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Housing wealth effect: Evidence from threshold estimation ☆

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ABSTRACT

This paper attempts to estimate the housing wealth effect of households in different income levels. To endogenously split the sample by income levels, we use the threshold estimation technique, developed in Hansen (1999), for non-dynamic panels with individual-specific fixed effects. The data are drawn from the Panel Study of Income Dynamics (PSID), during the waves of 2001, 2003, and 2005. We find two significant threshold income levels of $74,046, and $501,000. Housing wealth has a significant effect on consumption with a coefficient of 0.010602, if income is below $74,046. It is also significant and equals 0.028224 if income is between $74,046 and $501,000. For incomes above $501,000, the coefficient is not statistically significant.

1. Introduction

Several studies attempted to examine the impact of changes in household wealth on their consumption behavior, amidst concerns that substantial fluctuations in asset prices could cause subsequent fluctuations on aggregate demand. This impact, referred to as the wealth effect, depends upon the underpinnings of the life cycle theory which predicts that households adjust their saving and wealth over time to keep their planned spending levels steady in the face of uneven income streams. Thus, an unexpected increase in wealth should stimulate consumers to spread it over the remainder of their lifetime allowing a permanent increase in consumption. In this context, several studies such as Davis and Palumbo (2001); Dean and Michael (2001); Girouard and Blondal (2001); Mehra (2001); Sousa (2003); Benjamin et al. (2003); Juster et al. (2006) have attempted to quantify the total wealth effect on consumption by measuring the marginal propensity to consume out of a dollar increase in total wealth. Most of these studies, particularly that used the United States data, reached a consensus on the range of estimates for the marginal propensity to consume within 0.025–0.05, indicating that a 1 dollar increase in wealth permanently increases consumption by about 2.5–5 cents.

Though the conventional life cycle hypothesis predicts that consumption depends only on the present value of total wealth, the behavioral life cycle hypothesis predicts that assets are not fungible. This implies that the marginal propensities to consume out of different types of assets are different, as shown by Thaler (1990) and Levin (1998). In this paper, we focus on the housing wealth effect for several reasons. One, housing is the dominant component of wealth for typical households. Bertaut and Starr-McCluer (2002) show that residential property accounted for about one quarter of aggregate household wealth in the United States in the late 1990s. Two, as Tracy and Schneider (2001) show, housing wealth accounts for almost two-thirds of the wealth of the median household in the United States. And three, housing is less concentrated than stocks, which would allow a more widespread effect of any change in housing prices.

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Studies using macro data from the United States suggest that aggregate consumption responds to fluctuations in aggregate housing wealth. For instance, Girouard and Blondal (2001) find that the long run marginal propensity to consume out of gross housing assets shows a statistically significant housing wealth effect with a marginal propensity of 0.048. Benjamin et al. (2003) use a dataset that covers half a century, and find that the marginal propensity to consume from housing wealth is a statistically significant 0.079 when the variables are normalized by personal disposable income. When the variables are normalized by human capital income, the marginal propensity to consume from housing wealth is 0.157, and is statistically significant at the 1% level.

On the other hand, some studies used micro data to study the housing wealth effect. Hoynes and McFadden (1994) explore the effect of changes in housing prices on total, housing and non-housing savings rates. Their estimates imply that an increase in the growth rate of real housing prices of 10% points leads on average to an increase in the total savings rate and housing savings rate of almost 2.28% point. While for non-housing savings, capital gains are associated with both small and statistically insignificant changes. Also, increases in initial housing prices are associated with increases in the total and housing savings rates but have no significant effect on non-housing savings. Engelhardt et al. (1996) finds that a 1 dollar increase in real housing capital gains result in a significant 14.2 cents reduction in real non-housing active saving, while trimming off 2.5% of both tails of the distribution reduces the effect to an insignificant 3 cents. Juster et al. (2006) estimate the behavioral response of total active saving to housing capital gains, and show that a dollar of capital gains in housing reduces saving by a statistically insignificant 3 cents. In a matched sample of household data from the Survey of Consumer Finances and the Consumer Expenditure Survey, Bostic et al. (2009) estimate that the housing wealth elasticities are around 0.06 over the period 1981–2001.

Finally, an alternative was provided by Case et al. (2003) and Case et al. (2005) to avoid the disadvantages of both macro data and micro data by using a panel of state level data. Their results indicate that the elasticity of housing wealth lies between 0.05 and 0.09. When the effects of first order serial correlation, and when all variables are expressed as first differences, or when using an error correction model, they find that consumption changes are highly dependent on housing wealth more than on other types of wealth.

Unlike previous studies, we estimate the effect of changes in housing wealth on the consumption behavior of households, taking into consideration the heterogeneity of households in income levels. Some studies suggest that consumption behavior varies by the income level of the household. Carroll et al. (2000) developed a model of "Capitalist Spirit" in which wealth enters consumer's utility function directly. This can be interpreted as a consumer deciding on how to allocate lifetime resources between consumption and wealth, with wealth yielding utility directly. The proposal of such a functional form for the consumer's utility function captures the idea that rich people save more in a way that is consistent with the empirical evidence. The marginal propensity to save of the rich is higher than that of the poor. This is because, according to the precautionary saving motive, households with small assets tend to compress their consumption so that their marginal propensity to consume out of wealth is higher than that of those holding larger assets. Carroll et al. (2000) concludes that "a variety of evidence, strongly suggests that people at the top end of the wealth and income distributions behave in ways that are substantially different from the behavior of most of the rest of the population".

Therefore, we expect the housing wealth effect of the low income and small asset households to be different than those of high income and large asset households. The issue is how to split the sample along the income levels. Instead of imposing an exogenous criterion for splitting the sample by income levels and estimating the housing wealth effect of each income category, we use the threshold estimation technique developed in Hansen (1999). This econometric technique is developed for panels with individual-specific fixed effects. This is appropriate in our analysis since the main problem in the estimation of the wealth effect is that there may be individual attributes, such as future income, that can be correlated with both consumption and wealth in a non causal way. This implies that the estimation could suffer from omitted variable bias. By using fixed effects, we are getting rid of any omitted unobservable variables that are individual-specific. Accordingly, the main contribution of this paper is the application of an alternative econometric technique, that was not previously used in the literature, to estimate the housing wealth effect, while taking into consideration the heterogeneity of the behavior of those in different income categories.

