Regional-level household energy consumption determinants: The european perspective

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ARTICLE INFO

ABSTRACT

Starting from the assumption that household energy use is manifold and intertwined, shaped by many factors which overlap not only at the individual level, but also at a higher level of scales, the paper developed a more integrated approach to its determinants. To assess them and also to find out whether there is a difference between regional-level factors that determine it universally, and those that are context-dependent, the static and dynamic panel analyses were employed in 64 European regions over the period from 2005 to 2013.

Our findings suggest that there are common energy consumption determinants and those ones that are dependent on the regions' level of development. While the sign of the impact of the former is the same across regions, the impact of the latter may differ, depending on the character of the energy policy measures applied. Findings also suggest that energy policy authorities have opportunities to develop and encourage energy efficiency and sustainable use of energy of the household sector by creating regional-specific demand-side energy efficiency programs and measures as well as user practices in relation to technology.

1. Introduction

Understanding consumer behavior including how households make decisions on energy use is important not only to researchers, practitioners but also to policy makers aimed at encouraging and promoting a wise, efficient and sustainable use of energy by different policy programs, schemes and measures. For instance, the European Union (EU) has committed itself to cut its energy consumption by 20% by 2020. According to the Eurostat data from 2016 [1], in addition to transportation (33.2%) and industry (25.9), the household sector is one of the three main energy end users with the share of 24.8% in total final energy consumption. Clearly, decoupled energy from economic growth, reduced energy consumption and increased energy efficiency in all sectors will contribute thereto. Consequently, energy consumption has generally attracted a lot of attention, particularly with respect to energy efficiency and its benefit for climate change [2].

Despite that, little is still known about what the factors are that affect energy consumption in the household sector [3,4]. Certainly, consumer behavior in general has been extensively studied and various integrated approaches have been proposed. Some of them were used to explain the behavior of energy consumption (for a review, see [5–8]); but, nevertheless, our understanding of household energy use still remains limited. This could be explained by the fact that household energy use is manifold and intertwined, shaped by many factors which overlap not only at the individual level, but also at a higher level of scales. This also implicates a necessity to understand a wide spectrum of approaches, theories and explanations, as well as to create an integrated approach to its explanation.

Moreover, the empirical literature in this field is oriented to the national research level utilizing a micro level data set in most cases; and so far there have been only a few relevant studies on energy use determinants at the regional scale in the EU (e.g., Baranzelli et al. [9], who presented the results related to energy generation and consumption by the transport sector). But, the regional level, i.e., the nomenclature of territorial units for statistics (NUTS) 2 level, is the most important level for the design and implementation of EU policy. Namely, the EU applies the NUTS classification, which is a hierarchical system for dividing the EU economic territory into three main NUTS levels: NUTS 1, NUTS 2 and NUTS 3. The first one corresponds to the entire country, while the second and third levels are subdivisions of the first and second levels. The main criterion for classification is the average population size of the territory. For instance, to be classified as a NUTS 2 region, a region has to have between 800,000 and 3 million inhabitants. For more information on the NUTS classification, see [10]. Thus, the EU uses the NUTS classification to define regional boundaries and determine geographic eligibility for structural and investment funds. Moreover, several studies conducted at the sub-national level in the EU have shown that regional differences matter when energy consumption in households comes into question (e.g., Rehdanz [11] for Germany; Hill [12] for Austria).

To address these gaps in the literature, the paper aims to identify the determinants of energy consumption in households at NUTS 2 level, and then investigate whether they are sensitive to the regions' level of economic development. It assumes that energy consumption in households is determined by socio-economic and contextual determinants. To accomplish these aims, the paper employs the static and dynamic panel analysis on the sample consisting of 64 European NUTS 2 regions for which the data is available over the period 2005–2013. It also separates the NUTS 2 regions into less developed and more developed NUTS 2 regions.

The study contributes to the advancement of the energy- and environment-related literature in several ways. First, it develops a more integrated approach to studying the driving factors of household energy consumption at the regional level by examining not only economic, but also sociological variables, which turned out to be significant determinants. It also includes energy poverty variables into analysis, which were not considered in the previous studies on this topic. Second, it shows that there are common, universal energy consumption determinants regardless of the region's level of development. Third, it suggests that there are opportunities for energy policy authorities to encourage energy efficiency and sustainability by means of regional-specific demand-side energy efficiency policies and programs as well as user practices in relation to technology.

The remainder of the paper is organized as follows. The next section provides a brief review of the approaches used to examine energy consumption and their main findings which were used as the basis for model identification in this paper. Section 3 describes data and the method used for the econometric estimation of energy consumption models, while Section 4 presents and discusses the results and main findings. Section 5 concludes the paper.

