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 substitutability between market consumption and home production. The current paper estimates the intratemporal elasticity between home production and market consumption from within-person variation. Shocks in houseprices induced by the Great Recession are used to infer the extent to which persons 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 an elasticity of -0.65. Although the scope for substitution is limited (about 12% of total consumption), there are non-negligible possibilities to substitute away from market consumption to home production.

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

Keywords: Home production, Time-use, Consumption, Wealth shocks, Great Recession

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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*). The relative price of time determines the share of market expenditures and home production in the chosen consumption bundle. 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) and Velarde & Herrmann (2014) explain this phenomenon by showing that retired persons use their additionally available non-market time to substitute purchased goods and services for home production by substituting dining out for preparing meals. Stancanelli & Van Soest (2012) and Schwerdt (2005) confirm this using a broader definition of home production.

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). Conversely, Krueger & 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

[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).

al., 2000; Hall, 2009; Karabarbounis, 2014) as people become unemployed and 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. Home production is even found to be able to mimic the role of formal unemployment insurance (Guler & Taskin, 2013).

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 three aforementioned shocks in the opportunity cost of time have two simultaneous effects: 1) decrease the *monetary budget*[2] and 2) increase the *time budget*.[3] Aforementioned studies do not distinguish between these time- and substitution effects. To identify the substitution between home production and market consumption Hicks (2015) uses permanent shocks to income, and more specifically educational attainment, to estimate the intratemporal elasticity following Altonji (1986); Mroz (1987); Gonzalez Chapela (2011). In contrast to the transitory shocks in income, identification comes from cross-sectional differences between poorer and richer persons and not from within-person variation.

The current paper identifies the intratemporal substitution effect between market consumption and home production from within-person differences, while solving the issues regarding the time budget caused by identification from transitory shocks. We identify the elasticity by the unexpected and sub-

[2]The monetary budget is decreased by the difference in earnings and social insurance (e.g. pension, unemployment benefits, disability benefits).

[3]The time budget is increased as retired, unemployed and disabled persons have considerably more non-market time available.

stantial drop in houseprices observed during the Great Recession. This wealth shock implied substantial decreases in the monetary budget (Christelis et al., 2015; Angrisani et al., 2015) without changing the time budget. Therefore, we use the houseprice drop in the Great Recession as an instrument to estimate the causal effect of consumption on home production. The responses in home production due to drops in houseprice, as analyzed by Kuehn (2015), should be caused by their decrease in market consumption possibilities.[4] For identification, we rely on the subsample of retirees whose time budget does not correlate with the Great Recession.

Using a unique panel data set with detailed information on both consumption spending and time-use, we find an elasticity of home production with respect to market consumption of -0.65. The scope of substituting market consumption for home production is fairly small though. Nonetheless, our analysis suggest that the elasticity might be bigger among prime-age workers as they have a bigger scope for substitution. 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 have a large scope to substitute market consumption for home production.

Existing theoretical models of home production typically assume high substitutability between market consumption and home production (Campbell & Ludvigson, 2001).[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 (around 2) than aforementioned macro calibrations. Nonetheless, smaller micro elasticities are not necessarily inconsistent with larger macro elasticities (Chang & Kim, 2006). It should also be remarked that most of the micro estimates are based on very specific subsamples of the population such as (single) women (Gelber & Mitchell, 2012; Gonzalez Chapela, 2011). Or estimates use disputable instruments to correct for endogeneity issues, like lagged consumption (Rupert et al., 1995) or permanent income (Hicks, 2015). The current paper provides a reliable lower bound for the micro elasticity.

The remainder of the paper is organized as follows. Section 2 describes the HRS/CAMS data.

[4] Kuehn (2015) does not differentiate between the two effects which may explain the ambiguity of his results.

[5] Baxter & Jermann (1999) indicate that a plausible range of the elasticity would be between 0 and 5. 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).

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 econometric model is explained in Section 5. Estimation results are shown in Section 6. Section 7 provides a discussion. 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 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.

In this study we will therefore use CAMS data from 2005, 2007, 2009 and 2011. 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 data aggregate closely to categories of time use in the American Time Use Study (Hurd & Rohwedder, 2007).

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. 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).

Of particular interest for this study are the CAMS time-use categories related to home production following the definition of Aguiar et al. (2013):

- 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)

Respondents were also asked about a total of 39 spending categories in the CAMS waves. For durable goods, the respondent is asked to indicate whether the household purchased the item in the ”past 12 months,” and, to the best of their ability, provide the purchase price. For nondurable goods and services, the respondent is asked how much was spent in each category and is sometimes given the option, depending on the survey wave and category, of reporting the amount spent weekly, monthly, or yearly. For frequent spending categories, such as gasoline and food, respondents are given the option of reporting all three periodicities, while less frequent spending categories such as mortgage and utilities are only given monthly or yearly options. Consumption categories that are of particular interest in this paper are the consumption categories that have a direct substitute in terms of home production, so called ”home production substitutable consumption:”

- Housekeeping services
- Washing/drying machine (durable)
- Gardening services
- Dining out

- Dishwasher (durable)
- Homerepair services
- Vehicle maintenance services

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 information 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).

3 Descriptive statistics

3.1 Consumption spending

Table 1 shows the household spending on consumption that can be substituted for by home production. Here, we use the sample 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. 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 7% while total substitutable consumption decreased by about 16%. This larger drop in substitutable consumption implies that households' spending on substitutable consumption has a stronger cyclical reaction than total consumption. Households may have found it easier to shift away from market consumption that is well substitutable by home production.

Substitutable consumption is about 11-12% of total consumption spending across the 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 homecooking.[6] Standard

[6]One might well argue that homecooking is not a perfect substitute to dining out as dining out might be viewed as a luxury

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 (cross-sectional) 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.

3.2 Time-use

Table 2 shows the time spent in home production activities per wave by 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. 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 (about a day per week) and that virtually all persons engage in some form of home production (about 99% of the respondents). 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 subsample spends 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 (cross-sectional) variation around this average as the standard

good. Nonetheless, Table 1 shows that about 85% of the sample has dining out expenditures. This 85% is fairly constant across the business cycle, but spending is decreased in the downturn. This suggests that the frequency of dining out has decreased or people have shifted towards cheaper alternatives which supports the idea that homecooking are a substitute for dining out.

