_1×neg	-299.975	0.000	Observed_2×neg	-594.258	0.000

Notes: Estimates are obtained by interval regression, with the same specification and with the same samples as in table 1. Coefficient estimates for control variables are not reported but are available on request. p-values of interaction effects are obtained by means of Wald tests of the null hypothesis stating that the maim effect and the interaction are zero. For variable definitions refer to table A2 in the appendix.

Table 3 Savings of Renters: Interval Regression with Mundlak Terms

	(1)	(2)	(3)	(4)
Income	0.037***	0.036***	0.038***	0.037***
	(0.012)	(0.012)	(0.012)	(0.012)
Rent	-0.006	-0.006	-0.009	-0.009
	(0.015)	(0.015)	(0.014)	(0.014)
Age2	-500.769	-483.408	115.218	127.567
	(407.139)	(408.238)	(421.850)	(422.358)
Age3	-1352.543**	-1330.200**	-530.961	-510.844
	(536.112)	(538.178)	(545.368)	(546.919)
University	1325.714*	1314.000*	1262.182*	1265.694*
	(684.825)	(688.338)	(723.567)	(726.031)
N. of children	-374.978***	-394.878***	-537.284	-524.965
	(130.942)	(131.789)	(406.606)	(406.627)
Partner	1626.666*	1617.075*	1110.571	1129.186
	(894.948)	(892.270)	(954.324)	(956.758)
Risk aversion	114.508*	114.939*	110.168*	111.985*
	(63.479)	(63.559)	(65.949)	(66.098)
Growth	-90.641	-119.937	-54.389	-82.902
	(84.892)	(87.362)	(87.876)	(90.374)
Saving			3116.403***	3104.284***
			(593.415)	(611.622)
Observed_1	-0.877		-5.886	
	(51.655)		(52.111)	
Observed_2		17.569		8.734
		(49.357)		(50.107)
Observed_1*Saving			-378.966***	
			(127.165)	
Observed_2*Saving				-344.331***
				(127.828)
Constant	-3837.374***	-3791.242***	-4317.975***	-4272.884***
	(956.975)	(950.204)	(992.311)	(984.684)
Year dummies	No	No	No	No
Observations	3303	3291	3101	3089
Households	895	891	861	857

Notes: Standard errors, clustered by household, are reported in parentheses. Dependent variable is money put aside in the last 12 months, including all the zero responses. Time averages are included for all variables except for Age2, Age3, University, Partner, Growth, Looking, Observed_1 and Observed_2. The rate of economic growth is included as a proxy for the business cycle. *** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level. For variable definitions and summary statistics, refer to tables A2 and A3 in appendix 1.

of an effect of self-reported measures of house price changes. Restricting the attention to the variables Observed_1 and Observed_2, table 2 shows how the estimates in columns 3 and 4 of table 1 come strictly from negative changes in house prices. In fact, when using only negative changes the estimated effect is much larger than in table 1.[11] When using only positive changes, the effect is not significant.

Regarding the effect of house price changes for renters, columns 1 and 2 of table 3 show that there is no significant effect of the CBS measures on the savings of renters. To estimate the effect I use the same model as in (8) but I exclude mortgage related variables and I include yearly renting expenditures. The absence of an effect for renters suggests that the increase in average savings of homeowners during the sample period (recall figures A1 and A2 in the appendix) is due to the decrease in house prices. In addition, columns 3 and 4 of table 3 show the results I obtain when interacting the house price change with a dummy indicating whether the household is saving to buy a house. The results are interesting since they show that the effect for renters who are saving to purchase a house is clearly negative and significant. This suggests that, when house prices decline renters are incentivized to save for a house. Further work remains to be done to understand how renters who are saving for a home react to house price changes.

6 The Unexpected Change in House Prices

So far I have paid attention to the total change in house prices. However, the theoretical model predicts that there should only be an effect if the change is unexpected. The DHS dataset offers a good opportunity to take this into account since it includes questions on expected house price changes. Homeowners are asked every year how much they expect the price of their house is going to increase in the next year. They are also asked how much they expect the average price in the market to increase in the next year. For every year I subtract from the actual change in house prices the change that was expected for that particular year. In that way, only the unexpected part of the change is left. When the actual change is above the expected change, the household experiences a positive surprise, while a negative surprise occurs when the opposite takes place. Figure 5 shows that, previous to the year 2008, homeowners in the sample experienced on average positive surprises since they expected lower changes in house prices compared to what actually happened. However, this situation reverses after the year 2008, since then both observed and self-reported changes fall below the expected value. This offers some interesting variation that I exploit using the same method as I do for the total change in house prices.

Table 4 shows that, when using any of the different versions of the unexpected change in house prices, the estimate of β_1 is always negative.[12] However, the estimated effect is rather low and hardly significant. Only in columns 5 and 6 I obtain significance at the 10% level. However, the coefficients are not economically significant. The two measures that yield these results are obtained by subtracting the market price expectation from the national and provincial CBS measures respectivelly. The results in table 4 are rather striking since, according to the model

[11] When using Observed_1 the estimated effect with only negative changes is $-268.938 - 299.975 = -568.913$ while when using Observed_2 it is $59.748 - 594.258 = -534.510$.

[12] Combining the different measures of the actual change and of the expected change in house prices, I create six different measures of the unexpected change. For definitions and summary statistics, see appendix 1.

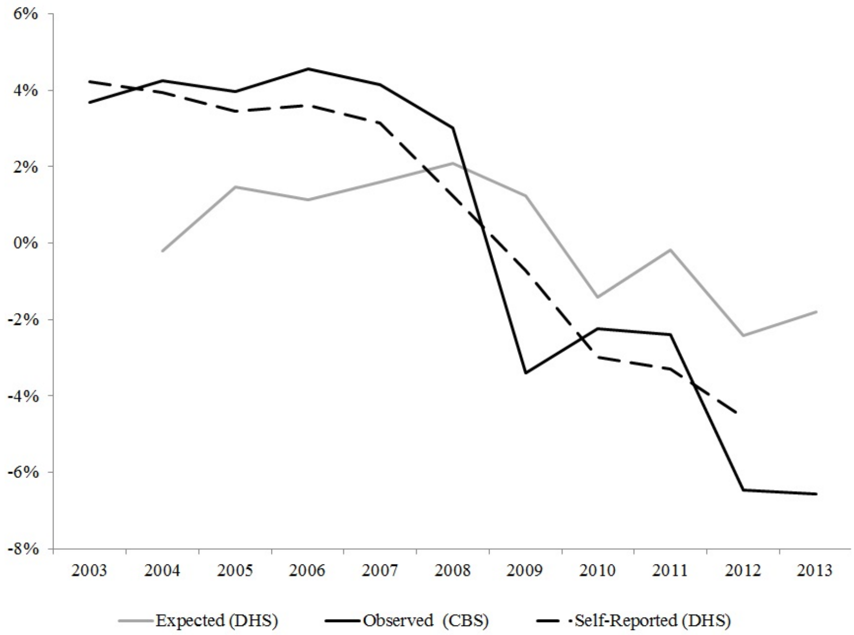

Figure 5 Expected, Self-Reported and Observed House Price Changes

Source: DHS and CBS; *Notes*: Expected change in house prices are measured at time *t-1*. Self-Reported changes are the same as Reported_2 in Figure 4. The observed change in house prices is the same as in Figure 4.

