Home production as a substitute to market consumption? Estimating the elasticity using houseprice shocks from the Great Recession *

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Abstract

The theory of home production suggests that people will substitute away from market consumption as the opportunity cost of time drops. This makes people able to smooth consumption in response to shocks in income. Prior studies have investigated the effect of a drop in the cost of time on home production by analyzing shocks of retirement, unemployment and disability. Such shocks both decrease the households monetary budget and increase the time budget. Hence, home production responses are the cumulative effect of decreased market consumption and increased non-market time available. The current paper contributes to the literature by estimating the intratemporal elasticity between home production and market consumption. Wealth shocks in houseprices induced by the Great Recession are used to infer the extent to which households adjusted home production in response to decreasing market consumption possibilities. By using a panel data set with detailed information on both consumption spending and time use, we find that a 10% decrease in substitutable consumption spending increases home production activities by about 6.5%. Although the scope in substitutability is rather limited, there are non-negligible possibilities to substitute away from market consumption to home production. This is in contrast with the high substitutability assumed in existing theoretical models of home production.

JEL codes: D12, D13, D91, J22, J26
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1 Introduction

In his seminal work, Becker (1965) argues that consumption is 'produced' by two inputs: market expenditures (*market consumption*) and time (*home production*). Whether the chosen consumption bundle exists of relatively many market expenditures or time depends on the relative price of time. The price of time, which is the wage foregone by spending time in non-market work, determines market expenditure. Hence, spending on market consumption is a bad proxy for actual consumption as 'time' can be used to increase consumption beyond market spending (Aguiar & Hurst, 2005). To the extent possible, market consumption can be substituted by time without changing well-being. Moreover, the theory of home production of Becker (1965) suggests that people will substitute away from market consumption as the opportunity cost of time drops. Both intertemporarily and intratemporarily (Aguiar et al., 2012). Shifting away from market consumption to home production makes people able to smooth consumption in response to shocks in income (Hicks, 2015).

Firstly, the drop in consumption spending at retirement that was long assumed to be inconsistent with the predictions of the Life-Cycle Hypothesis known as the *retirement consumption puzzle*,[1] may be explained by the increases in total time spent in home production during retirement. Hurst (2008) finds a large heterogeneity in spending changes at retirement across different categories of consumption. Especially food expenditures are found to fall sharply relative to other consumption components at retirement (Aguila et al., 2011; Hurd & Rohwedder, 2013; Velarde & Herrmann, 2014). Aguiar & Hurst (2005) explain this phenomenon by showing that retired persons use their additionally available non-market time to substitute purchased goods and services (e.g. dining out) for home production (e.g. cooking). Stancanelli & Van Soest (2012) show that the act of retirement increases time spent in home production activities next to food-related activities. So, home production makes people partially able to mitigate the consequences of retirement for well-being.

Secondly, it is found that time spent in home production activities is higher in households with unemployed individuals than in households with employed individuals (Ahn et al., 2008; Burda & Hamermesh, 2010; Taskin, 2011; Colella & Van Soest, 2013; Velarde & Herrmann, 2014). Conversely, Krueger

[1] Found by, among others, Mariger (1987); Robb & Burbidge (1989); Banks et al. (1998); Bernheim et al. (2001); Miniaci et al. (2003); Battistin et al. (2009).

& Mueller (2012) find sharp drops in home production at the time of reemployment. Hence, home production is found to fluctuate over the business cycle (Benhabib et al., 1991; Greenwood & Hercowitz, 1991; Rupert et al., 2000; Hall, 2009; Karabarbounis, 2014) as people become unemployed or reemployed. Burda & Hamermesh (2010) explicitly find evidence that individuals generally offset market hours with home production during times of high cyclical unemployment. Griffith et al. (2014) find that households lowered food spending by increased shopping effort during the Great Recession. Aguiar et al. (2013) find that about 30% of lost working hours were absorbed by home production during the Great Recession. So, home production makes people partially able to mitigate the consequences of unemployment for well-being. Home production is even partially able to mimic the role of formal unemployment insurance as Guler & Taskin (2013) suggest.

Thirdly, shocks in health are found to have consequences for time spent in home production. Health shocks increase the total non-work time available, but may also decrease the healthy non-work time available. Gimenez-Nadal & Ortega-Lapiedra (2013) find a negative relationship between health and time devoted to home production activities in Spain, e.g. people with a relatively poor health spent more hours in home production. In contrast, Halliday & Podor (2012) find that improvements to health increase time spent in home production activities in the US. Despite the fact that health has consequences for time spent in home production, the extent to which home production makes people partially able to mitigate the consequences of a health shock for consumption remains unclear.

The aforementioned shocks causing a drop in the opportunity cost of time (retirement, unemployment, disability) have two simultaneous effects 1) it decreases the *monetary budget* and 2) it increases the *time budget*. The monetary budget is decreased by the difference in earnings (wage times market hours) and social insurance (pension, unemployment benefits, disability benefits respectively) causing a drop in available income for consumption expenditures. The time budget is increased as retired, unemployed and disabled persons have considerably more non-market time available. However, prior studies do not distinguish these two effects such that the substitution between market consumption and home production found is a cumulative effect of the elasticity of home production to consumption spending and home production to non-market time.

Focusing on food expenditures of Mexican prime age workers, Hicks (2015) has estimated a (semi-)elasticity between home production and consumption spending possibilities.[2] By estimating the effect of permanent income on different food categories that differ in time needed to produce the food, Hicks (2015) finds a negative effect of permanent income on home production. Despite the fact that using permanent income solves the problems with the time budget, identification comes from differences between poorer and richer persons. Identifying within person responses using transitory shocks are, like previous studies, modeled using unemployment thereby introducing the problem of a non-constant time budget.

Compared to prior studies, the current paper identifies the intratemporal substitution effect between market consumption and home production from differences within a person over time, while keeping the time budget constant. This would be a direct measure of the extent to which individuals can smooth consumption while facing a shock in income. As time spent in home production and consumption spending is determined simultaneously, we identify the elasticity by the drop in houseprices observed during the Great Recession as a wealth shock. The drop in houseprices during the Great Recession were unexpected and sufficiently substantial to decrease the monetary budget. Angrisani et al. (2013) and Christelis et al. (2015) find substantial decreases in consumption spending due to the drop in houseprices. At the same time, there is no reason to expect to that this shock in wealth changed the total time available for home production.[3] Therefore, the responses in home production due to drops in houseprice, as analyzed by Kuehn (2015), should be caused by their effect on the monetary budget in stead of the time budget. Kuehn (2015) does not differentiate between the two effects which may explain the ambiguity of his results.

We use a unique panel data set with detailed information on both consumption- and time-use categories produced by combining the HRS with CAMS data for the years 2005-2011. To the best of our knowledge there is only a handful of papers that uses panel data with detailed information on both consumption spending and time use. The data in (Colella & Van Soest, 2013) is such an example but is restricted to the Netherlands for the period 2009-2012. Some home production papers only have infor-

[2]The Mexican ENIGH data used in Hicks (2015) is a cross-sectional data set. We focus on all spending categories for U.S. persons aged 51 and over using panel data.

[3]This assumption holds conditionally on the assumption that the houseprice drops during Great Recession are not associated with increases in total time available. However, we know that the Great Recession induced unemployment. Therefore, we only select retired individuals for our empirical analysis since these persons' time budget did not change during the Great Recession.

mation regarding time use (Burda & Hamermesh, 2010; Aguiar et al., 2013). Data with information on both consumption and time use are often imperfect because of a cross-sectional setting (Ahn et al., 2008) or because of a focus on a very specific expenditure such as food (Velarde & Herrmann, 2014; Griffith et al., 2014; Hicks, 2015).

We find an elasticity of home production with respect to market spending of -0.65. The elasticity is mostly driven by persons with a drop in the value of their relatively cheap home that is free of mortgage and who spent relatively much on market consumption that can be substituted for by home production prior to the Great Recession. Contrasting existing theoretical models of home production that typically assume high substitutability between market consumption and home production (Campbell & Ludvigson, 2001),[4] we conclude that the scope of substituting market spending for home production is fairly small. This implies that most of the home production responses found by earlier studies are primarily the consequence of increased non-market time available.

