Behavioural Economics and Housing Decisions

Lecture Seven: Housing Wealth and Energy Consumption

By Helen Bao

Outline

- Research questions
- Housing wealth
- Residential energy consumption & sustainable urban development
- Data and methods
- Findings and discussions
- Future research directions

Research Questions

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

- Related questions:
  - What's the role of housing wealth?
  - Why residential energy consumption?
  - What are the applications of behavioural interventions in residential energy consumption?

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

- Benjamin, J. D., et al. (2004). "Real estate versus financial wealth in consumption." *Journal of Real Estate Finance and Economics* 29(3): 341-354.
  - Quarterly aggregated data from 1952Q4 to 2001Q4
  - Variables: consumption (*c*), income (*y*), transferred payment (*g*), financial wealth (*s*), and housing wealth (*h*).

$$\Delta c_t = \beta[b_Y + (b_G - b_Y)\Delta g_{t-1} + \lambda_S \Delta s_{t-1} + \Delta h_{t-1}]$$

  - Considered both personal dispensable income and human capital income (i.e., property income from corporate dividends, net interest, rental income and proprietors' income is subtracted from total disposable income)
  - Non-linear, maximum likelihood estimation

Housing Wealth

- Benjamin, J. D., et al. (2004). "Real estate versus financial wealth in consumption." *Journal of Real Estate Finance and Economics* 29(3): 341-354.

An additional dollar of real estate wealth increases consumption by 8%, as compared with only 2 cents for financial wealth.

g: transferred payment
s: financial wealth
h: housing wealth

Table 4. Marginal propensities to consume from wealth, 1952:4–2001:4.

	(1)	(2)	(3)	(4)
	Personal Disposable Income		Human Capital Income	
	Estimate	*t*-Statistic	Estimate	*t*-Statistic
Constant	0.00	0.16	0.00	0.43
Δg	0.199	1.17	0.166	0.82
Δs	**0.023**	4.81	**0.025**	4.96
Δh	**0.079**	2.80	**0.157**	5.27
AR(1)	−0.223		−0.260	
Adjusted R^2	0.20		0.31	
LM Test	1.46		0.18	
N	197		197	

Housing Wealth

- Benjamin, J. D., et al. (2004). "Real estate versus financial wealth in consumption." *Journal of Real Estate Finance and Economics* 29(3): 341-354.

The positive real estate wealth effect offsets the decline in the financial wealth.

Table 5. Wealth and consumption 2000–2001 after the stock market decline.

	(1) s Financial	(2) h Real Estate	(3) c Consumption	(4) $1-c$ Saving	(5) $\hat{\beta}_S \Delta s$	(6) $\hat{\beta}_H \Delta h$	(7) $\hat{\beta}_S \Delta s + \hat{\beta}_H \Delta h$
2000.1	5.1435	0.9487	0.9596	0.0404			
2000.2	5.1542	0.9577	0.9544	0.0456	0.000246	0.000711	0.000957
2000.3	4.9757	0.9808	0.9582	0.0418	−0.004105	0.001823	−0.002281
2000.4	4.8857	0.9940	0.9557	0.0443	−0.002071	0.001046	−0.001025
2001.1	4.5954	1.0064	0.9565	0.0435	−0.006675	0.000982	−0.005693
2001.2	4.3254	1.0282	0.9567	0.0433	−0.006212	0.001717	−0.004494

Housing Wealth

- 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.
  - Quarterly indices for real estate prices, equity prices, personal consumption and disposable incomes and wages for 30 countries
  - Grouped the countries according to their financial structure and the level of national income: developed countries with market-based financial systems (Australia, Belgium, Canada, Hong Kong, Israel, Korea, Netherland, N. Zealand, Sweden, S. Africa, Switzerland, UK, and USA), developed countries with bank-based financial systems (Austria, Denmark, Finland, France, Iceland, Norway, Portugal, and Spain), and emerging countries with bank-based financial systems (Bulgaria, Croatia, Czech Rep., Estonia, Indonesia, Lithuania, Hungary, Russia, and Sloveni).
  - The market-based financial system has a larger, more liquid and more capitalized stock market than the bank-based financial systems
  - Error Correction Model: short-term adjustment to shocks, long-term equilibrium relationship, and the speed of adjustment from short-term deviation to long-term equilibrium

$$\Delta pc_{it} = \phi_i\left(pc_{i,t-1} - \gamma_{0i} - \gamma_{1i}eprice_{i,t-1} - \gamma_{2i}pprice_{i,t-1} - \gamma_{3i}wage_{i,t-1}\right) - \beta_{11i}\Delta eprice_{it} - \\ - \beta_{21i}\Delta pprice_{it} - \beta_{31i}\Delta wage_{it} + \eta_{it}$$

Housing Wealth

- 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.

$$\Delta pc_{it} = \phi_i\left(pc_{i,t-1} - \gamma_{0i} - \gamma_{1i} e\,price_{i,t-1} - \gamma_{2i}\, p\,price_{i,t-1} - \gamma_{3i} wage_{i,t-1}\right) - \beta_{11i}\Delta e\,price_{it} - \\ - \beta_{21i}\Delta p\,price_{it} - \beta_{31i}\Delta wage_{it} + \eta_{it}$$

	Emerging bank-based countries	Developed bank-based countries	Developed market-based countries
Speed of adjustment ϕ_i	−0.373*** [0.138]	−0.138** [0.066]	−0.025*** [0.009]
Long-run coefficients			
Housing wealth γ_{2i}	0.077*** [0.022]	0.047** [0.021]	0.060 [0.053]
Stock market wealth γ_{1i}	0.029*** [0.006]	0.053*** [0.007]	0.121*** [0.037]
Wages γ_{3i}	0.97*** [0.044]	1.07*** [0.050]	1.13*** [0.067]
Short-run coefficients			
Housing wealth β_{21i}	0.068 [0.072]	0.26 [0.017]	0.139** [0.015]
Stock market wealth β_{11i}	0.017 [0.027]	0.027*** [0.008]	0.016*** [0.005]
Wages β_{31i}	0.249 [0.213]	0.19 [0.12]	0.045 [0.079]
Long-run unit elasticity restriction on income Chi^2 (1) statistics	0.34 (0.55)	1.84 (0.17)	4.06** (0.04)
Number of observations	425	625	1466
Number of countries	9	8	13
Log likelihood	724.5	2435.73	6017.8
Hausman test for poolability of countries	1.51 (0.68)	3.05 (0.34)	6.23 (0.09)

Notes: The estimates are performed using the PMG estimator of Pesaran et al. (1999); panel ARDL (1, 1, 1, 1) model; all equations include a constant term; standard errors are in brackets, *p* values are in parentheses. Hausman test PMG denotes the test for long-run homogeneity.

Housing Wealth

- 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.
  - Data sources: **U.S. household expenditures** from the U.S. Bureau of Labor Statistics' *Consumer Expenditure Survey* and **household financial and housing wealth information** from the Federal Reserve Board's *Survey of Consumer Finances*
  - A non-parametric methods (statistical matching) was used to merge the two datasets, because the two surveys did not interview the same group of households. This approach is a significant weakness of the study, because the matching was based on four variables only: marital status, race, education, and age.
  - Homeowner only, household heads aged between 25 and 65 years only, about 2000 observations per year in 1989, 1992, 1995, 1998, and 2001.

Housing Wealth

- 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.

