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A General Maximum Entropy Econometric approach to model industrial electricity prices in Spain: A challenge for the competitiveness

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HIGHLIGHTS

- Electricity is a significant component of production costs of Spanish industries.
- Reducing industrial electricity prices is important for Spanish industry competitiveness.
- A General Maximum Entropy Econometric approach is used to estimate electricity price models.
- The models quantify the impacts of fuel costs on electricity prices for industrial consumers.
- The high fuel dependence affects competitiveness as it involves important effects on electricity prices.

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ABSTRACT

The *Spanish Integral Plan of Industrial Policy 2020* points out the energy cost containment as one of the priority actions to improve the competitiveness of industry. In fact, electricity prices for industrial consumers are of particular importance for international competitiveness, as electricity usually represents a significant proportion of its total energy costs.

In order to establish economic policies to reduce industrial electricity prices, it is important to analyze its determinants. Mainly, since the liberalization of the Spanish electricity industry, a wholesale electricity market is created where electricity price is determined by the short-term marginal cost (mainly the fuels) of the different electricity generation technologies.

This paper analyses how important are fuel cost- such as natural gas, coal and oil prices- in explaining the variations in Spanish electricity prices for industrial consumers by using a General Maximum Entropy Econometric approach. The obtained results suggest that imported fuel prices could affect competitiveness of manufacturing and other industries as it involves important effects on the level and stability of the electricity prices.

The promotion of clean technologies, the increase of the energy and resource efficiency of Spanish companies or the implementation of energy conservation projects at industrial sector become a way to reduce the vulnerability of Spanish industry competitiveness to electricity prices.

1. Introduction

The present economic-financial crisis, which has been happening in EU since 2008, has entailed important repercussions in the European Union member states and especially in the Spanish case. The Spanish industrial activity has reduced their contribution to GDP from 20.8% to 16.9% between 2000 and 2011 (Spanish Statistical Institute, INE). Moreover, the Spanish unemployment rate has increased from 13.9% to 21.6% in the same period (INE).

In this context, the development of a suitable industrial policy that supports a strong and competitive industry and that creates jobs emerges as a key concept. Although R&D investments are important for international competitiveness, another fundamental competitive strategy is the reduction of production costs to be competitive in prices. In fact, energy costs are a significant component of production costs for certain Spanish industrial activities. For example, basic industry (such as cement, metal or steel cases) is characterized by having great energetic costs which even triply labor costs. Thus, the *Spanish Integral Plan of Industrial Policy*

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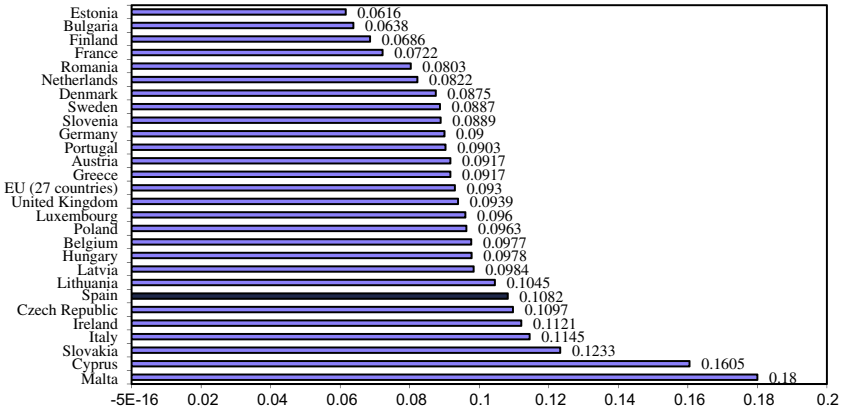

Fig. 1. EU-27 electricity prices for medium-sized industrial consumers (€/kW h). Year 2011. *Source*: Eurostat, Energy database [4].

2020 [1] indicates the energy cost containment as one of the priority actions to improve the competitiveness of industry in Spain.

