Understanding Society
THE UK HOUSEHOLD LONGITUDINAL STUDY

UNIVERSITY OF CAMBRIDGE

Insights 2025 – Housing at the heart: creating healthy, equitable and sustainable communities

How is rising housing wealth changing energy consumption?

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Housing Wealth

- Changes in wealth and income affect consumption: one of the most important topics in economics
- The theory – the life cycle model
  - Ando, A. and F. Modigliani (1963). The "Life Cycle" Hypothesis of Saving: Aggregate Implications and Tests. *American Economic Review* 53(1): 55-84.
  - Assumption: Individuals plan their consumption based on their lifetime resources.
  - Changes in wealth will not affect consumption, because any increases or decreases in wealth will be smoothed out in a life-time, which is typically assumed to be infinite in many of the early studies.
  - Marginal propensity to consume (MPC) out of current income: the percentage of an additional pound of income to be spent
  - The wealth effect under life-cycle model theory is essentially zero.

Housing Wealth

- The reality
  - MPC between 3% to 4% is common in many empirical studies
  - Remaining life span and opportunity cost matter
  - Older people have larger MPC
  - Low human capital, high MPC
  - The effect of financial wealth on general consumption has been weakening, from 5% in the 1950s to around 2% now
    - The decline of the share in financial wealth by low-income households
    - Stock ownership among mid- and low- income households is predominantly in the form of pension funds and mutual funds

Housing Wealth

- The reality
  - The effect size of housing wealth is much larger than that of financial wealth
  - **MPC = 8%**: Benjamin, J. D., et al. (2004). "Real estate versus financial wealth in consumption." *Journal of Real Estate Finance and Economics* 29(3): 341-354.
  - **Evidence from 30 developing and developed countries:** Sonje, A. A., et al. (2014). "The effect of housing and stock market wealth on consumption in emerging and developed countries." *Economic Systems* 38(3): 433-450.
  - **A 10% decline in housing wealth could lead to a 1% decline in real GDP growth:** Bostic, R., et al. (2009). "Housing wealth, financial wealth, and consumption: New evidence from micro data." *Regional Science and Urban Economics* 39(1): 79-89.

Housing Wealth

- The challenges: a large stake
  - The proportion of housing wealth has been increasing steadily, and has already surpassed financial wealth in many countries.

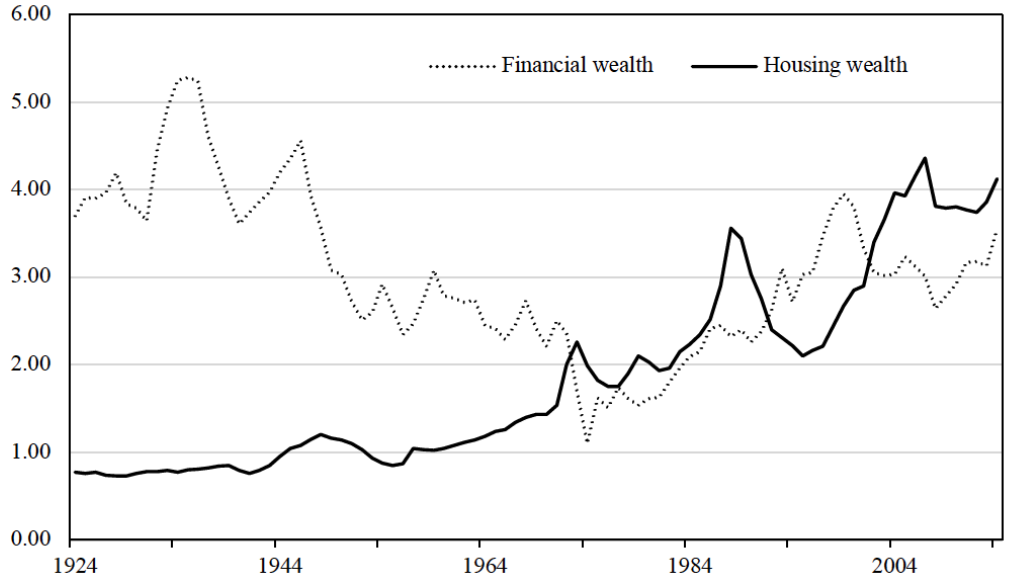

Figure 8.1: Housing wealth and financial wealth in the UK (ratio of Gross Domestic Income)

Data Source: 'Economic Statistics Transformation Programme: Historical estimates of financial accounts and balance sheets', Office for National Statistics, 2016.

