
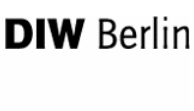

The differential effects of energy-efficient technology adoption and energy policies: A research note

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Differential effects of energy efficient technology adoption

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1. Introduction

This research note examines the distributional implications of policies to promote the use of energy efficient household appliances. Specifically, we document the progressive nature of incentives that encourage the adoption of Class-A energy-efficiency rated household 'cold' appliances; refrigerators, freezers, and refrigerator – freezer combination units.

The analysis focuses on two components of household behaviour that are most likely to influence the magnitude of impacts of policies to increase energy efficient appliance adoption across household income groups. The first component is the differential propensity for different household income groups to adopt energy efficient appliances. The second component is the potential savings from adoption relative to total household expenditures on electricity.

The analyses are based on the findings by Mills and Schleich (2010). Relying on data from a large survey of more than 20,000 German households they econometrically analyse the determinants of consumer knowledge of the EU energy label for household appliances and the choice of class-A energy-efficient appliances.

2. Methodology and Findings

2.1. Adoption propensities by income group

Constraints to the adoption of energy savings technologies include limited information on innovations and other transaction costs to adoption. Results from surveys on energy consumption patterns and technology use in private households in Germany suggest that the diffusion of energy efficient appliances and heating systems in private households is limited (Schlomann et al., 2004; Schlomann et al., 2005). Household purchasing decisions (product/technology choice) depend not only on the characteristics of the product (investment costs, operating costs, performance, quality), but also on socio-economic characteristics of the household, including education, household size, and income. These factors determine both household levels of information about, and attitudes toward, new energy-efficient technologies and may influence household adoption of energy efficient technologies.

The current research note draws directly on Mills and Schleich (2010) estimates of the impact of household income on the propensity for households to adopt Class-A refrigerators, freezers, and refrigerator – freezer combination units. The study isolates the impact of income by controlling for other household socio-economic characteristics, for residence characteristics, and for sample selection bias in survey responses. The calculated 2002 benchmarks Class-A adoption frequencies for the general population of German households are 40.6 percent of households for refrigerators, 44.5 percent of households for freezers, and 48.1 percent of households for refrigerator – freezer combination units. The crucial finding relevant for this research note is that, after controlling for these other factors, household income has no impact on the propensity for households to adopt Class-A cold appliances. As a result, no differences in adoption are assumed across income groups and the remainder of the analysis focuses on potential savings or costs as a share of total energy expenditures of each income group.

2.2. Energy expenditure savings from class-A adoption

Figures in Table 1 on the energy savings from Class-A adoption are based on a comparison of annual energy use for an average stock model in 2002 in comparison to the best available model in 2003. Accordingly, the calculated reduction in electricity use for refrigerators is 31.6 percent, while refrigerator – freezer combination units and freezers show reductions of 41.6 and 40.4 percent, respectively. The associated annual savings using a power price of 0.156 Euro per kWh are 12.6 Euro for refrigerators, 22.3 Euro for refrigerator – freezers, and 20.1 Euro for freezers. Since all of these appliances typically run 24 hours a day – seven days a

week, there is no reason to expect that annual savings will differ across income groups.

Table 1: Efficiency gains and electricity costs savings from class-A appliances

	Electricity use of stock average	Electricity consumption of most efficient appliance	Reduction of energy use	Electricity cost savings
	kWh/year	*kWh/year*	*%*	*Euro*
Refrigerators	256	175	31.6	12.64
Refrigerator-Freezers	344	291	41.6	22.31
Freezers	319	190	40.4	20.12

2.3. Household electricity expenditures by income group

Non-parametric estimates of the distribution of annual household electricity expenditures for the sixteen household income group are presented in

2. Methodology and findings

Figure 1. Clearly both the mean and the variance of household electricity expenditures are smaller for households in lower income groups. The associated means for each income group are displayed in Figure 2 and presented more detailed in Table A 1. As expected, mean electricity expenditure increases by income class, but decreases if measured as a share of income (see Figure 3 and Table A 1).