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	1,795	2,996	4.5	89.2	1,761	2,932	4.5	86.8	1,472	1,959	4.1	86.8	1,683	2,349	4.8	84.7
Housekeeping services	432	1,407	1.1	49.9	390	1,230	1.0	47.5	291	927	0.8	43.6	296	857	0.8	41.6
Gardening services	486	1,621	1.2	41.9	429	1,235	1.1	40.2	348	803	1.0	42.7	363	830	1.0	43.2
Homerepair services	1,403	3,587	3.5	59.5	1,412	3,780	3.6	58.4	1,176	2,720	3.3	54.5	1,059	3,083	3.0	53.6
Vehicle maintenance	632	803	1.6	88.3	558	736	1.4	84.5	556	724	1.5	82.9	545	726	1.5	83.3
Dishwasher	21	107	0.0	4.5	24	113	0.0	4.8	18	103	0.0	3.5	18	99	0.0	3.8
Washing/Drying machine	71	267	0.0	9.5	82	294	0.0	10.3	69	278	0.0	9.1	45	204	0.0	8.0
Substitutable consumption	4,841	5,784	12.1	98	4,656	6,097	12.0	97	3,930	4,402	10.9	97	4,009	4,768	11.3	97
Substitutable consumption excl. durables	4,749	5,758	11.8	98	4,549	6,069	11.7	97	3,843	4,350	10.6	97	3,946	4,750	11.2	97
Substitutable consumption incl. suppl. mat.	6,540	7,162	16.3	100	6,266	7,436	16.1	99	5,320	5,274	14.7	99	5,402	5,940	15.3	99
Total consumption	40,120	28,141	100	100	38,856	26,459	100	100	36,122	23,155	100	100	35,348	21,247	100	100

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

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 as a response to the consumption drops in the Great Recession.

Together, Table 2 and Table 1 give some cross-sectional evidence 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 theoretical framework including a simple life-cycle model augmented with home production and wealth shocks in the next section. The theoretical framework justifies our empirical identification method presented in Section 5 using within-person variation.

4 Theoretical framework

4.1 A simple Life-Cycle Model with Home Production

The extension of the life-cycle model proposed by Laitner & Silverman (2005) allows for complementarity or substitutability between time and consumption, but reduces to the standard life-cycle model for persons whose leisure is fixed (retirees, unemployed, disabled). We explicitly incorporate home production in the life-cycle model following, among others, 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

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

where c_t and l_t denote consumption and leisure in time period t, respectively. Both consumption and leisure are determined by working hours decisions h_{mt}. δ is the discount factor and T the time horizon of the person. 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,[7] namely the time spent in home production.

[7] 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.

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	4.5	5.5	19.5	82.1	5.2	6.8	21.8	83.6	5.0	6.0	21.4	83.2	4.8	5.9	20.6	81.4
Laundry	2.7	3.3	11.7	75.0	2.6	3.3	10.9	72.2	2.8	4.1	12.0	74.9	2.6	3.4	11.2	72.0
Gardening	2.7	4.6	11.7	56.0	3.0	5.3	12.6	58.4	2.9	5.8	12.4	56.6	3.0	6.3	12.9	55.7
Shopping	4.1	4.3	19.0	90.5	3.9	4.0	16.3	87.8	4.0	4.0	17.1	89.4	4.0	3.9	17.2	88.7
Cooking	7.0	6.3	30.3	86.6	7.0	7.0	29.3	87.0	6.8	6.0	29.1	88.2	7.1	6.8	30.5	87.5
Financial management	0.9	1.3	3.9	85.4	1.0	1.7	4.2	83.2	0.8	1.2	3.4	83.2	0.9	1.4	3.9	83.5
Home maintenance	1.0	3.0	4.3	47.2	0.9	2.3	3.8	45.2	0.7	2.3	3.0	42.3	0.7	1.8	3.0	39.7
Vehicle maintenance	0.3	0.6	1.3	50.0	0.4	0.9	1.7	49.5	0.4	1.1	1.7	47.3	0.4	1.2	1.7	46.6
Home production	23.1	16.5	100	99.0	23.9	19.0	100	98.6	23.4	17.2	100	98.4	23.3	18.7	100	98.5

Individuals maximize Equation 1 under the time budget and monetary budget constraint respectively

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

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

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

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 non-labor income (e.g. pensions, unemployment benefits, disability benefits and other unearned non-asset income).

Since not all consumption spending categories can be substituted by home production (e.g. utilities, drugs, etc.) we assume that market consumption bundle consists of a component that is substitutable (c^s_{mt}) and a component that is not (c^{ns}_{mt}).

$$c_{mt} = \{c^s_{mt}, c^{ns}_{mt}\} \tag{5}$$

Additionally, we assume that $h_{mt} = 0$. In this way, we only consider the corner solution of labor supply or, more specifically, retired individuals. These retirees are most likely to respond to houseprice shocks (Campbell & Cocco, 2007) and it can be assumed that the houseprice shock did not change the labor supply decisions (see Section 5). So, basically we constrain the analysis to the maximization of utility over the remaining life-time in retirement assuming retirement to be an absorbing state. Hence, the time budget (2) and monetary budget (3) are reduced to:

$$h_{nt} = H - l_t \tag{6}$$

$$A_{t+1} = (1+r)(A_t + b_t - c_{mt}) \tag{7}$$

Solving equation 1 subject to equations 6 and 7 gives the following Euler Equations of marginal utility with respect to h_{nt} (home production) and c_{mt} (market consumption).

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

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

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. The marginal utility of wealth takes into account all future expectations. Hence, 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).

Similarly, the marginal utility of home production depends on the marginal utility of wealth as well as the wage rate. A higher wage rate decreases the marginal utility of home production for which the wage rate is an opportunity cost similar to leisure. The model predicts that the marginal utility of home production is equal across different activities.

Expressions 8 and 9 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. Only an unanticipated shock, such as a shock in wealth, can result into a deviation from the optimal path.

