The role of income in energy efficiency and curtailment behaviours: Findings from the European Social Survey *

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Abstract

Reducing consumers' demand for energy is on the agenda of various energy and climate policies. Although these policies are increasingly internationalised in Europe, our understanding of consumers' energy saving behaviour remains fragmented with often contradicting findings from single case studies. Drawing on the latest round of the European Social Survey across 22 countries (n = 41,830), we find that many variables have the same relationship with different energy saving behaviours, except household income. While income correlates positively with the likelihood of buying energy efficient appliances, it correlates negatively with the frequency of engaging in energy curtailments. If income has a differentiating effect on consumers' energy saving behaviour, then the demand reduction policies that take this difference into account will be more successful.

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Introduction

Consuming energy has many repercussions. With increasing concerns not only for the environment but also for the economy and security (Black, Stern, & Elworth, 1985; European Commission, 2011; World Energy Council, 2016), energy consumption is hardly ever off the political agenda. In Europe, for example, the European Union (EU) mandates its members to cut their energy consumption down by 20% in this decade (Directive 2012/27/EU, 2012), with proposals in place for further reductions thereafter (European Commission, 2016). Such policies often include items to reduce the consumer demand for energy within and across the national borders. Indeed, research shows that demand reduction will be decisive for achieving the goals set in the Paris Agreement (Vandyck, Keramidas, Saveyn, Kitous, & Vrontisi, 2016) — the latest international effort to tackle climate change.

In turn, the success of any demand reduction policy depends ultimately on the energy consumption behaviour of individuals — whether they invest in more efficient technologies (*efficiency* behaviour) and (b) whether they use the existing technologies less (*curtailment* behaviour). Reduction targets are easier to set on policy papers than to meet in practice, especially when these policies lack public acceptability (Barr, Gilg, & Ford, 2005; Steg, Dreijerink, & Abrahamse, 2006). Many such targets require a substantive change in the consumers' energy saving behaviour (International Energy Agency, 2008; Stephenson et al., 2010) — something that unpopular policies are less likely to generate. Besides, politicians would also be reluctant to implement such policies (Gärling, 2007; Banister, 2008), which might cost them the public support that they need to stay in office. As a result, for demand reduction policies to be successful, it is crucial for policy makers to understand the determinants of individual behaviour to consume or save energy (Stephenson et al., 2010).

Despite its importance, our understanding of energy saving behaviour remains fragmented with often contradicting findings from individual countries. First, the problem of contradictory findings is most severe in the analyses of income as a socio-economic predictor of energy saving behaviours. With regard to energy efficiency behaviour, for example, there are reports that the consumers' likelihood to invest in energy efficient solutions increases with (Dillman, Rosa, & Dillman, 1983; Long, 1993; Mills & Schleich, 2010; Ameli & Brandt, 2015) or is unaffected by (Whitmarsh & O'Neill, 2010; Testa, Cosic, & Iraldo, 2016) their income in different countries. There is a similar pattern with regard to curtailment behaviour. Compared with people who earn lower levels of income, studies find that those with higher income are more (Testa et al., 2016), less (Dillman et al., 1983; Martinsson, Lundqvist, & Sundström, 2011; Trotta, 2018), or equally (Whitmarsh & O'Neill, 2010) likely to cut down on the energy used for daily activities. Second, given the internationalisation of energy policies, it is puzzling that the existing evidence on energy saving behaviours comes almost exclusively from case studies (see, for example, Dillman et al., 1983; Whitmarsh & O'Neill, 2010; Martinsson et al., 2011; Testa et al., 2016; Trotta, 2018).[1]

The empirical contribution of this study is to provide evidence from a cross national survey of nationally representative samples in 22 European countries. This is to remedy the fragmented nature of the existing evidence, and indeed most of the countries in our analysis have been completely missing in the literature. Specifically, we examine whether and how income is associated with energy efficiency and curtailment behaviours in comparison with other known factors. Our results show that income correlates positively with the consumer behaviour to increase technical energy efficiency in the household, but it correlates negatively with the behaviour to curtail

[1]For two exceptions, see Ameli and Brandt (2015) and Urban and Ščasný (2012), which we discuss in the following section.

habitual energy use. This differentiating effect seems unique to income as the other factors[2] have the same relationship with both types of energy saving behaviour.

The remainder of the article proceeds as follows. We first provide a brief review of the literature on energy saving behaviour, where we (a) discuss the efficiency and curtailment behaviours, (b) detail the contradictory findings on the effect of income on these behaviours, and (c) develop two hypotheses. The subsequent section on data provides detailed definitions of each variable used in the empirical part of the article. The results section then presents the descriptive analyses and multivariate tests of the hypotheses. Finally, the paper concludes with remarks on why the results of these tests might be politically significant for decision makers in the area of energy and climate policies. Interested readers can also find further details on descriptive results and robustness checks for the multivariate models in the Appendix.