2. Methodology and findings

Figure 1: Electricity expenditure density estimates by income group

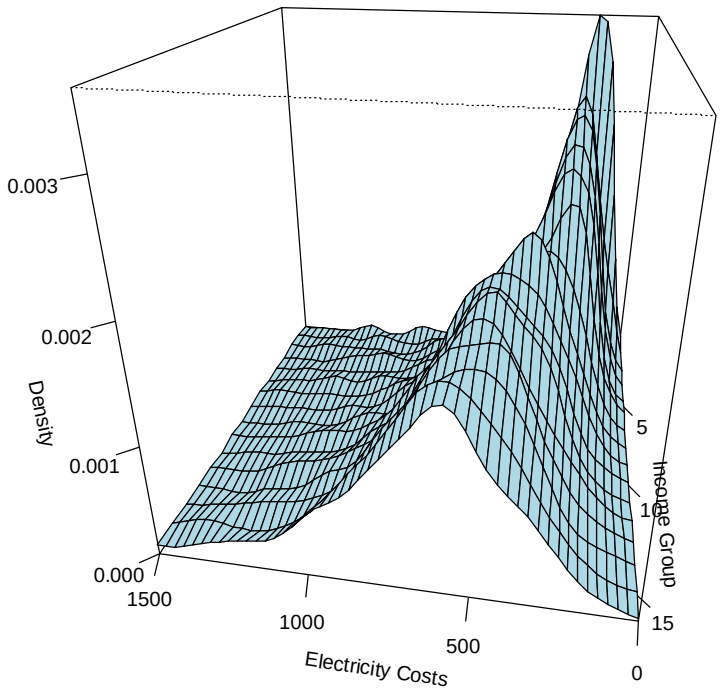


Figure 2: Annual electricity expenditures by income class

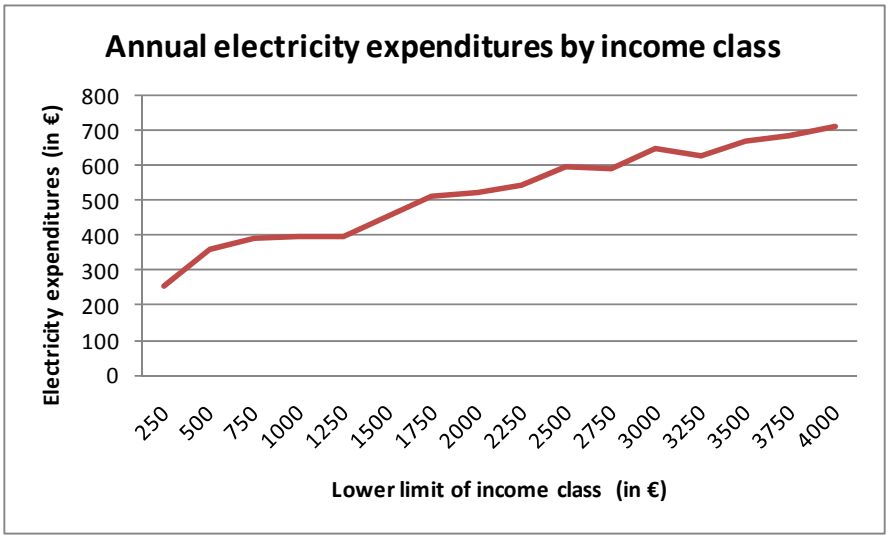
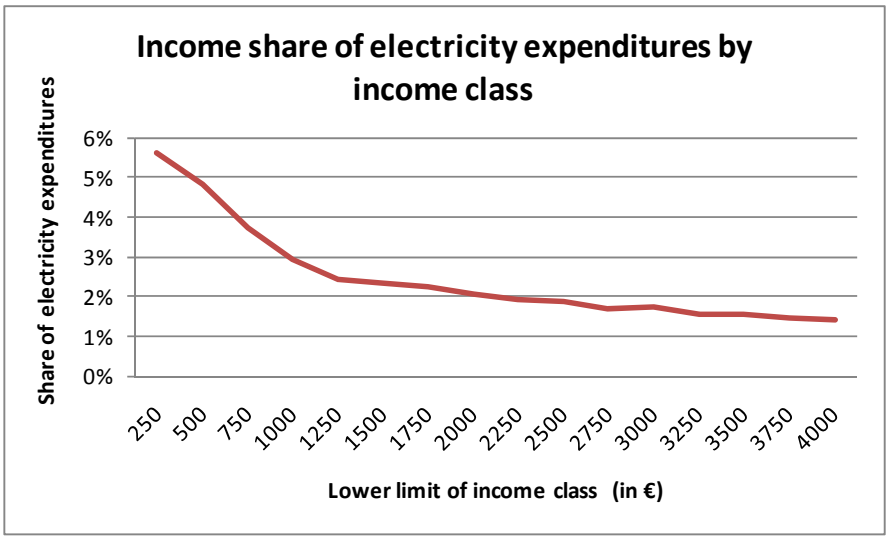