Electricity prices for industrial consumers are of particular importance for international competitiveness, as electricity usually represents a significant proportion of total energy costs for the industry (with percentages standing between 48% and 54% of the total- *Spanish Energy Consumption Survey* 2001–2011, [2]). In that sense, *Spanish Energy Commission* [3] has expressed concern about the negative impact of high electricity prices on business competitiveness, in relation to most European countries (as it is shown in Fig. 1).

If potential increases in electricity prices may harm the competitiveness of Spanish industrial activity, it would be desirable to implement economic policies designed to reduce industrial electricity prices. In the present context of a liberalized Spanish electricity market, the quantification of cross-price elasticities plays a central role. Thus, it is useful to measure to what extent the price of electricity is influenced by the short-term marginal energy cost of the different electricity generation technologies. In general, changes in the prices of primary energy sources -such as natural gas, coal and oil- can affect directly to retail electricity prices, since generation costs are likely to be transmitted through the wholesale electricity market.

Although the wholesale electricity prices are mainly sensitive to variations on crude oil, coal and natural gas prices, one should expect that a price increase in the used fuel of the marginal generator should make its way to the final consumer bill[1].

Empirical literature about the competitiveness implications of energy costs and the impact of fuel cost on electricity prices have been based on different econometric and modeling tools. For example, [5] analyze emergent economies by means of input–output table methodology and obtain that the impact of oil prices involves an increase of energy costs between 10% and 12%. Therefore, it has influenced negatively in the competitiveness of such countries. Similar results are obtained in [6,7] by means of the study of the influence of oil prices on electricity prices. Their results show how uncertainties in oil prices cause volatility in electricity prices with the consequent negative impact on industrial production.

Moreover, [8] analyze the impact of different energy prices (from various carbon-prices regulations) of US energy-intensive industries and obtain that energy prices influence the competitiveness of these industries. They establish that the extension of these effects depends on their energy intensities, how energy is used in production activities, the vulnerability of every industry to foreign imports and the speed of technology development and technology adoption. Similarly, [9] study the impact of oil price uncertainty on the US industrial production by decomposing oil price volatility into permanent and transitory components. Their results show the importance of setting energy policies towards establishing short-term uncertainties in oil prices in order to promote a suitable industrial competitiveness. [10] analyze the implications of the oil prices on electricity prices in Malaysia, by means of GARCH models. They recommend adopting renewable and green technologies in order to reduce the volatility of electricity prices.

In a different fashion, [11] study the effects of energy prices on China's competitiveness by means of the real effective exchange rate as a proxy for international competitiveness and the application of a cross correlation function approach. Their results show the volatility of energy prices has significant implications concerning information linkages between the energy market and China's international competitiveness.

However, in contrast to the existence of studies in other countries, the empirical contributions about the study of impact of fuel cost on electricity prices in Spain are scarce. In fact, these studies analyze the impact of fuel cost on wholesale electricity prices but not at industrial end-users level. For example [12] by using a vector error correction model (VECM) and daily data from 2005 to 2009 found that gas and oil prices play a prominent role in the Spanish electricity price formation process. In the same way, [13] by applying VAR models to monthly series from 2002 to 2005 found that Spanish wholesale price of electricity is explained by the evolution of the natural gas price.

In order to contribute to the body of empirical literature in Spain on this matter, this paper analyzes how important are energy fuel cost variables in explaining the variations in Spanish electricity prices for industrial consumers by estimating price elasticities in the liberalized Spanish electricity market. The recent liberalization of the Spanish electricity market (January 1998) limits our sample data to 1998–2011, which prevents applying traditional estimation techniques (as Least Squares) based on central limit theorems. When dealing with small samples, an alternative estimation strategy that has been gaining popularity in the empirical literature is the Generalized Maximum Entropy (GME) Econometrics. It has been defined by [14] as "a sub-discipline of processing information from limited and noisy data with minimal a priori information on the data-generating process". This approach has its roots in Information Theory and builds on the entropy-information measure [15], the classical maximum entropy principle [16,17], which was developed to recover information from underdetermined models, and the Generalized Maximum Entropy Theory [18]. This paper investigates its possibilities in the estimation

[1] In fact, *Breakdown of electricity tariff data* from Eurostat shows that most of the variation in industrial end-users prices should be accounted by electricity generation costs (70% over the final price).

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