2. Regional-level determinants of energy consumption in households

2.1. A review of the theoretical approaches

Across the social sciences, several approaches to modeling, explaining and predicting the drivers of individual energy consumption and related decision making are described in the literature. Conventional economics and behavioral economics, technology adoption theory and attitude-based decision making, social and environmental psychology and sociology are most popular and most commonly used in energy economics. They are reviewed by [5–8] and briefly described below.

The first approach is based on the microeconomic decision model of utility maximization given fixed and consistent preferences as well as budget constraints. Consumers, behaving as rational and independent actors in a predictable way to financial incentives, seek to maximize utility and their own interest [13]. This could be in accordance with energy efficiency and conservation. However, by drawing on critical analysis of individual behaviors in reality, which show that individuals often behave and respond in unexpected, undesirable and irrational ways [14], behavioral economics, enriched with psychological knowledge and empirical evidence, illuminates the need for incorporating new elements into microeconomic models. It aims to explain, predict and change consumer behavior, such as complexity, multiple choices, risk and uncertainty (see [3,5,15,16]).

The second approach, i.e., technology adoption and attitude-based decision models, explains the appearance and the diffusion of innovations. They are very important for developing more efficient and environment-friendly energy appliances and services, more efficient energy buildings, space heating technologies, etc. Thereby, perceived attributes of innovation (e.g., compatibility with existing needs or problems, prevailing social norms and behavior or complexity) are also relevant for explaining household energy consumption [5].

The third approach, i.e., social and environmental psychology,

explores the role of information and incentives, and more recently values, attitudes and norms in individual decision making, including energy use [5,7]. It turned out that information and incentives aiming at raising awareness and influencing consumer behavior are important but also not universally effective. The same holds for values, attitudes and norms which may predict, influence and change energy consumer behavior to more efficient and sustainable use of energy. Moreover, findings in this field suggest that individual consumer behavior also varies because of external conditions (e.g., physical, financial, legal or social) that directly and indirectly either support or hinder energy-related behavior (see [17]).

As stated by Wilson and Dowlatabadi [5], environmental psychology and sociology focuses on studying the role of and demand for energy services suggesting that individuals do not make energy use decisions, while demand for energy is created by services which are in turn provided by devices and infrastructures. Hence, energy use is a social construct that could be analyzed at the household level. Thereby, particular macro-level societal factors (such as technology, culture, economy, institutions or legislation) determine the household energy use. Karatasou et al. [7] highlighted that these models are important especially for policy developers.

Besides the reviewed approaches, there are others such as the lifestyle and practice approaches ([18–20]) that stress the role of the collective aspect of consumer practice in explaining energy consumption. For a brief review of these approaches, see [21].

2.2. Key findings from previous studies

Focusing on energy consumption in households at the regional level and aggregate data, we try to develop a more integrated approach by selecting variables, economic, sociological and contextual ones, to be employed in this study in accordance with the approaches briefly described above. The starting point is the idea that energy consumption in households may be understood as the interaction of the multifaceted and synergic interplay between a socio-economic and a contextual domain at a higher level of scales.

Among socio-economic determinants, human capital, labor market, poverty and economic variables seem to be important drivers of energy consumption.

Human capital is a set of productive capacities that enables wise use of energy through increased knowledge, awareness and concern regarding energy efficiency and other pro-environmental issues, and, on the other hand, standing improvements in technology and services that generate the need for energy. In the energy studies, it is often operationalized through different education and demographic variables. Thereby, some studies have found a significant effect of education level on pro-environmental behavior and/or energy use [22,23], while others have identified a statistically weak or insignificant one [24]. The same holds when demographic variables come into question, which were studied dominantly by utilizing micro-level data (for a review, see [25,26]).

Traditionally, economic variables, such as disposable income, are considered to be important determinants influencing energy consumption. Thus, most studies revealed that the relationship between energy consumption and disposable income of private households is positive and highly significant [3,22,27–29]. This means that increased disposable income leads to an enhancement of household capacity to invest in more energy saving products and improvements, and therefore to life-style changes, which in turn increase household's electricity consumption. However, there are some studies that found a weak to insignificant effect of disposable income on energy consumption [23,30], explaining this by a possible mediation of income by ownership of appliances. The literature is also inconclusive with regard to the effect of energy prices on household energy consumption. Some studies reported their significant negative effect [22,28,31], while others demonstrated that electricity consumption is not very sensitive to price