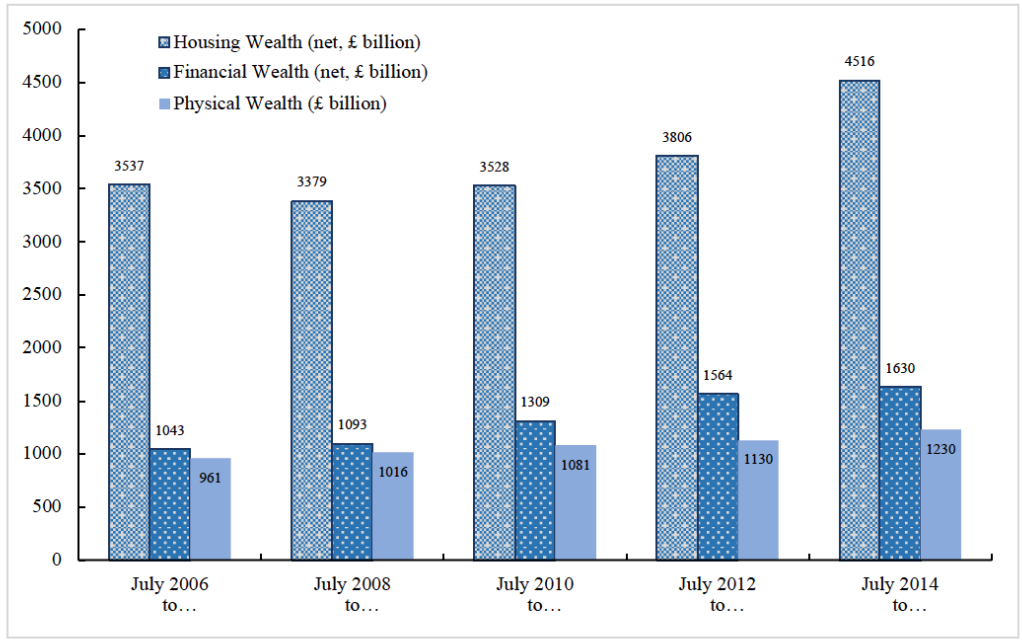

Figure 8.2: Housing wealth and financial wealth in the UK (net, in £ billion)

Data Source: Office for National Statistics, 2019.

Housing Wealth

- The challenges: less prepared decision makers
  - The proportion of mid- and low-income individuals is much higher among homeowners than stockholders
  - **Individuals with financial constraints are more likely to make mistakes in their financial decisions:** Mani, A., et al. (2013). "Poverty Impedes Cognitive Function." *Science* 341(6149): 976-980. & Shah, A. K., et al. (2012). "Some Consequences of Having Too Little." *Science* 338(6107): 682-685.
  - **Financial literacy also matters (which is usually a luxury for poor):** van Rooij, M. C. J., et al. (2012). "Financial Literacy, Retirement Planning and Household Wealth." *Economic Journal* 122(560): 449-478.

Housing Wealth

- The challenges: decisions are prone to judgmental biases
  - **Estimation of housing wealth has large errors for specific groups:** Windsor, C., et al. (2015). "Home price beliefs: Evidence from Australia." *Journal of Housing Economics* 29: 41-58.
  - **Homeowners are not good valuers, and their mistakes have consequences:** Agarwal, S. (2007). "The impact of homeowners' housing wealth misestimation on consumption and saving decisions." *Real Estate Economics* 35(2): 135-154.

Residential energy consumption

- Policy implication:
  - Energy reservation is a crucial step to achieve sustainable urban development and residential energy consumption plays a very important role in this pursuit
  - A good understanding of housing wealth effect on residential energy consumption will help policy making in this domain
  - Energy conservation is one of the most promising areas for behavioural interventions
    - Alberini, A. and C. Towe (2015). "Information v. energy efficiency incentives: Evidence from residential electricity consumption in Maryland." *Energy Economics* 52: S30-S40.
    - Aydin, E., et al. (2018). "Information provision and energy consumption: Evidence from a field experiment." *Energy Economics* 71: 403-410.