Figure 3: Income share of electricity expenditures by income class



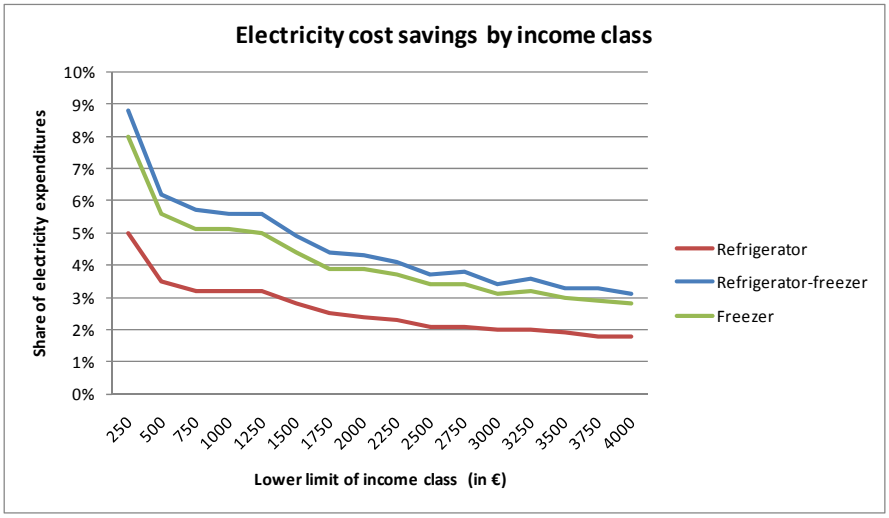
2.4. Energy savings as a share of total energy expenditures

Figure 4,

Figure 5 and Table A 1 also show that for each appliance type low income households save a greater share of their annual electricity expenditures and also of total household income from adopting class-A cold appliances than do higher income households.

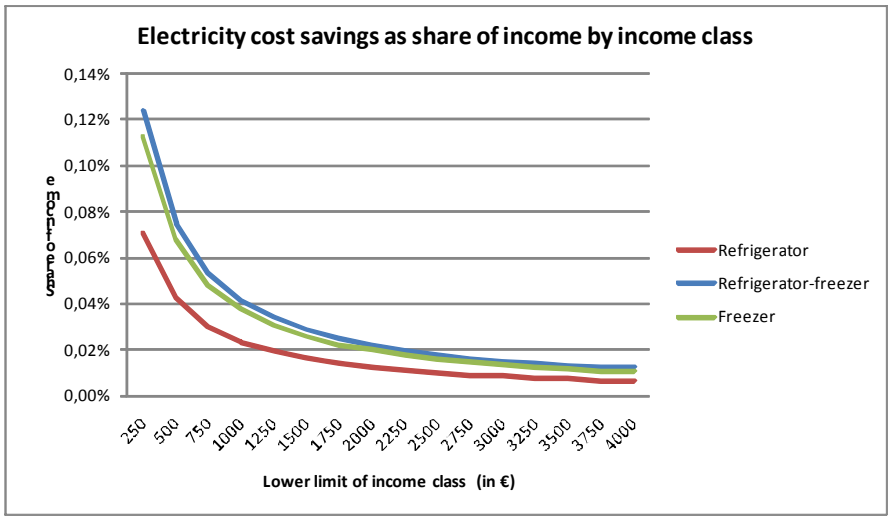
For refrigerators the lowest household income group that earns less than 250 Euros per month saves 5 percent of total electricity expenditures and 0.07% of income by adopting a class-A refrigerator, while the highest income group earning over 4000 Euros per month saves only 1.8 percent of total electricity expenditures and less than 0.007%. For refrigerator – freezer units savings are 5.0 and 1.8 percent of electricity expenditures for the lowest income group and highest income groups, respectively. For freezers the savings are 8.0 percent and 2.8 percent for the lowest and highest income groups, respectively. Dishwashers and washing machines have lower base levels of electricity consumption, but levels of electricity savings similar to refrigerators. Hence, distributional impacts for these appliances will be similar to those for refrigerators.