Literature and Expectations

The distinction between efficiency and curtailment behaviours to save energy is not new. Scholars (see, for example, Hayes, 1976; Stern & Gardner, 1981; Gardner & Stern, 1996) have long been referring to efficiency and curtailment as the main types of energy saving behaviour. Nor is this distinction merely theoretic. Research shows that people distinguish between efficiency and curtailment behaviours in practice as well (Barr et al., 2005; Whitmarsh & O'Neill, 2010). For example, public views of efficiency investments are significantly more favourable than of energy curtailments to save energy (Poortinga, Steg, Vlek, & Wiersma, 2003). Furthermore, these two behaviours are different also with regard to their conservation potential as consumers can save more by increasing the energy efficiency in their buildings than by curtailing their

[2]The other factors that we examine relate to personal efficacy and concerns (about energy and climate), household size, age, gender, and education. For details on all variables, see below the Data and Methods section.

consumption in their day-to-day practices (Gardner & Stern, 1996; Steg et al., 2006; Gardner & Stern, 2008). As a result, many researchers distinguish between efficiency investments and energy curtailments when they study energy saving behaviour empirically (for recent examples, see Testa et al., 2016; Trotta, 2018).

Income has an important place in this literature — albeit without a consensus on whether and how it affects the two types of the energy saving behaviour. To begin with one of the earliest empirical studies on efficiency investments, Dillman et al. (1983) surveyed people in ten Western states in the US and found that those with higher income report making more efficiency adjustments, such as insulations, to their house — a finding that Long (1993) confirms. Similarly, some studies suggests that fluorescent lamps (Mills & Schleich, 2010) and other energy-efficient appliances (Ameli & Brandt, 2015) are more likely to be found in high-income households. However, other studies tend not to confirm this relationship between income and efficiency behaviour. For example, Urban and Ščasný (2012) find, in most of the cases that they analyse, no correlation between income and five energy saving activities in nine countries. Likewise, the likelihood to invest in energy efficient solutions seems unaffected by income among the people living in two counties in the United Kingdom (Whitmarsh & O'Neill, 2010; Testa et al., 2016) or among the university students in Italy (Testa et al., 2016).

Nevertheless, we expect efficiency investments to be especially popular among the wealthier individuals for — at least three — reasons. First, efficiency investments include costly practices such as buying energy efficient electrical appliances (fridges, washing machines, cookers etc.) and installation of home energy retrofits (e.g. double-glazing windows, roof insulation, and secondary walls). As such, these practices might save energy and money in the long run, but they often require a substantial investment upfront. This implies that the affordability of efficiency measures increases with income. Indeed, when asked about what holds them back from investing in energy efficiency appliances, people note the economic reasons as the most

important barriers (Heinzle, 2010). Second, given the positive relationship between the levels of income and energy consumption (Brandon & Lewis, 1999; Wiedenhofer, Lenzen, & Steinberger, 2011), energy efficiency practices offer potentially more savings to wealthier consumers who tend to consume more energy in the first place. Finally, these practices pose no challenges to the quality of life that comes with wealth (Steg et al., 2006), and if anything, they contribute to that quality.

H1: There is a positive relationship between income and efficiency behaviour to save energy.

We expect the opposite for energy curtailments. This type of energy saving behaviour includes habitual practices such as putting on another jumper instead of turning up the heating and walking or cycling short distances instead of driving. On the one hand, unlike efficiency measures, these practices require no or minimal upfront investment, which makes them particularly attractive for lower income people. On the other, saving by curtailing depend on breaking habits that are associated with comfort and social status (Poortinga, Steg, & Vlek, 2004; Harrington et al., 2005). Nevertheless, people are willing to take this challenge up because it saves them money (Martinsson et al., 2011). We hypothesise that the incentives to do so is lower for individuals with higher income.

H2: There is a negative relationship between income and curtailment behaviour to save energy.

The existing evidence regarding this hypothesis is mixed to the fullest degree, although a number of studies find support for the hypothesised negative relationship between income and curtailments (e.g., Dillman et al., 1983; Martinsson et al., 2011; Trotta, 2018). Drawing on a survey in Sweden, for example, Martinsson et al. (2011) report that people with higher income are less likely to save energy on hot water or heating in general. In contrast, Testa et al. (2016) find the opposite relationship in Italy, where wealthier university students are shown

to be more likely to curtail their energy consumption in a variety of activities, including the heating. Completing the range of findings, Whitmarsh and O'Neill (2010) report that there is no statistical relationship between income and curtailment behaviour in their analysis in the United Kingdom.

The fragmentation of the literature might be one reason why these inconsistencies emerge. Indeed, much of the existing knowledge on energy saving behaviour comes from single-case studies, which examine not always the same behaviour in separate countries at different points in time with. There are two notable exceptions. In the first, Urban and Ščasný (2012) provide evidence from nine countries. Having said that, they analyse the effect of — among other factors — income on *individual* efficiency and curtailment activities in *separate* countries. With inconsistent results from different activities and countries in their study, we still do not know much about the overall picture. In the second, Ameli and Brandt (2015) do provide cross-national evidence on consumption attitudes from 11 countries, yet their analysis covers only efficiency behaviour. Our understanding of energy saving behaviour, and the role of income thereon, cannot be complete without evidence that includes both types of behaviour as well as that crosses the national borders. Our contribution addresses these gaps.