Residential energy consumption

- Analytical consideration
  - Energy is necessity. Its elasticity of demand should be very small, if any. Hence MPC = 0
  - If MPC > 0 for energy consumption, it is likely to be much larger for other types of consumption
- Technical advantage:
  - Energy consumption can be estimated accurately because the figures are available in household energy bills
  - It is a narrow focus, but with a much cleaner view of the effect of housing wealth.

Behavioural interventions for energy conservation

- **Key cognitive biases and motivational factors:** Frederiks, E. R., et al. (2015). "Household energy use: Applying behavioural economics to understand consumer decision-making and behaviour." *Renewable & Sustainable Energy Reviews* 41: 1385-1394.
- **The effectiveness of behavioural interventions:** Nisa, C. F., et al. (2019). "Meta-analysis of randomised controlled trials testing behavioural interventions to promote household action on climate change." *Nature Communications* 10.
- **One of the most studied topics:** Karlin, B., et al. (2015). "The Effects of Feedback on Energy Conservation: A Meta-Analysis." *Psychological Bulletin* 141(6): 1205-1227.

Data and variables

- Data source: Understanding Society – Innovation Panel (IP), a special component of Understanding Society: about 2,760 households between 2011 and 2015.

Variable	Definition	US-IP question(s)	US-IP variable(s)	Mean	Std. Dev.
energybill	Energy consumption in £	In the last year, how much has your household spent on electricity, or gas, or electricity and gas combined?	*xpelecy (electricity bill)* *xpgasy (gas bill)* *xpduely (combined energy bill)*	1283.14	514.49
hsval	Housing wealth in £	How much would you expect to get for your home if you sold it today?	*hsval*	240355	135665
income	Monthly gross household income in £	Gross household income: month before interview	*fihhmngrs_dv*	3759	2402
hw	= *hsval*/(12**income*)	*hsval*/(12**income*)	*hsval* *fihhmngrs_dv*	9.76	68.51
energy	= *energybill*/(12**income*)	*energybill*/(12**income*)	*xpelecy (electricity bill)* *xpgasy (gas bill)* *xpduely (combined energy bill)* *fihhmngrs_dv*	0.06	0.30
finfuture	= 1 if subjective future financial situation will be better off, 0 otherwise	Looking ahead, how do you think you will be financially a year from now, will you be 1: better off; 2: worse off than you are now; 3: or about the same?	*finfut*	0.16	0.36

Data and variables

Variable	Definition	US-IP question(s)	US-IP variable(s)	Mean	Std. Dev.
conservative	=1 if environmentally conscious, 0 otherwise	How often you personally do each of the following things? 1) leave your TV on standby for the night 2) keep the tap running while you brush your teeth 3) Switch off lights in rooms that aren't being used 4) put more clothes on when you feel cold rather than putting the heating on or turning it up 5) decide not to buy something because you feel it has too much packaging 6) buy recycled paper products such as toilet paper or tissues 7) take your own shopping bag when shopping 8) use public transport (e.g. bus, train) rather than travel by car 9) walk or cycle for short journeys less than 2 or 3 miles 10) car share with others who need to make a similar journey 11) take fewer flights when possible?	*envhabit1-envhabit11*	0.15	0.36

- The sum of scores of good habits (i.e., *envhabit3* through *envhabit11*) minus the sum of scores of bad habits (i.e., *envhabit1* and *envhabit2*) to form an energy conservativeness score for each respondent
- The median of the score is 3
- Conservative = 1 if the energy conservativeness score is greater than 3 in all four waves (2011 – 2014)