Table 1
Selected studies on wealth effects on consumption

	Data	Measure of housing/financial wealth	Housing wealth effect	Financial wealth effect
Studies using aggregatedata				
Case, Quigley, and Shiller (2005)	Panel of countries and panel of U.S. states	Aggregate housing and financial wealth	.11–.17 (Int'l), .05–.09 (States)	0 (Int'l), .02 (States)
Benjamin, Chinloy, and Jud (2004)	U.S. national time series of states	Aggregate housing and financial wealth net of debt outstanding	.08	.02
Dvornak and Kohler (2003)	Panel of Australian states	Aggregate housing and financial wealth net of debt outstanding	.03	.06–.09
Bhatia (1987)	U.S. Census, National accounts	Self-reported home values, no financial	.32–.53	–
Studies using household surveys				
Lehnart (2003)	Panel Survey of Income Dynamics (PSID)	Self-reported home values, no financial	.04–.05, varies with age	–
Engelhardt (1996)	PSID	Self-reported home values less improvement value, no financial	.14, .03 for median household	–
Skinner (1996)	PSID	Self-reported home values, no financial		–
Levin (1998)	Retirement History Survey	Housing equity (net of debt), financial wealth	.06, .05 for liquidity constrained	Less than .02
Studies using refinance activity				
Canner, Dynan, and Passmore (2002)	Survey of U.S. households	Cash extracted via mortgage refinancing, no financial	.60 of refinance dollars	–

NOTE: Wealth effects reflect increase in consumption spending associated with a 1 unit increase in wealth or net wealth.

Housing Wealth

- 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.

Table 3
Homeowners: market value regression results

	1989	1992	1995	1998	2001
Total Consumption					
log (Income)	0.162*** (0.012)	0.198*** (0.013)	0.188*** (0.012)	0.197*** (0.015)	0.191*** (0.012)
log (Financial wealth)	0.021*** (0.005)	0.024*** (0.005)	0.023*** (0.005)	0.018** (0.006)	0.020*** (0.005)
log (House value)	0.060*** (0.011)	0.050*** (0.013)	0.050*** (0.014)	0.046** (0.016)	0.042*** (0.012)
log (Other real estate)	0.008*** (0.002)	0.006** (0.002)	0.006** (0.002)	0.004 (0.003)	0.005* (0.002)
N	2116	2033	1994	2097	2759
R-squared	0.401	0.433	0.418	0.337	0.376
Durable Goods					
log (Income)	0.243*** (0.028)	0.207*** (0.024)	0.230*** (0.022)	0.226*** (0.023)	0.199*** (0.019)
log (Financial wealth)	0.021 (0.011)	0.030*** (0.009)	0.027** (0.009)	0.018 (0.009)	0.020* (0.008)
log (House value)	0.076** (0.026)	0.042 (0.024)	0.038 (0.025)	0.039 (0.023)	0.033 (0.021)
log (Other real estate)	0.008 (0.005)	0.006 (0.004)	0.006 (0.004)	0.006 (0.004)	0.002 (0.003)
N	2116	2033	1994	2097	2759
R-squared	0.191	0.268	0.234	0.256	*0.223*

Note: Standard errors are in parenthesis. *$p<0.05$; **$p<0.01$; ***$p<0.001$.

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.

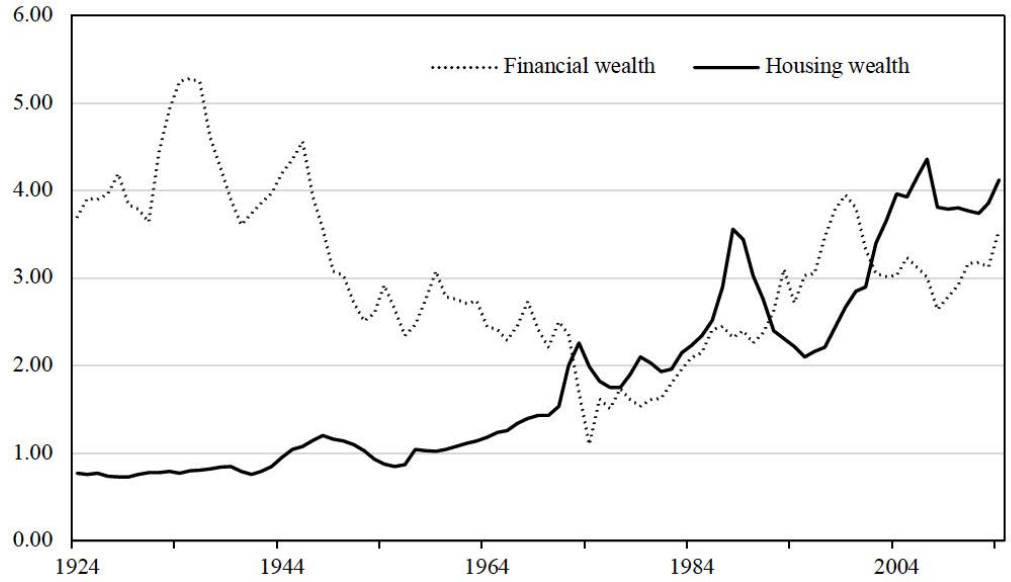

Figure 8.1: Housing wealth and financial wealth in the UK (ratio of Gross Domestic Income)

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

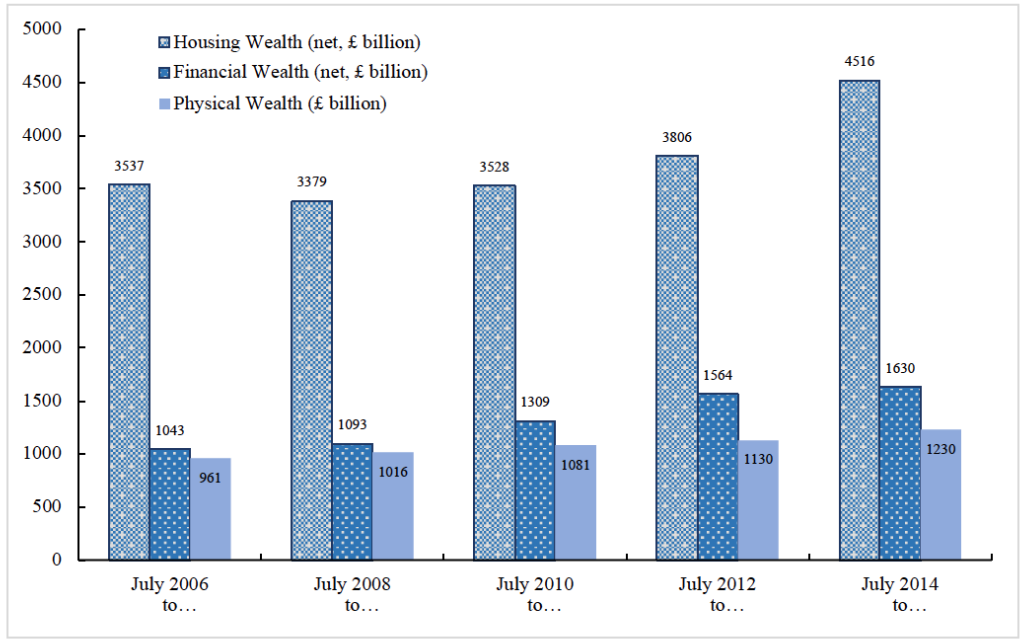

Figure 8.2: Housing wealth and financial wealth in the UK (net, in £ billion)

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

- Mani, A., et al. (2013). "Poverty Impedes Cognitive Function." *Science* 341(6149): 976-980.
  - Lab (in a shopping mall in New Jersey, USA) and field experiments (Indian sugarcane farmers). Both can be called lab-in-the-field experiments.
  - They experimentally induced thoughts about finances and found that this reduces cognitive performance among poor but not in well-off participants
  - The same Indian sugarcane farmer shows diminished cognitive performance before harvest (when poor) as compared with after harvest (when rich)
  - Conclusions: poverty-related concerns consume mental resources, leaving less for other tasks

Housing Wealth

- Mani, A., et al. (2013). "Poverty Impedes Cognitive Function." *Science* 341(6149): 976-980.