Data and Methods

The article draws on data from the European Social Survey (ESS) as its latest wave, Round 8 (ESS, 2016), provides a unique opportunity to test the hypotheses above across 22 countries in Europe (n = 41,830).[3] The ESS is a nationally-representative survey conducted every two years, but only the latest wave includes items on public attitudes to energy in an extra module.

[3]These countries are Austria, Belgium, Czech Republic, Estonia, Finland, France, Germany, Hungary, Iceland, Ireland, Italy, Lithuania, Netherlands, Norway, Poland, Portugal, Russian Federation, Slovenia, Spain, Sweden, Switzerland, and the United Kingdom.

This module allows us to provide cross national evidence for consumers' stated[4] energy saving behaviour in a large geographical area, including several countries that have previously been absent in the literature.

We use the multi-level regression modelling approach to test our hypotheses. This is because we are interested in the average effect of income across countries, rather than how this effect might differ from one country to another. To provide easily interpretable results in the main body of the article, specifically, we estimate multi-level *linear* regressions in Table 2, where we treat the dependent variables as continuous. In the Appendix, we provide robustness tests on this modelling choice by re-estimating the models using multi-level *ordered logistic* regressions. The results remain substantively the same.

The subsections below provide details for the variables used in the analysis, with summary statistics in presented in Table 1.

Dependent variables

The data for the dependent variables come from two consecutive survey questions regarding energy saving behaviours of individuals. As we are interested in understanding efficiency and curtailment behaviours, two particular items in the ESS Round 8 makes it unique opportunity for this purpose.

Efficiency. The respondents were asked 'If you are to buy a large electrical appliance for your home, how likely is it that you would buy one of the most energy efficient ones'? Notice that the question wording excludes home energy retrofits, which are more suitable for house owners than

[4] As in most survey research, we rely on the respondents' reports of their behaviour, which might differ from their actual behaviour. We discuss this potential problem, and what it means for our study, in the Conclusion section.

tenants (McKenzie-Mohr & Smith, 1999; Heinzle, 2010) irrespective of their income. Response options were on an 11-point scale, where 0 means 'Not at all likely' and 10 means 'Extremely likely'. The interviewers were instructed to explain that energy efficiency in this context refers to 'using less energy'.

Curtailment. The respondents were asked 'In your daily life, how often do you do things to reduce your energy use'? This question was read after the following text 'There are some things that can be done to reduce energy use, such as switching off appliances that are not being used, walking for short journeys, or only using the heating or air conditioning when really needed' and the interviewers were instructed to explain that 'energy' should be understood here 'in the broadest possible sense' — and not just as electricity. Response options were six-point Likert scale, coded as 'Never' = 1, 'Hardly ever' = 2, 'Sometimes' = 3, 'Often' = 4, 'Very often' = 5, and 'Always' = 6. In addition to the usual categories for refusals and *don't knows*, respondents were allowed to say 'cannot reduce energy use' as an option, which we ignore in the analysis. However, notice that models with the co-variates control for this over another variable, namely *Energy efficacy.*

Notice also that the dependent variables are originally on different scales, ranging between 0 and 10 for *Efficiency* but between 1 and 6 for *Curtailment.* For the linear regression models in Table 2, we use the standardised version of these variables (z-scores) so as to facilitate the interpenetration of the results across the dependent variables.

Independent variables

We use ten items from the ESS (2016) as independent variables, with our primary variable of interest being household income.

Table 1: Descriptive statistics

	N	Mean	Median	SD	Minimum	Maximum
Efficiency	40831	7.77 (0)	8 (0.10)	2.26 (1)	0 (–3.45)	10 (0.99)
Curtailment	41332	4.18 (0)	4 (–0.15)	1.19 (1)	1 (–2.66)	6 (1.53)
Household income ($10,000s)	34530	3.76	3.11	2.67	0.32	17.4
Energy efficacy	41048	6.05	6	2.62	0	10
Climate efficacy	39585	4.36	5	2.63	0	10
Energy expense concerns	41452	3.09	3	1.03	1	5
Climate change concerns	40351	3.03	3	0.92	1	5
Household size	41706	2.56	2	1.32	1	12
Age	41702	49.3	50	18.6	15	100
Female	41821	0.53	1	0.50	0	1
Education	41420	13.0	13	3.86	0	54
Ideology	36226	5.12	5	2.18	0	10

Note: In parentheses are the statistics for the standardised version of the dependent variables, used below in the multi-level linear regression models in Table 2.

Household income. The ESS measures income with pre-defined deciles of the national household income distribution. Respondents are then asked to place their household into one of these ten income categories. However, the cross-country comparability of the resulting variable is limited because (a) the range of the income categories as well as (b) the purchasing power of the same amount of income vary from one country to another (Donnelly & Pop-Eleches, 2018). To address these issues, we re-estimate this variable, in line with a solution offered by Donnelly and Pop-Eleches (2018). This process involves taking the midpoints of each income category by country, and normalising these values with the purchasing power parity for each country in 2016.[5] This results in a continuous variable measured in 2005 US dollars.[6].