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.

$$A_{t+1} = (1+r)(\mathbb{E}_t[A_t] + b_t - c_{mt}) \tag{10}$$

with

$$\mathbb{E}_t[A_t] = A_t + \xi_t \tag{11}$$

Here, we assume that $A_t = \{A_t^f, A_t^h\}$ consists of both financial (A_t^f) and housing wealth (A_t^h). Although financial wealth is more liquid, we assume that both are equally important in consumption decisions. Campbell & Cocco (2007) argue that housing wealth is important for consumption decision primarily through perceived wealth and borrowing constraints. For empirical evidence on the importance of housing wealth for consumption decisions, see for example Case et al. 2005, 2013; Carroll et al. 2011; Campbell & Cocco 2007; Angrisani et al. 2015; Christelis et al. 2015; Mian et al. 2013; Kaplan et al. 2016. This may especially be the case for our subgroup of retirees[8] who generally tend to have a strong bequest motive (Bernheim, 1991; Alessie et al., 1997, 1999; Skinner & Zeldes, 2002; Kopczuk & Lupton, 2007) although in part these wealth holdings me be accidental (Hurd, 1989).[9] Hence, shocks to the value of the house can result in different consumption decisions. The theoretical framework also assumes that housing is a pure investment good and that there is no consumption component to owning a house.

ξ_t yields a shock in the value of wealth available at time t consisting of both permanent (ζ_t) and transitory (ω_t) shocks

$$\xi_t = \zeta_t + \omega_t \tag{12}$$

with persistence parameter of the permanent shock ρ and the permanent shock ν_t.

$$\zeta_t = \rho\zeta_{t-1} + \nu_t \tag{13}$$

Both ν_t and ω are normally distributed. A negative shock ($\nu_t < 0$) is unanticipated and has a permanent effect on the life-time monetary budget constraint. As a consequence, it causes the future market consumption possibilities c_{mt+p} to decrease. Hence, retirees reoptimize h_{nt+p} and c_{mt+p} to the shock in the monetary budget accordingly. Note that shocks to income and wealth are completely independent in this theoretical framework. The theoretical framework predicts $(\frac{\Delta c_{mt}}{\Delta \nu_t} > 0)$ (marginal propensity to consume) and $(\frac{\Delta h_{nt}}{\Delta \nu_t} < 0)$ (marginal propensity to produce at home) if $(\frac{\Delta h_{nt}}{\Delta c_{mt}} < 0)$.

[8] Campbell & Cocco (2007) find that consumption responses to changes in houseprices increase with age.

[9] This can also be explicitly modeled by allowing for a bequest function in the utility function. See, for example, Kopczuk & Lupton (2007).

5 Empirical model

Much of the literature estimates the Euler equations by assuming a simple functional form[10] of the utility function and log-linearizing the parameterization (Rupert et al., 1995, 2000; Gortz, 2006). Since we are only interested in the elasticity of home production with respect to market consumption, and not in the particular levels, we use a reduced form approach that allows for identification of the elasticity. In order to stay close to the structural equation modeling that uses log-linearization of the Euler equations, we use a first-differences approach. An advantage of the first-difference specification is that the estimation is not affected by possible individual fixed effects that may influence the levels of market consumption, market work and home production (Parker, 1999).

Since it is expected that the intratemporal elasticity between non-substitutable market consumption (c^{ns}_{mt}) and home production ($c_{nt}(h_{it})$) is zero, we focus on the intratemporal elasticity between substitutable market consumption (c^{s}_{mt}) and home production. To estimate this elasticity between home production and market consumption, we need to estimate

$$\Delta ln(h_{int+1}) = \Delta X_{it+1}\beta_{n1} + \Delta ln(c^{s}_{imt+1})\beta_{n2} + \varepsilon_{int+1} \tag{14}$$

where $\beta_{n2} = \frac{\Delta h_{nt+1}}{\Delta c^{s}_{mt+1}}$ is the elasticity between home production (h_{nt+1}) and home production substitutable consumption spending (c^{s}_{mt+1}), X is a vector of control variables including individual- and household characteristics, and ε is the error term which is distributed *iid* $N(0,\sigma_h)$.

Here, h_{nt+1} and c^{s}_{mt+1} are simultaneously determined and therefore endogenous. Hence, estimates of β_{n2} would be biased and we need a *valid* and *relevant* instrument, e.g. an instrument that affects affects market consumption but not home production. Following our theoretical model in Section 4.2, we argue that unexpected and persistent wealth shocks are both valid and relevant. A negative shock in wealth decreases the market consumption possibilities *ceteris paribus* through the monetary budget constraint (Equation 10), but it does not change the number of hours available for home production (the time budget constraint, Equation 2). The effects of a wealth shock on home production run through its

[10] More sophisticated functional forms are used in macro calibration exercises such as 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.

effect on decreased market consumption possibilities. 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 instrumental variable capturing ξ_t in Equation 11. Using a two-step IV-GMM with Equation 14 as the second-stage, we define the first-stage as

$$\Delta ln(c^s_{imt+1}) = \Delta X_{it+1}\beta_{c1} + D_{GR}\Delta ln(W_{it})\beta_{c2} + \varepsilon_{ict+1} \tag{15}$$

