Determinants of Electricity Consumption in Private Households in Germany. Analysis of the German Sample Survey on Income and Expenditure.

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Abstract (max 250 words):

Private households are the third-largest consumers of electricity in Germany in 2021 (BDEW 2022). Moreover, the change to a carbon-neutral society is expected to permanently increase electricity prices. Since energy demand is inelastic in the short run, energy price rises are expected to disproportionately affect low-income households.

Therefore, understanding determinants of electricity consumption is key to ensure the transition to a fair carbon-neutral society. A scoping review conducted by the authors identified socio-demographic, housing-related and appliance-specific factors determining the electricity consumption of private households.

This paper analyses electricity expenditure of German private households utilizing the German Sample Survey on Income and Expenditure (EVS) 2018. German households spend about a third of net income on housing, energy, and maintenance. The determinants identified in the scoping review show weak to moderate correlations in bivariate analyses. The multivariate analyses shows the need for simultaneous analysis of sociodemographic and dwelling-related factors: Models only analyzing either aspect appear to overestimate the influence of sociodemographic determinants. Sociodemographic factors, household size, household income, and proportion of people present are identified as main determinants of electricity costs. Dwelling-related factors (such as living space or building age) have a weak but significant influence on electricity costs. Moreover, the geographic location of the households has an influence on electricity costs for the example of Germany. This is due the fact electricity network fees vary strongly across locations and make up about a quarter of electricity cost.

Long abstract (2 pages):

After industry (44%) and retail and services (27%), private households are the third biggest contributor to overall German electricity consumption in 2021 (Bundesverband für Energie und Wasserwirtschaft, 2022). In response to the Ukraine crisis, we observed huge price increases for energy, including electricity. Additionally, the change to a carbon-neutral economy is expected to permanently increase electricity prices (Wang et al., 2016).

Demand for energy is inelastic in the short-run, thus large price increases need to be absorbed through reduced consumption and / or reduced savings. Since energy is a necessary consumer good, higher energy prices disproportionately affect low-income households (Hobijn & Lagakos, 2005). The share of households' monthly income that goes on utilities and transport services (i.e. energy-intensive consumption) is an approximate indicator of their exposure to an energy price change. Therefore, understanding determinants of household electricity consumption is key to ensure the transition to a fair and just carbon-neutral society.

Private household energy consumption is driven by sociodemographic, residential, and appliance-specific factors that influence electricity consumption (Jones et al., 2015). Evidence from South Korea also suggests private energy consumption is driven by behavioral patterns, equipment use, and psychosocial aspects (Ryu & Kim, 2022). In October 2022, the authors conducted a scoping review identifying different drivers of household electricity consumption (Vetter et al., 2023). The scoping review identified sociodemographic, dwelling-related, and appliance-specific determinants of electricity consumption.

In this paper, we utilize the German Sample Survey on Income and Expenditure (EVS) to analyze determinants of household electricity consumption. The EVS (n = 42,226) contains detailed information on household income and expenditure structures, while also collecting detailed sociodemographic characteristics of the household. Apart from appliance-specific factors, all electricity consumption determinants identified in the scoping review are collected in the EVS Survey.

We analyze bivariate correlations between identified variables and electricity consumption and model household electricity consumption as linear function of socio-demographic and dwelling-related household variables.

Monthly household electricity expenditure averages 75€ (σ = 52) for households in Germany in 2018. The determinants identified in the scoping review show weak to

moderate correlations in bivariate analyses. In multivariate analysis, sociodemographic factors: household size, household income, and proportion of people present are identified as main determinants of electricity costs. Dwelling-related factors (such as living space or building age) have a weak but significant influence on electricity costs. However, models including both, dwelling-related and socio-demographic aspects perform best. The multivariate analysis proofs the need for simultaneous analysis of sociodemographic and dwelling-related factors: Models only analyzing either aspect appear to overestimate the influence of sociodemographic determinants. Previous analysis often focused on either aspect. Our paper shows the need to explain household electricity consumption using sociodemographic AND dwelling-related factors.

An artefact for the German situation is the influence of the geographic location on household electricity expenditure. About 25% of German household electricity price are made up of electricity network charges. These network charges differ strongly across locations depending on number of users, recent renovation of the network, etc.. The authors try to capture these through location dummies.

These findings inform about possibilities to reduce the impact of electricity price changes on households. Age of the building and type of heating have a significant effect on household electricity expenditure. These aspects are possible to be changed in the medium-term. These aspects may be affected by policy-responses to mediate the effect of electricity price rises.

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