[5]We use International Monetary Fund (IMF, 2018) data on purchasing power parity conversion factors. For detailed accounts of this re-estimation process, see Donnelly and Pop-Eleches (2018).

[6]For example, for a survey respondent in Austria, for whom the original income variable is coded as 6, we re-estimate *Household income* as follows. First, as the sixth decile ranges from €35,000 to €41,000 in this country, we take (35000 + 41000) / 2 = 38000 as the midpoint. We then divide this value by the purchasing power parity for Austria in 2016 — that is, 38000 / 0.841 = 45184.30 — in the second step. Notice that, to provide meaningful regression coefficients, we code this variable in $10,000, and therefore this respondent is assigned 4.52 as *Household income*.

Energy efficacy. Respondents' answer to the question 'Overall, how confident are you that you could use less energy than you do now?', on a 11-point scale, where 0 means 'Not at all confident' and 10 means 'Completely confident'. There is a likely positive relationship between respondents' confidence in their ability to use less energy and their energy saving behaviours (Boomsma, Jones, Pahl, & Fuertes, 2019).

Climate efficacy. Respondents' answer to the question 'How likely do you think it is that limiting your own energy use would help reduce climate change?', on a 11-point scale, where 0 means 'Not at all likely' and 10 means 'Extremely likely'. Those who believe they can personally help the environment are more likely to engage in energy saving behaviours (Hanss & Böhm, 2010).

Energy expense concerns. An ordinal variable measuring whether the respondents are 'not at all worried' = 1, 'not very worried' = 2, 'somewhat worried' = 3, 'very worried' = 4, or 'extremely worried' that energy may be too expensive for many people in their country. Concerns over expense are positively related to engagement in energy saving behaviours (Long, 1993; Godbolt, 2015; Chen, Xu, & Day, 2017).

Climate change concerns. An ordinal variable measuring whether the respondents are 'not at all worried' = 1, 'not very worried' = 2, 'somewhat worried' = 3, 'very worried' = 4, or 'extremely worried' about climate change. Environmental concerns correlate positively with energy saving behaviours as well (Poortinga et al., 2003; Urban & Ščasný, 2012; Ameli & Brandt, 2015; Trotta, 2018).

Household size. A continuous variable measuring the number of people regularly living in respondents' household. Larger households are more likely to engage in energy saving behaviours (Mills & Schleich, 2010; Poortinga et al., 2004).

Age. A continuous variable based on the age of respondents. As people get older, they are more likely to engage in energy saving behaviours (Long, 1993; Mills & Schleich, 2010).

Female. A binary variable based on gender, coded as 1 for females and 0 for males. Women are more likely to save energy then men (Chen et al., 2017).

Education. A continuous variable measuring the number of years respondents spent in full time education. There is a positive relationship between education and energy saving behaviours (Poortinga et al., 2004).

Ideology. An ordinal variable measuring where the respondents would place themselves on a left-right scale, where 0 indicates the left and 10 indicates the right. Political liberals are more likely engage in saving energy (Costa & Kahn, 2013).

Results

Descriptive results

As a first step in our empirical analysis, we examine the descriptive results presented in Figure 1, which plots the mean levels of energy saving behaviours in the 22 European countries in our dataset.[7] It shows that energy saving behaviours, as stated by the survey respondents, are quite common in Europe. Accordingly, Europeans report that they are on average more likely than not to buy one of the most energy efficient appliances when they are on the market for a large electrical appliance, with the mean value of 7.5 (SD = 2.4) on an 11-point scale ranging from 0 to 10. Similarly, they state that they often engage in energy curtailments in their day-to-day life. Here the mean response falls around the 4.1 mark (SD = 1.3) on a six-point scale ranging

[7] We also report these results in table format in the Appendix. See Table A1.

from 1 to 6, hence between *Often* (4) and *Very often* (5) but much closer to the former response category. The results from Estonia, Ireland, Netherlands, and Sweden mirror these averages closely.