- Step 1: A hypothetical scenario is used to establish the 'hard' or 'easy' condition
- "Your car is having some trouble and requires $X to be fixed. You can pay in full, take a loan, or take a chance and forego the service at the moment... How would you go about making this decision?"
- Hard: X= 1500; Easy: X = 150
- Step 2: Two tests to measure cognitive performance (both non-verbal)

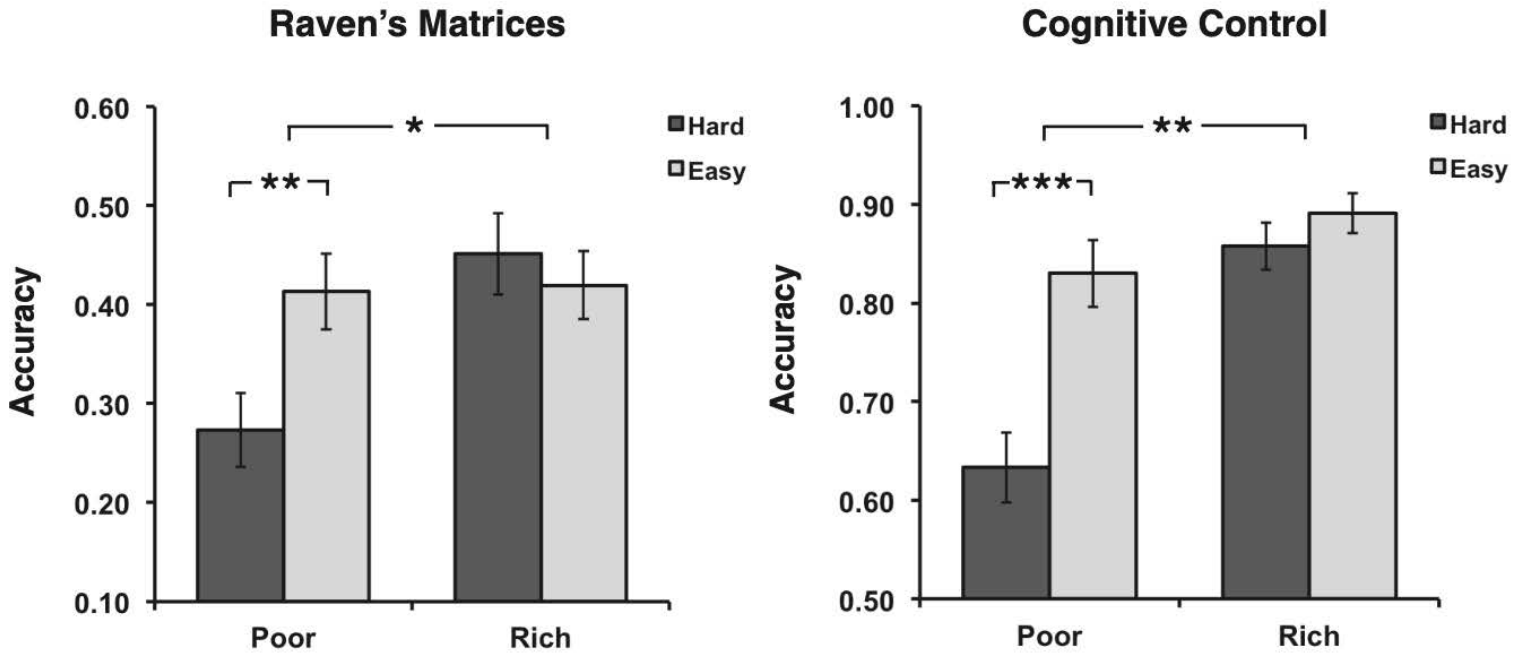

Fig. 1. Accuracy on the Raven's matrices and the cognitive control tasks in the hard and easy conditions, for the poor and the rich participants in experiment 1. (Left) Performance on the Raven's Matrices task. **(Right)** Performance on the cognitive control task. Error bars reflect ±1 SEM. Top horizontal bars show two-way interaction (poor versus rich × hard versus easy). $*P < 0.05$, $**P < 0.01$, $***P < 0.001$

Housing Wealth

- Mani, A., et al. (2013). "Poverty Impedes Cognitive Function." *Science* 341(6149): 976-980.

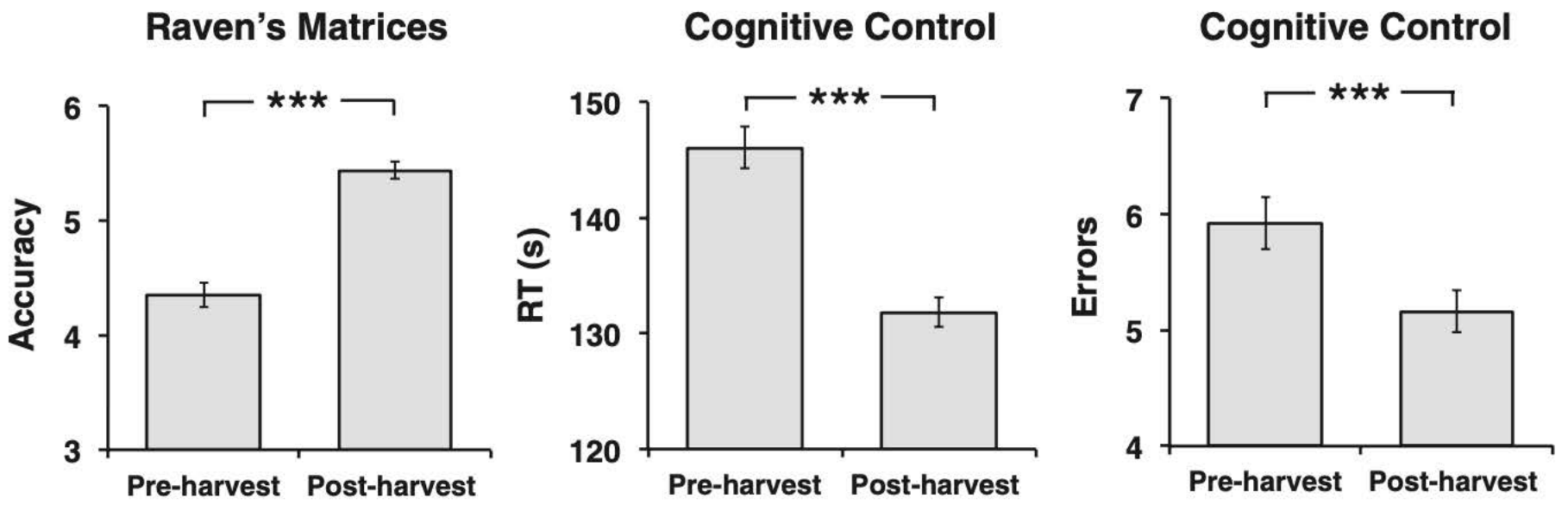

Fig. 4. Accuracy on the Raven's matrices and the cognitive control tasks for pre-harvest and post-harvest farmers in the field study. (**Left**) Performance on Raven's matrices task. (**Middle** and **Right**) Stroop task (measuring cognitive control) response times (RT) and error rates, respectively; error bars reflect ±1 SEM. Top horizontal bars show test for main effect of pre- versus post-harvest (***$P < 0.001$).

Housing Wealth

- van Rooij, M. C. J., et al. (2012). "Financial Literacy, Retirement Planning and Household Wealth." *Economic Journal* 122(560): 449-478.
  - Data source: De Nederlandsche Bank (DNB) Household Survey (DHS), 2005. The researchers designed a special module to be included in the survey. It includes a set of questions on financial knowledge as well as a section on retirement planning activities.
  - The response rate was 74.4% (1,508 out of 2,028), and the final sample size is 1091.
  - Both basic and advanced financial literacy are measured
  - Evidence of an association between financial literacy and net worth, even after controlling for many determinants of wealth

Housing Wealth

- van Rooij, M. C. J., et al. (2012). "Financial Literacy, Retirement Planning and Household Wealth." *Economic Journal* 122(560): 449-478.