The remainder of the paper is organized as follows. Section 2 describes the HRS and CAMS data used in the paper. Descriptive statistics of time use and consumption spending are presented in Section 3. To analyze home production formally, Section 4 presents a simple life-cycle model with home production and wealth shocks. The functional form and the empirical model are derived in Section 5 and Section 6 respectively. The results of the empirical model are shown in Section 7. Conclusions regarding the substitutability of home production and market consumption can be found in Section 8.

2 Data

The data for our empirical analyses come from the Health and Retirement Study (HRS), a longitudinal survey that is representative of the U.S. population over the age of 50 and their spouses. The HRS conducts core interviews of about 20,000 persons every two years. In addition the HRS conducts supplementary studies to cover specific topics beyond those covered in the core surveys. The time use data we use in this paper were collected as part of such a supplementary study, the Consumption and Activities

[4] Baxter & Jermann (1999) indicate that a plausible range of the elasticity would be between 0 and 5. Aguiar et al. (2012) describe that most of the estimated elasticities exceed 1 in the literature. However, micro estimates seem to produce somewhat smaller elasticities than macro estimates. A commonly assumed benchmark in theoretical models is 3 (Greenwood et al., 1995; Baxter & Jermann, 1999), while an elasticity of 5 is used as well (Benhabib et al., 1991).

Mail Survey (CAMS).

Health and Retirement Study Core interviews

The first wave of the HRS was fielded in 1992. It interviewed people born between 1931 and 1941 and their spouses, irrespective of age. The HRS re-interviews respondents every second year. Additional cohorts have been added so that beginning with the 1998-wave the HRS is representative of the entire population over the age of 50. The HRS collects detailed information on the health, labor force participation, economic circumstances, and social well-being of respondents. The survey dedicates considerable time to elicit income and wealth information, providing a complete inventory of the financial situation of households. In this study we use demographic and asset and income data from the HRS core waves spanning the years 2002 through 2010.

Consumption and Activities Mail Survey

The CAMS survey aims to obtain detailed measures of time use and total annual household spending on a subset of HRS respondents. These measures are merged to the data collected on the same households in the HRS core interviews. The CAMS surveys are conducted in the HRS off-years, that is, in odd-numbered years.

The first wave of CAMS was collected in 2001 and it has been collected every two years since. Questionnaires are sent out in late September or early October. Most questionnaires are returned in October and November. CAMS thus obtains a snap-shot of time use observed in the fall of the CAMS survey year. In the first wave, 5,000 households were chosen at random from the entire pool of households who participated in the HRS 2000 core interview. Only one person per household was chosen. About 3,800 HRS households responded, so CAMS 2001 was a survey of the time-use of 3,800 respondents and the total household spending of the 3,800 households in which these respondents live. Starting in the third wave of CAMS, both respondents in a couple household were asked to complete the time use section, so that the number of respondent-level observations on time use in each wave was larger for the waves from 2005 and onwards.

Respondents were asked about a total of 31 time-use categories in wave 1; wave 2 added two more categories; wave 4 added 4 additional categories. Thus, since CAMS 2007 the questionnaire elicits 37 time-use categories, as shown in Appendix A. Of particular interest for this study are the CAMS time use categories related to home production:

- House cleaning
- Washing, ironing or mending clothes
- Yard work or gardening
- Shopping or running errands
- Preparing meals and cleaning up afterwards
- Taking care of finances or investments, such as banking, paying bills, balancing the checkbook, doing taxes, etc.
- Doing home improvements, including painting, redecorating, or making home repairs
- Working on, maintaining, or cleaning car(s) and vehicle(s)

For most activities respondents are asked how many hours they spent on this activity last week. For less frequent categories they were asked how many hours they spent on these activities last month. Hurd & Rohwedder (2008) provide a detailed overview of the time use section of CAMS, its design features and structure, and descriptive statistics. A detailed comparison of time use as recorded in CAMS with that recorded in the American Time Use Survey (ATUS) shows summary statistics that are fairly close across the two surveys, despite a number of differences in design and methodology (Hurd & Rohwedder, 2007).

In this paper we use data from CAMS 2005, 2007, 2009 and 2011, each wave containing between about 5,300 and 6,500 respondent-level observations on time use that we merge with HRS core data. Combining the data from the HRS core and the CAMS provides us with data that are unique in that we observe demographics, economic status, time-use and spending for the same individuals and their households in panel.

The data for this study come from the HRS. In 2001, the HRS added a supplemental survey eliciting details of household spending, the *Consumption and Activities Mail Survey* (CAMS). Since then the

CAMS has been collected every two years (odd-numbered years) in the years between the core HRS interviews. For the 2001 CAMS sample some 5,000 HRS households were randomly selected from participants in the HRS 2000 core interview. As new cohorts were added to the HRS in 2004 and 2010 a random subsample of the new households was again added to the CAMS sample for subsequent CAMS data collections. The sample is representative for the US population over the age of 50.

The CAMS questionnaire consists of two parts: Part A asks about time use in about 35 categories and Part B asks about household spending in about 40 categories. For couples, the main respondent who fills out both sections of the survey is chosen at random and encouraged to solicit help from other household members in completing the questions about household spending. The respondent fills out the time use section referring only to his or her own personal time-use while the spending questions on spending ask about the spending of the entire household. Starting in 2005, a spouse questionnaire was added for couples which requested that the spouse fill out the time use questions referring to his or her personal time use.

In this study we will therefore use CAMS data from 2005, 2007, 2009 and 2011 where we have time use data on both spouses for couples. The CAMS data can be linked to the rich background information that respondents provide in the HRS core interviews. Rates of item nonresponse are very low (mostly single-digit), and CAMS spending totals aggregate closely to those in the CEX (Hurd & Rohwedder, 2009). The time use part of CAMS elicits time spent last week in 20 activities, and time spent last month in 13 additional activities, and the number of days on trips or vacation over the past year. These time use data aggregate closely to categories of time use in the American Time Use Study (Hurd & Rohwedder, 2007).

3 Descriptive statistics

3.1 Consumption

Table 1 shows the household spending on consumption that can be substituted for by home production. The waves prior to the Great Recession show that spending is on average more substantial than in the waves after the Great Recession. Interestingly, comparing wave 2007 to wave 2009 shows that total consumption spending decreased by about 6% while total substitutable consumption decreased by about 17%. This larger drop in substitutable consumption implies that households' spending on substitutable consumption has a stronger cyclical reaction than total consumption. That is because households may have found it easier to shift away from market consumption that well substitutable by home production.

Substitutable consumption is about 11-12% of total consumption spending and is consistent across waves. This makes the substitutable consumption spending a non-negligible part of total consumption spending. The biggest component of the substitutable consumption spending consists of dining out expenditures. This expenditure could be well substituted for by home production in the form of cooking. Standard deviations of the spending categories are relatively big compared to the mean. The relative size of the standard deviation compared to the mean is much smaller for the total of consumption spending. This suggest that there is especially large heterogeneity in consumption spending that could be substituted for by home production activities. We observe that virtually all households have expenditures that could be substituted for by home production although the percentage of households with spending on substitutable consumption decreased in later waves.

