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An analysis of the welfare and distributive implications of factors influencing household electricity consumption

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HIGHLIGHTS

- Impact of the economic crisis and higher electricity prices on electricity demand.
- Analysis of the welfare effects.
- Lower and steeper U-shape price elasticities of demand.
- Higher and steeper N-shape income elasticities of demand.
- Welfare of lower-income households more negatively affected.

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ABSTRACT

The deep economic crisis and the sharp rise in electricity prices have reduced electricity demand by Spanish households. This paper aims to analyse the responsiveness of household electricity demand and the welfare effects related to both factors in the 2006–2012 period by applying a demand model estimated with the quantile regression method. The results show that the electricity consumption of medium-high income households is particularly responsive to price increases, whereas that of medium-low income households is more responsive to changes in income. The retail electricity price increases and the economic crisis have led to lower and steeper U-shape price elasticities of demand and higher and steeper N-shape income elasticities of demand. The joint impact of those two factors on the welfare of lower-income households is higher in relative terms (i.e., as a share of household income) than for other income groups. These results suggest that the economic crisis and increases in retail electricity prices have had detrimental welfare effects, especially on the lower-income segment of the population. They should be considered when financing climate and energy policies through the electricity bill and provide a rationale to take such support, which pushes the retail electricity price upwards, out of the electricity bill.

1. Introduction

There is an ever-lasting interest in the economic analysis of energy demand. This is partly due to societal concerns with respect to the environment, energy security and energy price impacts on low-income households (Bernard et al., 2011). Household energy satisfies a varied range of needs that span from necessities and basics to recreational and luxury consumption. The relative importance of essential or luxury services of energy varies with income (Meier et al., 2013). Overall, energy services may be regarded as a necessity good implying an income elasticity of demand that is greater than zero and smaller than unity (Jamasb and Meier, 2010). Taking into account that the final electricity price has two components (the wholesale market price and the so-called "access fees" which include the costs of policies), the degree of sensibility to changes in price and income for different income groups is useful to analyse the welfare and distributional effects of electricity pricing policies. This issue is relevant in so far as climate and energy policies and, particularly, renewable electricity support schemes are being financed in many EU countries through the electricity bill. Policy makers are increasingly concerned about the distributional and welfare impacts of those climate and energy policies and, particularly, on the effects on the poorest segment of the population. Low-income households are more likely to be negatively affected by the economic crisis and by higher electricity

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prices. Too large welfare costs from energy and climate policies for the poorest segment of the population may generate a social backlash against the policy, making it socially unacceptable and politically unfeasible (del Río et al., 2012; Neuhoff et al., 2013).

The focus of this paper is on residential (household) electricity demand in Spain. The residential sector is responsible for 17% of the country's final energy consumption and 25% of its electricity consumption, whereas the shares in the EU are significantly higher (25% and 29%, respectively) (Instituto para la diversificación y el ahorro energético (IDAE), 2011a). In Spain, electricity represents 35% of overall energy consumption in the residential sector and 5%, 13% and 44% of all energy used for heating, water heating and cooking, respectively. All the energy used for air conditioning and lighting is covered by electricity (Instituto para la diversificación y el ahorro energético (IDAE), 2011b). The deep economic crisis experienced by Spain can be expected to have influenced electricity demand by households, with possibly wide-ranging implications in terms of welfare and distributional effects. GDP had growth rates in the range of 2.7–5.1% between 1996 and 2008, significantly higher than for most other EU countries and the unemployment rate fell from 19.9% in 1996 to 8.2% in 2007 (Eurostat 2015a). As in other developed countries, the Spanish economy entered into recession at the end of 2008. The impact of this crisis on unemployment and GDP rates has been particularly detrimental (Gruppe and Lange, 2014; Moro, 2014). Between 2009 and 2013, nominal GDP fell by an accumulated 6.7%, the unemployment rate rose to a historical high of 25.7% in 2012 and household disposable income fell by 4.3% in nominal terms. In parallel, according to Eurostat (2015b), the retail price of electricity has increased by 64% since 2007 (from 0.14 €/kWh to 0.23 €/kWh in 2013), raising the concerns of the government on its impact on the welfare of households, particularly the poorest ones.[1] This increase in the retail price can mostly be attributed to the objective of the government to reduce the so-called tariff-deficit, which amounts to 30,000 M€ in 2013, according to the European Commission (2014).[2] Arguably, the economic crisis and the increase in prices are the two main factors behind the drastic reduction in electricity demand in the last years. Thus, electricity consumption increased at an average annual growth rate of 4.4% between 2000 and 2007 and decreased by 1.3% between 2008 and 2010 (UNESA, 2013).