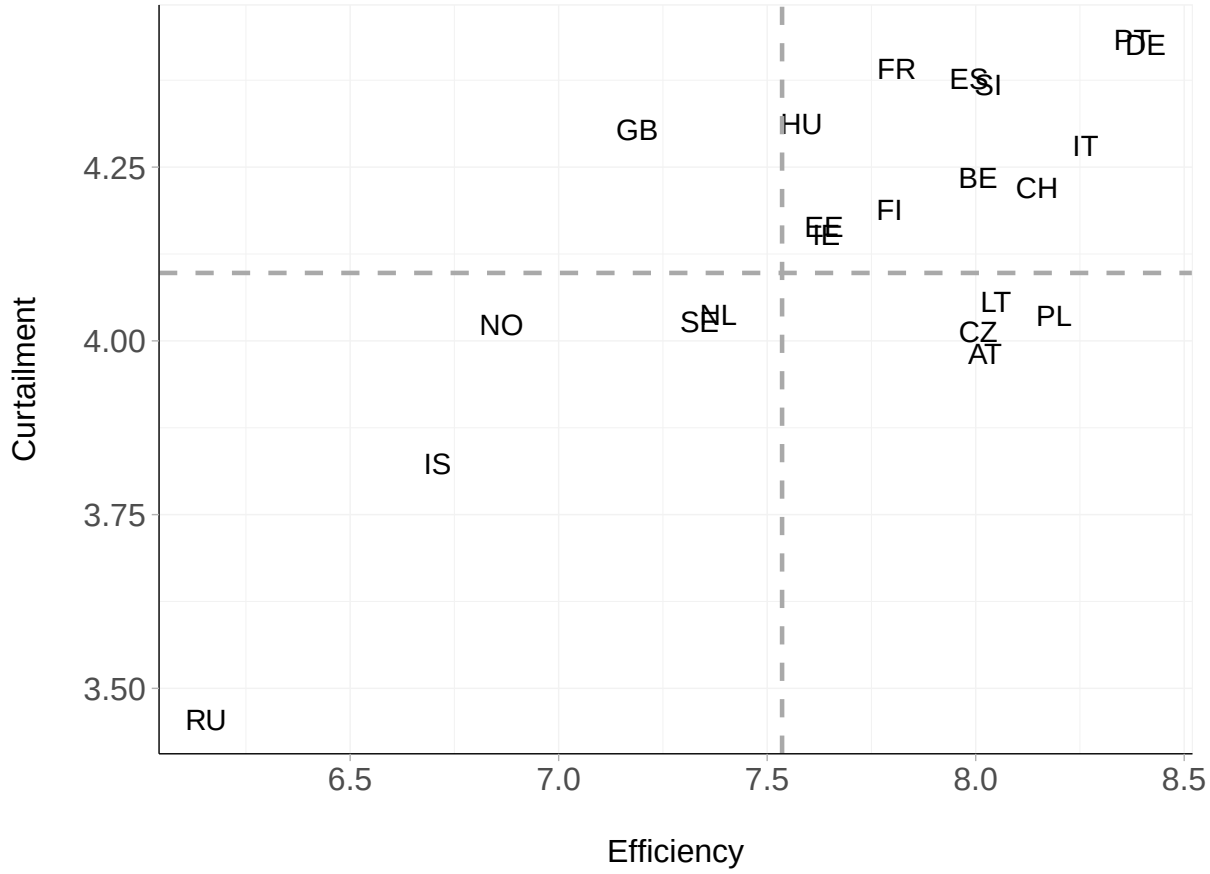

Figure 1: Mean levels of stated energy saving behaviours in 22 European countries. All values based on ESS Round 8 (ESS, 2016), weighted to account for sampling error, non-response bias, and differences in inclusion probabilities. The overall values, marked by the intersection point of the dotted lines (7.5 for *Efficiency* and 4.1 for *Curtailment*)—are calculated with additional weights to account for the different population sizes of the countries in the dataset. For further details, including the country codes, see Table A1 in the Appendix.

The data, however, suggests that there is a substantial cross-country variation with regard to the popularity of energy saving behaviours in Europe. Accordingly, Russia trails behind the remaining 21 counties in the dataset by a large margin; this is where the stated behaviours to save energy are clearly the least common (M = 6.2 and SD = 2.7 for energy efficiency; M = 3.5 and SD = 1.4 for energy curtailments). On the other end of the board lie Germany (the country with the highest average for the efficiency behaviour, with M = 8.4 and SD = 2.0) and

Portugal (the country with the highest average for the curtailment behaviour, with M = 4.4 and SD = 2.2). With Iceland having the second lowest ratings for both types of energy saving behaviour and Norway having the lowest third for efficiency, three out of four non-EU countries seem to lack behind the rest. Having said that, Switzerland — the fourth non-EU country in the dataset — is among the leading countries, with the fifth highest average (M = 8.1 and SD = 2.1) in energy efficiency.

There is also another variation within countries with regard to the relative popularity of different types of energy saving behaviours. Compared with the overall trend, curtailing energy is reported to be more common than investing in energy efficiency measures in a number of countries such as the United Kingdom, Hungary, and France. For example, while the United Kingdom ranks as the top seventh country with regard to how often consumers curtail their energy use, it has the bottom fourth position with regard to energy efficiency investments. In a number of other countries—such as Austria, Poland, and Czech Republic—we observe the contrary situation, where efficiency behaviour is reported to be relatively more common than curtailment behaviour. In Poland, where this difference is most stark, consumers are on average 8.2 likely to buy the most energy efficient large electrical appliance (SD = 2.0) according to the survey, making them the fourth country in this category. However, with regard to curtailing energy (M = 4.0 and SD = 1.1), they rank as low as the sixteenth among the 22 countries in the dataset.