Figure 4: Electricity cost savings from adoption of class-A appliances as share of electricity expenditures



For all three appliance types analysed, the effect of adoption of a class-A appliance measured as percentage change in income is about ten times higher for the lowest income class than for the highest income class.

Figure 5: Electricity cost savings from adoption of class-A appliances as share of income



3. Summary

The results presented in this research note rely on Mills and Schleich (2010) who find that household income has little direct impact on the propensity of households to adopt energy efficient appliances. Further, lower income households expect to receive the same absolute value of energy savings from adoption of class-A cold appliances. Thus, energy savings will be greater for low income households as a portion of both total electricity expenditures and total income. Incentives to adopt class-A appliances will generate correspondingly greater proportional energy savings for low income households.

References

Mills, B. and Schleich, J. (2010): What's Driving Energy Efficient Appliance Label Awareness and Purchase Propensity? Energy Policy. 38 (2010): 814-825.

Schlomann, B.; Gruber, E.; Eichhammer, W.; Kling, N.; Diekmann, J.; Ziesing, H.J.; Rieke, H.; Wittke, F.; Herzog, T.; Barbosa, M.; Lutz, S.; Broeske, U.; Merten, D.; Falkenberg, D.; Nill, M.; Kaltschmitt, M.; Geiger, B.; Kleeberger, H.; Eckl, R. (2004): Energieverbrauch der privaten Haushalte und des Sektors Gewerbe, Handel, Dienstleistungen (GHD), in Zusammenarbeit mit dem DIW Berlin, TU München, GfK Nürnberg, IE Leipzig, im Auftrag des Bundesministeriums für Wirtschaft und Arbeit, Karlsruhe, Berlin, Nürnberg, Leipzig, München.

Schlomann, B.; Cremer, C.; Friedewald, M.; Georgieff, P.; Gruber, E.; Corradini, R.; Kraus, D.; Arndt, U.; Mauch, W.; Schaefer, H.; Schulte, M.; Schröder, R. (2005): Technische und rechtliche Anwendungsmöglichkeiten einer verpflichtenden Kennzeichnung des Leerlaufverbrauchs strombetriebener Haushalts- und Bürogeräte, in Kooperation mit der Forschungsstelle für Energiewirtschaft (FfE) und der TU Dresden, im Auftrag des Bundesministeriums für Wirtschaft und Arbeit, Karlsruhe, München, Dresden.

Annex

Table A 1: Effects of adoption of class-A appliance on electricity expenditure and income by income classes

				Percentage electricity savings			Electricity savings as share of income		
Income class	Lower limit of income class	Annual electricity expenditures	Mean income share of electricity expenditure	Refrigerator	Refrigerator-freezer	Freezer	Refrigerator	Refrigerator-freezer	Freezer
1	250	253	5.63%	5.0	8.8	8.0	0.070%	0.124%	0.113%
2	500	361	4.82%	3.5	6.2	5.6	0.042%	0.075%	0.067%
3	750	391	3.73%	3.2	5.7	5.1	0.030%	0.053%	0.048%
4	1000	395	2.93%	3.2	5.6	5.1	0.023%	0.041%	0.037%
5	1250	399	2.42%	3.2	5.6	5.0	0.019%	0.034%	0.030%
6	1500	456	2.34%	2.8	4.9	4.4	0.016%	0.029%	0.026%
7	1750	510	2.27%	2.5	4.4	3.9	0.014%	0.025%	0.022%
8	2000	520	2.04%	2.4	4.3	3.9	0.012%	0.022%	0.020%
9	2250	545	1.91%	2.3	4.1	3.7	0.011%	0.020%	0.018%
10	2500	595	1.89%	2.1	3.7	3.4	0.010%	0.017%	0.016%
11	2750	588	1.70%	2.1	3.8	3.4	0.009%	0.016%	0.014%
12	3000	648	1.73%	2.0	3.4	3.1	0.009%	0.015%	0.013%
13	3250	627	1.55%	2.0	3.6	3.2	0.008%	0.014%	0.012%
14	3500	670	1.54%	1.9	3.3	3.0	0.007%	0.013%	0.012%
15	3750	683	1.47%	1.8	3.3	2.9	0.007%	0.012%	0.011%
16	4000	711	<1.47%	1.8	3.1	2.8	<0.007%	<0.012%	<0.011%