We use the Panel Study of Income Dynamics for the waves of 2001, 2003 and 2005. Our estimation results are consistent with the hypothesis above. We find two significant threshold income levels of $\$74,046$, and $\$501,000$. Housing wealth has a significant effect on consumption with a coefficient of 0.010602, if income is below $\$74,046$. It is also significant and equals 0.028224 if income is between $\$74,046$ and $\$501,000$. For incomes above $\$501,000$, the coefficient is not statistically significant. We test the robustness of our results by trimming 2.5%, 5% and 10% from both tails of the distribution after ordering the sample by average income over the three waves. Our results show that the first threshold is robust, while the second threshold is less robust as there are limited number of households whose income is above the second threshold.

The remainder of the paper is organized as follows: Section 2 describes the data, Section 3 presents the empirical estimation and Section 4 tests for robustness, Section 5 examines the permanent income hypothesis, Section 6 conducts simulations and Section 7 concludes. References, tables, and figures follow thereafter.

2. Data

The dataset is drawn from the Panel Study of Income Dynamics (PSID). We use the three waves of 2001, 2003 and 2005. We exclude all observations for households that do not know or were not able to estimate their consumption, income or housing wealth variables. As is standard in the literature, we select households whose head is between 25 and 65 years old in 2003. We also choose households who continued to have the same head during the three waves, and delete those who have a non-positive housing wealth value in any of the given years. Our final dataset has 2148 households.

Consumption spending on non durable goods include spending on food, on health care (hospital and nursing home, doctor, prescription drugs), on housing (mortgage, rent, homeowner's insurance premium, property tax, electricity, heat, water and sewer, other utilities), on transportation (vehicle loan payment, car insurance, repairs and maintenance, gas, parking and carpool, bus fares and train fares, taxicabs, other transportation, and other vehicle expenditures), on educational expenses, and on child care.

Income includes wages and salaries earned in a job, net income from business, bonuses, overtime, tips, commissions, any income received from professional practice or trade, from farming or market gardening, from roomers or boarders, from rent. It also includes income received from dividends, from interest, from trust funds and royalties, from supplemental security income, from social security, from retirement pay or pensions, from annuities or IRAs, from unemployment compensation, from workers' compensation, from child support, alimony, a big settlement from an insurance company, or an inheritance.

As for the housing wealth, it is the value of the house where the household lives if sold, less the remaining principal on the mortgage. The value of the house is the answer to the question "Could you tell me what the present value of your (house/apartment) is – I mean about how much would it bring if you sold it today?". The remaining mortgage is the answer to the question "About how much is the remaining principal on this mortgage? The values for this variable represent the principal currently owed from all mortgages or land contracts on the home in whole dollars".

In this context, studies using micro data have serious issues. They rely on self reported values of housing wealth that might be correlated with saving behavior, have high sampling variances, and probably contaminated by expenditure on improvements and additions and by moving behavior, and thus leaves much ambiguity in the interpretation of the statistical results. This is confirmed by Goodman et al. (1992) who compare home owner's reported house values to subsequent sale values, and find that homeowners systematically overestimated the value of their homes by 10% relative to its subsequent sale value, and that reporting errors associated with self reported house values will only bias the parameter estimates on the housing capital gains variable. Benitez-Silva et al. (2008) also find that the self-reported house values in the Health and Retirement Study data tend to overestimate the price by 10%. However, in the context of our study in which households are distinguished by their income categories, we have to use household data. This allows us to distinguish between households by their income level, which cannot be accomplished by relying on aggregate data.

3. Estimation

To empirically test the housing wealth effect of households in different income categories, we use the threshold estimation technique developed in Hansen (1999). This econometric technique is developed for panels with individual-specific fixed effects. This is appropriate in our analysis since the main problem in the estimation of the wealth effect is that there may be individual attributes, such as future income, that can be correlated with both consumption and wealth in a non causal way. This implies that the estimation could suffer from omitted variable bias. By using fixed effects, we are getting rid of any omitted unobservable variables that are individual-specific.

The specification estimates consumption as a function of income, housing wealth, and a vector of households characteristics which include demographic variables. The threshold estimation model is, thus, given by:

$$\mathbf{C}_{it} = \begin{cases} \mu_i + \beta_1 \mathbf{HW}_{it} + \phi_1 \mathbf{Y}_{it} + \phi_2 \mathbf{D}_{it} + e_{it} & \text{if} \quad \mathbf{Y}_{it} \leqslant Y^T \\ \mu_i + \beta_2 \mathbf{HW}_{it} + \phi_1 \mathbf{Y}_{it} + \phi_2 \mathbf{D}_{it} + e_{it} & \text{if} \quad \mathbf{Y}_{it} > Y^T \end{cases} \tag{1}$$

where the subscript i indexes the household, and the subscript t indexes time, or wave of the survey. The dependent variable **C** denotes the non-durable consumption spending. The variable **HW** denotes the value of the house where the household live if sold, less the remaining principal on the mortgage. The variable **Y** denotes households annual income. The variable **D** is a vector of family characteristics that includes demographic variables, such that $\mathbf{D}_{it}$ = [age, family size, sex, education, marital status]. Detailed description of the variables is included in Table 1.

In this context, the observations are divided depending on whether the threshold variable Y_{it} is smaller or larger than the threshold level Y^T. If the regression slopes, β_1 and β_2 are different, Eq. (1) is given by:

$$\mathbf{C}_{it} = \mu_i + \beta_1 \mathbf{HW}_{it} I(\mathbf{Y}_{it} \leqslant Y^T) + \beta_2 \mathbf{HW}_{it} I(\mathbf{Y}_{it} > Y^T) + \phi_1 \mathbf{Y}_{it} + \phi_2 \mathbf{D}_{it} + e_{it} \tag{2}$$

where $I(\cdot)$ is the indicator function. Summary statistics of the variables used in the estimation are provided in Table 2.

Table 1
Variable definitions.

