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TEMPERATURE EFFECTS ON FIRMS' ELECTRICITY DEMAND: AN ANALYSIS OF SECTORIAL DIFFERENCES IN SPAIN

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Overview

Global warming, intermittent production, and efficient use of energy require of adequate demand response policies. The price inelasticity of electricity demand represents the main obstacle for developing adequate measures. A potential source of demand inelasticity is the temperature effect - the reaction of electricity demand to variations in temperature. Studies using aggregate data show that temperature-driven electricity demand is growing in most countries. Using disaggregated data by sectors, we analyze the sectorial breakdown of temperature effects on firms' electricity demand. In-depth knowledge of sectorial demand responses to temperature changes is fundamental for improved energy planning. If electricity consumption in a sector heavily reacts to temperature, "flattening" electricity demand will eventually become infeasible. Our findings indicate that in Spain firms' aggregate electricity demand is rather insensitive to temperature. However, there are marked differences among sectors, with the highest sensitivity found for firms in the service sector.

Methods

The effect of climate variables, temperature mainly, on electricity demand is widely known. The current paper focuses on sectorial breakdown of temperature-driven electricity consumption. Distinct responses of electricity demand to temperatures by residential, industrial, and service sectors are commonly assumed. The literature usually assumes electricity demand by industrial activities to not be affected by temperature. This generally accepted view stands in stark contrast to the scarcity of available studies on this topic, mainly due to problems of data availability. A deeper understanding of how sector electricity demand reacts to weather variables can help to disentangle sources of demand variability and demand price inelasticity. Advances in our knowledge about consumer behavior in electricity markets allow for designing more adequately oriented measures of short and long term energy planning. Electricity demand behavior by sectors can help to understand how demand response actions - like "time of day pricing schemes" or "interruptible tariffs" - affect aggregate and sectorial electricity demand.

For our analysis of sectorial temperature thresholds we employ a smooth transition model (STR) similar to the one by Moral-Carcedo and Vices-Otero (2005) and Bessec and Fouquau (2008).

Results

Our results show that firms' electricity aggregate demand is in general insensitive to temperature variations. Sectors that represent around 81% of all firms' electricity consumption do not display remarkable "heating needs". Therefore their electricity demand is relatively insensitive to low temperatures. With respect to the "cooling effect", we find a higher sensitivity. Sectors which show a significant effect of high temperatures on demand represent around 44% of total firms' electricity consumption. Most significant temperature effects are found in the service sector. In this sector it is most likely that electricity consumption is linked to final usages of heating and cooling. Demand for cooling on the other hand, is much more pronounced in sector 87:"Residential care activities," sector 93: "Sports activities and amusement," sector 59: "Motion picture, video and television program production", sector 94: "Activities of membership organizations", sector 86: "Human health activities", sector 96: "Other

personal service activities", and sector 47: "Retail trade". Apart from being more significant the "cooling effect" also shows a higher potential impact on total electricity demand. Our estimates reflect that significant "cooling effects" exist in sectors that individually represent more than 2% of total firms' electricity demand.

Once analyzed how sectorial electricity demand reacts to temperature changes it is important to know how evolves the aggregate response in order to disentangle what are the drivers of the inverted "W" shape of monthly firms' electricity demand. This shape seems to be inconsistent with traditional explanations based on temperature effects. There are remarkable differences both in monthly sectorial demand patterns and in their final impact on total electricity demand. Aggregate demand variability depend not only on how sectors individually react to changes in temperature. It also matter how react all the other sectors.

Conclusions

In this paper, we analyze the change in sectorial electricity demand driven by temperature variations. While electricity demand by households, as well as by some service sectors (e.g. the commercial sector), has been analyzed in detail, to the best of our knowledge this is the first work that provides detailed results by sectors; an analysis that we could carry out thanks to the availability of detailed data provided by REE.

Our results are in line with the generally accepted view regarding a higher sensitivity to temperatures in electricity demand of the service sector, and the absence of any significant response in industrial activities. However, according to our results there are significant differences in both the average sensitivity and total sensitivity at the sectorial level.

A high demand sensitivity to temperatures leads to a higher price inelasticity of electricity demand. This is why in-depth knowledge of sectorial demand responses to temperature changes is fundamental. Once sectorial differences in temperature effects have been assessed, the potential effects of energy planning measures can be addressed more adequately. In this paper we have also showed the relevance of the composition effect when analyzing the demand variability of electricity throughout the year.

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