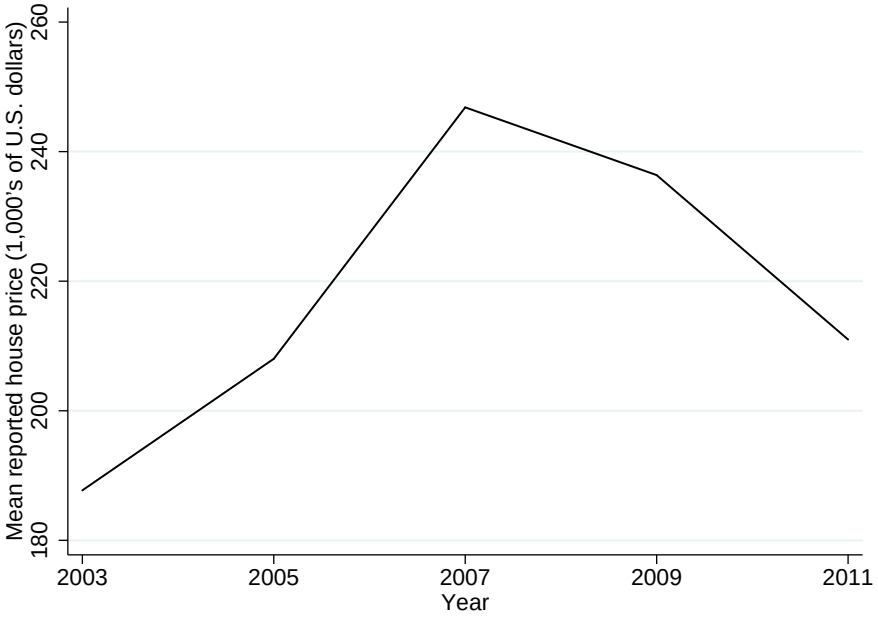
Angrisani et al. (2015) and Christelis et al. (2015) show that this unexpected and sufficiently large and persistent shock decreased market consumption spending. In general it is found that consumption responds to unexpected shocks in houseprices (Case et al., 2005, 2013; Carroll et al., 2011). Especially among older households as these are most likely to gain and lose from houseprice changes (Campbell & Cocco, 2007). Case et al. (2005) and Case et al. (2013) also argue that the sensitivity of consumption to unexpected changes in housing wealth is greater than the sensitivity to unexpected changes in financial wealth.

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. Contrasting Kuehn (2015) who uses state-level houseprice indices, we use individual-level houseprice values[11] following Christelis et al. (2015). The average houseprices 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 houseprice from 2007-2009 is used as the instrument in the IV-GMM regression. The average reported houseprices follow a similar trend as other objective house price indices 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 way we make sure that $\Delta h_{mt+1} = 0$, $\Delta w_{t+1} = 0$ and $\Delta b_{t+1} = 0$. For this sample of 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 by definition.

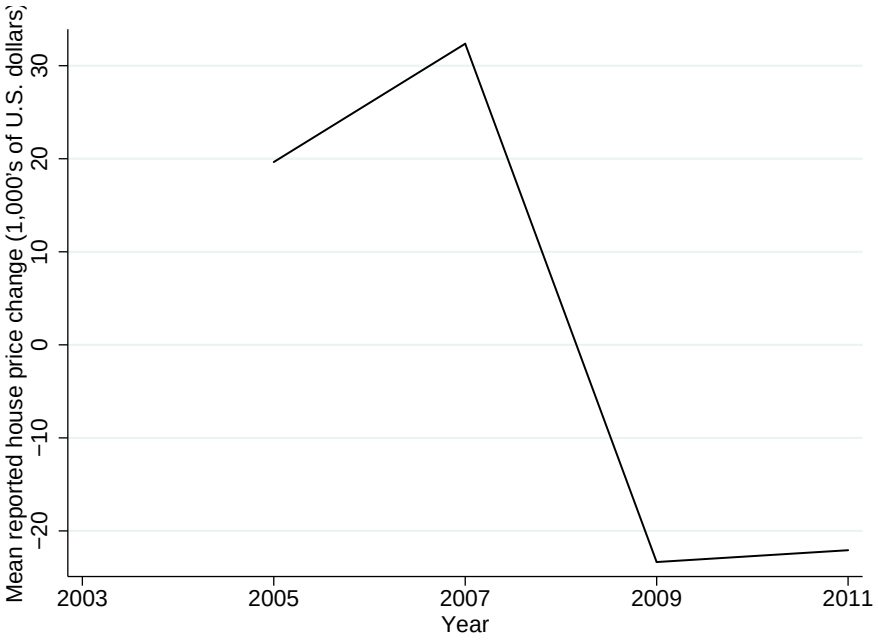
[11] From the RAND HRS Income and Wealth Imputation.

Figure 1: Development of houseprices



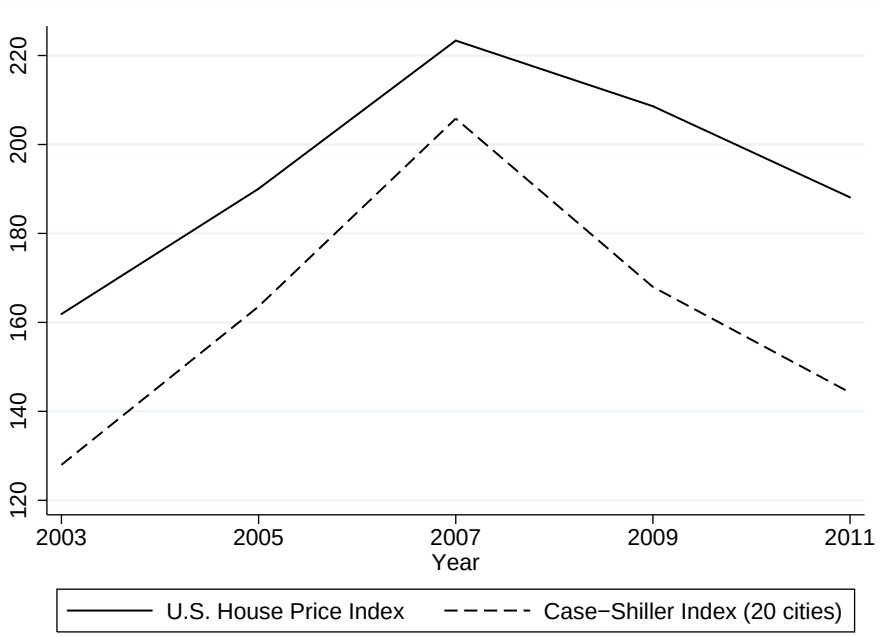
Source: HRS.

Figure 2: Year-to-year changes in houseprices



Source: HRS.

Figure 3: Development of houseprice indices



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

We condition the elasticity on a set of observable personal- and household characteristics X_{it+1}. This vector includes age effects, health effects, period effects, marital status as well as information regarding the health and retirement statuses of the spouse.[12] Due to our first-difference specification we therefore condition on shocks in health[13] and marital status.[14] We combine quadratic age-effects with semi-parametric age effects in the age of 62, 65 and 70.[15] At these ages, people can claim Social Security benefits at the earliest possible age, without actuarial reductions[16] and the latest possible age respectively.