Variable	Definition
C_{it}	Annual family spending on nondurable goods
Y_{it}	Annual family income
HW_{it}	Estimated value of primary house less mortgage
Age_{it}	Age of head of family
Size_{it}	Number of family members
Sex_{it}	Sex of the head of the family; =1 if male
Marital_{it}	Marital status of the head of the family; =1 if married
High School_{it}	=1 if head of family's highest education is high school degree
Some College_{it}	=1 if head of family's highest education is some college
College_{it}	=1 if head of family's highest education is college degree

Table 2
Summary statistics.

	Minimum	25% Quantile	Median	75% Quantile	Maximum
No trimming					
Consumption	5	6654	12151	21856	170111
Income	1	45603	71456	106975	3660650
Housing	1	35500	78000	159991	4150000
Trimming 2.5%					
Consumption	52	6866	12221	21410	168991
Income	1	46900	71506	104770	596100
Housing	1	37000	78000	155000	2280000
Trimming 5%					
Consumption	52	6984	12231	21093	168991
Income	1	48004	71810	103300	420650
Housing	1	37000	77000	150000	2280000
Trimming 10%					
Consumption	52	7063	12188	20763	168991
Income	500	50977	72100	100094	336776
Housing	1	36000	75000	149910	2280000

To determine the number of thresholds, the fixed effect model is estimated allowing for zero, one and two thresholds. First, we look for one threshold, and Y^T is estimated by least squares. It is the argument of the minimization of the squared residuals from the estimation of Eq. (1). Second, the existence of a threshold effect is tested through $H_0: \beta_1 = \beta_2$ by computing a likelihood ratio statistic $F_1 = \frac{S_0 - S_1(\widehat{Y^T})}{\widehat{\sigma}^2}$ where S_0 and S_1 are respectively the constrained and unconstrained sum of squared residuals, and $\widehat{\sigma} = \frac{1}{n(T-1)}\widehat{e}^{*T}\widehat{e}^{*} = \frac{1}{n(T-1)}S_1(\widehat{Y}^T)$, where $\widehat{e}^{*}$ are the unconstrained residuals when $Y^T = \widehat{Y}^T$. Under H_0, we expect F_1 to be small.

To test the statistical significance of the threshold, the non-standard asymptotic distribution of the likelihood ratio statistic is derived by bootstrap, and confidence intervals are constructed. If the null hypothesis of no threshold is rejected, the likelihood ratio procedure is used to check whether we have one or two thresholds by calculating F_2. The computed likelihood ratio statistics are plotted as a function of the threshold parameters (income), and the test rejects the null hypothesis for large values of the statistic. Therefore the likelihood function will approach zero at a threshold.

The number of thresholds is estimated sequentially. Once the existence of a one-threshold effect is established, we look for a second threshold by first estimating $\widehat{Y}^{T2}$ as the argument of the minimization of the squared residuals amongst values higher than the first threshold, and then computing the likelihood ratio statistics for the existence of a second threshold effect F_2 . We expect F_2 to be close to zero at a certain income level higher than our first threshold if the second threshold effect exists. If the significance value of the second threshold effect is rejected, we conclude that our model has one threshold [See Hansen (1999) for more details].

The test statistics F_1 and F_2, along with their bootstrap[1] p-values are shown in Table 3. The test for a single threshold

[1] Five thousands bootstrap replications are used for each of the three bootstrap tests.

Table 3
Tests for threshold effects in Housing Wealth (no trimming).

Test for single threshold	
F_1	39.054405
p-Value	0.002000
(10%, 5%, 1% Critical values)	(11.434570, 14.155213, 24.374648)
Test for double threshold	
F_2	15.023734
p-Value	0.046000
(10%, 5%, 1% Critical values)	(11.826692, 14.610890, 22.914050)

F_1 is highly significant at the 1% level with a bootstrap p-value of 0.002000. The test for the double threshold model is significant at the 5% level with a bootstrap p-value of 0.046000. Thus, we conclude that there are two thresholds in the regression relationship. The point estimates of the two thresholds are \$74,046 and \$501,000. Figs. 1 and 2 display the concentrated likelihood ratio functions, that confirm that the estimate for the first threshold $Y^{T1} = \$74,046$, and the second threshold $Y^{T2} = \$501,000$.

The estimates, conventional OLS standard errors, and White-corrected standard errors are reported in Table 7. The estimates of primary interest are those on housing wealth. Housing wealth has a significant effect on consumption with a coefficient of 0.010602, if income is below \$74,046. It is also significant and equals 0.028224 if income is between \$74,046 and \$501,000. For incomes above \$501,000, the coefficient is not statistically significant.

This implies that households whose income is lower than \$75,000 will increase their consumption by 1 cent for every dollar increase in housing wealth. While households whose income is between \$75,000 and \$501,000 will increase their income by almost 2.8 cents for every dollar increase in housing wealth. Thus, for households with lower income levels, housing wealth effect is significant and the coefficient is about half that of those in the middle income category. This is because these households are relatively more cautious in transforming any increase in housing wealth into a corresponding increase in consumption. For those in the middle income category, these

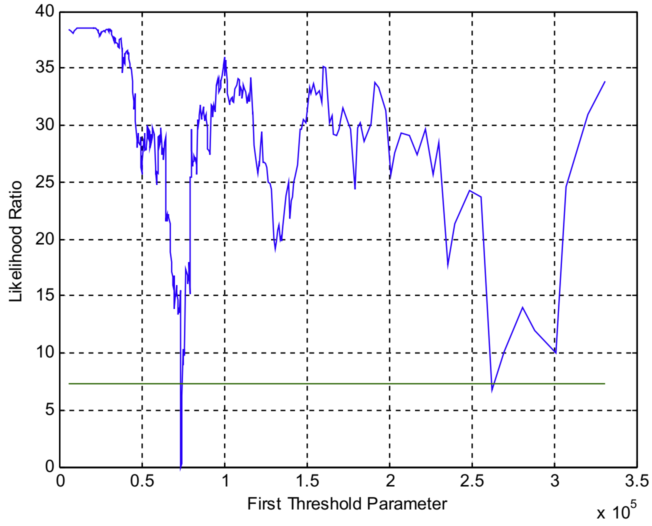

Fig. 1. Confidence interval construction in double threshold housing wealth model (no trimming).