Total Net Worth and Financial Literacy; Thousands of Euro ($N = 1{,}091$)

	Total net worth		
	Median	Mean	SD
Basic literacy quartiles			
1 (low)	43.9	117.2	162.3
2	98.8	150.2	164.7
3	111.2	156.5	173.6
4 (high)	142.8	195.7	209.3
Advanced literacy quartiles			
1 (low)	46.7	100.1	121.2
2	82.0	129.3	151.0
3	112.4	167.5	181.4
4 (high)	185.9	236.3	228.4

Housing Wealth

- van Rooij, M. C. J., et al. (2012). "Financial Literacy, Retirement Planning and Household Wealth." *Economic Journal* 122(560): 449-478.

A wide range of control variables are included in the multiple linear regression model in order to separate the net effect of financial literacy

Explanatory variable	Definition	Whole sample	Final sample
Age dummies			
Age ≤ 30	Respondent's age falls within mentioned age category	0.135	0.119
30 < age ≤ 40		0.205	0.187
40 < age ≤ 50		0.191	0.195
50 < age ≤ 60		0.211	0.212
60 < age ≤ 70		0.148	0.160
Age > 70		0.109	0.127
Education dummies			
Lower intermediate and primary	Highest level of education completed by respondent	0.306	0.324
Intermediate vocational		0.198	0.190
Secondary pre-university		0.152	0.151
Higher vocational		0.223	0.222
University		0.121	0.113
Male	Respondent is male	0.515	0.531
Married	Respondent is married or co-habiting	0.568	0.567
Number of children	Number of children living within household	0.616	0.576
Retired	Respondent has retired	0.184	0.204
Self-employed	Respondent is self-employed	0.056	0.049
Household income	Net disposable household income (in €000)	24.600	23.800
High confidence in financial skills	Respondent is relatively overconfident	0.286	0.288
Low confidence in financial skills	Respondent is relatively underconfident	0.397	0.395
Risk aversion			
Risk aversion 1 (completely disagree)	Based upon the following question: To what extent do you agree or disagree with the statement 'Investing in stocks is something I don't do, since it is too risky' (on a scale from 1 to 7, where 1 means 'completely disagree' and 7 means ' completely agree')?	0.093	0.092
Risk aversion 2		0.104	0.106
Risk aversion 3		0.094	0.094
Risk aversion 4		0.164	0.155
Risk aversion 5		0.099	0.093

Housing Wealth

- van Rooij, M. C. J., et al. (2012). "Financial Literacy, Retirement Planning and Household Wealth." *Economic Journal* 122(560): 449-478.
  - Instrumental variable: years in education before first employment

Total Net Worth and Financial Literacy: Multivariate Regressions

	Ordinary least squares		Instrumental variables
	(1)	(2)	(3)
Advanced financial literacy index		23.51***	67.12**
		(4.86)	(2.28)
Basic financial literacy index	16.69***	9.05	−5.13
	(3.17)	(1.64)	(0.45)

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.
    - Data source: Australian Property Monitors for sale prices and the Household Income and Labour Dynamics in Australia survey for self-reported home valuations (do not have location of homes)
    - Neighbourhood level analysis, not based on the individual home level
    - Homeowners that appear to overvalue their homes typically spend more and are more leveraged than owners who appear unbiased
    - Beliefs about home values affect household financial decisions

Housing Wealth

- The challenges: decisions are prone to judgmental biases
  - **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.
    - Field data from a large lender in the US, with detailed demographic and financial background information
    - Salient signal of estimation errors for homeowners i.e., 10%, which was used by the financial institution to trigger an in-person appraisal with no cost to the borrower for the appraisal
    - Homeowners overestimate their house value by 3.1%
    - Overestimators are more likely to increase their spending ex post, and to default on their loans.

Housing Wealth

- Summary
  - Housing wealth affects spending and other financial decisions significantly
  - Housing wealth are controlled by many low- or medium-income households, who make their consumption decisions based on estimated housing wealth (i.e., self-assessed house price)
  - Poor people are more likely to be affected by behavioural biases
  - They tend to over-estimate the value of their home
  - Poor people tend to have higher MPC. Hence, they may overspend when house prices are increasing

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
- 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

- Alberini, A. and C. Towe (2015). "Information v. energy efficiency incentives: Evidence from residential electricity consumption in Maryland." Energy Economics 52: S30-S40.
  - Field studies to compare the effectiveness of two programmes:
    - Information (behavioural intervention): A home energy audit offered to customers free of charge, where information is provided to the consumer about ways to save energy and money, and the consumer is free to choose which advice to implement, and when.
    - Financial Incentives: A rebate of $200 - $400 on the purchase of a high-efficiency heat pump.
  - Both approach reduced electricity usage by 5% on average
  - However, the behavioural approach imposes no cost to the consumer. The overall cost of the behavioural approach is lower

Behavioural interventions for energy conservation

- Alberini, A. and C. Towe (2015). "Information v. energy efficiency incentives: Evidence from residential electricity consumption in Maryland." Energy Economics 52: S30-S40.
  - Control group is selected by coarsened exact matching (CEM): based on 2008 electricity usage, house characteristics, or both.

Table 8
DDD model. Dep. variable: ln electricity use. Treatment: quick home energy audit. T statistics in parentheses.

	Full DDD no weights	Full DDD CEM 3 weights	Simplified DDD (summers 2010–11) CEM 3 weights	Simplified DDD (summers only) CEM 3 weights
Regressors or fixed effects from Eq. (1)				
Treatment dummy	−0.0278	−0.0544	−0.0480	−0.0479
	(−2.04)	(−3.63)	(−4.61)	(−2.86)
Household × season FE	Yes	Yes	Yes	Yes
Season × year FE	Yes	Yes	Yes	Yes
Household × year FE	Yes	Yes	No	No
Weather controls	Yes	Yes	Yes	Yes
Matching variables to control for any residual imbalance				
Benchmark year usage	No*	No*	Yes	Yes
House characteristics	No*	No*	Yes	Yes
Number observations	108,387	37,511	5780	9338

Behavioural interventions for energy conservation

- Alberini, A. and C. Towe (2015). "Information v. energy efficiency incentives: Evidence from residential electricity consumption in Maryland." Energy Economics 52: S30-S40.

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Regressors or fixed effects from Eq. (1)				
Treatment dummy	−0.0278	−0.0544	−0.0480	−0.0479
	(−2.04)	(−3.63)	(−4.61)	(−2.86)

Table 12
DDD model. Dep. variable: ln electricity use. Treatment: heat pump rebate. T statistics in parentheses.

	Full DDD No weights	Full DDD CEM 3 weights	Simplified DDD (summers 2010–11) CEM 3 weights	Simplified DDD (summers only) CEM 3 weights
Regressors or fixed effects from Eq. (1)				
Treatment dummy	−0.0546	−0.0419	−0.0202	−0.0202
	(−3.15)	(−2.49)	(−1.52)	(−1.65)

The results are similar between the two approaches. However, the behavioural approach (i.e., quick home energy audit) is cheaper, and likely to have 'spill-over' effect.