[12]Estimation results are highly robust to excluding information regarding the spouse

[13]Estimation results are highly robust to excluding changes in health.

[14]Estimation results are highly robust to excluding changes in marital status.

[15]Estimation results are highly robust to excluding such semi-parametric age effects.

[16]The Full Retirement Age is 65 for all persons born before 1938.

6 Estimation results

6.1 Baseline estimates

Estimation results of the baseline specification are presented in Table 3 and indicate that the elasticity between home production and substitutable consumption spending is -0.65.[17] This 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 (substitutable) market consumption.[18]

For comparison, the elasticity is bigger than the estimated elasticities of Hicks (2015) for Mexico (0.049-0.064%) and 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.

The estimated 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 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. (2015) estimate a non-recession and recession-specific elasticity. The non-recession elasticity is not significant, the recession-specific elasticity is bigger than our elasticity (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

[17] The F-statistic of the excluded instrument is 5.6. Therefore, we test our estimation results with a Fuller-k estimator which is more robust to possibly weak instruments. Estimation results of the elasticity are robust: -0.56*.

[18] 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). Running a simple OLS regression with potential endogeneity issues does not show a significant elasticity (not reported here).

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 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.

6.2 Sensitivity

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. Defining home production substitutable consumption solely by dining out (e.g. the biggest potential spending category with a substantial drop from 2007 to 2009, on average (Table 1)) gives an elasticity that is much smaller than the aforementioned definitions of substitutable consumption (-0.29). This might be explained by the relatively large amount of time spent on cooking, on average (Table 2). Hence, there might be little scope to increase the time spent in cooking. Excluding maintenance to the house from the home production substitutable consumption spending might be relevant as as the drop in houseprices might change the propensity to fix the house. This is also suggested by the large drop in spending on homerepair services in Table 1. The elasticity in which homerepair services are excluded is fairly similar to the baseline elasticity (-0.74). The same applies to additionally excluding gardening services.

In the baseline regression we assumed full sharing of the household market consumption spending.

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
$\Delta 1(Age \geq 62)$	0.03	0.14
$\Delta 1(Age \geq 65)$	-0.14	0.12
$\Delta 1(Age \geq 70)$	-0.15*	0.09
$\Delta Health(-)$	0.04	0.07
$\Delta Health(+)$	0.05	0.08
Δ Partner retired	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		
$\Delta ln(c^s_{imt+1})$	-0.65*	0.37

First-stage	$\Delta ln(c^s_{imt+1})$	
	Coeff.	S.E.
Instrument		
$D_{GR}\Delta ln(W_{it})$	0.14**	0.06
Observations ($N \times T$)	2,500	

[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 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. (2015); 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: Elasticities with different definitions of (substitutable) consumption spending[a]

Definition	**First-stage**		**Second-stage**		
	β_{c2}	$\sigma^2_{\beta_{c2}}$	β_{n2}	$\sigma^2_{\beta_{n2}}$	Obs.
$ln(c^s_{imt+1})$	0.14**	0.06	-0.65*	0.37	2,500
$ln(c^s_{imt+1})$ excl. durables	0.12**	0.06	-0.71*	0.44	2,500
$ln(c^s_{imt+1})$ incl. suppl. material	0.14**	0.06	-0.61**	0.31	2,504
$ln(c^s_{imt+1})$ dining out only	0.30***	0.11	-0.29*	0.17	2,489
$ln(c^s_{imt+1})$ excl. homerepair services	0.12**	0.06	-0.74*	0.45	2,491
$ln(c^s_{imt+1})$ excl. homerepair/gardening services	0.12**	0.06	-0.74*	0.45	2,490

[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 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. (2015); 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.

Nonetheless, the estimated elasticity is highly robust to a variety of equivalence scales to correct market consumption spending such as the *Oxford equivalence scale*,[19] *OECD equivalence scale*[20] and the *Square root scale* (all show an elasticity of about -0.65).[21]

Regarding individual- and household characteristics we find substantial differences in the estimated elasticity between age-groups and health status (Table 5). We do not find such heterogeneous elasticities for single versus couple households and males versus females (Table 5).

Different identification strategies to estimate the elasticity were proposed by Rupert et al. (1995) and Hicks (2015). Using permanent income as an instrumental variable as proposed by Hicks (2015) is not identified in our IV-GMM setting because permanent income is time-invariant. Rupert et al. (1995) proposed using lagged consumption as an instrumental variable. Estimation results using this identification method are shown in Table 6 and indicate an elasticity of zero.[22] However, drawback of

[19] Assigning a value of 1 to the first household member and 0.7 to each additional adult.

[20] Assigning a value of 1 to the first household member and 0.5 to each additional adult.

[21] Dividing consumption spending by the square root of household size.

[22] This applies to both subsamples including and excluding non-homeowners.

Table 5: Elasticities for subgroups[a]

Subsample	**First-stage**		**Second-stage**		
	β_{c2}	$\sigma^2_{\beta_{c2}}$	β_{n2}	$\sigma^2_{\beta_{n2}}$	Obs.
Age					
Age $\leq$ 62	0.16***	0.06	-0.63*	0.34	2,328
Age $\leq$ 65	0.17***	0.06	-0.57*	0.31	2,152
Age $\leq$ 70	0.18**	0.08	-0.39	0.25	1,547
Age $\leq$ 75	0.24*	0.14	-0.21	0.16	771
Health					
Fair or poor	0.22**	0.11	-0.32	0.25	689
Non-poor	0.15**	0.06	-0.60*	0.34	2,309
Household					
Single	0.07	0.06	-0.64	0.91	989
Couple	0.20*	0.11	-0.76	0.49	1,511
Gender					
Male	0.04	0.09	-3.74	7.94	917
Female	0.16**	0.07	-0.43	0.31	1,583

[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 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. (2015); 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 6: Identification from lagged consumption[a]

Second-stage	$\Delta ln(h_{int+1})$	
	Coeff.	S.E.
Elasticity		
$\Delta ln(c^s_{imt+1})$	-0.05	0.04
First-stage	$\Delta ln(c^s_{imt+1})$	
	Coeff.	S.E.
Instrument		
$\Delta ln(c^s_{imt})$	-0.49***	0.05
Observations ($N \times T$)	1,519	

[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 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. (2015); 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.

this approach is that the instrument might not be valid as it is well-possible that persons with structurally high levels of consumption spending generally engage less in home production. Our baseline estimates are therefore preferred.