Table 1: Household level consumption spending (US dollars per year)[a]

	Wave 2005				Wave 2007				Wave 2009				Wave 2011			
	Mean	S.D.	% Total	% Households	Mean	S.D.	% Total	% Households	Mean	S.D.	% Total	% Households	Mean	S.D.	% Total	% Households
Dining out	1,912	3,530	4.7	85.0	1,808	2,912	4.5	84.5	1,513	2,096	4.0	83.9	1,598	2,443	4.4	81.2
Housekeeping services	414	1,194	1.0	49.3	386	1,054	1.0	49.5	331	984	1.0	45.2	349	1,014	1.0	43.4
Gardening services	381	1,371	1.0	34.2	355	1,179	1.0	33.8	314	833	1.0	35.6	296	854	0.8	33.5
Homerepair services	1,347	3,923	3.3	49.8	1,465	6,515	3.7	48.5	1,068	2,829	2.8	48.4	1,006	3,534	2.8	43.2
Vehicle maintenance	649	875	1.6	83.0	614	804	1.5	81.6	618	809	1.6	80.4	598	833	1.6	78.2
Dishwasher	23	115	0.0	4.4	27	127	0.0	5.0	19	105	0.0	3.6	15	91	0.0	3.5
Washing/Drying machine	63	250	0.0	8.7	76	293	0.0	9.7	68	278	0.0	9.2	53	232	0.0	8.3
Substitutable consumption	4,788	6,633	11.8	96	4,730	8,253	11.9	95	3,931	4,748	10.5	95	3,915	5,557	10.8	94
Substitutable consumption excl. durables	4,703	6,590	11.6	96	4,627	8,201	11.6	95	3,844	4,700	10.2	95	3,847	5,515	10.6	93
Substitutable consumption incl. suppl. mat.	6,487	8,069	16.0	99	6,387	9,878	16.0	99	5,342	5,795	14.2	99	5,382	7,071	14.8	98
Total consumption	40,558	29,427	100	100	39,904	29,268	100	100	37,515	25,778	100	100	36,359	26,086	100	100

[a] Monetary measures are expressed in 2011 US dollars using the Consumer Price Index of the Bureau of Labor Statistics.

3.2 Time use

Table 2 shows the time spent in home production activities per wave by persons aged 51-80. These activities can be used as a substitute for the market bought goods and services shown in Table 1. The aggregate of home production activities shows that a non-negligible part of the weekly available time is spent on home production and that virtually all persons engage in some form of home production. Hence, issues regarding left-censoring of the home production variable are negligible.

Most of the home production is devoted to the cooking of meals. Together with the house cleaning, this accounts for about half of total time spent in home production. More than 80% of the persons in the data spend some time on these two home production activities. About 90% of the people engage in shopping activities although the average time spent in this activity is somewhat smaller than the time spent in house cleaning and cooking. Unlike activities such as house cleaning, cooking and doing the laundry, it is harder to buy the service for shopping on the market which may explain the relatively high percentage of persons engaging in this activity. Approximately half of the people engage in gardening and maintenance of the home and vehicles but the amount of time spent in these activities are fairly small. More than 80% of the people spend time on managing their finances, but the amount of time spent in this activity is only about an hour per week.

Despite the fact that a non-negligible part of the weekly available time is devoted to home production activities on average, there is a lot of variation around this average as the standard deviations of most activities are about the same size as the averages (or even bigger). However, the variation across waves is only marginal despite the observed drop in substitutable market consumption in Table 1. This might suggest that people do not adjust their time use in home production that much during the course of the business cycle.

Table 2: Time-use in home production activities (hours per week)

	Wave 2005				Wave 2007				Wave 2009				Wave 2011			
	Mean	S.D.	% Total	% Respondents	Mean	S.D.	% Total	% Respondents	Mean	S.D.	% Total	% Respondents	Mean	S.D.	% Total	% Respondents
House cleaning	4.7	6.3	21.2	80.8	4.8	7.1	22.0	82.1	4.7	6.1	21.9	83.0	4.8	6.5	22.2	83.3
Laundry	2.6	3.7	11.7	72.9	2.7	4.7	12.4	72.9	2.6	3.7	12.1	73.9	2.6	4.0	12.0	72.8
Gardening	2.2	4.9	9.9	50.4	2.2	4.2	10.1	52.4	2.3	4.5	10.7	51.9	2.2	4.7	9.3	49.4
Shopping	3.9	4.9	17.6	88.5	3.8	4.7	17.4	87.4	3.8	4.5	17.7	89.1	3.8	4.2	17.6	88.1
Cooking	6.4	6.9	28.8	85.8	6.3	7.2	28.9	85.9	6.3	6.6	29.3	86.7	6.2	6.6	28.7	86.2
Financial management	1.0	2.1	4.5	85.6	1.0	2.0	4.6	83.5	0.8	1.4	3.7	83.4	0.9	1.6	4.2	83.3
Home maintenance	1.0	3.0	4.5	45.8	0.8	2.0	3.7	44.2	0.7	2.5	3.3	40.1	0.7	2.2	3.2	39.2
Vehicle maintenance	0.4	0.9	1.8	52.1	0.3	0.7	1.8	51.7	0.3	0.9	1.4	48.5	0.4	1.1	1.9	48.6
Home production	22.2	19.4	100	98.5	21.8	21.1	100	98.1	21.5	17.7	100	97.9	21.6	20.1	100	98.4

Together, Table 2 and Table 1 give some idea on the scope of substituting market purchases for home production activities. To capture the possible substitution effects between the two more formally, we present a life-cycle model with home production in the next section.

4 Model

4.1 A simple Life-Cycle Model with Home Production

The extension of the life-cycle model to allow for complementarity or substitutability between time and consumption proposed by Laitner & Silverman (2005) reduces to the standard life-cycle model for persons whose leisure is fixed (retirees, unemployed, disabled). Since our identifying assumption is a non-changing time budget available, we need to explicitly incorporate home production in the life-cycle model following Becker (1965); Gronau (1977); Apps & Rees (1997); Rupert et al. (2000); Apps & Rees (2005). This introduces home produced goods c_{nt} next to the classical market consumption c_{mt} and leisure l_t such that individuals maximize

$$U_\tau = max \mathbb{E}_\tau \left[\sum_{t=\tau}^{T} (1+\rho)^{\tau-t} u(c_{mt}, c_{nt}(h_{nt}), l_t) \psi(v_t) \right] \tag{1}$$

where c_t and l_t denote consumption and leisure in time period t, respectively. ρ is the discount factor and T the time horizon of the household. v_t are the personal- and household characteristics that influence utility directly known as taste-shifters (e.g. age, household size, number of children). $c_{nt}(h_{nt}) = g_t(h_{nt})$ is being the home production function with time spent in home production h_{nt}. For simplicity, we assume that the home production function is strictly concave in one variable input,[5] namely the time spent in home production. Individuals maximize Equation 1 under the time budget and monetary budget constraint respectively

$$h_{mt} = H - l_t - h_{nt} \tag{2}$$

$$A_{t+1} = (1+r)(A_t + (w_t \cdot h_{mt}) + b_t - c_{mt}) \tag{3}$$

[5]Relaxing this assumption would give $c_{nt}(h_{nt}) = g_t(x_t, h_{nt})$ with x_t as market purchased inputs used in home production. Working with this relaxed assumption would give an additional expenditure term in the budget constraint.

$$A_T \geq 0 \tag{4}$$

where A_t is the amount of assets at time t, r is a constant real interest rate, w_t is the (after-tax) wage rate, H the total time-endowment (e.g. 24 hours per day) and b_t are benefits (e.g. pensions, unemployment benefits, disability benefits and other unearned non-asset income).

Solving equation 1 subject to equations 3 and 2 gives the following Euler Equations of marginal utility with respect to c_{mt} (market goods), h_{nt} (home production) and h_{mt} (market production).

$$u_{c_{mt}}(c_{mt}, c_{nt}(h_{nt}), l_t)\psi(v_t) = \left(\frac{1+r}{1+\delta}\right)\mathbb{E}_t\left[u_{c_{mt+1}}(c_{mt+1}, c_{nt+1}(h_{nt+1}), l_{t+1})\psi(v_{t+1})\right] \tag{5}$$

$$u_{h_{mt}}(c_{mt}, c_{nt}(h_{nt}), l_t)\psi(v_t) = -w_t\left(\frac{1+r}{1+\delta}\right)\mathbb{E}_t\left[u_{h_{mt+1}}(c_{mt+1}, c_{nt+1}(h_{nt+1}), l_{t+1})\psi(v_{t+1})\right] \tag{6}$$

$$u_{h_{nt}}(c_{mt}, c_{nt}(h_{nt}), l_t)\psi(v_t) = w_t\left(\frac{1+r}{1+\delta}\right)\mathbb{E}_t\left[u_{h_{nt+1}}(c_{mt+1}, c_{nt+1}(h_{nt+1}), l_{t+1})\psi(v_{t+1})\right] \tag{7}$$

where $\left(\frac{1+r}{1+\delta}\right)\mathbb{E}_t\left[u_{c_{mt+1}}(c_{mt+1}, c_{nt+1}(h_{nt+1}), l_{t+1})\psi(v_{t+1})\right]$ captures the marginal utility of wealth. In other words, the optimal level of consumption of market goods is where the marginal utility of consumption of market goods equals the marginal utility of wealth (taking into account a fixed interest rate and discount factor). The marginal utility of wealth takes into account all future expectations. Similarly, the marginal utility of market production and home production depend on the marginal utility of wealth as well as the wage rate. A higher wage rate, however, increases the marginal utility of market production and decreases the marginal utility of home production for which the wage rate is an opportunity cost. The model predicts that the marginal utility of market production and home production is equal across different activities.