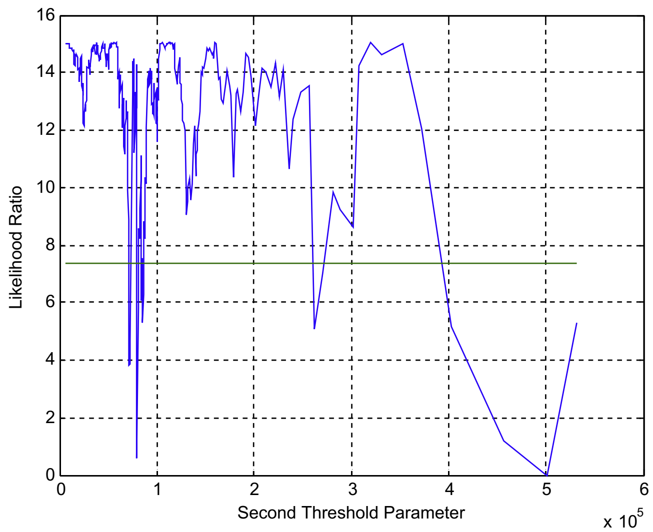

Fig. 2. Confidence interval construction in double threshold housing wealth model (no trimming).

are households with higher demand for consumption, and accordingly they utilize other sources of income to satisfy the higher demand. The insignificant housing wealth effect of the households whose income is above $501,000 is intuitive, because these are households with sufficiently high income they can depend on to increase their consumption level.

For comparison, we split the sample by standard income stratification techniques. First, we split the sample exogenously by the quantiles of income, as shown in the summary statistics. We run separate fixed effect estimations for every quantile. The results in Table 15 show that the housing wealth effect is 0.0221092, for incomes below the 25% quantile. It is 0.0055578 for incomes between the 25% quantile and the median income, 0.0297201 for incomes between the median income and the 75% quantile, and it is 0.016252 for incomes above the 75% quantile. It is obvious that the median income is not far from our first threshold, and the weighted average coefficient of those whose income is below the median is close to the coefficient of those whose income is below the first threshold.

We also split the sample by the estimated thresholds, and run separate fixed effects estimations for each income category. The results in Table 16 show that the housing wealth effect is 0.0171715 for those whose income is below the first threshold, and is 0.0266448 for those whose income is between the first and second thresholds, and statistically insignificant for those whose income is above the third threshold. These coefficients are close to the ones derived in the threshold estimation. However, the advantage of the threshold estimation is that it allows us to determine the threshold income levels endogenously.

4. Robustness

In order to examine the robustness of our results, we trim the data by 2.5%, 5% and 10% from both tails of the distribution, after ordering the households by average income over the three waves.

First, we trim the data by 2.5% from both tails of the distribution. The test statistics, along with their bootstrap *p*-values for the sample after trimming, are shown in Table 4. From the *p*-values, we conclude that there are two thresholds in the regression relationship, with a point estimate of \$75,566 and \$258,647. The asymptotic 99% confidence interval is [74,046–79,104] and [258,647–258,647], respectively. Table 8 contains the estimates, conventional OLS standard errors, and White-corrected standard errors. In this case, housing wealth has a statistically significant effect on consumption with a coefficient of 0.009226, if income is below \$75,566. The coefficient is also statistically significant and equals 0.025257 if income is between \$75,566 and \$258,647. For incomes above \$258,647, the coefficient is not statistically significant.

Second, we trim the data by 5% from both tails of the distribution. The test statistics, along with their bootstrap *p*-values for the sample after trimming, are shown in Table 5. From the *p*-values, we conclude that there are two thresholds in the regression relationship, with a point estimate of \$76,414 and \$131,062. The asymptotic 99% confidence interval is [75,332–78,400], and [127,406–142,140] respectively. Table 9 contains the estimates, conventional OLS standard errors and White-corrected standard errors. In this case, housing wealth has a significant effect on consumption with a coefficient of 0.011735, if income is below \$76,414. The coefficient is also statistically significant and equals 0.053893 if income is between \$76,414 and \$131,062. For incomes above \$131,062, the coefficient is statistically significant with a coefficient of 0.022977.

Finally, we trim the data by 10% from both tails of the distribution. The test statistics, along with their bootstrap *p*-values for the sample after trimming, are shown in Table 6. From the *p*-values, we conclude that there are two thresholds in the regression relationship, with a point estimate of \$76,291 and \$131,010. The asymptotic 99% confidence interval is [75,318–76,500] and [124,400–141,550] respectively. Table 10 contains the estimates, conventional OLS standard errors, and White-corrected standard errors. In this case, housing wealth has a significant effect on consumption with a coefficient of 0.008839, if income is below \$76,291. The coefficient is also statistically significant and equals 0.052914 if income is between \$76,291 and \$131,010. For incomes above \$131,010, the coefficient is statistically significant with a coefficient of 0.025463.

It is obvious that in all these cases, the lower threshold of almost \$75,000 is maintained. This implies that this threshold is robust. In addition, the housing wealth effect for those households whose income is below this threshold is around 1 cent for a dollar increase in housing wealth. This is close to the coefficient of the same group in the non-trimming case. However, the upper threshold changes when we trim the data. It declines to around \$250,000 when we trim the data by 2.5% and then to almost \$131,000, when we trim the data by 5% and 10%. This implies that the higher threshold is less robust. This could be attributed to the fact that there is a limited number of

Table 4
Tests for threshold effects in Housing Wealth (trimming 2.5%).

Test for single threshold	
F_1	27.314039
p-Value	0.002000
(10%, 5%, 1% Critical values)	(10.520300, 13.462839, 23.803747)
Test for double threshold	
F_2	29.359889
p-Value	0.004000
(10%, 5%, 1% Critical values)	(10.934736, 12.706455, 20.239085)

Table 5
Tests for threshold effects in Housing Wealth (trimming 5%).

Test for single threshold	
F_1	26.962302
p-Value	0.006000
(10%, 5%, 1% Critical values)	(11.573876, 13.947222, 23.629309)
Test for double threshold	
F_2	20.154825
p-Value	0.016000
(10%, 5%, 1% Critical values)	(12.399834, 15.168673, 24.325613)

Table 6
Tests for threshold effects in Housing Wealth (trimming 10%).