Data and variables

Variable	Definition	US-IP question(s)	US-IP variable(s)	Mean	Std. Dev.
combined	= 1 if energy bills are paid as a combined one, 0 otherwise	In the last year, how much has your household spent on electricity and gas combined?	*xpduely*	0.58	0.49
old	= 1 if older than 60, 0 otherwise	Age in years	*dvage*	0.39	0.49
sex	= 1 if male, 0 otherwise	Sex	*gender*	0.45	0.50
ncars	Number of cars owned	How many cars or vans in total does your household own or have continuous use of?	*ncars*	1.70	0.91
hheat	= 1 if household is able to keep property warm enough, 0 otherwise	In winter, are you able to keep this accommodation warm enough?	*hheat*	1.04	0.20
hhsize	Number of people in household	Number of people in household	*hhsize*	2.62	1.20
hsbeds	Number of bedrooms	How many bedrooms are there here excluding any bedrooms you may let or sublet?	*hsbeds*	3.21	0.90
employ	= 1 if individual is in paid employment, 0 otherwise	Are you in paid employment?	*employ*	0.59	0.49

Models and estimation strategy

$$energy_{it} = \alpha + \beta hw_{it} + \boldsymbol{\theta}\begin{bmatrix} old_{it} \\ conservative_i \\ finfuture_{it} \\ combined_{it} \end{bmatrix} + \boldsymbol{\gamma}\begin{bmatrix} old_{it} \\ conservative_i \\ finfuture_{it} \\ combined_{it} \end{bmatrix} \cdot hw_{it} + \boldsymbol{\varphi}\begin{bmatrix} sex_i \\ ncars_{it} \\ hheat_{it} \\ hhsize_{it} \\ hsbed_{it} \\ employ_{it} \end{bmatrix} + \varepsilon_{it}$$

- β captures direct housing wealth effect, $\boldsymbol{\gamma}$ estimates indirect housing wealth effect
- old_{it}, $conservative_i$, $finfuture_{it}$, and $combined_{it}$ are moderators
- Housing wealth effect presents if $\beta \neq 0$ or $\boldsymbol{\gamma} \neq 0$
- If $\boldsymbol{\gamma} \neq 0$, housing wealth effect is different between old and young groups, people with high and low environmentally consciousness, people who have positive and negative expectation about their finance in next year, and households that use combined and separate energy bills.

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Empirical Findings

- Linear regression with wave and regional dummies
- Clustered Standard Deviation is used in the final model, because households across different waves are correlated
- Coefficient estimates of key variables are stable across models

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
hw	0.0030***	0.0050***	0.0088***	0.0088***	0.0088***
	0.0000	0.0000	(0.0001)	(0.0001)	(0.0017)
finfuture		0.0191***	0.0440***	0.0436***	0.0436***
		(0.0047)	(0.0030)	(0.0030)	(0.0104)
finfuture_hw		-0.0028***	-0.0069***	-0.0069***	-0.0069***
		(0.0001)	(0.0001)	(0.0001)	(0.0017)
old			0.0336***	0.0298***	0.0298***
			(0.0023)	(0.0030)	(0.0115)
old_hw			-0.0047***	-0.0047***	-0.0047***
			(0.0001)	(0.0001)	(0.0017)
combined			-0.0092***	-0.0084***	-0.0084***
			(0.0021)	(0.0022)	(0.0014)
combined_hw			0.0004***	0.0003***	0.0003***
			(0.0001)	(0.0001)	(0.0001)
conservative			0.0050*	0.0046	0.0046
			(0.0029)	(0.0029)	(0.0044)
conservative_hw			-0.0023***	-0.0025***	-0.0025**
			(0.0001)	(0.0001)	(0.0012)
sex				-0.0041*	-0.0041*
				(0.0021)	(0.0022)
ncars				-0.0021	-0.0021**
				(0.0014)	(0.0010)
hheat				-0.0022	-0.0022
				(0.0057)	(0.0062)
hhsize				0.0023**	0.0023**
				(0.0011)	(0.0010)
hsbeds				-0.0055***	-0.0055***
				(0.0014)	(0.0012)
employ				-0.0070**	-0.0070*
				(0.0028)	(0.0039)
Constant	0.0154	-0.0059	-0.0079*	0.0154*	0.0154
	(0.0105)	(0.0071)	(0.0046)	(0.0091)	(0.0097)
wave dummies	yes	yes	yes	yes	yes
region dummies	yes	yes	yes	yes	yes
clustered SE	no	no	no	no	yes
N	2613	2613	2613	2529	2529
R2	0.7560	0.8904	0.9597	0.9614	0.9614
Adj-R2	0.7547	0.8897	0.9594	0.9610	0.9610
F-stat	575***	1318***	2807***	2227***	3690***

Notes: *, **, and *** denote significance level of 10%, 5%, and 1%, respectively.