6.3 Heterogeneous elasticities

To get an idea of what drives the elasticity found in Table 3, Table 7 presents estimated elasticities for a subsample of retirees with characteristics that might influence the strength of their home production reactions to drops in substitutable market consumption. The estimated elasticity of the complementary subsample of the regressions shown in Table 7 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 react more strongly than the average person. The same goes for the people that repaid their mortgage.

Interestingly, we do not find heterogeneous elasticities for differences in financial wealth (e.g. stocks, bonds, savings deposits, checking accounts, IRA's).

Regarding household income, we find that persons with a medium household income substitute more strongly. It is likely that these persons are sufficiently well off to be able to buy market consumption that can be substituted for by home production, unlike households with a low income.

Compared to persons with a high household income, they are likely to be more responsive for substitution. Not surprisingly, the strongest reaction is found for persons whose market consumption bundle consisted of a relatively large share of home production substitutable market consumption prior to the Great Recession. These persons have a relatively large scope to use home production. Similarly, the scope of using home production to substitute market consumption is strongest among people who have not fully utilized their home production possibilities. The estimation results indicate that persons with relatively low levels of home production react more strongly than the average person in the sample.

The estimation results also indicate that the elasticity is not driven by differences in credit lines, e.g. we do not find different effects for persons with and without debt (other than mortgage) and IRA/Keogh accounts. The regressions also show that only a few people have a negative net housing equity (e.g. housing value minus mortgage debt) and that the estimation results are highly robust to taking into account persons with a positive net housing equity only.

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 of their medium household income on market consumption and who have enough scope to increase their effort in home production.

7 Discussion

Table 3, showing that home production is a less than perfect substitute to market consumption (elasticity of -0.65), and Table 1 showing the small amount of total market spending that is substitutable (about 12%), indicate that substitution possibilities between market consumption and home production exist although the scope for doing so is fairly small. One should keep in mind that, for identification purposes,

Table 7: Heterogeneous elasticities[ab]

Subsample	**First-stage**		**Second-stage**		
	β_{c2}	$\sigma^2_{\beta_{c2}}$	β_{n2}	$\sigma^2_{\beta_{n2}}$	Obs.
Housing value					
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
P(25)[e]$<$ Houseprice$_{t-1}$ $<$ P(75)[f]	0.18	0.13	-0.18	0.24	1,299
Δ Houseprice < 0, Houseprice$_{t-1}$ $<$ Median[c]	0.17**	0.08	-0.73*	0.43	1,184
Wealth					
Mortgage$= 0$	0.14**	0.06	-0.59*	0.36	1,877
Financial wealth $<$ Median[g]	0.11**	0.05	-0.89	0.63	1,095
P(25)[h]$<$ Financial wealth $<$ P(75)[i]	0.12**	0.06	-0.61	0.49	1,171
Income					
Household income $<$ Median[j]	0.12*	0.07	-0.53	0.44	1,418
P(25)[k]$<$ Household income $<$ P(75)[l]	0.23**	0.10	-0.53*	0.30	1,480
Scope					
Substitutable consumption$_{t-1}$ (% total) $>$ Median[m]	0.09**	0.04	-1.32*	0.76	1,277
P(25)[n]$<$ Home production $<$ P(75)[o]	0.19***	0.05	-0.53*	0.30	1,263
Home production $<$ P(75)[p]	0.14***	0.05	-0.87*	0.45	1,778
Financial					
Debt$_{t-1} = 0$[q]	0.18**	0.07	-0.40	0.28	1,813
Net houseprice$_{t-1} > 0$[r]	0.13**	0.06	-0.67*	0.40	2,484
Net IRA, Keogh accounts $= 0$	0.13**	0.05	-0.66	0.50	1,287

[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 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. (2015); 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] 100,419 dollars.

[f] 313,427 dollars.

[g] 46,304 dollars.

[h] 4,701 dollars.

[i] 206,313 dollars.

[j] 32,773 dollars.

[k] 17,852 dollars.

[l] 59,136 dollars.

[m] 8.52%.

[n] 10.12 hours per week.

[o] 28.09 hours per week.

[p] 28.09 hours per week.

[q] Debt excludes mortgage debt.

[r] Houseprice minus mortgage debt.

Table 8: Substitution possibilities retirees and non-retirees[a]

	h_n		c_m^s	
	Mean	S.E.	Mean	S.E.
Non-retired	19.8	0.26	5,177.5	103.4
Retired	23.2	0.23	3,747.8	64.0
Δ	3.4***	0.35	-1,429.7***	115.3
Non-retired men	16.1	0.29	6,013.6	175.9
Retired men	19.1	0.23	3,992.8	96.3
Δ	3.0***	0.50	-2,020.7***	194.9
Non-retired women	22.6	0.39	4,540.6	122.1
Retired women	25.2	0.28	3,624.5	83.0
Δ	2.6***	0.47	-916.0***	143.1
Non-retired < 65	19.4	0.27	5,247.1	133.6
Retired < 65	23.6	0.47	3,766.0	126.9
Δ	4.2***	0.51	-1,481.1***	199.2
Non-retired 65+	20.6	0.55	5,029.1	153.8
Retired 65+	23.0	0.27	3,740.8	73.9
Δ	2.4***	0.58	-1,288.3***	158.6

[a] * Significant at the .10 level; ** at the .05 level; *** at the .01 level using t-statistics.

this conclusion is based on a subsample of retired homeowners.

This specific subsample may have a different elasticity than non-retirees. The heterogeneous elasticities in Table 7 suggest that persons who spent more of their total budget on market consumption that is substitutable have a relatively big elasticity. Also, persons with a relatively small amount of time spent on home production have a relatively big elasticity. These results imply that the endowment of consumption and home production has consequences for the elasticity. Since retirees are expected to be more well-endowed in terms of home production than non-retirees (because of total non-work time available), it is expected that non-retirees may have a bigger elasticity.