Test for single threshold	
F_1	43.105406
p-Value	0.004000
(10%, 5%, 1% Critical values)	(9.363212, 13.317802, 22.513664)
Test for double threshold	
F_2	20.579849
p-Value	0.014000
(10%, 5%, 1% Critical values)	(12.136888, 14.617984, 21.466938)

Table 7
Housing wealth effect regression estimates (no trimming).

Regressor	Coefficient estimate	OLS SE	White SE
Age_{it}	14.864986	11.365631	9.411999
Y_{it}	0.004160	0.003513	0.006978
Size_{it}	48.052305	387.930416	264.971113
Sex_{it}	−2995.399689	4398.645265	3286.235928
Marital_{it}	3031.451496	1752.812587	865.893644
High School_{it}	−174.180206	3013.816220	897.209309
Some College_{it}	−2391.432840	2340.288188	1231.535665
College_{it}	723.769353	2186.488506	1315.853659
$\text{HW}_{it}I(Y_{it} \leqslant Y^{T1})$	0.010602	0.004290	0.004121
$\text{HW}_{it}I(Y^{T1} < Y_{it} \leqslant Y^{T2})$	0.028224	0.003242	0.003881
$\text{HW}_{it}I(Y^{T2} < Y_{it})$	0.009699	0.007152	0.013689

Table 8
Housing wealth effect regression estimates (trimming 2.5%).

Regressor	Coefficient estimate	OLS SE	White SE
Age_{it}	13.718090	10.631209	8.997201
Y_{it}	−0.000779	0.007487	0.008785
Size_{it}	98.826829	371.316088	253.417576
Sex_{it}	−2098.821419	4358.571164	2978.909718
Marital_{it}	3093.929570	1663.676871	868.917244
High School_{it}	−314.315986	2819.713969	898.054452
Some College_{it}	−2694.038052	2213.440744	1270.757550
College_{it}	894.046064	2065.452302	1351.318703
$\text{HW}_{it}I(Y_{it} \leqslant Y^{T1})$	0.009226	0.004246	0.003924
$\text{HW}_{it}I(Y^{T1} < Y_{it} \leqslant Y^{T2})$	0.025257	0.003719	0.004230
$\text{HW}_{it}I(Y^{T2} < Y_{it})$	0.058325	0.009321	0.011744

Table 9
Housing wealth effect regression estimates (trimming 5%).

Regressor	Coefficient estimate	OLS SE	White SE
Age_{it}	18.884216	10.500081	11.702260
Y_{it}	0.009207	0.008203	0.008617
Size_{it}	139.093954	372.217851	249.236296
Sex_{it}	−1695.553075	4254.429069	2958.524720
Marital_{it}	2509.826917	1674.210496	806.624861
High School_{it}	−242.376087	2803.087579	933.046784
Some College_{it}	−2437.018625	2186.725674	1272.844956
College_{it}	982.470762	2077.754970	1343.675694
$\text{HW}_{it}I(Y_{it} \leqslant Y^{T1})$	0.011735	0.004280	0.003639
$\text{HW}_{it}I(Y^{T1} < Y_{it} \leqslant Y^{T2})$	0.053893	0.009291	0.016898
$\text{HW}_{it}I(Y^{T2} < Y_{it})$	0.022977	0.003828	0.004019

Table 10
Housing wealth effect regression estimates (trimming 10%).

Regressor	Coefficient estimate	OLS SE	White SE
Age_{it}	18.590388	10.186214	11.791578
Y_{it}	−0.003788	0.009810	0.010864
Size_{it}	143.019922	395.190773	262.466871
Sex_{it}	−2405.499582	4204.492974	1848.582349
Marital_{it}	2531.601260	1700.818404	743.819614
High School_{it}	314.175676	2860.514731	966.957924
Some College_{it}	−851.372254	2256.259667	1010.049406
College_{it}	1764.083051	2170.032762	1252.400071
$\text{HW}_{it}I(Y_{it} \leqslant Y^{T1})$	0.008839	0.004416	0.003483
$\text{HW}_{it}I(Y^{T1} < Y_{it} \leqslant Y^{T2})$	0.052914	0.008864	0.015898
$\text{HW}_{it}I(Y^{T2} < Y_{it})$	0.025463	0.004241	0.004628

households above the higher threshold[2]. Accordingly, the higher threshold disappears when we trim the sample by 5% and by 10%.

5. Other tests

We attempt to distinguish between predictable and unpredictable changes in housing wealth. We test whether consumption responds to predictable changes in housing wealth, which is closely related to the literature on the excess sensitivity of consumption to income. The hypothesis to be tested is the permanent income hypothesis, which states that consumption should respond only to unpredictable changes in income. Campbell et al. (2007) test the permanent income hypothesis by including house prices as a regressor. In their paper, they examine whether consumption responds to predictable changes in house prices. We follow their suit, and test whether consumption responds to predictable changes in housing wealth. The model we estimate is:

$$\mathbf{C}_{it} = \mu_i + \beta_1 E_t \mathbf{HW}_{it} I(\mathbf{Y}_{it} \leqslant Y^T) + \beta_2 E_t \mathbf{HW}_{it} I(\mathbf{Y}_{it} > Y^T) + \phi_1 E_t \mathbf{Y}_{it} + \boldsymbol{\phi}_2 E_t \mathbf{D}_{it} + e_{it} \quad (3)$$

where E_t is the expectation operator. If the permanent income hypothesis is true, $\beta_1, \beta_2,$ and ϕ_1 should be zero.

We follow the methodology in Campbell et al. (2007) to estimate the response of consumption to predictable changes in housing wealth. The equation is estimated using instrumental variables. We use instruments dated $t-1$, or the first lag of the housing wealth, income, and consumption. This means that we estimate Eq. (1) using lagged variables as instruments, which correspond to estimating Eq. (3). This is the methodology that is adopted in the literature on the excess sensitivity of consumption.