in section 4, one would expect a clear negative effect of the unexpected change in house prices. Table 5 shows that when looking at the interaction with age and NMG, and when testing for asymmetry still no measure of the unexpected change in house prices yields meaningful results.

A plausible interpretation is that household savings are not sensitive to one year expectations in house prices. Long run expectations may play a more important role, especially when a household is planning to stay in the current residence still for a long period. The DHS dataset provides a possible solution to this issue since it contains information on long run house price expectations. More specifically, it asks respondents what they consider to be a normal yearly precentage increase in house prices in ten years ahead from the survey time. Table A2 shows that the average response for this variable is 3.43, which is much higher than the average one-year expectation. Only in the last years of the sample households start reporting negative values for the expected yearly house price change ten years ahead. However, I do not find an effect of the ten-year expectation on household savings.[13] Even though the results in this section shed some light on how to treat house price expectations, further work on how households form these expectations, how they report them and how they react to them still needs to be done.

[13]For economy of space, these results are not reported here. They are available on request.

Table 4 Savings of Homeowners: Interval Regression with Mundlak Terms

- Unexpected Change in House Prices -

	(1)	(2)	(3)	(4)	(5)	(6)
Income	0.095***	0.093***	0.048***	0.048***	0.052***	0.052***
	(0.019)	(0.021)	(0.016)	(0.015)	(0.016)	(0.016)
House value	0.823	-0.105	0.006	0.075	-0.309	-0.222
	(2.608)	(2.000)	(2.124)	(2.125)	(2.263)	(2.258)
Mortgage debt	-3.584	-4.146	-3.717	-3.541	-4.620	-4.404
	(3.869)	(4.270)	(3.733)	(3.709)	(3.732)	(3.708)
M. expenditures	-0.038	-0.030	-0.057	-0.058	-0.039	-0.041
	(0.080)	(0.087)	(0.074)	(0.074)	(0.071)	(0.071)
Age2	15.773	264.989	112.645	117.247	131.167	144.576
	(628.754)	(651.057)	(618.206)	(617.673)	(621.888)	(622.355)
Age3	-1722.378**	-1820.440**	-1528.520**	-1511.516**	-188.513**	-1559.306**
	(794.007)	(825.700)	(771.022)	(769.960)	(771.549)	(771.153)
University	660.083	1062.354*	773.855	798.300	981.506*	1007.151*
	(637.902)	(580.853)	(630.933)	(630.073)	(501.082)	(549.219)
N. of children	-799.074***	-964.777***	-806.291***	-803.528***	-788.820***	-786.961***
	(198.276)	(222.658)	(196.564)	(196.834)	(201.287)	(201.563)
Partner	23.864	880.119	124.238	117.034	132.232	124.661
	(536.059)	(573.659)	(528.558)	(528.209)	(538.345)	(538.023)
Risk aversion	8.518	-66.039	-4.203	-5.289	14.037	12.943
	(92.952)	(109.221)	(92.013)	(92.088)	(97.924)	(97.969)
Growth			-77.763	-83.825	-56.967	-66.427
			(61.093)	(58.746)	(63.680)	(61.043)
Surprise_1	-1.015					
	(2.804)					
Surprise_2		-35.570				
		(25.169)				
Surprise_3			-38.201			
			(42.400)			
Surprise_4				-36.023		
				(38.328)		
Surprise_5					-75.659*	
					(44.067)	
Surprise_6						-62.851*
						(39.769)
Constant	-5607.51***	-5935.51***	-4947.52***	-4930.89***	-4774.34***	-4777.28***
	(1576.522)	(1938.239)	(1509.697)	(1510.490)	(1518.554)	(1518.485)
Year dummies	Yes	Yes	No	No	No	No
Observations	3360	2582	3415	3414	3405	3404
Households	881	705	896	896	896	896

Notes: Standard errors, clustered by household, are reported in parentheses. Dependent variable is money put aside in the last 12 months, including all the zero responses. Mortgage expenditures are rescaled. Time averages are included for all variables except for Age2, Age3, University, Partner, Growth, Surprise_1 and Surprise_2. Times dummies are always included except for when CBS data are employed. In the latter cases, the rate of economic growth is included as a proxy for the business cycle. *** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level. For variable definitions and summary statistics, refer to tables A2 and A3 in appendix 1.

Table 5 Interaction Effects

- Unexpected Change in House Prices -

Age

	Coefficient Estimate	*p*-value		Coefficient Estimate	*p*-value		Coefficient Estimate	*p*-value
Surprise_1	-4.032	0.868	Surprise_2	49.530	0.533	Surprise_3	89.211	0.403
Surprise_1×Age2	3.474	0.983	Surprise_2×Age2	-84.478	0.331	Surprise_3×Age2	-91.881	0.488
Surprise_1×Age3	2.182		Surprise_2×Age3	-121.253		Surprise_3×Age3	-178.460	
Surprise_4	74.374	0.482	Surprise_5	-60.607	0.640	Surprise_6	-51.050	0.680
Surprise_4×Age2	-68.687	0.351	Surprise_5×Age2	26.738	0.220	Surprise_6×Age2	29.845	0.145
Surprise_4×Age3	-183.397		Surprise_5×Age3	-86.986		Surprise_6×Age3	-110.492	

National Mortgage Guarantee (NMG)

	Coefficient Estimate	*p*-value		Coefficient Estimate	*p*-value		Coefficient Estimate	*p*-value
Surprise_1	-1.036	0.769	Surprise_2	-8.687	0.771	Surprise_3	-43.770	0.372
Surprise_1×NMG	-.349	0.917	Surprise_2×NMG	-85.374	0.180	Surprise_3×NMG	99.688	0.272
Surprise_4	43.136	0.350	Surprise_5	-108.142	0.022	Surprise_6	-98.873	0.023
Surprise_4×NMG	88.933	0.330	Surprise_5×NMG	127.571	0.038	Surprise_6×NMG	114.635	0.048