By comparing groups of retirees and non-retirees, Table 8 confirms that retirees have higher levels of home production and non-retirees have higher levels of substitutable market consumption. Based on these descriptives non-retirees have a bigger scope to increase home production when necessary. Hence, it is highly likely that the sample of non-retirees have a bigger elasticity than retirees since retirees have used more of their substitution possibilities. The elasticity estimated in this paper can therefore be seen as a lower bound of the elasticity for the whole population. However, it should also be kept in mind that non-retirees have more possibilities to smooth shocks in income by adjusting their labor supply decision.

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 for well-being (Aguiar & Hurst, 2005).

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. Shocks in retirement, unemployment and 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 from within-person variation. Earlier attempts to estimate the intratemporal elasticity econometrically are based on subsamples of single women (Gelber & Mitchell, 2012; Gonzalez Chapela, 2011), use debatable instruments (Rupert et al., 1995) or use between-person variation (Hicks, 2015). We propose using a wealth shock as instrumental variable as shocks in wealth affect the monetary budget constraint (e.g. market consumption) but not the time budget constraint (e.g. home production). More specifically, we use the persistent and unanticipated shock in houseprices during the Great Recession (Christelis et al., 2015; Angrisani et al., 2015; Kuehn, 2015) to identify 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 substitutable market consumption 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 shocks for well-being. The scope for doing so remains rather limited, however. Home production substitutable market consumption makes up 12% of total market consumption, on average, which makes it small but

non-negligible. The elasticity we find is largely driven by persons with a drop in the value of their relatively cheap home, that is free of mortgage, and who spent relatively much of their medium household income on market consumption that can be substituted for by home production prior to the Great Recession.

The micro elasticity estimated is much lower than the typically assumed high substitutability between market consumption and home production in existing macro models (Campbell & Ludvigson, 2001). This, however, does not need to be inconsistent (Chang & Kim, 2006). Also, 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 endowments in home production and substitutable market consumption are different. Our elasticity is therefore to be seen as a lower bound for the whole population.

References

Aguiar, M., & Hurst, E. (2005). Consumption versus expenditure. *Journal of Political Economy*, *113*(5), 919–948.

Aguiar, M., Hurst, E., & Karabarbounis, L. (2012). Recent developments in the economics of time use. *Annual Review of Economics*, *4*, 373–397.

Aguiar, M., Hurst, E., & Karabarbounis, L. (2013). Time use during the Great Recession. *American Economic Review*, *103*, 1664–1696.

Aguila, E., Attanasio, O., & Meghir, C. (2011). Changes in consumption at retirement: Evidence from panel data. *Review of Economics and Statistics*, *3*, 1094–1099.

Ahn, N., Jimeno, J., & Ugidos, A. (2008). *"Mondays at the sun": Unemployment, time-use, and consumption patterns in Spain.* (FEDEA Working Paper Paper, No. 2003-18)

Alessie, R., Lusardi, A., & Aldershof, T. (1997). Income and wealth over the life cycle: Evidence from panel data. *Review of Income and Wealth*, *43*, 729–758.

Alessie, R., Lusardi, A., & Kapteyn, A. (1999). Saving after retirement: Evidence based on three different savings measures. *Labour Economics*, *6*, 729–758.

Altonji, J. (1986). Intertemporal substitution in labor supply: Evidence from micro data. *Journal of Political Economy*, *94*, S176–S215.

Angrisani, M., Hurd, M., & Rohwedder, S. (2015). *The effect of housing and stock wealth losses on spending in the Great Recession.* (RAND Working Paper, No. WR-1101)

Apps, P., & Rees, R. (1997). Collective labour supply and household production. *Journal of Political Economy*, *105*, 178–190.

Apps, P., & Rees, R. (2005). Gender, time use, and public policy over the life-cycle. *Oxford Review of Economic Policy*, *21*, 439–461.

Banks, J., Blundell, R., & Tanner, S. (1998). Is there a retirement-savings puzzle? *American Economic Review*, *88*(4), 769–788.

Battistin, E., Brugiavini, A., Rettore, E., & Weber, G. (2009). The retirement consumption puzzle: Evidence from a regression discontinuity approach. *American Economic Review*, *99*, 2209–2226.

Baxter, M., & Jermann, U. (1999). Household productivity and the excess sensitivity of consumption to current income. *American Economic Review*, *89*, 902–920.

Becker, G. (1965). A theory of the allocation of time. *The Economic Journal*, *75*, 493–517.

Benhabib, J., Rogerson, R., & Wright, R. (1991). Homework in macroeconomics: Household production and aggregate fluctuations. *Journal of Political Economy*, *99*, 1166–1187.

Bernheim, B. (1991). How strong are bequest motives? Evidence based on estimates of the demand for life insurance and annuities. *Journal of Political Economy*, *99*, 899–927.

Bernheim, B., Skinner, J., & Weinberg, S. (2001). What accounts for the variation in retirement wealth among US households? *American Economic Review*, *91*(4), 832–857.

Burda, M., & Hamermesh, D. (2010). Unemployment, market work and household production. *Economics Letters*, *107*, 131–133.

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

Campbell, J., & Ludvigson, S. (2001). Elasticities of substitution in Real Business Cycle models with home production. *Journal of Money, Credit, and Banking*, *33*, 847–875.

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

Case, K., Quigley, J., & Shiller, R. (2005). Comparing wealth effects: The stock market versus the housing market. *Advances in Macroeconomics*, *5*, 1–34.

Case, K., Quigley, J., & Shiller, R. (2013). Wealth effects revisited 1975-2012. *Critical Finance Review*, *2*, 101–128.

Chang, Y., & Kim, S. (2006). From individual to aggregate labor supply: A quantitative analysis based on a heterogeneous agent macroeconomy. *International Economic Review*, *47*, 1–27.

Christelis, D., Georgarakos, D., & Jappelli, T. (2015). Wealth shocks, unemployment shocks and consumption in the wake of the Great Recession. *Journal of Monetary Economics*, *72*, 21–41.