Expressions 5 and 7 imply that market consumption and home production are functions of the individual's current characteristics that determine the wage as well as all relevant information about other periods, including future periods. To see this, introducing an expectation error ε_{t+1} allows us to rewrite the Euler Equations into

$$u_{c_{mt}}(c_{mt+1}, c_{nt+1}(h_{nt+1}), l_{t+1})\psi(v_{t+1}) = \left(\frac{1+\delta}{1+r}\right) u_{c_{mt}}(c_{mt}, c_{nt}(h_{nt}), l_t)\psi(v_t) + \varepsilon_{t+1} \tag{8}$$

$$u_{h_{mt}}(c_{mt+1}, c_{nt+1}(h_{nt+1}), l_{t+1})\psi(v_{t+1}) = -w_t \left(\frac{1+\delta}{1+r}\right) u_{h_{mt}}(c_{mt}, c_{nt}(h_{nt}), l_t)\psi(v_t) + \varepsilon_{t+1} \tag{9}$$

$$u_{h_{nt}}(c_{mt+1}, c_{nt+1}(h_{nt+1}), l_{t+1})\psi(v_{t+1}) = w_t \left(\frac{1+\delta}{1+r}\right) u_{h_{nt}}(c_{mt}, c_{nt}(h_{nt}), l_t)\psi(v_t) + \varepsilon_{t+1} \tag{10}$$

where ε_{t+1} is uncorrelated with all the information available at time t. The rewritten expressions explicitly show the recursive nature of the marginal utility of wealth in which only an unanticipated shock (ε_{t+1}) can result into a deviation from the optimal path. This implies that the marginal utility of wealth at time t is a function of (in our case) a constant representing the ratio between the interest rate and the discount rate as well as a term that captures the individual specific effects (e.g. fixed effects) and a random error that reflects the expectational error up to the current period. We use these facts to derive our empirical model later.

4.2 A simple Life-Cycle Model with Home Production and Wealth Shocks

Since we are explicitly interested in how a wealth shock affects home production through its effect on the monetary budget constraint, we add a stochastic component to the deterministic life-cycle monetary budget constraint in Equation 3.

$$A_{t+1} = (1+r)(\mathbb{E}_t[A_t] + (w_t \cdot h_{mt}) + b_t - c_{mt}) \tag{11}$$

with

$$\mathbb{E}_t[A_t] = A_t + \xi_t \tag{12}$$

where ξ_t yields a random term with $\mathbb{E}_t[\xi_t] = 0$ that captures a shock in the value of wealth available at time t. We assume $\mathbb{E}_t[\xi_t] = 0$ in the marginal utility of wealth. A negative shock ($\xi_t < 0$) causes the market consumption possibilities c_{mt+1} at time $t+1$ to decrease because $\Delta A_{t+1} < 0$. Hence, individuals reoptimize h_{mt+1}, h_{nt+1} and c_{mt+1} to the $\xi_t < 0$ accordingly in order to maximize Equation 1. $\xi_t < 0$ allows us to analyze $\frac{\Delta h_{nt+1}}{\Delta c_{mt+1}}$ in a situation of $\Delta c_{mt+1} < 0$ and $\Delta h_{mt+1} = 0$. This rules out that the change in home production is a consequence of having more time available for home production. In stead, $\frac{\Delta h_{nt+1}}{\Delta c_{mt+1}}$ measures the true substitution effect between market consumption and home production.

In contrast, a shock of retirement, unemployment or disability would result in $w_t = 0$, $h_{mt} = 0$ and $b_t \geq 0$. Therefore, Δh_{nt+1} can be the result of both $\Delta c_{mt+1} < 0$ and $\Delta h_{mt+1} < 0$, e.g. the change in home production is $\frac{\Delta h_{nt+1}}{\Delta c_{mt+1}} + \frac{\Delta h_{nt+1}}{\Delta l_{t+1}}$.

5 A functional form to derive the empirical model

For simplicity, the functional form representation of preferences for market consumption, home production and leisure is an additive utility function such that preferences are additively separable.[6] A similar simple functional form of the utility function was used by Rupert et al. (2000) and Gortz (2006). Kuehn (2015) uses a multiplicative utility function with home production. More sophisticated functional forms are used in Benhabib et al. (1991), Greenwood & Hercowitz (1991), Fang & Zhu (2012), Dotsey et al. (2010), Rogerson & Wallenius (2013) and Karabarbounis (2014). These papers use a Cobb-Douglas period utility function as a CES parameterization of the utility function with home production.[7] Alessie & De Ree (2008) also allow for a functional form that distinguishes between husband's and wife's home production.

As we only intend to derive our empirical model from the life-cycle model with home production,

[6]We assume additively separable preferences in this framework to keep the derivation of our empirical model tractable. In practice, it is likely that the marginal utility of consumption does depend on home production, for example.

[7]This parameterization looks as follows.

$$u(c_{mt}, c_{nt}(h_{nt}), l_t) = \frac{\left(c_t^{1-b} l_t^b\right)^{1-\phi} - 1}{1-\phi} \tag{13}$$

with

$$c_t = \left((1-a)c_{mt}^{\kappa} + a c_{nt}^{\kappa}\right)^{1/\kappa} \tag{14}$$

Here, κ is the willingness to substitute between market consumption and home production. Market goods and home produced goods are substitutes if $\kappa < 1$. ϕ is the willingness to substitute leisure and consumption. A consequence of this specification in relation to our specification is that the marginal utility of consumption (either market or home produced) depends on the amount of leisure as well and vice versa.

it suffices to use the following simple functional form of the utility function as used by Gortz (2006) where market consumption, home production and leisure are summed over spouses (e.g. joint decision-making).[8] Most importantly, this simple parameterization provides the expected negative relationship between wages and home production which suggests that the opportunity cost of home production equals the wage thereby introducing home production as a substitute to market consumption.

$$u(c_{mt}, c_{nt}(h_{nt}), l_t) = c_{mt}^{\theta_{mt}} + c_{nt}(h_{nt})^{\theta_{nt}} + l_t^{\theta_{lt}} \tag{15}$$

with θ_{mt}, θ_{nt} and θ_{lt} being the preference parameters for market consumption, home production and leisure such that $\theta_{mt} + \theta_{nt} + \theta_{lt} = 1$. Productivity in home production $c_{nt}(h_{nt}) = g_t(h_{nt})$ is assumed to have constant economies of scale but is assumed to be different over time:[9] $c_{nt}(h_{nt}) = g_t(h_{nt}) = \gamma_t h_{nt}$ with γ_t being a positive parameter.

Inserting the derivative of Equation 15 with respect to market consumption, home production and leisure into the Euler Equation (Equation 5-7) and using $h_{mt} = H - l_t - h_{nt}$ gives the following first-order approximations of the Euler Equations of market consumption, home production and market production given that the solution is interior.[10]

$$\theta_{mt} c_{mt}^{(\theta_{mt}-1)} \psi(v_t) = \left(\frac{1+r}{1+\delta}\right) \mathbb{E}_t \left[\theta_{mt+1} c_{mt+1}^{(\theta_{mt+1}-1)} \psi(v_{t+1})\right] \tag{16}$$

$$\theta_{lt} h_{mt}^{(\theta_{lt}-1)} \psi(v_t) = -w_t \left(\frac{1+r}{1+\delta}\right) \mathbb{E}_t \left[\theta_{lt+1} h_{mt+1}^{(\theta_{lt+1}-1)} \psi(v_{t+1})\right] \tag{17}$$

[8] Deriving the empirical model from using the Cobb-Douglas period utility function as a functional form would result in a reduced form model with extra parameters a, b, ϕ, ρ and marginal utility of consumption that depends on leisure and vice versa.