Symmetry of the House Price Effect

	Coefficient Estimate	*p*-value		Coefficient Estimate	*p*-value		Coefficient Estimate	*p*-value
Surprise_1	-3.100	0.349	Surprise_2	-73.392	0.120	Surprise_3	-77.948	0.258
Surprise_1×neg	26.589	0.408	Surprise_2×neg	219.896	0.118	Surprise_3×neg	90.424	0.515
Surprise_4	-34.193	0.579	Surprise_5	-108.142	0.122	Surprise_6	-79.887	0.159
Surprise_4×neg	36.972	0.856	Surprise_5×neg	4.607	0.137	Surprise_6×neg	-11.987	0.320

Notes: Estimates are obtained by interval regression, with the same specification and with the same samples as in table 4. Coefficient estimates for control variables are not reported but are available on request. *p*-values of interaction effects are obtained by means of Wald tests of the null hypothesis stating that the maim effect and the interaction are zero. For variable definitions refer to table A2 in the appendix.

7 Conclusions

In this paper I look at the effect of house price changes on household savings. In doing so, I contribute to the existing literature in a number of ways. First, I provide a simplified version of the life cycle model that allows studying the housing asset without many of the difficulties that it usually entails. This framework can be further extended to study other realted issues. Second, I employ different measures of the change in house prices, which include measures of the total change in house prices and measures of the unexpected change in house prices. Third, I introduce a different measure of savings as the one employed in the literature. I use savings as money put aside, whereas previous authors employ the yearly change in household assets. The latter measure makes very difficult to separate active savings from capital gains and losses. Fourth, I exploit both the cross section and the time dimensions of the data by using the Mundlak method. More specifically, I add to the regression equation the time average of only those variables that are potentially correlated with the individual household effect c_i. The resulting method is a hybrid between a random effects and a fixed effects method.

The model I present in this paper predicts that households will offset losses in housing wealth by increasing their savings. In addition, it predicts that there will only be an effect if the change in house prices is unexpected and that such effect increases with age. These predictions are partially confirmed by the results I obtain. However, there are two aspects about my results that are rather striking. The first is that households do not appear to react to self-reported measures of the change in house prices, whereas the they do react to CBS observed measures of the same variable. A plausible explanation points at the inconsistency between the two measures of the self-reported change in house prices. If the outcome changes depending on how the question is formulated, then it is hard to believe that households are consistent in reporting the change in the price of their own house. This makes it difficult to estimate the effect on savings based on self-reported measures of the change in house prices. In that sense, more research needs to be done in understanding how individuals report the market value of their house, and whether there are any psychological and/or cognitive factors at play.

The second striking aspect about my results is the fact that households do not react to the unexpected change in house prices. Measuring expectations is a really difficult endeavour. Nevertheless, the measures I present in this paper are really promising. The problem is perhaps that they still do not capture house price expectations in an accurate manner. On the one hand, it is likely that households react only to very long run expectations. Especially those that still plan to stay in their current residence for a long time. On the other hand, the only households that are truly surprised by a house price change are those that are willing to sell their house in the short term. Therefore it would be interesting to focus on how old households who are willing to liquidate their house react to an unexpected loss in home equity. In addition, it can be that households are inconsistent in their expectations and/or that they report the mode instead of the expectation when asked about future changes in house prices. In that sense, more work needs to be done to understand how households form their expectations, how they report them and how they react to them.

Focusing on the part of my results that are significant, I do find a clearly negative effect of price changes in the house market as observed by CBS. Even though homeowners do not react to self-reported measures of the change in house prices, they seem to be aware of what is going on in the market and they respond to it. I find similar results when I use changes at the national level and at the province level. These results suggest that households regard the housing asset as an instrument to save for the future, and that, to some extent, home equity is substitutable with more liquid forms of saving. I find that the estimated effect increases in magnitude with age. This result is interesting since it means that as population ages aggregate savings may become more sensitive to house price changes, which means that in case of recession a decrease in house prices will depress the economy further by increasing household savings and reducing consumption. Furthermore, I find a lower effect for households with an NMG. This is a relevant result since this type of guarantee is quite popular in the Netherlands. In addition, I find that the effect comes solely from negative changes in house prices. That means households respond asymmetrically to positive and negative changes. This connects with the idea introduced by Kahneman and Tversky (1979) which states that individuals assign higher weight to losses than to gains. Regarding the effect of house price changes on the savings of renters, I do not find a significant effect. This result for renters suggests that the observed increase in the savings of homeowners is due to the decrease in house prices. I do find an effect when I focus only on renters who are saving to buy a house. However, more work needs to be done to understand well how changes in house prices affect renters who are saving for a house.

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Appendix 1: Additional Figures and Tables

Table A1 Regional Average Price Variation in the Dutch Second Hand Housing Market

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Netherlands	87.10	90.80	94.40	98.70	102.80	105.90	102.30	100.00	97.60	91.30	85.30
	3.69	4.25	3.96	4.56	4.15	3.02	-3.40	-2.25	-2.40	-6.45	-6.57
Groningen	83.30	88.00	94.50	100.10	103.40	105.50	101.30	100.00	96.90	90.70	85.80
	6.11	5.64	7.39	5.93	3.30	2.03	-3.98	-1.28	-3.10	-6.40	-5.40
Friesland	84.10	89.40	93.70	99.00	102.60	105.10	100.60	100.00	95.70	89.60	83.10
	6.86	6.30	4.81	5.66	3.64	2.44	-4.28	-0.60	-4.30	-6.37	-7.25
Drenthe	86.00	90.00	94.20	98.70	103.00	105.10	102.10	100.00	97.30	91.70	85.00
	4.12	4.65	4.67	4.78	4.36	2.04	-2.85	-2.06	-2.70	-5.76	-7.31
Overijssel	89.20	93.20	96.50	100.80	103.00	105.00	102.00	100.00	97.10	92.10	86.30
	3.60	4.48	3.54	4.46	2.18	1.94	-2.86	-1.96	-2.90	-5.15	-6.30
Flevoland	96.70	98.30	100.80	103.20	105.70	106.10	102.80	100.00	97.30	92.20	87.50
	3.42	1.65	2.54	2.38	2.42	0.38	-3.11	-2.72	-2.70	-5.24	-5.10
Gelderland	88.90	93.00	95.90	100.30	104.10	106.30	102.10	100.00	96.80	90.10	83.90
	3.37	4.61	3.12	4.59	3.79	2.11	-3.95	-2.06	-3.20	-6.92	-6.88
Utrecht	82.90	86.90	90.80	95.40	101.40	105.40	102.40	100.00	97.50	91.10	85.10
	3.75	4.83	4.49	5.07	6.29	3.94	-2.85	-2.34	-2.50	-6.56	-6.59
N. Holland	83.60	86.60	89.90	95.00	101.50	106.70	102.90	100.00	98.70	92.30	85.80
	0.60	3.59	3.81	5.67	6.84	5.12	-3.56	-2.82	-1.30	-6.48	-7.04
Z. Holland	87.90	91.60	95.40	99.10	102.40	105.60	102.20	100.00	98.30	91.90	86.30
	5.02	4.21	4.15	3.88	3.33	3.12	-3.22	-2.15	-1.70	-6.51	-6.09
Zeeland	81.40	87.70	93.10	98.20	100.60	103.50	102.10	100.00	99.00	93.90	91.30
	7.25	7.74	6.16	5.48	2.44	2.88	-1.35	-2.06	-1.00	-5.15	-2.77
N. Brabant	87.60	91.20	94.80	99.10	103.00	106.00	102.40	100.00	96.80	89.90	83.40
	4.04	4.11	3.95	4.54	3.94	2.91	-3.40	-2.34	-3.20	-7.13	-7.23
Limburg	95.50	99.40	101.20	104.30	106.70	107.20	102.40	100.00	97.80	91.80	86.40
	2.03	4.08	1.81	3.06	2.30	0.47	-4.48	-2.34	-2.20	-6.13	-5.88