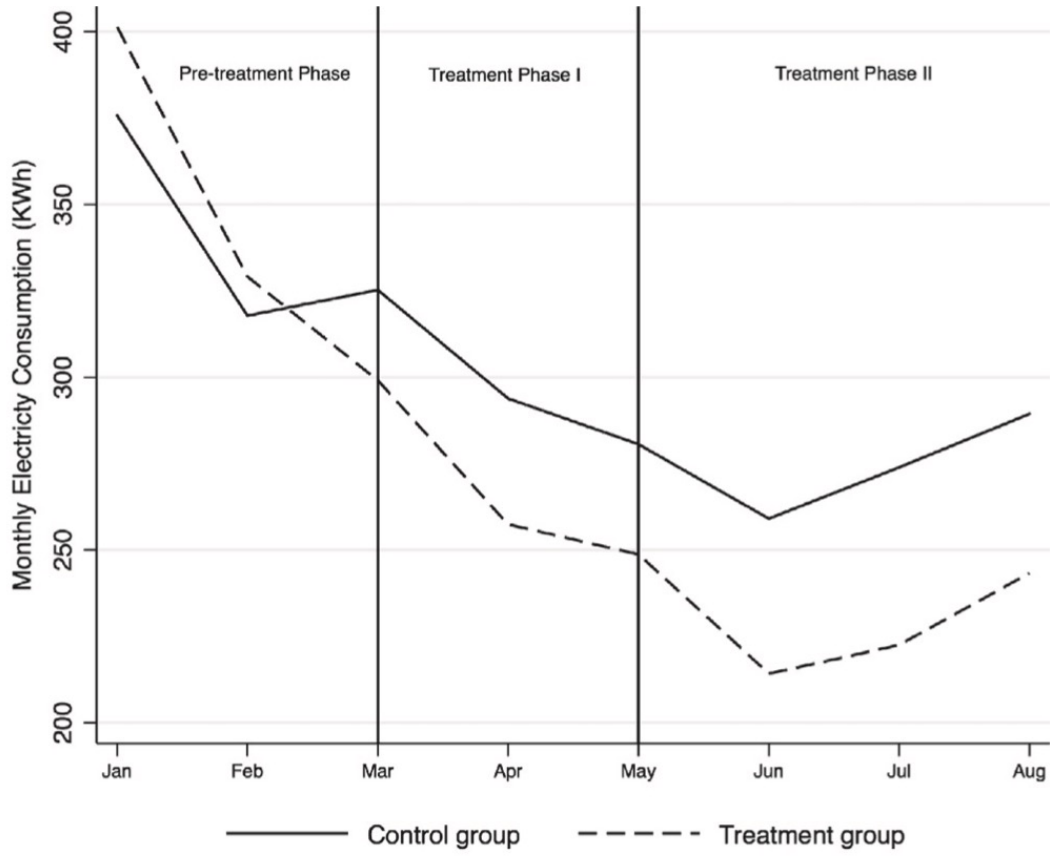
Behavioural interventions for energy conservation

- Aydin, E., et al. (2018). "Information provision and energy consumption: Evidence from a field experiment." *Energy Economics* 71: 403-410.
  - Field experiments in Texel, Netherlands, in 2014
  - In-home displays
  - 104 observations in the treatment group, and 54 in the control group
  - Phase I: install the device and receive real time usage information only
  - Phase II: weekly messages about energy saving advice
  - Information provision reduces electricity consumption by around 20% on average
  - The saving happened mostly during off-peak hours, and among older or more energy conservative households.

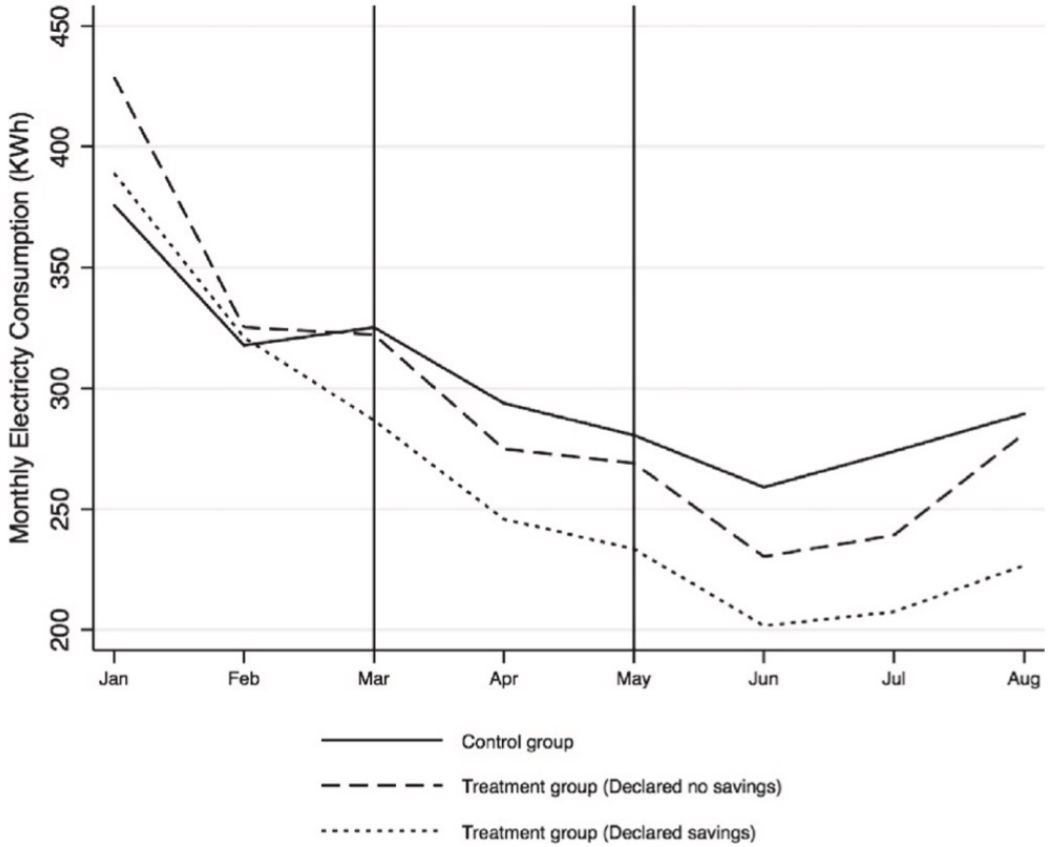
Behavioural interventions for energy conservation

- Aydin, E., et al. (2018). "Information provision and energy consumption: Evidence from a field experiment." *Energy Economics* 71: 403-410.

A: Treatment and Control Groups



B: Savers versus non-savers



Behavioural interventions for energy conservation

- Aydin, E., et al. (2018). "Information provision and energy consumption: Evidence from a field experiment." *Energy Economics* 71: 403-410.

Table 2
Difference-in-differences estimation results.

Variables	(1)	(2)	(3)	(4)
	Simple DID	Savers versus non-savers	Peak	Off-peak
Treatment * Phase1	−0.205*		−0.033	−0.388***
	(0.115)		(0.121)	(0.120)
Treatment * Phase2	−0.229**		0.038	−0.520***
	(0.086)		(0.090)	(0.089)
Treatment group	0.178**		−0.013	0.371***
	(0.066)		(0.070)	(0.069)
Treatment (declared no savings) * Phase1		−0.102		
		(0.239)		
Treatment (declared savings) * Phase1		−0.218*		
		(0.123)		
Treatment (declared no savings) * Phase2		−0.096		
		(0.178)		
Treatment (declared savings) * Phase2		−0.268***		
		(0.091)		
Treatment group (declared no savings)		0.119		
		(0.138)		
Treatment group (declared savings)		0.158**		
		(0.071)		
Phase1	−0.162*	−0.162*	−0.215**	−0.101
	(0.093)	(0.093)	(0.098)	(0.097)
Phase2	−0.270***	−0.270***	−0.379***	−0.158**
	(0.070)	(0.070)	(0.073)	(0.072)
Constant	5.616***	5.616***	5.012***	4.806***
	(0.054)	(0.054)	(0.057)	(0.056)
Observations	948	852	948	948
R-squared	0.110	0.112	0.068	0.157

Behavioural interventions for energy conservation

- Aydin, E., et al. (2018). "Information provision and energy consumption: Evidence from a field experiment." *Energy Economics* 71: 403-410.

Table 4
Logit analysis: energy savings and respondent characteristics.