[9] In this way, productivity does not increase nor decrease with the number of hours of home production supplied, but can increase or decrease over time because of, for example, aging or shocks in health. The assumption of constant economies of scale has no constraining consequences for our empirical model, but allows us to neatly write down the derivation of the empirical model.

[10] To allow for corner solutions, such as people in retirement without labor supply ($h_{mt} = 0$), equations 16-18 can be adjusted by multiplying the righthandside with $e^{(-\pi R_t)}$ (Deaton, 1971). $R_t = 1$ if a person is retired and zero otherwise. π is the degree to which a person adjusts the marginal utility of market production and home production. $\pi > 0$ is assumed such that $0 < e^{(-\pi R_t)} < 1$ if a person is retired meaning that the marginal utility of market production and home production does not have to equal the marginal wage rate times the marginal utility of wealth as would be in interior solutions. Since we explicitly condition the regression equations on the subsample of retired persons we do not explicitly account for the interior solution in the derivation of the model.

$$\theta_{nt}\gamma_t h_{nt}^{(\theta_{nt}-1)}\psi(v_t) = w_t\left(\frac{1+r}{1+\delta}\right)\mathbb{E}_t\left[\theta_{nt+1}\gamma_{t+1}h_{nt+1}^{(\theta_{nt+1}-1)}\psi(v_{t+1})\right] \quad (18)$$

The log-linear approximation of Equation 16-18 gives

$$\begin{aligned} &ln(\theta_{mt}) + (\theta_{mt}-1)ln(c_{mt}) + ln(\psi(v_t)) = \\ &ln(1+r) - ln(1+\delta) + \mathbb{E}_t\left[ln(\theta_{mt+1}) + (\theta_{mt+1}-1)ln(c_{mt+1}) + ln(\psi(v_{t+1}))\right] \end{aligned} \quad (19)$$

$$\begin{aligned} &ln(\theta_{lt}) + (\theta_{lt}-1)ln(h_{mt}) + ln(\psi(v_t)) = \\ &-ln(w_t) + ln(1+r) - ln(1+\delta) + \mathbb{E}_t\left[ln(\theta_{lt+1}) + (\theta_{lt+1}-1)ln(h_{mt+1}) + ln(\psi(v_{t+1}))\right] \end{aligned} \quad (20)$$

$$\begin{aligned} &ln(\gamma_t) + ln(\theta_{nt}) + (\theta_{nt}-1)ln(h_{nt}) + ln(\psi(v_t)) = \\ &ln(w_t) + ln(1+r) - ln(1+\delta) + \mathbb{E}_t\left[ln(\gamma_{t+1}) + ln(\theta_{nt+1}) + (\theta_{nt+1}-1)ln(h_{nt+1}) + ln(\psi(v_{t+1}))\right] \end{aligned} \quad (21)$$

Using 8-10 this yields[11]

$$\Delta ln(c_{mt+1}) = \frac{1}{\Delta(\theta_{mt+1}-1)}\left(ln(1+r) - ln(1+\delta) + \Delta ln(\theta_{mt+1}) + \Delta ln(\psi(v_{t+1}))\right) + \varepsilon_{t+1} \quad (22)$$

$$\begin{aligned} &\Delta ln(h_{mt+1}) = \\ &\frac{1}{\Delta(\theta_{mt+1}-1)}\left(-ln(w_t) + ln(1+r) - ln(1+\delta) + \Delta ln(\theta_{mt+1}) + \Delta ln(\psi(v_{t+1}))\right) + \varepsilon_{t+1} \end{aligned} \quad (23)$$

$$\begin{aligned} &\Delta ln(h_{nt+1}) = \\ &\frac{1}{\Delta(\theta_{nt+1}-1)}\left(ln(w_t) - \Delta ln(\gamma_{t+1}) + ln(1+r) - ln(1+\delta) + \Delta ln(\theta_{nt+1}) + \Delta ln(\psi(v_{t+1}))\right) + \varepsilon_{t+1} \end{aligned} \quad (24)$$

[11] Explicitly allowing for retirement as a corner solution would add an extra term $\pi\Delta R_{t+1}$ to equations 23 and 24.

Here, we assume that that the time-constant interest rate (r) and discount rate (δ) reduce to a constant α.

$$\alpha = ln(1+r) - ln(1+\delta) \tag{25}$$

Furthermore, we assume that θ_{mt+1} and θ_{nt+1} (the time-varying preference parameters of market consumption and home production respectively) can be approximated by a set of individual- and household specific characteristics (captured in the vector X_{t+1}) such as age, gender, marital status, household structure, educational status, health and unobserved characteristics captured in η_m and η_n respectively.

As η_j represents individual fixed effects, the combination of $X_{t+1} + \eta_j$ and ε_{t+1} capture the marginal utility of wealth.

$\psi(v_{t+1})$ includes the personal- and household characteristics that affect utility directly. Therefore, it is captured by the vector X_{t+1} (observed heterogeneity) and η_j (unobserved heterogeneity).

γ_{t+1} is a time-varying parameter that represents the productivity of home production and is likely to be captured by the vector X_{t+1} and the individual specific effects as well.

Since the life-cycle model only applies to non-corner solutions, w_t should be positive. To incorporate corner solutions as well in the model,[12] we do not use w_t but we use the life-cycle wage profile which can be approximated by the variables in vector X_{t+1} and the individual specific effects in stead (Kalwij & Alessie, 2007). This wage profile also includes the expected wages over the remainder of the life-cycle.

The fixed effects parameters capture the unobserved heterogeneity in the marginal utility of wealth, unobserved heterogeneity in preferences and unobserved heterogeneity in potential wages (only η_n).

$$\theta_{jt+1} = X_{t+1} + \eta_j \tag{26}$$

$$\psi_{t+1} = X_{t+1} + \eta_j \tag{27}$$

$$\gamma_{t+1} = X_{t+1} + \eta_j \tag{28}$$

$$w_t = X_{t+1} + \eta_j, j = m, n \tag{29}$$

[12] Which is important to condition on a non-changing time budget.

Summarizing, X_{it} captures the effects of individual- and household characteristics such as age on preferences, potential wages and the marginal utility of wealth. Taking aforementioned assumptions into account, equation 22 to 24 reduce to the following empirical first-differences specifications for household i. Note that the constant (α) and the individual fixed effects (η_m and η_n) cancel out in a first-differences specification.

$$\Delta ln(c_{imt+1}) = \Delta X_{it+1}\beta_c + \varepsilon_{ict+1} \tag{30}$$

$$\Delta ln(h_{imt+1}) = \Delta X_{it+1}\beta_m + \varepsilon_{imt+1} \tag{31}$$

$$\Delta ln(h_{int+1}) = \Delta X_{it+1}\beta_n + \varepsilon_{int+1} \tag{32}$$

The error terms $\varepsilon_{ijt+1}, j = c,m,n$ are distributed *iid* $N(0,\sigma_j)$. These error terms capture the random error of the recursive process of the marginal utility of wealth (including possible shocks in wealth), the random error in equations 30-32 as well as the random error of vector X_{it} capturing preferences and potential wages (the latter only for $j = m,n$).

The first-difference specification of Equations 30-32 nests the log-linearized Euler equations in 16-18 under the aforementioned assumptions regarding the approximation of parameters. An advantage of the first-difference specification is that the estimation is not affected by possible household fixed effects that may influence the levels of market consumption, market work and home production (Parker, 1999). Since we are not interested in estimating the levels of market consumption and home production but in the substitution between the two instead, we present the empirical model to analyze these substitution effects in the next section.