Source: CBS; *Notes:* For each province the first row shows the evolution of the average price in the second hand housing market. The year 2010 is taken as a reference. The second row shows yearly percentage changes.

Table A2 Variable Definitions and Sources

Variable	Definition	Source
Savings	Money in Euros put aside in the past 12 months.	DHS
Income	Total net income of the household in Euros.	DHS
House value	Amount in thousands of Euros the household expects to get for their residence if sold at the second hand housing market (first residence).	DHS
Mortgage debt	Amount in thousands of Euros of the mortgage loan that is still to be paid (first residence).	DHS
Mortgage expenditure	Yearly amount in Euros of mortgage related expenditure (first residence).	DHS
Age1, Age2, Age3	Dummies indicating age of the household head. Age1: 35 or younger, Age2: between 35 and 65, Age3: above 65.	DHS
University	Dummy indicating university education.	DHS
Number of children	Number of children living in the household.	DHS
Partner	Dummy indicating the presence of a partner.	DHS
Risk aversion	Index variable indicating how much household heads agree with having save investments with guaranteed returns. 1: totally disagree, 7: totally agree.	DHS
NMG	Dummy indicating the presence of a national mortgage guarantee.	DHS
Rent	Yearly amount spent in Euros in renting the first residence.	DHS
Saving	Dummy indicating whether a renter is saving to buy a house.	DHS
Growth	Growth rate of real GDP (prices 2005).	CBS
Reported_1	Yearly percentage change in the self-reported house value with respect to the previous year.	DHS
Reported_2	Reported yearly percentage change in the house value with respect to the previous year.	DHS
Expected_1	Expected percentage change in the house value for the next year with respect to the present year.	DHS
Expected_2	Expected percentage change in house market prices for the next year with respect to the present year.	DHS
Longexp	Expected yearly percentage change in property prices in 10 years.	DHS
Observed_1	Average observed percentage change in second hand house market prices at the national level.	CBS
Observed_2	Average observed percentage change in second hand house market prices at the province level.	CBS
Surprise_1	Reported_1 minus lagged Expected_1.	DHS
Surprise_2	Reported_2 minus lagged Expected_1.	DHS
Surprise_3	Observed_1 minus lagged Expected_1.	DHS and CBS
Surprise_4	Observed_2 minus lagged Expected_1.	DHS and CBS
Surprise_5	Observed_1 minus lagged Expected_2.	DHS and CBS
Surprise_6	Observed_2 minus lagged Expected_2.	DHS and CBS

Notes: House value, Mortgage debt, Mortgage expenditure, Guarantee and all of the DHS house price changes variables are only available for homeowners. Rent and Saving are only available for renters. DHS stands for Dutch National Bank Household Survey and CBS is the Dutch acronym for the national statistical services.

Table A3 Summary Statistics

Variable	Mean	Median	Std. Dev.	Min.	Max.	N. of Obs.
Savings	3763.900	3250	6424.423	0	75000	12681
Income	45357.240	56000	20348.030	5000	75000	12994
House value	278.148	240	166.679	0	5500	8170
Mortgage debt	90.368	75	70.458	0	750	5932
Mortgage expenditure	398.730	0.002	2097.407	0	12000	8327
Age_1	0.156	-	-	-	-	18725
Age_2	0.623	-	-	-	-	18725
Age_3	0.222	-	-	-	-	18725
University	0.143	-	-	-	-	18492
Number of children	0.684	0	1.052	0	7	18726
Partner	0.707	-	-	-	-	18726
Risk aversion	5.080	6	1.806	1	7	12186
NMG	0.329	-	-	-	-	6045
Rent	515.911	440	1676.816	0	81714	4405
Saving	0.063	-	-	-	-	4244
Growth	2.520	2.515	2.520	-3.583	5.850	18726
Reported_1	3.623	0	40.219	-100	1163.158	5847
Reported_2	1.174	0	6.011	-29.167	41.667	6270
Expected_1	-0.009	0	3.966	-45	75	7813
Expected_2	-0.487	0	4.118	-50	50	7796
Longexp	3.427	3	4.71	-40	100	7762
Observed_1	0.465	3.016	4.266	-6.572	4.555	18726
Observed_2	0.493	2.437	4.399	-7.306	7.740	18726
Surprise_1	3.611	0	39.158	-100	1163.158	5426
Surprise_2	0.633	0	5.965	-29.1667	49.667	4303
Surprise_3	0.297	0.555	5.007	-78.399	42.752	6612
Surprise_4	0.289	0.469	5.104	-79.478	42.847	6608
Surprise_5	0.748	1.016	5.138	-53.399	47.600	6584
Surprise_6	0.734	0.943	5.245	-54.478	47.500	6580

Notes: All data correspond to the household head of each household. House value, Mortgage debt, Mortgage expenditure, Guarantee and all of the DHS house price change variables are only available for homeowners. Rent and Saving are only available for renters. Savings and income are coded in intervals. In both cases I take the midpoint of each interval to compute summary statistics.