The test statistics, along with their bootstrap p-values are shown in Table 11. From the p-values, we conclude that there are two thresholds in the regression relationship, with a point estimate of \$74,360 and \$410,200 . The asymptotic 99% confidence interval is [69,283—245,000], and [393,134—530,406] respectively. Table 13 contains the estimates, conventional OLS standard errors, and White-corrected standard errors. In this case, predictable changes in housing wealth has a significant effect on consumption with a coefficient of 0.010780, if income is below \$74,360. The coefficient is also statistically significant and equals 0.032314 if income is between \$74,360 and \$410,200. For incomes above \$410,200, the coefficient is statistically insignificant. This implies that those households, who have a significant housing wealth effect, are borrowing constrained and a predictable increase in their housing wealth increase their borrowing capacity. Amongst those households, the ones in the lower income category are likely to have a precautionary saving motive. That is why their housing wealth effect coefficient is small. While those in the higher income category may exhibit myopic behavior.

If a fraction of the households are forward looking and unconstrained, then their consumption should respond to unpredictable movements in housing wealth. To explore this effect, we identify the unpredictable housing wealth changes. We first estimate $E_t\mathbf{HW}_{it}$, and then obtain the shocks to housing wealth ($\mathbf{HW}_{it} - E_t\mathbf{HW}_{it}$). In the estimate of expected housing wealth changes, we include as explanatory variables the same instrumental variables that we used in the previous estimation. We do the same for income and consumption, to obtain measures of the unexpected changes in income and consumption, ($\mathbf{Y}_{it} - E_t\mathbf{Y}_{it}$) and ($\mathbf{C}_{it} - E_t\mathbf{C}_{it}$), respectively. We test whether unexpected

[2] According to the data, there are 13 households whose income is above the upper threshold.

Table 11
Tests for threshold effects in Housing Wealth (Predictable).

Test for single threshold	
F_1	53.546112
p-Value	0.000000
(10%, 5%, 1% Critical values)	(11.211229, 12.483621, 17.063476)
Test for double threshold	
F_2	30.130833
p-Value	0.002000
(10%, 5%, 1% Critical values)	(10.700002, 13.630125, 23.804595)

Table 12
Tests for threshold effects in Housing Wealth (Unpredictable).

Test for single threshold	
F_1	36.743851
p-Value	0.000000
(10%, 5%, 1% Critical values)	(9.138532, 10.520121, 16.074838)
Test for double threshold	
F_2	26.328580
p-Value	0.000000
(10%, 5%, 1% Critical values)	(9.368987, 11.288868, 15.952177)

Table 13
Housing wealth effect regression estimates (Predictable).

Regressor	Coefficient estimate	OLS SE	White SE
Age_{it}	139.809324	41.451545	30.680076
Y_{it}	0.023866	0.004537	0.008819
$Size_{it}$	775.377247	288.169156	204.076893
Sex_{it}	413.494204	1557.817036	891.204201
$Marital_{it}$	3690.753541	1313.428170	778.080575
$High School_{it}$	−253.883688	1376.256496	809.517200
$Some College_{it}$	1453.584126	1413.443235	879.894061
$College_{it}$	5065.188789	1408.038035	950.524499
$HW_{it}I(Y_{it} \leqslant Y^{T1})$	0.010780	0.005592	0.004897
$HW_{it}I(Y^{T1} < Y_{it} \leqslant Y^{T2})$	0.032314	0.003116	0.004309
$HW_{it}I(Y^{T2} < Y_{it})$	0.000381	0.006240	0.005422

Table 14
Housing Wealth Effect regression estimates (Unpredictable).

Regressor	Coefficient estimate	OLS SE	White SE
Age_{it}	−158.574591	46.392258	38.591223
Y_{it}	0.020344	0.004088	0.007887
$Size_{it}$	648.834370	290.568486	206.086593
Sex_{it}	−5246.064542	1574.159006	905.496203
$Marital_{it}$	4526.119347	1326.528256	796.597231
$High School_{it}$	−634.991610	1434.332797	893.349073
$Some College_{it}$	5211.267262	1425.970616	904.370172
$College_{it}$	−3937.080245	1413.318917	955.649408
$HW_{it}I(Y_{it} \leqslant Y^{T1})$	0.011624	0.003220	0.003233
$HW_{it}I(Y^{T1} < Y_{it} \leqslant Y^{T2})$	0.047155	0.009415	0.010171
$HW_{it}I(Y^{T2} < Y_{it})$	−0.011995	0.005955	0.005330

changes in consumption react to unexpected changes in housing wealth by estimating the following regression:

$$(\mathbf{C}_{it} - E_t\mathbf{C}_{it}) = \mu_i + \beta_1(\mathbf{HW}_{it} - E_t\mathbf{HW}_{it})I(\mathbf{Y}_{it} \leqslant Y^T) + \beta_2(\mathbf{HW}_{it} - E_t\mathbf{HW}_{it})I(\mathbf{Y}_{it} > Y^T) + \phi_1(\mathbf{Y}_{it} - E_t\mathbf{Y}_{it}) + \boldsymbol{\phi}_2 E_t\mathbf{D}_{it} + e_{it} \qquad (4)$$

The test statistics along with their bootstrap p-values are shown in Table 12. From the p-values, we conclude that there are two thresholds in the regression relationship with a point estimate of \$129,944 and \$176,049.8. The asymptotic 99% confidence interval is [71,620.72–129,944] and [165,951.5–197083.6], respectively. Table 14 contains the estimates, conventional OLS standard errors, and White-corrected standard errors. In this case, unpredictable changes in housing wealth has a significant effect on consumption with a coefficient of 0.011624, if income is below \$129,944. The coefficient is also statistically significant and equals 0.047155 if income is between \$129,944 and \$176,049.8. For incomes above \$176,049.8, the coefficient is statistically insignificant.

6. Simulations

We use our results to make back-of-the-envelope calculations of the impact that the house price bubble and burst had on aggregate consumption and ultimately gross domestic product GDP in the United States. Our analysis covers the period from 2000 to 2010, when the housing market in the United States witnessed a price bubble as the median house price increased by almost 75% from 2002 to 2006. This was followed by a crash, as the median house price declined by almost 20% from 2006 to 2010[3]. Quarterly data on aggregate housing wealth are extracted from the Federal Reserve Board of Governors Flow of Funds. Data on aggregate consumption and aggregate GDP are extracted from the National Income and Products Accounts. We first calculate housing wealth changes from one quarter to another. We apply our coefficient for the housing wealth effect to translate changes in housing wealth to changes in

[3] The data on house prices are compiled from the Federal Housing Finance Agency.