6 Empirical model

6.1 Estimating the Elasticity in Home Production and Market Consumption

Rupert et al. (1995) are the first to explicitly estimate the elasticity between market consumption and home production. Drawback of their approach is that the elasticity is only valid for interior solutions and identification depends on fairly general instrumental variables.[13]

The life-cycle model with home production and wealth shocks in Section 4.2 indicated that a wealth shock allows us to estimate the elasticity of home production to market consumption $\frac{\Delta h_{nt+1}}{\Delta c_{mt+1}}$ as this shock causes $\Delta c_{mt+1} < 0$ while $\Delta h_{mt+1} = 0$. We use this fact in estimating the substitution effect between home production and market consumption. Ideally, we are interested in $\beta_{n2} = \frac{\Delta h_{nt+1}}{\Delta c_{mt+1}}$:

$$\Delta ln(h_{int+1}) = \Delta X_{it+1}\beta_{n1} + \Delta ln(c_{imt+1})\beta_{n2} + \varepsilon_{int+1} \tag{33}$$

Since home production and market consumption are simultaneously determined, as shown in Equations 30-32, estimates of β_{n2} would be biased due to endogeneity. We argue that a wealth shock is both a *valid* and *relevant* instrument for the estimation of the elasticity. As a wealth shock causes $\Delta c_{mt+1} < 0$ (relevancy) while $\Delta h_{mt+1} = 0$ (validity) all the effects of the wealth shock on home production run through its effect on decreased market consumption possibilities. This can be observed in Equations 2 (time budget) and 11 (monetary budget).

Therefore, we propose the unexpected change in (the log of) house prices due to the Great Recession ($D_{GR}\Delta ln(W_{it})$) as an exclusion restriction in the first-stage equation that represents ξ_t in Equation 12:

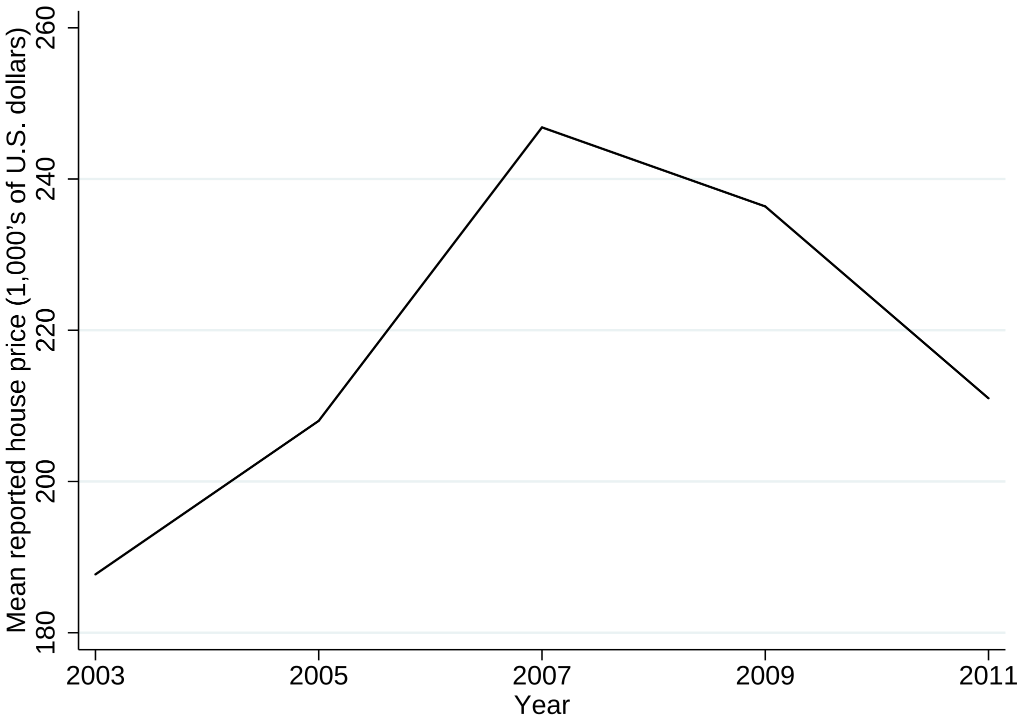
$$\Delta ln(c_{imt+1}) = \Delta X_{it+1}\beta_{c1} + D_{GR}\Delta ln(W_{it})\beta_{c2} + \varepsilon_{ict+1} \tag{34}$$

Angrisani et al. (2013) show that this unexpected and sufficiently large and persistent shock decreased market consumption. We estimate a two-stage model with Equation 34 as the first-stage and Equation 33 as the second-stage using an IV-GMM estimator.

Compared to Kuehn (2015) who estimates a drop in houseprices directly on time spent in home production, we explicitly use the fact that the effect of wealth runs through market consumption. Nevertheless, Kuehn (2015) mentions the indirect effect of wealth on home production: *"It also introduces a critical role for wealth endowments that do not affect the wage rate, which have a positive relationship*

[13]Such as age effects, lagged consumption, union coverage, living in an SMSA and in a Southern state.

Figure 1: Self-reported house prices development



Source: HRS.

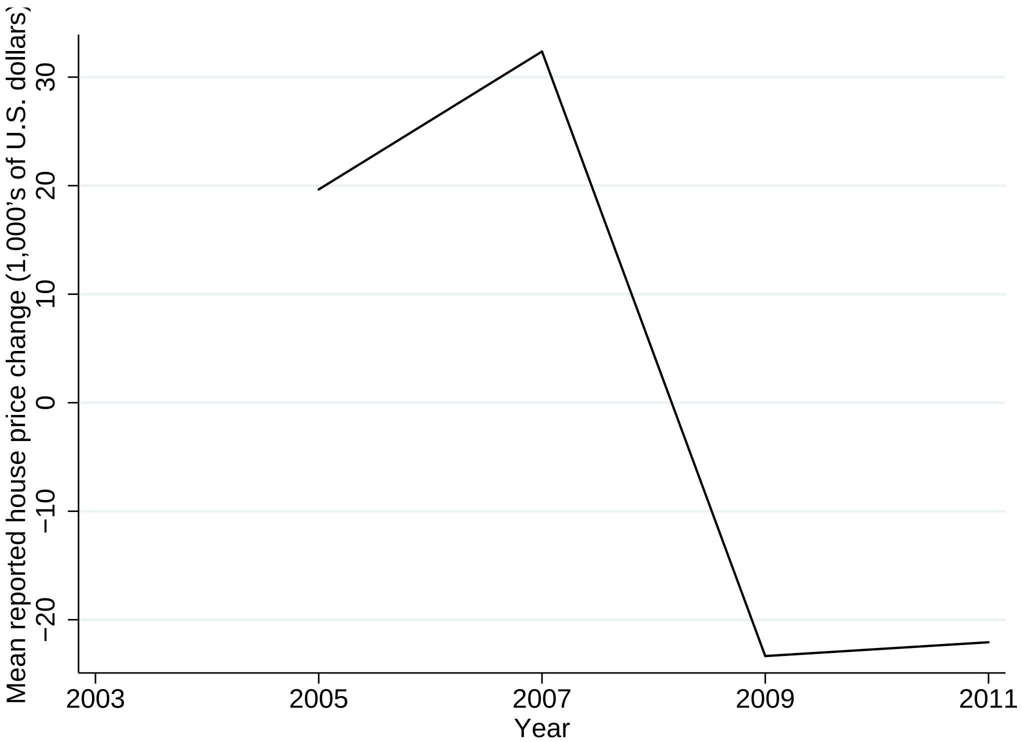
with home production (because they allow workers to supply less time to the market and more to home production and leisure).”

Contrasting Kuehn (2015) who uses state-level houseprice indices, we use individual-level self-reported houseprice values following Christelis et al. (2015). The average reported house prices over the CAMS waves are shown in Figure 1. The average year-to-year change in reported house prices is presented in Figure 2. The individual-level change in the reported house price from 2007-2009 is used as the instrument in the IV-GMM regression.

The self-reported houseprice values may not fully reflect the true houseprices, but they are a good representation of individuals' responses to the Great Recession. Besides, the average reported house prices follow the trend in more objective house price indices quite well as can be seen in Figure 3.