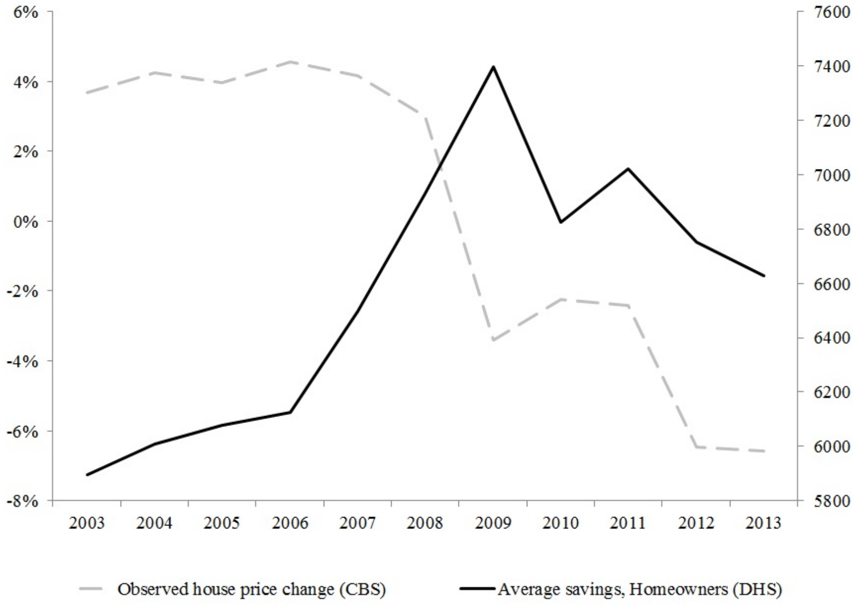

Figure A1 Savings and the Change in House Prices

Source: DHS and CBS; *Notes:* Unexpected change in house prices is the reported percentage change minus the expected percentage change. Observed house price change is the same as reported in figure 6. Data on the unexpected change are unavailable for 2003 and 2013. The respondents who reported zero money put aside are not included in the graph. The left axis measures house price percentage changes while the right axis measures savings in Euros.

Figure A2 Savings and the Change in House Prices

Source: DHS and CBS; *Notes:* Unexpected change in house prices is the reported percentage change minus the expected percentage change. Observed house price change is the same as reported in figure 6. Data on the unexpected change are unavailable for 2003 and 2013. The respondents who reported zero money put aside are not included in the graph. The left axis measures house price percentage changes while the right axis measures savings in Euros.

Appendix 2: Model (Extended Version)

Introduction

In this appendix I present an extended and more detailed version of the model in section 2 of this paper. This appendix is structured as follows. In the next section I introduce and explain a basic four period life cycle model without neither income nor lifetime uncertainty. In the third and fourth sections I study the optimal life cycle profile of a homeowner and of a renter respectively. In section fifith I study the effects of an unexpected decline in house prices.

Life Cycle Model Without Housing

The results I arrive to in this section are standard and are really close to the ones found in Deaton (1992) and Attanasio and Brugiavini (2003). Nevertheless, this section is relevant since it lays out the basis for the introduction of housing. The model with housing appears as a special case of the basic model without housing.

Assume that the household lives for four periods, which can be roughly identified with the different stages of the life cycle. Furthermore, assume that there is neiether lifetime nor income uncertainty and that there are no liquidity constraints and no bequest motive. The non-consolidated budget constraint for each period can be written as

$$S_{t-1}(1+r) + Y_t = C_t + S_t, \tag{10}$$

where C_t and Y_t are the flow of consumption and income in period t, S_t is the stock of savings at the end of period t and r is the interest rate, which, for simplicity, I assume to be constant over time.[14] Furthermore, I assume the household is born without assets, there is no bequest motive, and credit markets do not allow the household to die indebted, which all together imply $S_0 = S_4 = 0$.

At the beginning of period one, the household maximizes the CRRA utility function

$$U(C_t^1) = \sum_{t=1}^{4} \frac{1}{(1+\rho)^{t-1}} \frac{(C_t^1)^{1-\gamma}}{1-\gamma}, \tag{11}$$

where C_t^1 stands for consumption at time t as planned in period one, γ stands for the level of relative risk aversion and ρ is the rate of time preference, subject to the consolidated lifetime budget constraint given by

$$\sum_{t=1}^{4} \frac{Y_t}{(1+r)^{t-1}} = \sum_{t=1}^{4} \frac{C_t^1}{(1+r)^{t-1}}. \tag{12}$$

The first order conditions yield the usual Euler equation

$$\left(\frac{C_{t+1}^1}{C_t^1}\right)^{\gamma} = \frac{1+r}{1+\rho}, \tag{13}$$

[14] Stock variables, like savings, are considered at the end of every period. All quantities are given in real terms.

which, combined with (12), gives the following closed form sloutions for consumption corresponding to periods one to four

$$\begin{aligned}
C_1^1 &= \frac{\sum_{t=1}^{4} \frac{Y_t}{(1+r)^{t-1}}}{1 + \left(\frac{1+r}{1+\rho}\right)^{\frac{1}{\gamma}} \frac{1}{(1+r)} + \left(\frac{1+r}{1+\rho}\right)^{\frac{2}{\gamma}} \frac{1}{(1+r)^2} + \left(\frac{1+r}{1+\rho}\right)^{\frac{3}{\gamma}} \frac{1}{(1+r)^3}} \\
&= \frac{\Omega^1}{\Lambda_1^1},
\end{aligned}$$

$$\begin{aligned}
C_2^1 &= \frac{\sum_{t=1}^{4} \frac{Y_t}{(1+r)^{t-1}}}{\left(\frac{1+\rho}{1+r}\right)^{\frac{1}{\gamma}} + \frac{1}{(1+r)} + \left(\frac{1+r}{1+\rho}\right)^{\frac{1}{\gamma}} \frac{1}{(1+r)^2} + \left(\frac{1+r}{1+\rho}\right)^{\frac{2}{\gamma}} \frac{1}{(1+r)^3}} \\
&= \frac{\Omega^1}{\Lambda_2^1},
\end{aligned}$$

$$\begin{aligned}
C_3^1 &= \frac{\sum_{t=1}^{4} \frac{Y_t}{(1+r)^{t-1}}}{\left(\frac{1+\rho}{1+r}\right)^{\frac{2}{\gamma}} + \left(\frac{1+\rho}{1+r}\right)^{\frac{1}{\gamma}} \frac{1}{(1+r)} + \frac{1}{(1+r)^2} + \left(\frac{1+r}{1+\rho}\right)^{\frac{1}{\gamma}} \frac{1}{(1+r)^3}} \\
&= \frac{\Omega^1}{\Lambda_3^1},
\end{aligned}$$