Colella, F., & Van Soest, A. (2013). *Time use, consumption expenditures and employment status: Evidence from the LISS panel.* (Paper presented at the 7th MESS Workshop)

Dotsey, M., Li, W., & Yang, F. (2010). *Consumption and time use over the life-cycle.* (Federal Reserve Bank of Philadelphia Research Department Working Paper, No. 10-37)

Fang, L., & Zhu, G. (2012). *Home production technology and time allocation - empirics, theory and implications.* (mimeo)

Gelber, A., & Mitchell, J. (2012). Taxes and time allocation: Evidence from single women and men. *Review of Economic Studies*, *79*, 863–897.

Ghez, G., & Becker, G. (1975). *The allocation of time and goods over the life cycle*. New York: Columbia University Press.

Gimenez-Nadal, J., & Ortega-Lapiedra, R. (2013). Health status and time allocation in spain. *Applied Economics Letters*, *20*(15), 1435–1439.

Gonzalez Chapela, J. (2011). Recreation, home production, and intertemporal substitution of female labor supply: Evidence on the intensive margin. *Review of Economic Dynamics*, *14*, 532–548.

Gortz, M. (2006). *Heterogeneity in preferences and productivity - implications for retirement.* (Leisure, household production, consumption and economic well-being, Ph.D. thesis, Chapter 4)

Greenwood, J., & Hercowitz, Z. (1991). The allocation of capital and time over the business cycle. *Journal of Political Economy*, *99*, 1188–1214.

Greenwood, J., Rogerson, R., & Wright, R. (1995). Household production in Real Business Cycle theory. In T. Cooley (Ed.), *Frotniers of Business Cycle research* (p. 157-174). Princeton: Princeton University Press.

Griffith, R., O'Connell, M., & Smith, K. (2014). *Shopping around? How households adjusted food spending over the Great Recession.* (paper presented at the EEA-ESEM 2014, Toulouse)

Gronau, R. (1977). Leisure, home production and work - the theory of the allocation of time revisited. *Journal of Political Economy*, *85*, 1099–1124.

Guler, B., & Taskin, T. (2013). Does unemployment insurance crowd out home production? *European Economic Review*, *62*, 1–16.

Hall, R. (2009). Reconciling cyclical movements in the marginal value of time and the marginal product of labor. *Journal of Political Economy*, *117*, 281–323.

Halliday, T., & Podor, M. (2012). Health status and the allocation of time. *Health Economics*, *21*, 514–527.

Hicks, D. (2015). Consumption volatility, marketization, and expenditure in an emerging market economy. *American Economic Journal: Macroeconomics*, *7*(2), 95–123.

Hurd, M. (1989). Mortality risks and bequests. *Econometrica*, *57*, 779–813.

Hurd, M., & Rohwedder, S. (2007). *Time-use in the older population. variation by socio-economic status and health.* (RAND Labor and Population Working Paper Series, No. WP-463)

Hurd, M., & Rohwedder, S. (2008). *The adequacy of economic resources in retirement.* (MRRC Working Paper Series, No. WP2008-184)

Hurd, M., & Rohwedder, S. (2009). Methodological innovations in collecting spending data: The HRS Consumption and Activities Mail Survey. *Fiscal Studies*, *30*(3/4), 435–459.

Hurd, M., & Rohwedder, S. (2013). Heterogeneity in spending change at retirement. *The Journal of the Economics of Aging*, *1-2*, 60–71.

Hurst, E. (2008). *The retirement of a consumption puzzle.* (NBER Working Paper Series, No. 13789)

Kaplan, G., Mitman, K., & Violante, G. (2016). *Non-durable consumption and housing net worth in the Great Recession: Evidence from easily accessible data.* (mimeo)

Karabarbounis, L. (2014). Home production, labor wedges, and international business cycles. *Journal of Monetary Economics*, *64*, 68–84.

Kopczuk, W., & Lupton, J. (2007). To leave or not to leave: The distribution of bequest motives. *Review of Economic Studies*, *74*, 207–235.

Krueger, A., & Mueller, A. (2012). Time use, emotional well-being, and unemployment: Evidence from longitudinal data. *American Economic Review: Papers & Proceedings*, *102*, 594–599.

Kuehn, D. (2015). Home production, house values, and the great recession. *Journal of Family and Economic Issues*, *DOI 10.1007/s10834-015-9438-3*.

Laitner, J., & Silverman, D. (2005). *Estimating life-cycle parameters from consumption behavior at retirement.* (NBER Working Paper Series, No. 11163)

Mariger, R. (1987). A life-cycle consumption model with liquidity constraints: Theory and empirical results. *Econometrica*, *55*, 533–557.

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

Miniaci, R., Monfardini, C., & Weber, G. (2003). *Is there a retirement-consumption puzzle in Italy?* (Institute for Fiscal Studies Working Paper Series, No. 03/14)

Mroz, T. (1987). The sensitivity of an empirical model of married women's hours of work to economic and statistical assumptions. *Econometrica*, *55*, 765–799.

Parker, J. (1999). The reaction of household consumption to predictable changes in social security taxes. *American Economic Review*, *89*, 959–973.

Robb, A., & Burbidge, J. (1989). Consumption, income, and retirement. *Canadian Journal of Economics*, *22*, 522–542.

Rogerson, R., & Wallenius, J. (2013). Nonconvexities, retirement, and the elasticity of labor supply. *American Economic Review*, *103*, 1445–1462.

Rupert, P., Rogerson, R., & Wright, R. (1995). Estimating substitution elasticities in household production models. *Economic Theory*, *6*, 179–193.

Rupert, P., Rogerson, R., & Wright, R. (2000). Homework in labor economics: Household production and intertemporal substitution. *Journal of Monetary Economics*, *46*, 557–579.

Schwerdt, G. (2005). Why does consumption fall at retirement? Evidence from Germany. *Economics Letters*, *89*, 300–305.

Skinner, J., & Zeldes, P. (2002). The importance of bequests and life-cycle savings in capital accumulation: A new answer. *American Economic Review*, *92*, 274–278.

Stancanelli, E., & Van Soest, A. (2012). *Joint leisure before and after retirement: A double regression discontinuity approach.* (IZA Discussion Paper, No. 6698)

Taskin, T. (2011). *Unemployment insurance and home production.* (MPRA Working Paper, No. 34878)

Velarde, M., & Herrmann, R. (2014). How retirement changes consumption and household production of food: Lessons from German time-use data. *The Journal of the Economics of Aging*, *3*, 1–10.