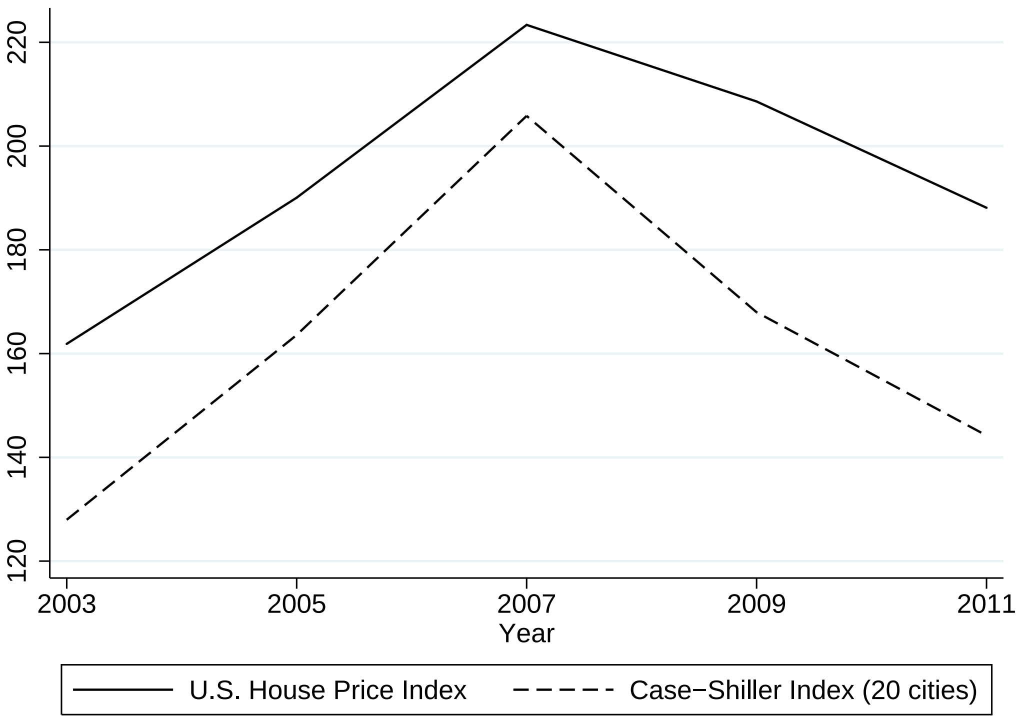
To make sure that the wealth shock does not change the time budget because of consequences for unemployment we estimate the model on the subsample of full retirees at time t and $t+1$ only. In this

Figure 2: Self-reported house prices development



Source: HRS.

Figure 3: Development of houseprice indices



Source: Federal Housing Finance Agency (FHFA) and S&P Case-Shiller Home Price Indices.

way we make sure that $\Delta h_{mt+1} = 0$, $\Delta w_{t+1} = 0$ and $\Delta b_{t+1} = 0$.[14]

For these retirees, the mechanism is most tractable. A shock in wealth decreases the monetary budget and, since the time budget does not change, decreases market consumption possibilities. However, these retirees can substitute leisure for time spent in home production to mitigate the effects on well-being which allows us to infer a causal relationship between market consumption spending and time use in home production.

7 Estimation results

Estimation results of the baseline specification are presented in Table 3. The parameter $\Delta ln(c_{imt+1})$ indicates that the elasticity between home production and consumption spending is -0.65 which means that a 10% decrease in consumption spending that is substitutable for home production increases home production by 6.5%. Home production is therefore found to be a (less than perfect) substitute for market consumption.[15]

For comparison, the elasticity is bigger than the estimated elasticities of Hicks (2015) for Mexico (0.049-0.064%) the US (0.028-0.031%). It should, however, be noted that the estimated elasticities of Hicks (2015) include prime age persons and are solely based on food consumption which is a subgroup of our definition of home production substitutable consumption. Also, the econometric specification used by Hicks (2015) does not correct for simultaneity in consumption and home production decisions. Neither does the specification of Hicks (2015) take into account possible changes in the time budget.

This elasticity is identified by the significant effect of the instrument $D_{GR}\Delta ln(W_{it})$ on consumption spending. More specifically, the estimated coefficient of the instrument implies that a 10% decrease in the self-reported houseprice during the Great Recession decreased home production substitutable consumption spending by 1.4%. This elasticity is somewhat bigger than the elasticity found by Christelis et al. (2015) (0.56%). However, their elasticity is not recession-specific like ours, but accounts for the whole time-span. Angrisani et al. (2013) estimate a non-recession and recession-specific elasticity. The non-recession elasticity is not significant, the recession-specific elasticity is bigger then our elasticity

[14]This basically makes Equation 31 redundant and reduces the analysis to Equations 30 and 32.

[15]The validity of our approach depends on keeping the time budget constant. Significance of the estimated elasticity disappears when we do not restrict the sample to persons with a constant time budget (not reported here).

(about 4%). The elasticity found by Campbell & Cocco (2007) is most in line with our estimated elasticity between market consumption and housing wealth (1.2%).

To facilitate the interpretation of the results, we can translate the effects into average effects for the sample of persons used in the regression analysis. Average consumption spending on home production substitutable goods and services is 3,970 dollars per year. The average number of hours spent in home production is 22.6 hours per week. The elasticity implies that, on average, a drop in consumption spending of 40 dollars (per year) on home production substitutable market goods and services increases home production activities by about 9 minutes per week or about 7.6 hours per year. The combination of these facts imply a shadow price of about 5.30 dollars per hour. For comparison, this shadow price is somewhat smaller than most minimum wages in the US, except for the states Georgia and Wyoming (both 5.15 dollars p/h). A shadow price below the minimum wage seems quite plausible for the group of retired persons as the reservation wage drops in retirement (Ghez & Becker, 1975).

The average self-reported houseprice in the year before the Great Recession is 223,563 dollars. A houseprice drop of 2,235 dollars due to the Great Recession decreased home production substitutable consumption spending by about 5.6 dollars in 2009 compared to 2007.

Table 3: Estimate of the elasticity between consumption spending and home production[a]

Second-stage	$\Delta ln(h_{int+1})$	
	Coeff.	S.E.
Control variables		
ΔAge	0.46**	0.21
$\Delta Age^2(/100)$	-0.27**	0.14
$\Delta Age(1 \geq 62)$	0.03	0.14
$\Delta Age(1 \geq 65)$	-0.14	0.12
$\Delta Age(1 \geq 70)$	-0.15*	0.09
$\Delta Health(-)$	0.04	0.07
$\Delta Health(+)$	0.05	0.08
Δ Time budget partner $= 0$	0.01	0.06
$\Delta Health(-)$ partner	0.06	0.08
$\Delta Health(+)$ partner	0.03	0.09
$\Delta Single$	0.99*	0.52
$\Delta Partner$	-0.15	0.25
$\Delta Wave2007$	-0.29*	0.17
$\Delta Wave2009$	-0.54*	0.32
$\Delta Wave2011$	-0.84*	0.48
Elasticity		
$\Delta ln(c_{imt+1})$	-0.65*	0.37
First-stage	$\Delta ln(c_{imt+1})$	
	Coeff.	S.E.
Instrument		
$D_{GR}\Delta ln(W_{it})$	0.14**	0.06
Observations ($N \times T$)	2,500	
Hansens J statistic (p-value reported)	0.00	

[a] * Significant at the .10 level; ** at the .05 level; *** at the .01 level using t-statistics. Standard errors reported are robust to heteroskedasticity and autocorrelation. Time use in Home Production includes: Housecleaning, Laundry, Gardening, Shopping, Cooking, Financial Management, Home improvements, Car improvements. Consumption spending includes spending on: Vehicle maintenance, Dishwasher, Wash and drying machine, Home repair services, Housekeeping services, Gardening services, Dining out. Time use in Home Production and Consumption spending are transformed using the inverse hyperbolic sine transformation. Changes in Time use in Home Production and Consumption spending are trimmed for the top and bottom 1 percent of the sample in each survey wave following Angrisani et al. (2013); Hicks (2015). The sample for the estimation consists of persons aged 51-80, who own a house, who have not moved since the previous period and who have a constant time budget since the previous period.

Table 4 indicates that the results are robust to different consumption spending definitions. Consumption excluding durables excludes the expenditures on a dishwasher and a washing and/or drying machine. Consumption including supplementary material includes expenditures on home repair supplements, housekeeping supplements and gardening supplements. In the baseline regression we assumed full sharing of the household market consumption spending. Nonetheless, the estimated elasticity is highly robust to a variety of equivalence scales to correct market consumption spending such as the *Oxford equivalence scale*,[16] *OECD equivalence scale*[17] and the *Square root scale* (not reported here).[18] The estimated elasticity does not significantly differ between single and couple households. Neither does the elasticity significantly differ between male and female respondents.