Variables	Coef.	Marginal effects
Motivation to participate: money saving	0.212	0.048
	(0.447)	(0.099)
Willing to pay for renewable energy	−0.077	−0.018
	(0.420)	(0.096)
Energy conservation behavior in the past > median score	0.724*	0.165*
	(0.399)	(0.090)
Knows the amount of energy consumed	−0.145**	−0.033
	(0.444)	(0.103)
Age > 55	1.330***	0.296***
	(0.416)	(0.087)
Higher education (university or higher)	0.463	0.105
	(0.419)	(0.095)
Constant	−0.689	
	(0.514)	
Observations	106	106

Notes: Dependent variable is a dummy variable which is one for the households who declared positive savings and zero otherwise. Age > 55: 1 if respondent's age is above 55, 0 otherwise. Education level: 1 if "university and higher", 0 otherwise. Money motivation: 1 if above the median score, 0 otherwise. Willing to pay for renewable energy: 1 if positive, 0 otherwise. Energy conservation behavior in the past: 1 if above the median score, 0 otherwise.

Table 5
Logit analysis: energy savings and involvement with the treatments.

Variables	Coef.	Marginal effects
Positive expectations before treatment	0.574*	0.048
	(0.616)	(0.054)
Checking IHD at least once a day	1.775***	0.185**
	(0.644)	(0.080)
Used saving tips	2.116***	0.214***
	(0.711)	(0.075)
Used smart plugs	−0.562	−0.039
	(0.822)	(0.048)
Constant	0.113	
	(0.784)	
Observations	106	

Notes: Dependent variable is a dummy variable which is one for the households who declared positive savings and zero otherwise.

Behavioural interventions for energy conservation

- Lessons and guidelines
  - **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.

Behavioural interventions for energy conservation

- 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.
  - A summary of key cognitive biases and motivational factors that may explain why energy-related behaviour so often fails to align with either the personal values or material interests of consumers
  - A list of behavioural public policy interventions
  - Suggestions of future research directions

Behavioural interventions for energy conservation

- 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.
  - Status quo bias (stick to default settings)
  - Satisfying (settling for 'good enough' rather than 'best')
  - Loss aversion
  - Risk averse
  - Sank cost effect
  - Hyperbolic discounting
  - Social comparison
  - Intrinsic and extrinsic incentives/rewards/motivations
  - Free-riding effect
  - Use trust as a simple decision-making heuristic
  - Availability bias

Behavioural interventions for energy conservation

- 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.
  - A review of 83 papers, providing a total of 144 estimates
  - Behavioural interventions promote climate change mitigation to a very small degree while the intervention lasts, with no evidence of sustained positive effects once the intervention ends.
  - Behavioural interventions considered:
    1. **Information:** simple messages conveying tips on how to save energy, in-home displays, energy labels or statistics about climate change
    2. **Appeals:** requests, pleas and appeals to change behaviour based on values of humanity, cooperation and social responsibility
    3. **Engagement:** try to change psychological processes, such as promoting goal-setting, implementation intentions, commitment or engagement, and mindfulness towards climate change mitigation
    4. **Social comparison:** provide a comparative reference with respect to the mitigation behaviours of close others, such as neighbours, colleagues/friends or fellow citizens, based on principles of social influence and social comparison
    5. **Choice architecture (nudge):** removing external barriers, expediting access or facilitating climate change mitigation behaviours by altering the structure of the environment in which people make choices
  - The intervention with the highest average effect size is choice architecture (nudges) but this strategy has been tested in a limited number of behaviours.

Behavioural interventions for energy conservation

- 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.

Table 1 Effect sizes per key moderators

Moderator		k	N	Effect size d (CI)	I^2 (%)	POB (%)
Overall effect size		144	3,092,678	−0.093 (−0.160, −0.055)	64.6**	6.6
Sensitivity analysis						
Sample type	Households	66	724,792	−0.112 (−0.221, −0.057)	73.1**	
	Individuals	78	2,367,886	−0.118 (−0.221, −0.060)	51.9**	
Sample size per condition	≤100	82	5709	−0.335 (−−0.555, −0.190)	49.9**	
	]100, 500[	45	22,840	−0.141 (−0.280, −0.063)	51.4**	
	≥500	17	3,074,121	−0.028 (−0.106, −0.006)	25.6	
Self-selection	Self-selected	79	12,550	−0.279 (−0.465, −0.161)	60.3**	
	Naïve	65	3,080,128	−0.040 (−0.103, −0.016)	53.6**	
Region	Europe	43	2,333,441	−0.210 (−0.446, −0.093)	58.6**	
	US/Canada	78	750,854	−0.108 (−0.208, −0.054)	72.7**	
	Rest World	23	8383	−0.059 (−0.407, −0.013)	0	
Behaviour[a]						
Energy		47	719,059	−0.094 (−0.133, −0.055)	67.7**	6.6
	Appliances	12	108,077	−0.036 (−0.129, 0.058)	22.6	2.5
Transportation		29	2,245,972	−0.136 (−0.183, −0.089)	98.4**	9.6
	Car use	21	2,242,781	−0.036 (−0.039, −0.034)	0	2.5
Water		42	124,082	−0.052 (−0.079, −0.025)	40.1**	3.7
	Towel	18	8909	−0.168 (−0.271, −0.064)	47.8**	11.9
Food waste		4	218	−0.231 (−0.518, 0.056)	21.6	16.3
Meat		7	666	−0.239 (−2.81, 0.008)	36.8	16.9
Recycling		23	2766	−0.457 (−0.595, −0.319)	69.9**	32.3
Intervention						
Information		53	2,354,243	−0.048 (−0.075, −0.021)	34.7**	3.4
Social comparison		32	719,756	−0.077 (−0.108, −0.046)	72.2**	5.4
Engagement		38	10,486	−0.253 (−0.336, −0.170)	71.8**	17.9
	Commitment	10	1446	−0.480 (−0.704, −0.255)	75.8**	33.9
Appeals		10	5952	−0.266 (−0.445, −0.086)	70.5**	18.8
Nudges		11	795	−0.352 (−0.492, −0.212)	0	24.9

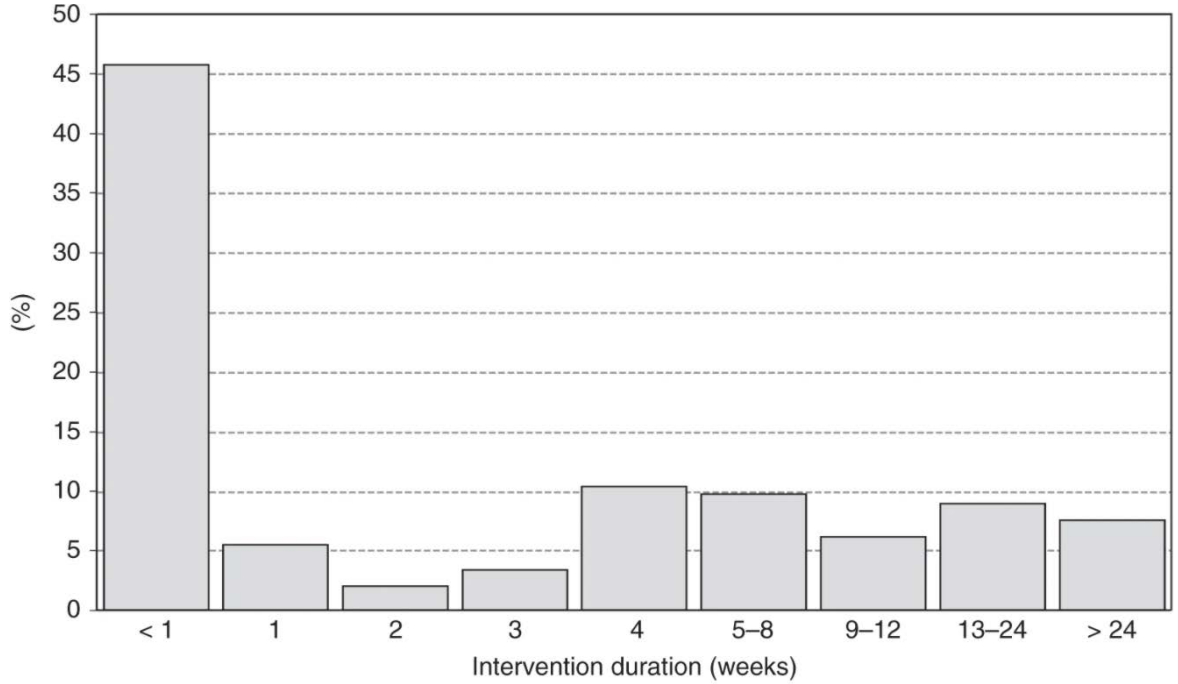
Note: k = #estimates; N = sample size; I^2 = Heterogeneity; POB = probability of benefit (effect size $d/\sqrt{2}$)
**$p < 0.05$
[a]The total aggregate sample size per analysis of behaviour is 3,092,763—an additional 85 individuals than the overall 3,092,678. This difference is due to a single study (Kurz et al. 2005 in Supplementary References) testing the effect of an intervention in both water and energy and, thus, its sample ($N = 85$) was accounted in both behaviours