The aim of this paper is to analyse the responsiveness of household electricity demand and the welfare effects related to both factors (the deep economic crisis and the sharp rise in electricity prices) between 2006 and 2012 in Spain. The sample is segmented in two subperiods: 2006–2008 and 2010–2012. The impact of the economic crisis and the increase in electricity prices has been felt in the second subperiod.[3] The demand model has been estimated using a quantile regression of the cross-sections of the Family Budget Survey (EPF) from the National Statistical Office. This paper covers a gap in the literature since analyses on the impact of the economic crisis on electricity demand are virtually absent.[4] To our best knowledge, it is the first time that an electricity demand model estimated with the quantile regression method has been applied to such analysis. Furthermore, this is one of the few contributions to the analysis of the impact of higher electricity prices on household welfare.

This topic has both political and academic relevance. Particularly worrisome is the possibly unequal distribution of welfare losses across different income segments of the population. Both factors combined would further exacerbate fuel poverty if the lower-income households were the most affected, taking into account that electricity is not a luxury good, but a necessity in today's modern societies (at least below some consumption thresholds). As the focus of this study is on household energy consumption and the differences between income groups, our analysis is deemed relevant in the context of the fuel poverty problem. It connects to two main causes of energy poverty: household revenues (affected by the economic crisis) and energy costs (negatively influenced by higher electricity prices). In 2012, 7 million Spanish households (17% of the total) had “disproportionate expenditures on energy” (e.g., beyond 10% of their annual revenues), up from 12% in 2010 (Tirado et al., 2014). These households can be expected to have had severe difficulties in paying their energy bills (Tirado Herrero et al., 2012). Subjective indicators also suggest the importance of energy poverty: 9% of all households declared that they were incapable of maintaining an appropriate temperature in their homes during winter (Tirado et al., 2014).[5] Phimister et al. (2015) show that between 10% and 27% of all Spanish households are fuel poor, depending on the indicator of fuel poverty chosen.[6] This range is even wider in Romero et al. (2015) (between 6% and 24%).

Accordingly, the paper is structured as follows. The next section provides a brief review of the literature, develops the hypotheses tested in the study and discusses the model. Section 3 describes the data. The results are provided in Section 4 and discussed in Section 5. The last section concludes.

2. Methods

2.1. A brief literature review

The analysis of residential electricity demand has received considerable attention in the past (see Romero-Jordán et al., 2014 for a review). Some studies have focused on household characteristics and their relation to electricity consumption, including age, employment status and number of children or retired persons in the households (see, among others, Baker and Blundell, 1991; Yamasaki and Tominaga, 1997; Liao and Chang, 2002; Jamasb and Meier, 2010)). However, few studies analise the distribution of elasticities across different household income levels. Table 1 summarises the results of the main contributions to the literature.

Overall, the results of the literature regarding the price elasticities for different income groups are ambiguous: N-shape for California (Reiss and White, 2005), U-shape for the United States as a whole (Fell et al., 2010; Alberini et al., 2011), monotonic increase with negative values for Philippines (Manalo-Macua, 2007) and monotonic increase with positive values for the United

[1] It is about 15% higher than the EU average, where the increase has been lower (30%), over the same period.

[2] This tariff deficit has been the result of regulated prices for electricity being set below the regulated prices for electricity being set below the regulated costs, and the increase in regulated costs mostly, although not only, as a result of renewable energy net support costs (from about 1700 M€ in 2006 to 7500 M€ 2012). Net support costs are calculated as the whole feed-in tariffs and premiums paid to renewable electricity generators minus the average wholesale price.

[3] The average unemployment rate in the first subperiod was 10.2% and increased to 23% in the second subperiod. In addition, the electricity price increased by 30% in the second subperiod.

[4] Analyses of the welfare and distributional effects of these factors on electricity demand are relatively scarce and circumscribed to the increases in the electricity price.

[5] Almost 70% of the respondents to the December 2011 opinion poll of the Center for Sociological Research (CIS (Center for Sociological Research), 2011) had reduced their expenditures on domestic energy and other household fixed costs in order to save money and as a result of the economic crisis (Tirado and Lopez, 2013).

[6] Other data suggest the increasing importance of electricity spending and its possible relationship with fuel poverty. For example, annual household expenditures on electricity have increased by 65% between 2006 and 2012 and the proportion of those expenditures with respect to household revenues has increased from 2.5% to 4.5% over the same period (Tirado et al., 2014).