Table 4: Elasticities with different definitions of consumption spending[a]

	First-stage		**Second-stage**		
	β_{c2}	$\sigma^2_{\beta_{c2}}$	β_{n2}	$\sigma^2_{\beta_{n2}}$	Obs.
Consumption	0.14**	0.06	-0.65*	0.37	2,500
Consumption excluding durables	0.12**	0.06	-0.71*	0.44	2,500
Consumption including supplementary material	0.14**	0.06	-0.61**	0.31	2,504

[a] * Significant at the .10 level; ** at the .05 level; *** at the .01 level using t-statistics. Standard errors reported are robust to heteroskedasticity and autocorrelation. Time use in Home Production includes: Housecleaning, Laundry, Gardening, Shopping, Cooking, Financial Management, Home improvements, Car improvements. Consumption spending includes spending on: Vehicle maintenance, Dishwasher, Wash and drying machine, Home repair services, Housekeeping services, Gardening services, Dining out. Time use in Home Production and Consumption spending are transformed using the inverse hyperbolic sine transformation. Changes in Time use in Home Production and Consumption spending are trimmed for the top and bottom 1 percent of the sample in each survey wave following Angrisani et al. (2013); Hicks (2015). The sample for the estimation consists of persons aged 51-80, who own a house, who have not moved since the previous period and who have a constant time budget since the previous period. All regressions control for changes in age (including non-linearities), health, single/couple household, shocks to the partner and wave.

To get an idea of what drives the elasticity found in Table 3, Table 5 presents estimated elasticities for persons with a houseprice drop, with relatively low houseprice values, without a mortgage, with relatively low financial wealth, with relatively low household income and with a relatively high percentage of total consumption spending spent on home production substitutable market consumption. The estimated elasticity of the complement of the regressions shown in Table 5 are not significantly different from zero.

The results suggest that much of the home production responses to drops in home production substitutable market consumption found in Table 3 stem from persons who report a decline in their houseprice value due to the Great Recession. Persons with a relatively low houseprice value prior to the recession

[16] Assigning a value of 1 to the first household member and 0.7 to each additional adult.
[17] Assigning a value of 1 to the first household member and 0.5 to each additional adult.
[18] Dividing consumption spending by the square root of household size.

react more strongly than the average person. The majority of the sample has repaid their mortgage. However, this does not lower the elasticity compared to the average. Interestingly, we do not find heterogeneous elasticities for differences in financial wealth (e.g. stocks, bonds, savings deposits, checking accounts, IRA's). Neither do we find heterogeneous elasticities for differences in the total of household income. The strongest elasticity if found for persons whose market consumption bundle consisted of a relatively large share of home production substitutable market consumption prior to the Great Recession: a 10% decrease in home production substitutable market consumption increases home production by 13.2%.

All in all we can conclude that the elasticity is mostly driven by persons with a drop in the value of their relatively cheap house that is mortgage free and who spent relatively much on market consumption that can be substituted for by home production prior to the Great Recession.

Table 5: Heterogeneous elasticities[ab]

	First-stage		**Second-stage**		
	β_{c2}	$\sigma^2_{\beta_{c2}}$	β_{n2}	$\sigma^2_{\beta_{n2}}$	Obs.
Δ Houseprice < 0	0.14**	0.06	-0.60*	0.37	2,255
$Houseprice_{t-1} <$ Median[c]	0.15**	0.08	-0.77*	0.48	1,347
$Houseprice_{t-1} <$ P(90)[d]	0.14**	0.06	-0.56*	0.34	2,309
Δ Houseprice < 0, $Houseprice_{t-1} <$ Median[c]	0.17**	0.08	-0.73*	0.43	1,184
$Mortgage = 0$	0.14**	0.06	-0.59*	0.36	1,877
Financial wealth $<$ Median[e]	0.11**	0.05	-0.89	0.63	1,095
Household income $<$ Median[f]	0.12*	0.07	-0.53	0.44	1,418
Substitutable $consumption_{t-1}$ (% total) $>$ Median[g]	0.09**	0.04	-1.32*	0.76	1,277

[a] * Significant at the .10 level; ** at the .05 level; *** at the .01 level using t-statistics. Standard errors reported are robust to heteroskedasticity and autocorrelation. Time use in Home Production includes: Housecleaning, Laundry, Gardening, Shopping, Cooking, Financial Management, Home improvements, Car improvements. Consumption spending includes spending on: Vehicle maintenance, Dishwasher, Wash and drying machine, Home repair services, Housekeeping services, Gardening services, Dining out. Time use in Home Production and Consumption spending are transformed using the inverse hyperbolic sine transformation. Changes in Time use in Home Production and Consumption spending are trimmed for the top and bottom 1 percent of the sample in each survey wave following Angrisani et al. (2013); Hicks (2015). The sample for the estimation consists of persons aged 51-80, who own a house, who have not moved since the previous period and who have a constant time budget since the previous period.

[b] The complements of the regression constraints do not show elasticities that are significantly different from zero.

[c] 178,523 dollars.

[d] 522,378 dollars.

[e] 46,304 dollars.

[f] 32,773 dollars.

[g] 8.52%.

8 Conclusion

The theory of home production suggests that people will substitute away from market consumption as the opportunity cost of time drops (Becker, 1965). Shifting away from market consumption to home production makes people able to smooth consumption in response to income decreases (Hicks, 2015). This is relevant as home production might be used to mitigate the consequences of shocks in unemployment, health, retirement and wealth for well-being.

Prior studies have found that people respond to shocks in unemployment (Aguiar et al., 2013), health (Gimenez-Nadal & Ortega-Lapiedra, 2013), retirement (Aguiar & Hurst, 2005) or wealth (Kuehn, 2015) by increasing their home production. Hence, people substitute market consumption for home production as the opportunity cost of time drops. The shocks causing a drop in the opportunity cost of time (retirement, unemployment, disability) have two simultaneous effects 1) it decreases the *monetary budget* and 2) it increases the *time budget*. Therefore, the extent to which home production is a substitute to market consumption remains unclear as the increases in home production might be due to considerable increases non-work time available.

Compared to these prior studies, the current paper estimates the intratemporal elasticity between home production and consumption spending. This elasticity would be a direct measure of the degree of substitution between home production and market consumption. To exclude possible effects of a changing time budget we estimate an IV-GMM model in which consumption spending is instrumented with a wealth shock. A wealth shock is likely to decrease the monetary budget and therefore market consumption (instrument relevance), but is unrelated to the time budget (instrument validity). More specifically, we use the large and unanticipated shock in houseprices during the Great Recession (Christelis et al., 2015; Angrisani et al., 2013; Kuehn, 2015) to identify the estimation of the elasticity. To exclude any possible effects of the Great Recession on the non-market time available, we estimate elasticities for retirees only.

We find that a 10% decrease in market consumption that can be substituted for by home production increases the time spent in home production activities by about 6.5%. The elasticity implies that a part of the decreased market consumption possibilities can be replaced by home production to mitigate the consequences of wealth shocks for well-being. The scope for doing so remains rather limited, however. Home production substitutable market consumption makes up 12% of total consumption, on average, which makes it small but non-negligible. The other 88% of total consumption, on average, can not be substituted by home production. The elasticity is mostly driven by persons with a drop in the value of their relatively cheap home that is free of mortgage and who spent relatively much on market consumption that can be substituted for by home production prior to the Great Recession.

Our findings suggest that much of the home production responses to shocks in income found by earlier studies are likely to be the consequence of increased total time available for home production. Hence, the elasticity between home production and non-market time available is likely to be bigger than the elasticity between home production and market consumption. Moreover, our results are in contrast with the typically assumed high substitutability between market consumption and home production in existing theoretical models (Campbell & Ludvigson, 2001). Nonetheless, it should be kept in mind that our results are identified by a sample of retirees. Responses of prime age workers may be different as their opportunity costs of home production are likely to be different.

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