$$\begin{aligned}
C_4^1 &= \frac{\sum_{t=1}^{4} \frac{Y_t}{(1+r)^{t-1}}}{\left(\frac{1+\rho}{1+r}\right)^{\frac{3}{\gamma}} + \left(\frac{1+\rho}{1+r}\right)^{\frac{2}{\gamma}} \frac{1}{(1+r)} + \left(\frac{1+\rho}{1+r}\right)^{\frac{1}{\gamma}} \frac{1}{(1+r)^2} + \frac{1}{(1+r)^3}} \\
&= \frac{\Omega^1}{\Lambda_4^1},
\end{aligned}$$

where Ω^1 stands for the discounted value of lifetime income evaluated at period one and the $\Lambda^1 s$ are the factors that distribute income among all the periods when consumption is planned at period one, hence the superscript.[15] The closed form solution for each period's savings can be found by plugging the above expressions for consumption into the non-consolidated budget constraint (10), which yields the expression for savings at time t as planned in period one, given by

$$S_t^1 = S_{t-1}^1(1+r) + Y_t - C_t^1,$$

which holds for periods one to three, since $S_4^1 = 0$. As the Λ factors show, the way income is allocated among periods crucially depends on the relative values of ρ and r. Note that if $\rho = r$ consmuption is the same in all four periods. In what follows, I study what happens when housing is added to this very simple set up.

[15]A numerical superscript indicates the period at which a particular variable is evaluated. Except for consumption and savings, in which case a numerical superscript indicates the period at which they where planned.

Life Cycle Model With Housing: The Case of a Buyer

In this section I consider the case of a household that owns the house it occupies. To buy a house in the Netherlands there is no downpayment required. The only requirement is that the income level of the household is high enough to cover the mortgage installments. Therefore, since there is previous income required, I consider the house is purchased at the start of the second period, hence the household is a renter in the first period. Because there is no bequest motive, the house is sold at the beginning of the last period. Therefore, in the last period, the household is again a renter. For simplicity, I do not consider the possibility of selling the house in periods two and three.

I start by writing the non-consolidated budget constraint of a homeowner for each one of the four periods. Given that the homeowner buys the house in the second period and sells it in the fourth (in both cases at the beginning of the period), and that the mortgage schedule needs to be satisfied, the non-consolidated budget constraints of a buyer for each one of the four are given by

$$Y_1 = C_1 + S_1 + K_1,$$

$$S_1(1+r) + Y_2 + (1-r^M)M = C_2 + S_2 + \alpha_2 H,$$

$$S_2(1+r) + Y_3 = C_3 + S_3 + M(1+r^M),$$

$$S_3(1+r) + Y_4 + \alpha_4 H(1-\phi) = C_4 + K_4,$$

respectively, where H is (constant) housing, α_t is the real price of housing, ϕ is the transaction cost related to selling the house, M is the borrowed amount in period two to pay for the house, r^M is the interest rate on the mortgage and K_t is the rental price. The αs are the ratio of the price of housing over the general price level (housing excluded). The rate of change in house prices is given by μ_t. If μ_t is equal to general inflation, the real value of the house is constant. I assume constant general price level, hence it holds that $\alpha_t = \alpha_{t-1}(1+\mu_t)$. The household borrows in period two an amount M, which uses to afford the 100 % of the house price, which is $\alpha_2 H$. Therefore, $M = \alpha_2 H$ and both M and $\alpha_2 H$ cancel each other out in the non-consolidated budget constraint corresponding to the second period. This amount is repaid at the end of period three, while mortgage interests are paid both in period two and period three. As mentioned above, the household is a renter in the first and last periods. Therefore, in each of these periods it pays the rental price $K_t = \kappa + \delta\alpha_t H$, where κ is a constant factor and δ is the effect of the house value on the rental price. If $\delta = 0$ the rental price is independent of the home value. Like in the second section above, it holds again that $S_0 = S_4 = 0$.

I assume that there is uncertainty regarding the value of μ_t. In turn, this implies uncertainty regarding future house and rental prices. I assume the expected value of μ_t is positive and constant, which means the household expects a constant increase in house prices over time. Taking these assumptions into account, the consolidated budget constraint for a homeowner that sets an optimal plan for consumption and savings at the beginning of period one can be written as

$$\Omega^1 + E_1 \frac{\alpha_4 H(1-\phi)}{(1+r)^3} = \sum_{t=1}^{4} \frac{C_t^1}{(1+r)^{t-1}} + K_1 + E_1 \left(\frac{Mr^M}{(1+r)} + \frac{M(1+r^M)}{(1+r)^2} + \frac{K_4}{(1+r)^3} \right), \quad (14)$$

where the expectations operator appears due to the uncertainty in μ_t. The second term on the left hand side of (14) denotes the amount the household is expecting to receive when the house is sold at the beginning of the fourth period. The last term on the right hand side, denotes expected future housing costs. The rental price in the first period is excluded from the expectation since it is already known in the planning period. Following Campbell and Cocco (2007), I define the following utility function featuring separability between consumption and housing

$$U(C_t^1, H) = \sum_{t=1}^{4} \frac{1}{(1+\rho)^{t-1}} \left(\frac{(C^1)_t^{1-\gamma}}{1-\gamma} + \theta \frac{(H(1+\lambda))^{1-\gamma}}{1-\gamma} \right), \quad (15)$$

where θ denotes the preference for housing and λ represents the utility gain from owning the occupied house. This implies $\lambda = 0$ for a renter and $\lambda \geq 0$ for an owner. In the latter case, the value of λ depends on the household preference for owning. Note that (14) is the same CRRA type of function as (11) but with housing included.

Due to the separability feature, the marginal utility of consumption is not affected by housing. Therefore, choosing consumption to maximize utility subject to the budget constraint yields the same Euler equation as given by equation (13). This simplifies the matter since it allows studying changes in the value of housing solely as an income effect. Using the budget constraint (14) to find the closed form solution for consumption, I find

$$\begin{aligned} C_t^1 &= \frac{\Omega^1}{\Lambda_t^1} + \frac{1}{\Lambda_t^1} E_1 \left(\frac{\alpha_4 H(1-\phi)}{(1+r)^3} - K_1 - \frac{Mr^M}{(1+r)} - \frac{M(1+r^M)}{(1+r)^2} - \frac{K_4}{(1+r)^3} \right) \\ &= \frac{\Omega^1 + E_1 \Xi^1}{\Lambda_t^1}, \end{aligned}$$

where Ξ^1 is what I call the owning factor and represents the share of lifetime income derived from houseing as evaluated in period one, hence the superscript. The above result holds for all periods from one to four. Note that K_1 can be taken out of the expectation and that for period one realized consumption is equal to planned consumption. The owning factor is the only change with respect to the closed form solutions for consumption found in the second section. Any change in the owning factor that is known in the planning period will be distributed among the four periods according to the Λ_t^1 factors.

