

Cross-country comparison of energy use behavior in households

Maud Fournier

Abstract

Households contribute greatly to their country's emissions of greenhouse gases, especially with their use of energy at home or with their car. This paper intends to prove statistically that their behavior is not only influenced by the technical characteristics of these households, but also by the culture of the country and its awareness towards the impact that saving energy can have on the world's ecological footprint. These aspects are clearly figured out by a macro-statistical comparison of households of the USA and Germany (Long, Mills and Schleich 2018).

Keywords: Household, behavior, energy use, statistical study, global warming

Ländervergleich des Energieverbrauchverhaltens privater Haushalte

Kurzfassung

Haushalte tragen intensiv zu den Treibhausgasemissionen ihres Landes bei, insbesondere durch den Energieverbrauch zu Hause oder mit dem Auto. Dieser Artikel zeigt durch statistischen Nachweis, dass das Verhalten der Haushalte nicht nur von deren technischen Eigenschaften beeinflusst wird, sondern auch von den kulturellen Besonderheiten des Landes und dessen Bewusstsein für die Auswirkungen des Energiesparens auf den ökologischen Fußabdruck der Welt. Diese Aspekte werden im makrostatistischen Vergleich von Haushalten in USA und in Deutschland klar verdeutlicht (Long, Mills and Schleich 2018).

Schlüsselworte: Privathaushalt, Verhalten, Energieverbrauch, Makrostatistik, Erderwärmung

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Introduction

In recent years, more and more global governmental initiatives have been launched in order to tackle the urgent issue of global warming and avoid a rise of global average temperatures of 2 °C before the end of the century. Greenhouse gases (GHG) emissions caused by human activities have been held responsible for this worsened phenomenon, as they have increased by 35 % worldwide between 1990 and 2010. Carbon dioxide (CO₂) accounts for up to 82 % of all greenhouse gases emission (United States Environmental Protection Agency 2016). Energy use in private households is one of the largest shares accountable for CO₂ emissions (around 40 % according to the Federal Statistical Office of Germany).

Household characteristics influence their energy use behavior: the number of household member, its size, the level of education or the income of its members etc.. Numerous studies have analyzed and proven the sway of these characteristics on the energy use habits of households. However, several recent studies have tried to prove that the country's culture also plays a role in the subsequent energy use behavior of its inhabitants.

Taking into account the role of national culture in the general behaviors of households, energy use could be a way to implement more efficient measures to curb the GHG emissions with actions tailored to fit the country's level of environmental awareness towards climate change and the urgency of taking action.

This paper presents a literature review of several examples proving the influence of the country's culture on energy use behavior in private households and then introduce the results of the 2018 statistical study comparing energy use behaviors of German and American households (Long, Mills, Schleich 2018) as an example for culture influence on private energy use.

Literature review: how the country's culture can play a role in energy use behaviors

Studies have shown that developing countries tend to have a growing energy use in households. For instance Malaysia has seen its energy consumption of air-conditioner increase from 9.500 MWh in 2000 to about 20.000 GWh by 2010 (Mangruwa et al. 2015). On the contrary, developed countries are more likely to be able to invest in energy-saving plans, in new technologies or raise the awareness of the population.

A striking event proving the possible influence of a government on the energy use behaviors of its inhabitants occurred in 2011 after an earthquake in Japan, which caused recurring energy shortages and led the government to recommend a reduction of energy use in office buildings by cutting back on air conditioning during the summer months: this campaign was called "Super Cool Biz" and office workers were urged to wear cooler outfits (short sleeve shirts for instance). The Peninsula Tokyo Hotel, one of the numerous businesses which embraced the campaign, managed an energy consumption reduction of 11 % (Mazur-Stommen 2015). Even if such events can't be reproduced everywhere, the idea that the government can play a role in influencing strong-rooted habits of the population to reduce their emissions should be remembered.

More and more, social science is being involved in the process of research and the setting of new energy use-policies, with the realization that not only new technologies development can help curb CO₂ emissions in the households.