d	Size
< 0.1	Very small
Around 0.2	Small
0.3 - 0.4	Medium-small
0.5 – 0.6	Medium
>= 0.7	Large

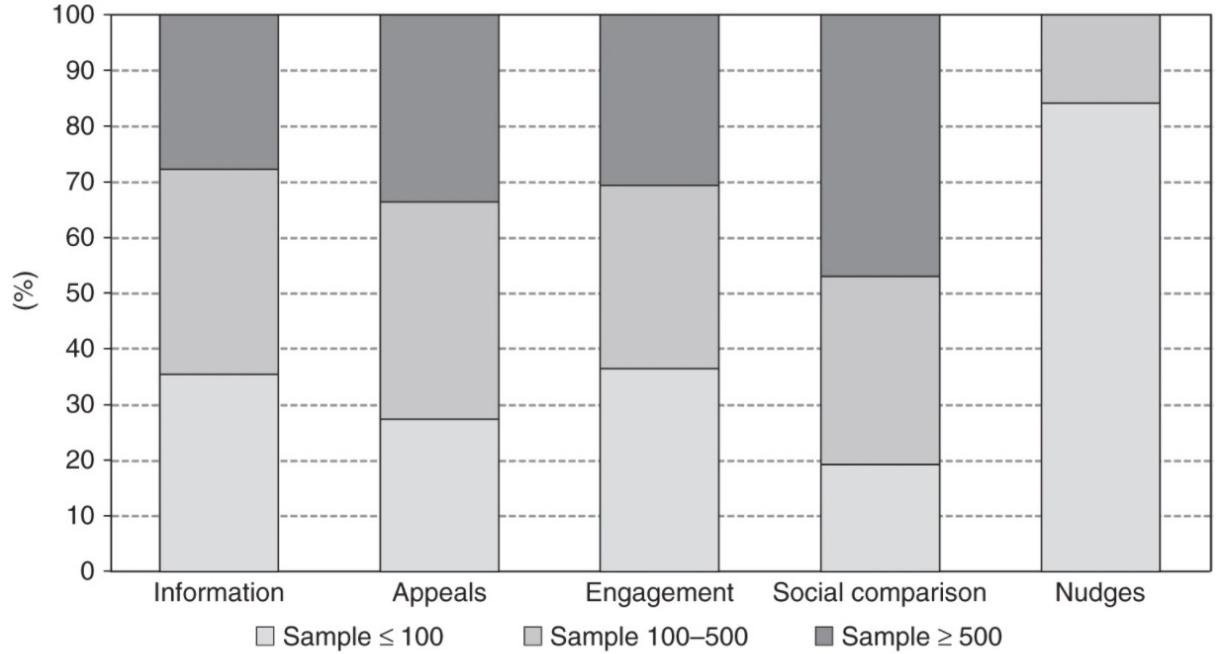
POB is the probability that the intervention will promote climate change mitigation behaviours in the experimental group, by comparison to the control no-intervention group.

Behavioural interventions for energy conservation

- 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.



Duration of the behavioural interventions in weeks. Shows the distribution of intervention duration according to the number of weeks from the beginning to the conclusion of the experimental period



Sample size per experimental group in behavioural interventions using different strategies. Shows how different behavioural stimuli have been tested in interventions with a distinct number of observations

Data and variables

- Data source: Understanding Society (UK)
- The largest household longitudinal study in the world, with approximately 40,000 British households surveyed either in person or online on an annual basis since 2009.
- Covers a wide range of social, economic and behavioural factors making it relevant to researchers and policy makers in many different fields.
- For example, there are questions on device use and online activities, harassment, family networks, retirement planning, loneliness, parenting styles, and social support.

Data and variables

- Data source: Understanding Society (UK), https://www.understandingsociety.ac.uk/
- We use the Innovation Panel (IP), a special component of Understanding Society.
  - A much smaller sample: about 1,500 households
  - About one half of the questions in IP surveys are different every year
  - New questions come from the annual **Innovation Panel Competition** where researchers are invited to submit proposals for an experiment or test to be carried in the subsequent wave or waves of the IP (free of charge).
  - IP leverages the talent from the whole community so that the topics included in the 'innovation' part of the survey are at the frontier of social and economic research, such as misreporting in body weight and height in survey interviews

Variables

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

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 three waves

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.

Results and discussions

- 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.

Results and discussions

- 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 9oth percentile)
- Energy poverty might be a concern

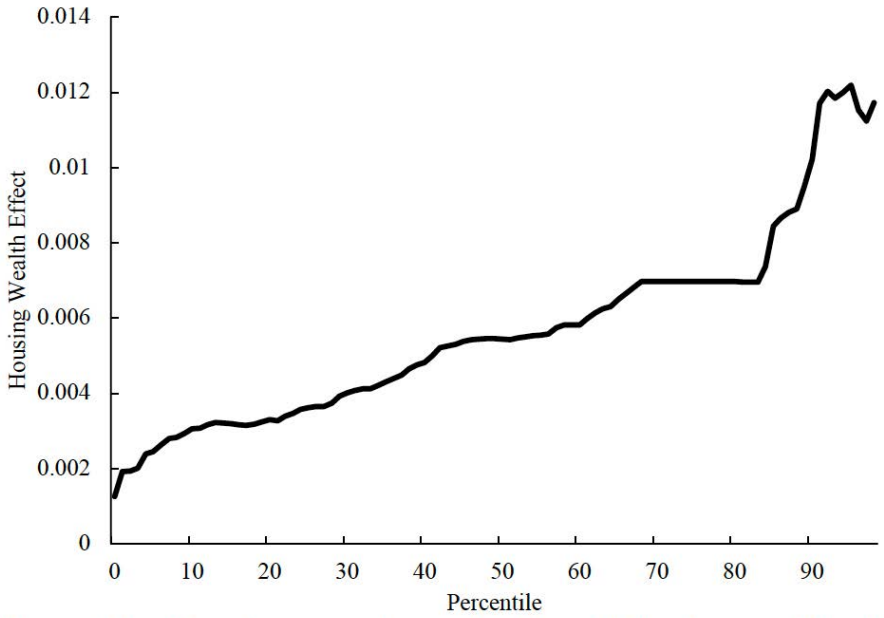


Figure 8.3: Quantile regression estimation of housing wealth effect on energy consumption (1st to 99th percentile)

	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)