Empirical Findings

- Financial wealth variable is missing
- Quantile regression (by income) to reduce this omitted variable bias
- Housing wealth is stronger among poor households (e.g., the 90th percentile)
- Energy poverty might be a concern

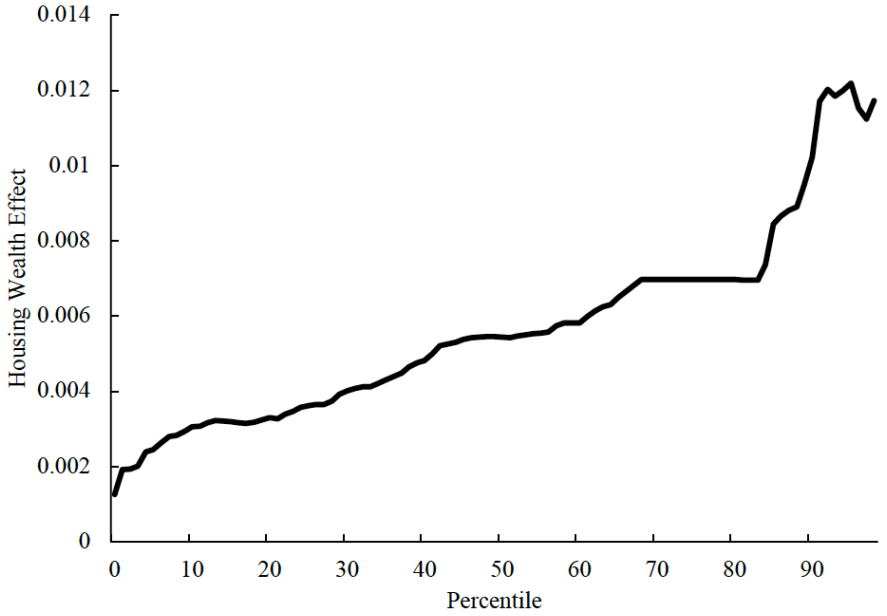

Figure 8.3: Quantile regression estimation of housing wealth effect on energy consumption (1st to 99th percentile)

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Percentile	0.1	0.25	0.5	0.75	0.9	OLS
hw	0.0029***	0.0036***	0.0055***	0.0070***	0.0095***	0.0088***
	0.0000	0.0000	0.0000	0.0000	(0.0002)	(0.0017)
finfuture	0.0056***	0.0084***	0.0170***	0.0275***	0.0319***	0.0436***
	(0.0014)	(0.0014)	(0.0011)	(0.0016)	(0.0061)	(0.0104)
finfuture_hw	-0.0012***	-0.0020***	-0.0035***	-0.0050***	-0.0055***	-0.0069***
	0.0000	0.0000	0.0000	0.0000	(0.0001)	(0.0017)
old	0.0054***	0.0018	0.0074***	0.0155***	0.0301***	0.0298***
	(0.0014)	(0.0014)	(0.0011)	(0.0016)	(0.0061)	(0.0115)
old_hw	-0.0006***	-0.0002***	-0.0013***	-0.0028***	-0.0054***	-0.0047***
	0.0000	0.0000	0.0000	0.0000	(0.0002)	(0.0017)
combined	-0.0059***	-0.0068***	-0.0061***	-0.0082***	-0.0114***	-0.0084***
	(0.0010)	(0.0010)	(0.0008)	(0.0011)	(0.0044)	(0.0014)
combined_hw	0.0005***	0.0006***	0.0003***	0.0003***	0.0003**	0.0003***
	0.0000	0.0000	0.0000	0.0000	(0.0001)	(0.0001)
conservative	-0.0017	-0.0016	-0.0009	-0.0009	-0.0032	0.0046
	(0.0013)	(0.0013)	(0.0010)	(0.0015)	(0.0059)	(0.0044)
conservative_hw	-0.0004***	-0.0005***	-0.0008***	-0.0005***	-0.0006**	-0.0025**
	(0.0001)	(0.0001)	0.0000	(0.0001)	(0.0003)	(0.0012)
sex	0.0003	-0.0003	-0.0001	-0.0006	-0.0012	-0.0041*
	(0.0010)	(0.0010)	(0.0007)	(0.0011)	(0.0042)	(0.0022)
ncars	-0.0011*	-0.0002	-0.0007	-0.0015**	-0.0027	-0.0021**
	(0.0006)	(0.0006)	(0.0005)	(0.0007)	(0.0028)	(0.0010)
hheat	-0.0089***	-0.0023	0.0026	0.0056*	0.0088	-0.0022
	(0.0026)	(0.0026)	(0.0020)	(0.0030)	(0.0114)	(0.0062)
hhsize	0.0020***	0.0012**	0.0015***	0.0020***	0.0023	0.0023**
	(0.0005)	(0.0005)	(0.0004)	(0.0006)	(0.0022)	(0.0010)
hsbeds	-0.0025***	-0.0027***	-0.0033***	-0.0044***	-0.0054*	-0.0055***
	(0.0006)	(0.0006)	(0.0005)	(0.0007)	(0.0028)	(0.0012)
employ	-0.0019	-0.0006	-0.0009	-0.0038**	-0.0074	-0.0070*
	(0.0013)	(0.0013)	(0.0010)	(0.0015)	(0.0057)	(0.0039)
Constant	0.0186***	0.0153***	0.0086***	0.0106**	0.0173	0.0154
	(0.0042)	(0.0042)	(0.0032)	(0.0048)	(0.0184)	(0.0097)