Table 15
Regression results for the quantiles.

	Q1	Q2	Q3	Q4
Age_{it}	−1.940469	883.2643	33.04783	1596.233
	(8.573273)	(104.5115)	(12.65095)	(267.02)
Y_{it}	0.0406591	0.0226111	0.0558	0.000659
	(0.018217)	(0.0119811)	(0.0117439)	(0.0038617)
$Size_{it}$	128.0815	250.8583	−1030.399	1397.488
	(339.0941)	(409.6875)	(505.9905)	(810.7236)
Sex_{it}	−2432.266	811.499	−9355.703	5575.933
	(3747.921)	(3837.484)	(4032.383)	(8565.826)
$Marital_{it}$	−567.7297	752.2916	5202.733	7003.301
	(1740.58)	(1477.447)	(2193.161)	(4754.769)
High $School_{it}$	−1657.338	874.023	2233.88	5188.207
	(2505.798)	(2874)	(6085.838)	(10043.28)
Some $College_{it}$	−3438.04	−215.9009	−399.0887	−4876.671
	(2647.372)	(2417.883)	(3509.284)	(5355.445)
$College_{it}$	−6977.802	−699.6696	2880.692	2490.537
	(4815.572)	(2408.488)	(2928.878)	(4522.229)
HW_{it}	0.0221092	0.0055578	0.0297201	0.016252
	(0.0038356)	(0.0038641)	(0.0043057)	(0.0040318)

Table 16
Regression results for thresholds. In column 3, the coefficients are dropped out because the observations for these variables do not vary.

	1	2	3
Age_{it}	4.210698	41.1394	8421.922
	(9.354755)	(16.0851)	(5169.748)
Y_{it}	0.0332807	0.0032875	0.0003684
	(0.009902)	(0.0046006)	(0.0124432)
$Size_{it}$	−174.0053	45.14652	9584.647
	(271.0415)	(474.0161)	(14407.27)
Sex_{it}	−1911.247	−4740.015	−141.9719
	(2815.834)	(4230.309)	(48257.65)
$Marital_{it}$	1242.531	7719.302	
	(1156.256)	(2365.678)	()
High $School_{it}$	−402.4068	2613.453	
	(1978.841)	(5626.205)	()
Some $College_{it}$	−1353.681	−2761.443	
	(1869.668)	(3105.114)	()
$College_{it}$	−1780.028	1766.439	34922.17
	(2181.752)	(2681.523)	(52315.15)
HW_{it}	0.0171715	0.0266448	0.0088904
	(0.0027733)	(0.002828)	(0.0240942)

consumption. The coefficient is a weighted average of the statistically significant coefficients in the total non-trimming sample threshold estimation. The weighted average coefficient of the housing wealth effect is 0.015335269. The calculated changes in consumption are applied to the initial aggregate consumption in the data, in order to create a simulated consumption variable. The simulated consumption variable is used to calculate a consumption growth variable. The consumption change is then translated into changes in GDP, by multiplying the change in consumption by $(\frac{1}{MPC})$, where MPC is the marginal propensity to consume. We conduct simulations using two estimates of the MPC: 0.85 and 0.95. These are the common estimates derived and estimated in the pertinent literature. The change in GDP variable is applied to the initial GDP variable in the data in order to create a simulated GDP variable. The simulated GDP variable is used to calculate a variable for GDP growth.

Fig. 3 shows the data aggregate housing wealth growth, the data consumption growth, and the simulated consumption growth. Fig. 4 displays the data aggregate housing wealth growth, the data aggregate GDP growth, and the simulated GDP growth if MPC = 0.85. Fig. 5 displays the data aggregate housing wealth growth, the data aggregate GDP growth, and the simulated GDP growth if the MPC = 0.95. The graphs show the success of the simulations to generate consumption and GDP variables that display similar patterns to those of the actual data.

7. Conclusion

This paper estimates the effect of changes in housing wealth on the consumption behavior of heterogeneous households. Previous studies suggest that consumption behavior, measured by the marginal propensity to consume, varies by income level. Therefore, we expect that the housing wealth effect of the poor households is different than that of the rich households.

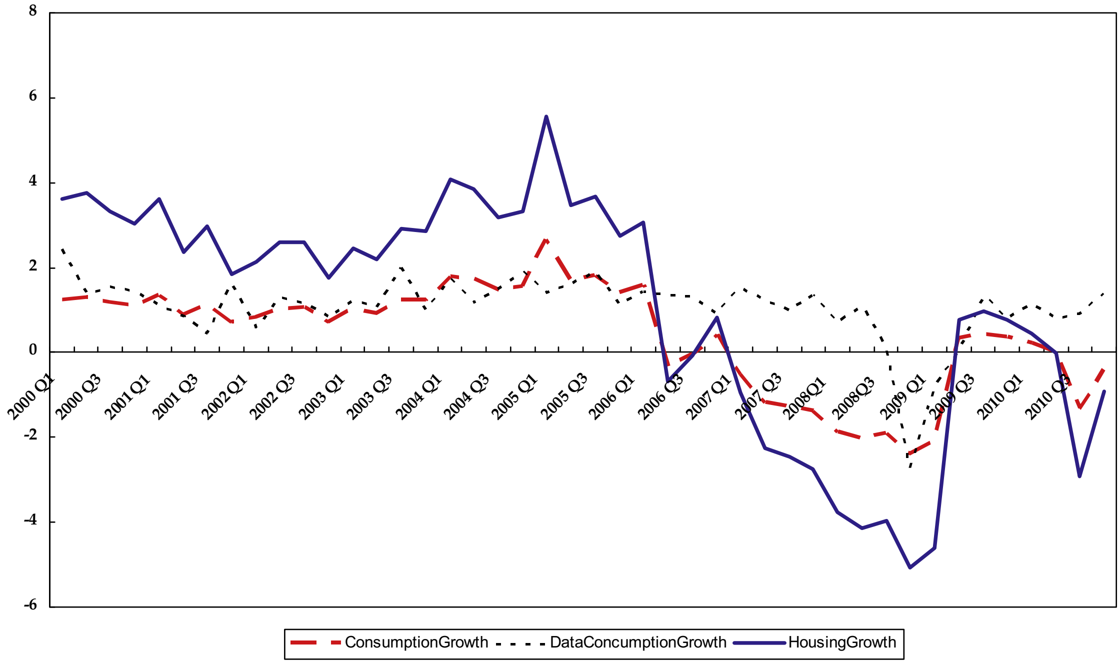

Fig. 3. Housing wealth growth, data consumption growth and simulated consumption growth.