Multivariate results

We now turn to the multivariate results. To summarise our hypotheses, we expect income to be positively associated with efficiency behaviour but negatively associated with curtailment behaviour. As reported in Table 2 and visualised in Figure 2, our empirical analysis confirms both expectations. Table 2 presents four multi-level linear regression models, two for each

energy saving behaviour — with and without control variables to show that the results that we report are robust to inclusion and exclusion of potentially related factors. Figure 2 then plots the mean predicted values of the standardised dependent variables along the range of *Household income* as estimated in the respective models with controls.

To begin with Model 1, we find a statistically significant positive relationship between yearly household income and engagement in efficiency behaviour as reported by the respondents. This result persists in Model 2, which accounts for various other variables. Substantively, the effects sizes are not large. A yearly increase of $10,000 in *Household income* is associated with a 0.01 standard deviation increase in *Efficiency*. As Figure 2a shows, overall, there is about one-fifth of a standard deviation increase along the range of *Household income*. This supports Hypothesis 1 that there is a positive relationship between income and energy efficiency investments.

There is a statistically significant relationship between income and stated engagement in energy curtailments as well, but in the opposite direction. Model 3 shows that as their income increases, respondents reports that they less often take habitual measures to decrease their energy use — a result robust to the inclusion of control variables in Model 4. This confirms Hypothesis 2 that there is a negative relationship between income and curtailment behaviour. Here the effect size is twice as large as that we find for efficiency behaviour. This difference in effect sizes is also evident in Figure 2, where the mean predicted values drop visibly more for *Curtailment* than it rises for *Efficiency* along the range of *Household income*.

Table 2: Multilevel linear regression models

	Efficiency		Curtailment	
	Model 1	Model 2	Model 3	Model 4
Household income ($10,000)	0.024***	0.010***	–0.019***	–0.018***
	0.002	0.003	0.002	0.003
Energy efficacy		0.035***		0.015***
		0.002		0.002
Climate efficacy		0.021***		0.021***
		0.002		0.002
Energy expense concerns		0.049***		0.073***
		0.006		0.006
Climate change concerns		0.135***		0.157***
		0.006		0.006
Household size		0.031***		0.011*
		0.005		0.005
Age		0.009***		0.008***
		0.000		0.000
Female		0.064***		0.066***
		0.011		0.011
Education		0.020***		0.017***
		0.002		0.002
Ideology		–0.000		–0.012***
		0.003		0.003
Intercept	–0.095	–1.732***	0.088*	–1.431***
	0.052	0.066	0.040	0.054
Intercept(Countries)	0.058***	0.051***	0.032***	0.021***
	0.018	0.016	0.010	0.006
Intercept(Residual)	0.935***	0.825***	0.945***	0.835***
	0.007	0.007	0.007	0.007
N—Observations	33877	28988	34219	29079
N—Countries	22	22	22	22
Log likelihood	–46985.831	–38400.751	–47627.491	–38685.548
Wald χ^2	108.946	2161.979	67.425	2165.890

Notes: Models are calculated with multilevel linear regressions, where individual respondents are nested in countries. Standard errors are in parentheses. The dependent variables are standardised. See Table 1 for more details on the data and variables. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

For no other variable do we find such a stark differentiation between efficiency and curtailment behaviours. To start with personal efficacy in energy consumption and climate change, the models include two variables to measure (1) how confident respondent are that they could use less energy (*Energy efficacy*) and (2) how likely that limiting their energy consumption could reduce climate change (*Climate efficacy*). We find that both efficiency and curtailment behaviour increase with personal efficacy factors. Remarkably, however, while the coefficients for *Climate efficacy* remains the same across the two behaviours, the effect of *Energy efficacy* reduces to less than half of its size from *Efficiency* in Model 2 to *Curtailment* in Model 4.

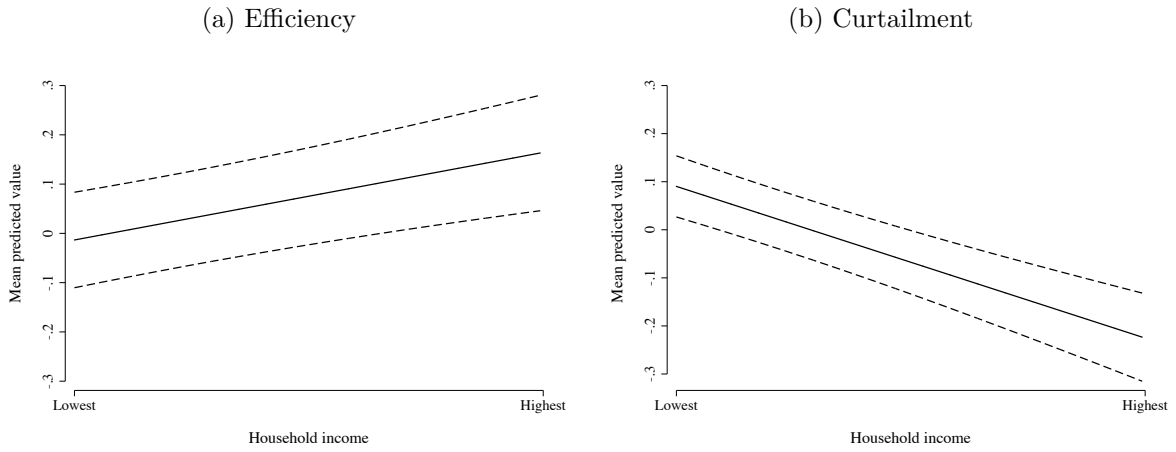

Figure 2: The effect of income on different behaviours to save energy. The figure is based on the respective models with control variables — Models 2 and 4. Dashed lines indicate 95% confidence intervals. Other variables set to observed values.