Again, the solution for savings can be found by using the non-consolidated budget constraint for every period. For each period, planned savings is be given by

$$S_1 = Y_1 - C_1 - K_1,$$

$$S_2^1 = S_1(1+r) + Y_2 - C_2^1 - E_1 Mr^M,$$

$$S_3^1 = S_2^1(1+r) + Y_3 - C_3^1 - E_1 M(1+r^M),$$

and $S_4^1 = 0$. It becomes clear now that unexpected changes in the value of housing will have an effect on consumption and saving behaviour. I leave the analysis of the consequences of a change in the value of housing for the fifth section of this appendix.

Life Cycle Model With Housing: The Case of a Renter

In this section I consider the case of a household that rents the house it occupies. Just like in the case of an owner, I start by writing the non-consolidated budget constraints for each period, which, in generic form, are given by

$$S_{t-1}(1+r) + Y_t = C_t + S_t + K_t,$$

where once more we have $S_0 = S_4 = 0$ and $K_t = \kappa + \delta\alpha_t H$. The consolidated budget constraint for a household that solves the maximization problem at the beginning of the first period can be written as

$$\Omega^1 = \sum_{t=1}^{4} \frac{C_t^1 + E_1 K_t}{(1+r)^{t-1}}. \tag{16}$$

Employing the same CRRA utility function as the one given in equation (15) and setting $\lambda = 0$, I arrive again to the Euler equation as given by equation (13). Combining the Euler equation and the consolidated budget constraint (16), I find the closed form solutions for consumption, which are given by

$$C_t^1 = \frac{\Omega_1}{\Lambda_t^1} - \frac{1}{\Lambda_t^1} E_1 \sum_{t=1}^{4} \frac{K_t}{(1+r)^{t-1}} = \frac{\Omega^1 - E_1 \Psi^1}{\Lambda_t^1},$$

where Ψ^1 is what I call the renting factor which includes lifetime rental payments as evaluated in period one. Note that K_1 can be taken out of the expectation and that in period one planned consumption is equal to realized consumption. Just like in the case of the owining factor, any change in the renting factor that is known in the planning period will be distributed among the four periods according to the Λ_t^1 factors. Again the solution for savings can be found by using the non-consolidated budget constraint for every period, which yields

$$S_t^1 = S_{t-1}^1(1+r) + Y_t - C_t^1 - K_t$$

for periods one to three. Again $S_4^1 = 0$ due to the lack of a bequest motive.

The Effect of Housing Price Declines on Consumption and Savings

Within the context of the model presented in this document, there are different possible ways of studying the effect of changes in the price of housing on savings and consumption. Since the model I present here is the basis to study the effects of the decline in house prices observed in the Netherlands since 2008, I consider an unexpected decline in the rate of change in house prices, μ_t, from positive to negative. This implies a negative surprise for the household, since, as stated above, the household expects μ_t to be positive and constant over time. Once the surprise takes place, the household expects that the rate of change in house prices will come back to its previous level after one period and stay constant from that moment onwards. That means the negative surprise has no effect on expected future changes in house prices. The information about the change becomes available at the beginning of the period in which it takes place.

I study the reaction in terms of consumption and savings when the drop in μ_t takes place in the second, third or fourth period. Therefore I consider three different scenarios for a particlar household. It is clear that if the change takes place in the first period the new information will be automatically incorporated in the decision determining the optimal plan. However, if the unexpected change in μ_t takes place between the second and fourth period, the household will reoptimize consumption and savings behaviour of that period and of those that are still to come. In the latter cases, realized consumption will differ from the plan set in period one. In what follows I show how the size of the contemporaneous effect of a change in α_t imlpied by a negative μ_t is contigent on the stage of the life cycle.

I start by focusing on the case of the buyer. If the change takes place in the second period, *i.e.* $\mu_2 < 0$, I assume that it happens right after the home purchase, which implies that the mortgage payment will not be affected by the drop in house prices .[16] Therefore, reoptimization implies choosing C_2, C_3 and C_4 to maximize the utility function (15) subject to the updated budget constraint

$$\Omega^2 + E_2 \frac{\alpha_4 H(1-\phi)}{(1+r)^2} = \sum_{t=2}^{4} \frac{C_t^2}{(1+r)^{t-2}} + Mr^M + E_2 \left(\frac{M(1+r^M)}{(1+r)} + \frac{K_4}{(1+r)^2} \right), \tag{17}$$

where

$$\Omega^2 = \sum_{t=2}^{4} \frac{Y_t}{(1+r)^{t-2}}.$$

Note that $E_2\alpha_4 = \alpha_1(1+\mu_2)E_2(1+\mu_3)(1+\mu_4) < E_1\alpha_4 = E_1\alpha_1(1+\mu_2)(1+\mu_3)(1+\mu_4)$, since the realized value of μ_2 is lower than was expected in period one. Therefore, the household is negativelly surprised and now expects to sell the house in the last period for a lower price than it was expected in period one. Since the decline in house prices is not taken into account in the price paid for the newly acquired house, the mortgage payments remain the same. Reoptimization consits of maximizing

$$U(C_t^2) = \sum_{t=2}^{4} \frac{1}{(1+\rho)^{t-2}} \left(\frac{(C_t^2)^{1-\gamma}}{1-\gamma} + \theta \frac{(H(1+\lambda))^{1-\gamma}}{1-\gamma} \right),$$

subject to the updated budget constraint (17), which yields

$$C_t^2 = \frac{\Omega^2}{\Lambda_t^2} + \frac{1}{\Lambda_t^2} E_2 \left(\frac{\alpha_4 H(1-\phi)}{(1+r)^2} - Mr^M - \frac{M(1+r^M)}{(1+r)} - \frac{K_4}{(1+r)^2} \right) = \frac{\Omega^2 + E_2 \Xi^2}{\Lambda_t^2},$$

[16] This assumption is grounded on the fact that in this section I want to study the effect of house price declines for the case of homeowners, and not soon-to-be homeowners.

where

$$\Lambda_2^2 = 1 + \left(\frac{1+r}{1+\rho}\right)^{\frac{1}{\gamma}} \frac{1}{(1+r)} + \left(\frac{1+r}{1+\rho}\right)^{\frac{2}{\gamma}} \frac{1}{(1+r)^2},$$

$$\Lambda_3^2 = \left(\frac{1+\rho}{1+r}\right)^{\frac{1}{\gamma}} + \frac{1}{(1+r)} + \left(\frac{1+r}{1+\rho}\right)^{\frac{1}{\gamma}} \frac{1}{(1+r)^2},$$

and

$$\Lambda_4^2 = \left(\frac{1+\rho}{1+r}\right)^{\frac{2}{\gamma}} + \left(\frac{1+\rho}{1+r}\right)^{\frac{1}{\gamma}} \frac{1}{(1+r)} + \frac{1}{(1+r)^2}.$$

Note that Mr^M can be taken out of the expectation since it is already realized in the second period and that for the second period planned consumption is equal to realized consumption.