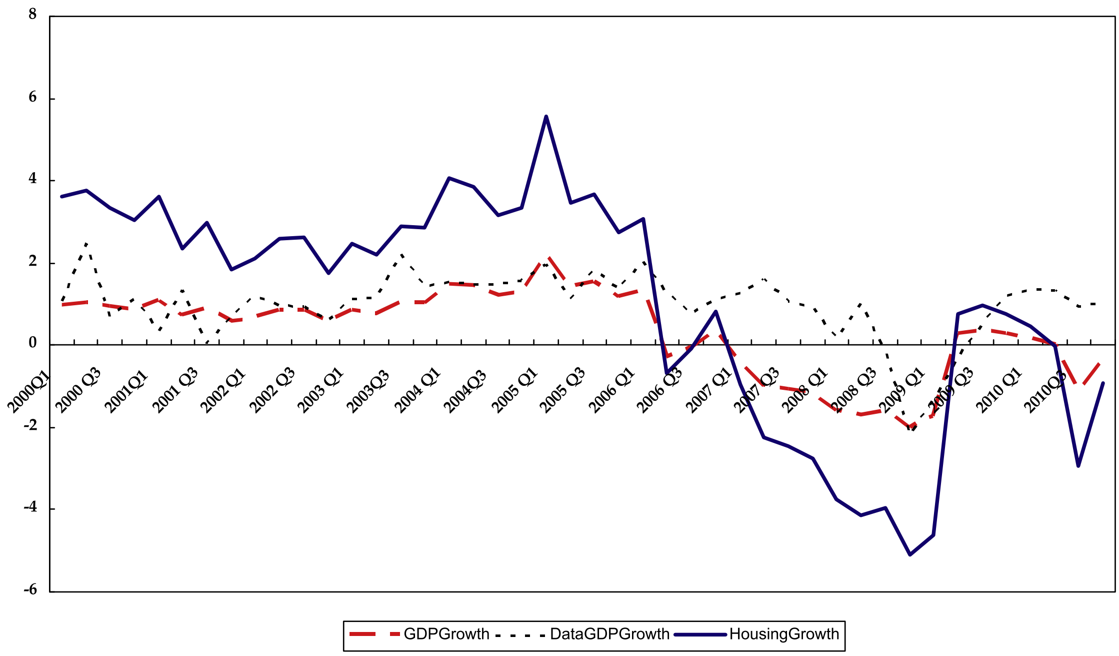

Fig. 4. Housing wealth growth, data GDP growth and simulated GDP growth (MPC = 0.85).

We use the Panel Study of Income Dynamics for the waves of 2001, 2003 and 2005. Our estimation results are consistent with the hypothesis above. We find two significant threshold income levels of $\$74,046$ and $\$501,000$. Housing wealth has a significant effect on consumption with a coefficient of 0.010602, if income is below $\$74,046$. It is also significant and equals 0.028224 if income is between $\$74,046$ and $\$501,000$. For incomes above $\$501,000$, the coefficient is not statistically significant. Our results show that the first threshold is robust,

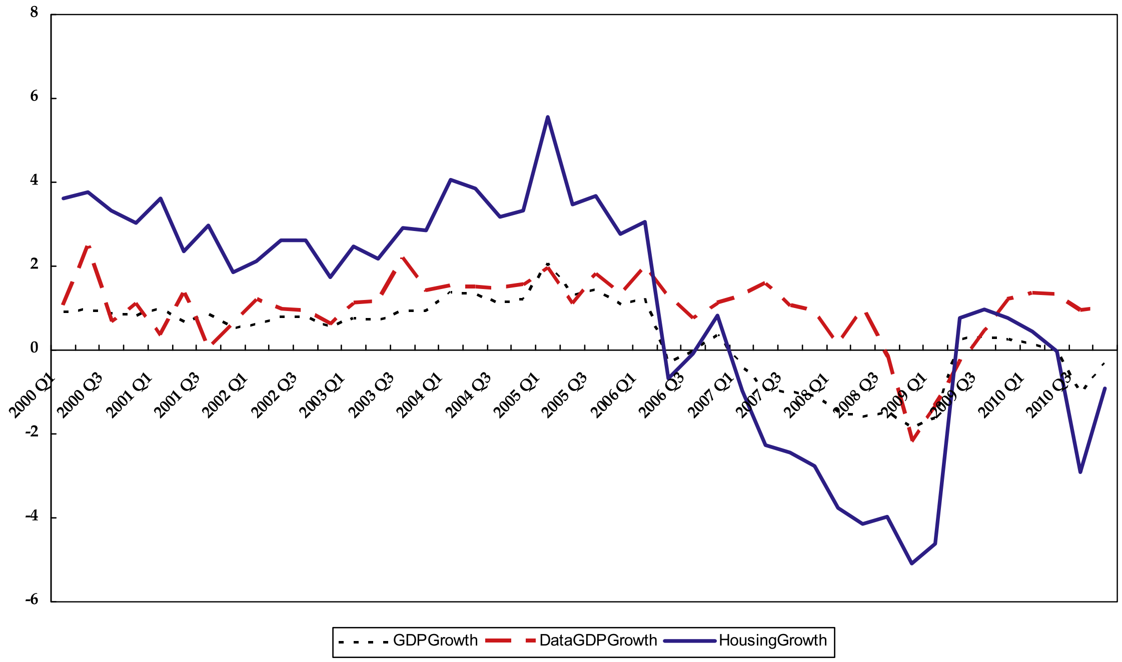

Fig. 5. Housing wealth growth, data GDP growth and simulated GDP growth (MPC = 0.95).

while the second threshold is less robust as there are limited number of households whose income is above the second threshold.

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