Statistical study: comparison of US and German household energy use behaviors

Study context

The study intends to determine whether a country's culture has a significant weight in shaping behaviors of energy use in private households, or whether the attributes of the households play a globally more important role in the matter.

To answer this question, the results of a 2013 survey ordered by the market research company Gesellschaft für Konsumforschung have been statistically analyzed. This survey compared the responses of 1005 US citizens and 1010 German citizens.

The choice of comparing US and German data originates in the countries well-known differences in governmental decision-making towards climate change policies. Germany is leading the way in the European Union and worldwide with its actions to develop renewable energies production and the continued governmental support to this cause. In the United States, disagreements on policies led former President Barack Obama to sign the 2015 Paris Agreement without being able to ratify it, and in 2017 the Trump Administration declared its intention of withdrawing its support to it. In addition to the governmental position on the matter, both countries show drastically different approaches to the matter of climate change: in 2017, 58 % of Americans believed climate change was real and human-caused (Yale Program on Climate Change Communication 2017), while a 2011 German national survey indicated that only 20 % of the German population had doubts on the seriousness of climate change or its human-caused attribution (Engels et al. 2013).

Thanks to a linear probability model, the study intends to assess the influence of three independent variables: household characteristics, household environmental attitudes and household perceived benefits of energy conservation, on the three discreet choices of purchasing energy-efficient appliances, taking energy-saving actions at home, and purchasing fuel-efficient cars in Germany and the USA.

The three independent variables are suspected to be factors able to explain the three latter choices representing three eco-friendly ways of reducing energy use. The results of the linear probability model regression will thus evaluate parameter estimates for each discreet choice and compare their magnitude in both countries: with this data, it will then be possible to determine which factors make the inhabitants of each country decide to change their energy use behaviors.

In a second time, the data goes through an "Oaxaca-Blinder decomposition". This statistical method intends to explain the difference between the US and German household parameter means by **separating the differences that are due to household characteristics** (for instance, there could be more homeowners in the US panel, and if this characteristic leads to more eco-friendly energy use behaviors, it would lead to a difference in mean that isn't caused by an attribute concerning the country itself) **from the differences that are due to other independent variables**. Thanks to this decomposition, it is then possible to conclude that the difference that can't be explained by household characteristics is the fact of culture differences, such as attitude, understanding and perception of environmental matters.

Study results

First, means for each parameter were calculated and compared. For all three dependent variables, Germany shows higher propensities of eco-friendly energy use behaviors, for instance 79 % of German panelists purchase energy-efficient appliances, while 73 % of American panelists do so. 89 % of German respondents try to save energy at home, and 85 % of US respondents do so. Finally, 51 % of German and 44 % of US respondents have purchased a fuel-efficient car.

It has been found after the data analysis that household characteristics can be quite different between Germany and the USA (for instance: 51 % of German, compared to 76 % of Americans, is a homeowner). Concerning household environmental attitudes, it has been found that the German people feel more concerned by the environment's conservation (average New Ecological Paradigm scale¹ - *NEP scale* - of 4.1 for German panelists and of 3.2 for US panelists).

¹ The NEP (New Ecological Paradigm) scale is a measure from 1 to 5 of endorsement of a "pro-ecological" world view (5 being the more concerned by ecological issues) (Mark Anderson, U. of Maine).

But more Americans believe they are well-informed of international climate conferences. In order to solve global challenges, 83 % of German and 66 % of US respondents think combating climate change is an important matter.

Then, statistically significant parameter estimates (marked with an asterisk) were analyzed thanks to regressions. Out of the three parameters, only the choice of saving energy at home will be presented here. The coefficients calculated are shown in Table 1.