Assuming that the loss implied by the decrease in the expected value of housing is larger than the benefit implied by the expected decrease in the fourth period rental price, the period two decline in house prices reduces lifetime income and thus implies, ceteris paribus, a reduction in consumption. However, the decline in consumption is smoothed over periods two, three and four. Note that the effect on consumption would be ambiguous if mortgage payments were allowed to change as well.

To study the contemporaneous effect of the house price decline, I define realized consumption in period two as a function of the plan set in period one and a forecast error, *i.e.*

$$C_2 = C_2^1 + \eta_2,$$

where η_2 is the forecast error denoting the difference between realized and planned consumption in period two. The forecast error appears directly as a consequence of the unexpected change in house prices. Since I am considering a decline in house prices, the forecast error is negative, which means that realized consumption is smaller than planned consumption.

If the household is in the third stage of the life cycle when the change in μ_t takes place, reoptimization will imply choosing C_3 and C_4 to maximize utility subject to the updated budget constraint

$$\Omega^3 + E_3 \frac{\alpha_4 H(1-\phi)}{(1+r)} = \sum_{t=3}^{4} \frac{C_t^3}{(1+r)^{t-3}} + M(1+r^M) + E_3 \frac{K_4}{(1+r)}, \tag{18}$$

where the change in α_3 implied by the surprise in μ_3 represents exactly the same change in lifetime income as when the price decline was considered in the second period of the life cycle.[17] That is the case because of three reasons: first, I am always considering the same unexpected change in μ_t; second, $E_t\mu_t$ is constant and positive over time and, third, in the periods previous the houseprice decline I assume the expectations about μ_t were satisfied. These assumptions have the advantage of allowing the evaluation of exactly the same drop in lifetime income, but at different stages of the life cycle.

[17] That means $E_2\alpha_4$ takes the same value irrespective of whether the decline in house prices takes place in the second or thrid periods. Therefore, the household expects to sell the house for the same diminished value no matter when the decline in the price takes place. However, the time between the surprise in house prices and the sell of the house does play a role.

Maximizing utility subject to the updated budget constraint (18) yields

$$C_t^3 = \frac{\Omega^3}{\Lambda_t^3} + \frac{1}{\Lambda_t^3} E_3 \left(\frac{\alpha_4 H(1-\phi)}{(1+r)} - M(1+r^M) - \frac{K_4}{(1+r)} \right) = \frac{\Omega^3 + E_3 \Xi^3}{\Lambda_t^3},$$

where

$$\Lambda_3^3 = 1 + \left(\frac{1+r}{1+\rho} \right)^{\frac{1}{\gamma}} \frac{1}{(1+r)},$$

and

$$\Lambda_4^3 = \left(\frac{1+\rho}{1+r} \right)^{\frac{1}{\gamma}} + \frac{1}{(1+r)}.$$

Note that $M(1+r^M)$ could be taken out of the expectation and for period three planned consumption equals realized consumption. The household has now only two periods to smooth the shock implied by the drop in lifetime income. Therefore, the contemopraneous negative effect on consumption for a household in the third stage of the life cycle is greater than for a household that is on the second stage of the lifecycle. Once again the contemporanous effect of the decline in house prices can be depicted by writing realized consumption as a function of the plan set in period one plus a forecast error, *i.e.*

$$C_3 = C_3^1 + \eta_3.$$

If the household is in the fourth stage of the life cycle when the change in μ_t takes place, reoptimization will imply choosing only C_4 to maximize utility subject to the updated budget constraint

$$Y_4 + \alpha_4 H(1-\phi) = C_4 + K_4,$$

which directly yields

$$C_4 = Y_4 + \alpha_4 H(1-\phi) - K_4 = Y_4 + \Xi^4,$$

where there are no expectations and planned consumption is equal to realized consumption. Now the full shock to lifetime income is absorved by a reduction in consumption in period four. Therefore, the contemporaneous shock to consumption is the greatest when the household is at the last stage of the life cycle. These results make sense, since the longer is the planning horizon when the shock takes place the more periods there are to absorve it and the smallest is the contemporaneous effect on consumption. Once again, the contemporanous effect of the decline in house prices can be depicted by writing realized consumption as

$$C_4 = C_4^1 + \eta_4.$$

To find the effect on savings, I use the expressions that derive from the unconsolidated budget constraints, which are given in the third section. As it is shown there, for a given level of income and mortgage payments, savings will change by the same amount but in the opposite direction as consumption. By the same result given for consumption, the savings increase will be higher the later in life the shock occurs, with the exception of the fourth period, for which it still holds that $S_4 = 0$ due to the absence of a bequest motive. Just like I have done for consumption, the contemporaneous effect of a house price decline on savings can be studied by expressing realized savings as planned savings plus a forecast error. The contemporenous effect on savings of a change in house prices in period two and three is then given by

$$S_2 = S_1^*(1+r) + Y_2 - C_2^1 - Mr^M - \eta_2$$

and

$$S_3 = S_2^*(1+r) + Y_3 - C_3^1 - M(1+r^M) - \eta_3$$

respectively. Note that plugging in a negative surprise in lifetime income implied by a decline in house prices, *i.e.* $\eta_2 < 0$ and $\eta_3 < 0$ respectively, will imply an increase in realized savings above what was planned in period one.

Regarding the effect of the above considered housing shock for a household who rents the place it occupies, it can be easily seen that it will imply a decline on the rental price. That is because I have considered the rental price as a function of the value of the house. Therefore, a decline in the real vaule of the house implies a decline in the rental price as long as $\delta > 0$. This decline would imply an increase in lifetime income and thus an increase in consumption and a decrease in savings. However, this does not seem very realistic, especially for the Dutch case, where the rental market is highly regulated and, according to CBS, almost 50% of rental homes are part of social housing programs and thus rental prices are rather sticky.