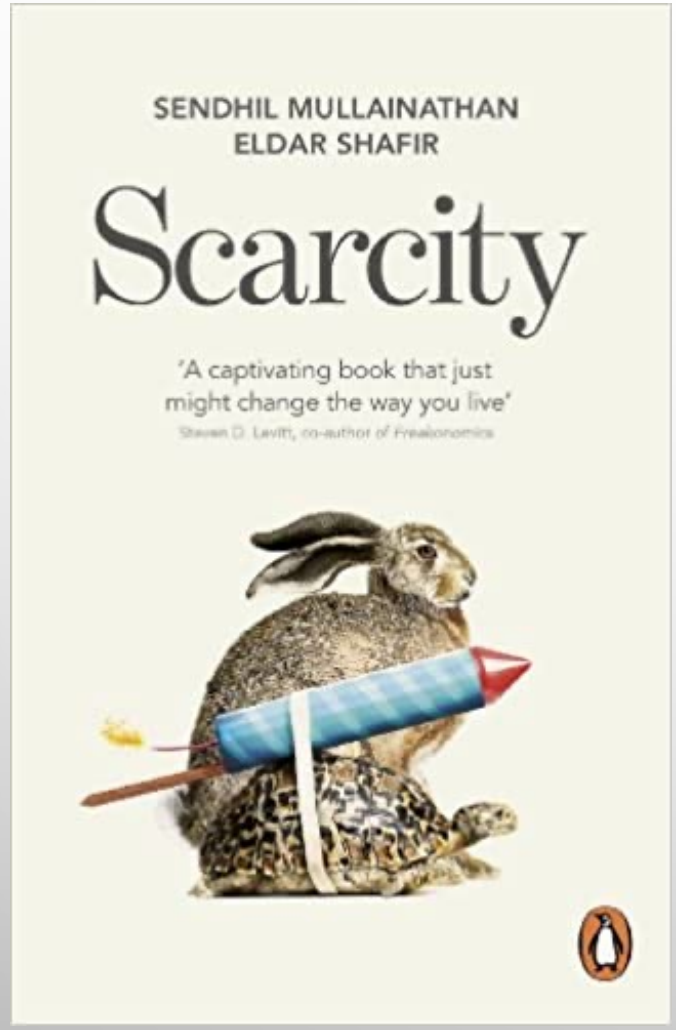
Conclusions

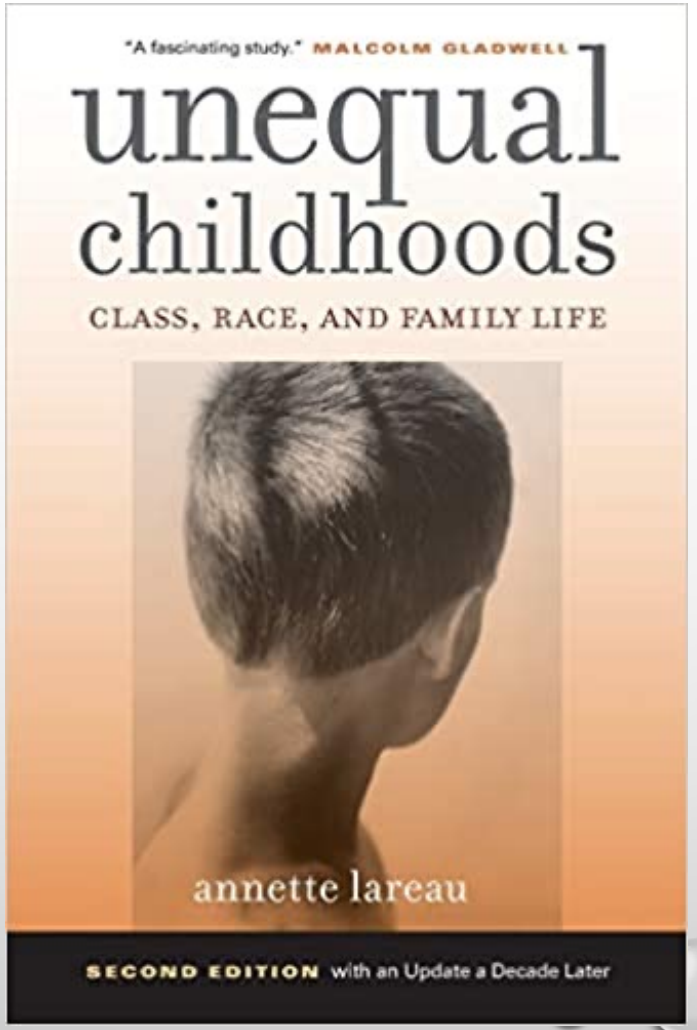
- The study uses a reliable data source. The quality of the data is good.
- Significant wealth effect identified in disadvantaged groups (i.e., low-income households)
- Only homeowners are considered in this study. Renters' behaviours could be quite different.
- Micro-level data only. It does not include the conventional macro-level time series analysis that is common in wealth effect studies.
- These analyses have been included in Helen X. H. Bao and Steven H. Li (2020). Housing Wealth and Residential Energy Consumption. *Energy Policy*, V144, August 2020, Article number: 111581.

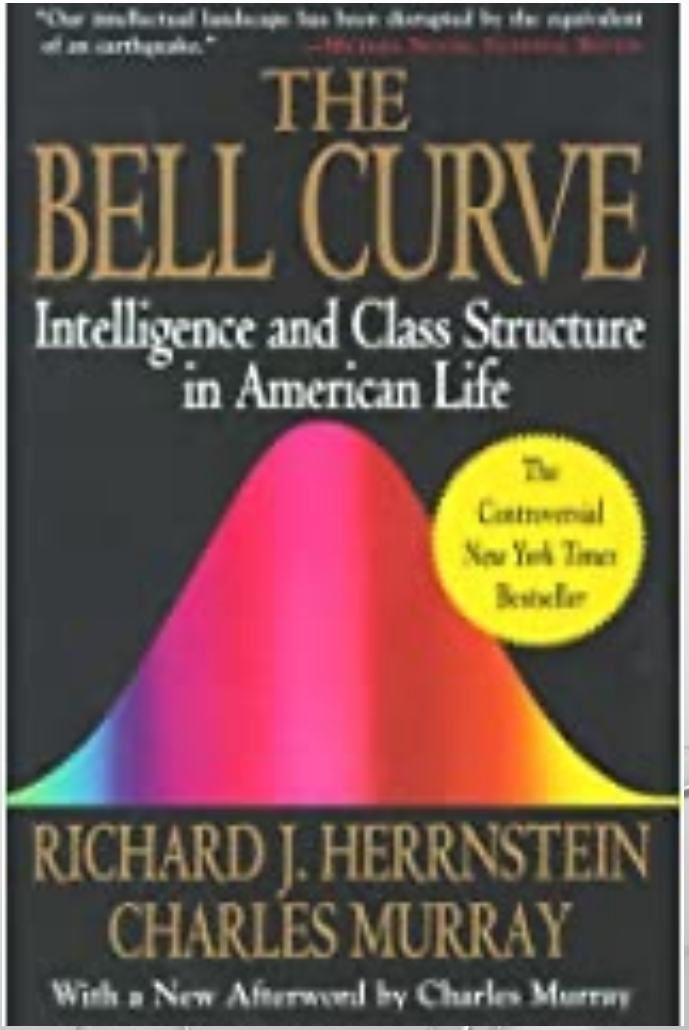
Practical session

- Open the IP questionnaire (pdf format). Can you find some of the questions used in this case study?
- Open the original data file from the survey (g_indresp_ip.xlsx). Can you find some of the variables used in this case study?
- If you want to conduct a similar study in China, can you use the same set of questions to collect data? Why or why not?
- Suggest ways to improve the data and methods used in this case study.

Further readings







Summary

- Research questions
- Housing wealth
- Residential energy consumption & sustainable urban development
- Data and methods
- Findings and discussions
- Future research directions