Next, individuals' energy saving behaviours are likely related to their concerns for energy expense and climate change, and we control for these factors with a variable for each type of concern. Again, we find statistically significant positive relationships between *Energy expense concerns* and *Climate change concerns* on the one hand and energy saving behaviours on the other. Given that both variables are measured with the same 4-point scale, the effect-size differences between these independent variables are meaningful. Indeed, we find that, compared to energy expense, concerns for climate change are associated with about two to three times larger effect sizes on energy saving behaviours. This result suggests that concerns for climate

change is a stronger driver of the consumer behaviour to save energy than concerns for energy expense. It is also meaningful that this difference (about three times versus twice) is smaller for energy curtailments, which — as we argued above — are motivated by saving money.

Household size is another important control variable — not least because our income variable is a household level rather than an individual level measure. Here we find that it has a statistical relationship with *Efficiency* and *Curtailment*, associated with an increase in both dependent variables on saving energy.

With regard to other individual level characteristics, respondents' increasing *Age* and *Education* have statistically significant positive relationships with both types of energy saving behaviours as does being *Female*. On their *Ideology*, the results suggest that the people on the right of the political spectrum are less likely to save energy than the people on the left, which becomes a statistically significant difference for only the curtailment behaviour.

Conclusion

At a time when reducing energy consumption is at the top of the agenda across Europe, there is surprisingly little cross-national evidence about the factors behind consumers' energy saving behaviours. Indeed, many suspects that income for example might be one of such factors, but — with contradictory evidence from a handful of separate countries — we are not sure what kind of an effect it might have. In this article, we approach this problem with data from 22 European countries, providing the much-needed cross national evidence on energy efficiency behaviour, where consumers invest in more efficient technologies, and energy curtailments, where they use their existing technologies less often.

According to what the respondents state in the European Social Survey (ESS, 2016), generally speaking, people already have strong engagement in energy saving behaviours in Europe: Europeans report that they are very likely to choose energy efficient electrical appliances over other options and that they often curtail their energy consumption with existing appliances. This suggests that demand reduction policies have been successful to a certain extent, although there is still more room for some increases in the level of energy that consumers can save. However, the results also make it clear that there are substantial differences among the countries in Europe, with consumers in some countries — and particularly in Russia — are reported to be less likely to save energy through increased efficiency or energy curtailments. Moreover, we also see a within country variation, where one of these two types of energy saving behaviours is reported to be relatively more popular than the other. These variations suggest that there are important practices that countries can learn from each other.

We find that the different types of behaviours to save energy have the same relationship with many potential factors. Increasing personal efficacy and concerns about energy and climate change, for instance, is associated with saving more energy in general — be it through efficiency investments or energy curtailments. Similarly, consumers' age and education have a positive relationship with both types of energy saving behaviours. In fact, this seems to be the overall pattern for all but one factor: income. We find strong evidence that it is the income that significantly differentiates people with regard to their stated choice of actions to save energy.

On the one hand, we find that wealthier individuals are more likely to say that they save energy by investing in energy efficient technologies in their life. Such investments are not only more affordable for people with higher income, but they also pose relatively little or no challenges to their quality of life. However, as their income increases, individuals also consume more energy with these technologies because they report that they engage less in curtailing their energy consumption. This implies that demand reduction policies based on efficiency measures

have a bigger potential to be successful among higher income groups. Such measures are not only more likely to be effective among these groups, but also — once these measures lead to the purchase of energy efficient appliances — they have a bigger potential to save more energy.

On the other hand, lower income individuals tend to say that they save energy by using their existing technologies less often, but that they are less likely to invest in energy efficient appliances in the first place. For the demand reduction policies based on efficiency measures, this finding implies that increasing the affordability of energy efficient appliances — or decreasing the perception that they are less affordable — would help these appliances spread further to the households with lower income.

An important limitation of our study is that it relies on stated — as opposed to observed — behaviour. There might indeed be a gap between what people state about their behaviour in response to survey questions and how they behave in real life, especially if surveys are about sensitive issues (Krumpal, 2013). What is reassuring, however, is that there is little evidence of this gap with regard to energy consumption behaviour. In fact, self-reported behaviour of energy consumption is shown to be a robust indicator of actual behaviour before (Warriner, McDougall, & Claxton, 1984; Fuj, Hennessy, & Mak, 1985). Importantly for our study, most studies show that income does not have a role in any mismatch between perceptions and actual energy use or savings (Fuj et al., 1985; Attari, DeKay, Davidson, & De Bruin, 2010; Schley & DeKay, 2015). In contrast, (Warriner et al., 1984) find that high-income households tend to over-report their energy curtailment behaviour. Note that this finding would only imply that the negative relationship between income and curtailment might actually be stronger than what we report here.