Notes: *, **, and *** denote significance level of 10%, 5%, and 1%, respectively.

Findings and conclusions

- Is there housing wealth effect on energy consumption in the UK?

Table 8.2: Housing wealth and energy consumption

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
hw	0.0030***	0.0050***	0.0088***	0.0088***	0.0088***
	0.0000	0.0000	(0.0001)	(0.0001)	(0.0017)

- Housing wealth significantly affects energy consumption in the UK
- When housing wealth as a percentage of income (*hw*) increase by 1%, energy consumption as a percentage of income (*energy*) increase by 0.0088%

Findings and conclusions

- How does housing wealth affect energy consumption in the UK?

Age, combined energy bill payment method, and energy conservative attitude all serve as moderator in the housing wealth effect on energy consumption.

Higher marginal consumption for fuel poor households.

Table 8.3: Quantile regression results: housing wealth effect on energy consumption

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Percentile	0.1	0.25	0.5	0.75	0.9	OLS
hw	0.0029***	0.0036***	0.0055***	0.0070***	0.0095***	0.0088***
	0.0000	0.0000	0.0000	0.0000	(0.0002)	(0.0017)
finfuture_hw	-0.0012***	-0.0020***	-0.0035***	-0.0050***	-0.0055***	-0.0069***
	0.0000	0.0000	0.0000	0.0000	(0.0001)	(0.0017)
old_hw	-0.0006***	-0.0002***	-0.0013***	-0.0028***	-0.0054***	-0.0047***
	0.0000	0.0000	0.0000	0.0000	(0.0002)	(0.0017)
combined_hw	0.0005***	0.0006***	0.0003***	0.0003***	0.0003**	0.0003***
	0.0000	0.0000	0.0000	0.0000	(0.0001)	(0.0001)
conservative_hw	-0.0004***	-0.0005***	-0.0008***	-0.0005***	-0.0006**	-0.0025**
	(0.0001)	(0.0001)	0.0000	(0.0001)	(0.0003)	(0.0012)

Conclusions

- Household-level data from Understanding Society – Innovation Panel. It does not include the conventional macro-level time series analysis that is common in wealth effect studies.
- Significant wealth effect identified in disadvantaged groups (i.e., low-income households)
- Only homeowners are considered in this study. Renters' behaviours could be quite different.
- For further details, see Helen X. H. Bao and Steven H. Li (2020). Housing Wealth and Residential Energy Consumption. *Energy Policy*, Article number: 111581.