Table 1: Household energy-saving behavior regression results for the parameter of "saving energy at home" (Long, Mills, Schleich 2018)

	Germany		USA	
	Coeff.	Std. dev.	Coeff.	Std. dev.
Household characteristics				
HouseholdSize	0.005	0.030	- 0.012	0.030
HighEdu	0.049	0.036	0.027	0.041
Income (\$,000)	- 0.020*	0.011	0.005	0.005
LiveTogether	0.053	0.045	0.020	0.041
NumOfChildrenHH	- 0.007	0.031	- 0.007	0.036
Female	0.001	0.035	0.045	0.039
NumOfCars	0.005	0.037	- 0.015	0.029
MilesDriven (000)	0.005	0.002	0.000	0.001
HomeOwner	0.058	0.039	0.051	0.045
Household environmental attitudes				
NEP	0.034***	0.012	0.019*	0.010
EnvOrg	0.002	0.068	- 0.009	0.051
FeelWorried	- 0.047	0.047	- 0.009	0.047
FeelResponsible	0.078*	0.045	0.010	0.038
FeelHopeless	- 0.087*	0.046	0.005	0.043
WellInformed	- 0.012	0.038	- 0.041	0.044
HumanCause	- 0.017	0.045	0.101**	0.043
AlreadyOccurs	0.075	0.082	- 0.016	0.058
ImpClimateChange	0.032	0.089	- 0.022	0.061
ImpPoverty	0.071	0.081	0.068	0.063
Household perceptions of energy conservation behavior				
FinBuyEAA	0.017	0.042	- 0.004	0.062
FinBuyEffCar	0.001	0.038	0.138**	0.058
FinRenewableEnergy	- 0.029	0.035	- 0.043	0.045
EffBuyEAA	0.127***	0.049	0.119*	0.068
EffBuyEffCar	0.037	0.046	- 0.058	0.059
EffRenewableEnergy	- 0.039	0.043	0.053	0.053
R-squared	0.186		0.134	
Number of observations	570		546	

Statistically significant differences at the * $p=0.10$, ** $p=0.05$ and *** $p=0.01$ levels in two-tailed t tests

From these results can be concluded that with more income, German households tend to care less about energy conservation. A higher average on the NEP scale is naturally correlated with a tendency to save more energy.

In the US only, believing that climate change is human-caused influence one's position towards energy conservation. Finally, being aware of the financial benefits of owning an energy-efficient car or of the environmental benefits of purchasing energy-efficient appliances in the US is a sign for a higher tendency to save energy at home.

Finally, the US and German decomposition with the Blinder-Oaxaca method divided the results between three categories: an overall comparison between the US and Germany: each country's variable estimate's mean and the difference between them, and two other terms: the endowment term (try to determine the impact of the variable mean differences) and the coefficient term (try to determine the impact of the variable estimate differences).

For instance, the first category will measure how much people buy energy-efficient appliances in Germany, in the US and then measure its difference. The goal is then to explain if the difference is caused by the fact that the characteristics are different or if there really is something different in how people act, and this would have to be related to the influence of the country. Each parameter is analyzed, for example, while trying to explain the fact that American households buy less energy-efficient appliances, it is easy to notice the fact that there are more homeowners and more high-income households in the American panel. These characteristics usually influence the households to buy these energy-saving technologies. However, in this case, the variable means don't change the fact that the American panel buys them less (even if those two characteristics have a positive influence) than the German panel.

The results of the decomposition enabled the conclusion that the cultural parameters: attitudes and perception of environmental issues actually have a larger effect on energy use behaviors of households than household characteristics.

Study conclusion

This recent study demonstrates statistically with nationally representative panels that not only household characteristics but more importantly cultural factors play a major role in influencing propensities of energy-saving actions. This research proves mathematically for instance that by raising awareness of climate change, ways to curb it and how to include them in one's everyday life in the US, energy use behaviors are likely to change towards a more energy-saving attitudes.

Conclusion and discussion

In future global decisions of reducing CO₂ emissions, cultural aspects should be taken into account and more tailored objectives to each country's current situation and awareness of the issue might prove much more efficient, as it has been proven with the comparison of Germany and the USA.

Moreover, the influence on everyday life behaviors made possible by social movements should be highlighted. Each country of the 195 parties who signed the 2015 Paris Agreement will be much closer to its goal with the help of its citizens, reducing their own emissions at home and with their cars.

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