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Appendix

Descriptive results

Figure 1 in the main text plotted the means of Efficiency and Curtailment behaviours against each other in each country. In this section, we provide the source data in Table A1.

Table A1: Mean levels of energy saving behaviours.

			Efficiency		Curtailment	
	Country	Sample	Mean	SD	Mean	SD
AT	Austria	2010	8.02	2.07	3.98	1.20
BE	Belgium	1766	8.01	1.91	4.24	1.15
CH	Switzerland	1525	8.15	2.14	4.22	1.12
CZ	Czech Republic	2269	8.01	2.06	4.01	1.19
DE	Germany	2852	8.41	2.01	4.43	1.07
EE	Estonia	2019	7.64	2.34	4.16	1.19
ES	Spain	1958	7.98	2.20	4.38	1.26
FI	Finland	1925	7.79	2.13	4.19	1.04
FR	France	2070	7.81	2.13	4.39	1.18
GB	United Kingdom	1959	7.19	2.53	4.30	1.17
HU	Hungary	1614	7.58	2.44	4.31	1.11
IE	Ireland	2757	7.64	2.20	4.15	1.18
IS	Iceland	880	6.71	2.81	3.82	1.17
IT	Italy	2626	8.26	1.92	4.28	1.26
LT	Lithuania	2122	8.05	2.01	4.06	1.19
NL	Netherlands	1681	7.38	2.26	4.04	1.12
NO	Norway	1545	6.86	2.41	4.02	1.10
PL	Poland	1694	8.19	2.02	4.04	1.12
PT	Portugal	1270	8.38	2.10	4.43	1.20
RU	Russian Federation	2430	6.15	2.67	3.45	1.39
SE	Sweden	1551	7.34	2.22	4.03	1.10
SI	Slovenia	1307	8.03	2.24	4.37	1.15
Overall		41830	7.54	2.42	4.10	1.27

Notes: This table reports the means and standard deviations (SD) of energy saving behaviours, as plotted in Figure 1. All values based on ESS Round 8 (ESS, 2016), weighted to account for sampling error, non-response bias, and differences in inclusion probabilities. The overall values are calculated with additional weights to account for the different population sizes of the countries in the dataset.

Multi-level ordered logit models

In the main text, we treated various variables — most importantly, the dependent variables — as continuous although they are ordinal. In this section, we show that our substantive findings remain virtually the same if we treat them as ordinal instead. Table A2 presents the results re-estimated in multi-level ordered logistic regression models.

Table A2: Multilevel ordered logistic regression models

	Efficiency				Curtailment			
	Model 5		Model 6		Model 7		Model 8	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Household income	0.033***	0.004	0.013*	0.005	–0.037***	0.004	–0.035***	0.005
Energy efficacy			0.064***	0.005			0.028***	0.005
Climate efficacy			0.031***	0.004			0.039***	0.004
Energy expense concerns			0.121***	0.012			0.148***	0.012
Climate change concerns			0.291***	0.013			0.319***	0.013
Household size			0.064***	0.010			0.015	0.010
Age			0.018***	0.001			0.016***	0.001
Female			0.140***	0.021			0.125***	0.021
Education			0.037***	0.003			0.031***	0.003
Ideology			–0.002	0.005			–0.025***	0.005
Cut-point 1	–4.146***	0.107	–1.088***	0.139	–4.267***	0.086	–1.655***	0.119
Cut-point 2	–3.786***	0.104	–0.702***	0.136	–2.834***	0.078	–0.070	0.111
Cut-point 3	–3.261***	0.101	–0.128	0.133	–1.076***	0.076	1.823***	0.110
Cut-point 4	–2.736***	0.100	0.443***	0.132	0.229**	0.076	3.232***	0.111
Cut-point 5	–2.365***	0.099	0.840***	0.131	1.630***	0.076	4.753***	0.113
Cut-point 6	–1.597***	0.098	1.627***	0.131				
Cut-point 7	–1.152***	0.098	2.099***	0.131				
Cut-point 8	–0.524***	0.098	2.769***	0.131				
Cut-point 9	0.364***	0.098	3.730***	0.132				
Cut-point 10	1.127***	0.098	4.553***	0.133				
N—Observations	33877		28988		34219		29079	
N—Countries	22		22		22		22	
Country-level variance	0.200**	0.061	0.199**	0.061	0.117**	0.036	0.087**	0.027
Log likelihood	–64868.988		–53880.179		–52384.937		–42896.139	
Wald χ^2	59.518		2015.667		73.909		1997.755	

Notes: Models are calculated with multilevel ordered logistic regressions, where individual respondents are nested in countries. Standard errors are in adjoining columns. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.