Utilities Policy xxx (2017) 1–16

Contents lists available at ScienceDirect

Utilities Policy

journal homepage: www.elsevier.com/locate/jup

Gas and electricity demand in Spanish manufacturing industries: An analysis using homogeneous and heterogeneous estimators

Cristina Peñasco [a, *], Pablo del Río [a], Desiderio Romero-Jordán [b]

[a] Spanish National Research Council (CSIC), Institute of Public Goods and Policies (IPP), C/Albasanz, 26-28, 28037 Madrid, Spain
[b] Universidad Rey Juan Carlos, Paseo de Artilleros s/n, 28032 Vicálvaro, Madrid, Spain

ARTICLE INFO

Article history:
Received 3 June 2015
Received in revised form
17 January 2017
Accepted 17 January 2017
Available online xxx

JEL-code:
Q41
Q55

Keywords:
Gas
Electricity
Demand
Manufacturing sector
Homogeneous and heterogeneous estimators

ABSTRACT

A comparative analysis of electricity and gas demand in the industrial sector over a long period of time appears to be absent in the literature. In fact, unlike electricity demand, natural gas demand in the industrial sector has not been well researched. Our paper aims to cover this gap. It analyses electricity and gas consumption patterns by the Spanish manufacturing sector, between 1995 and 2010. A novel and innovative quantitative approach based on, both, homogenous and heterogeneous estimators was used for this purpose. The results of the no-spurious estimations (the Augmented Mean Group Estimator) show that the price elasticity of gas demand is significantly negative and within the −0.44 to −0.48 range. In contrast, the price elasticity of electricity demand is not statistically significant. The income elasticities show the opposite pattern: those of natural gas are not statistically significant, whereas the income elasticities for electricity are statistically significant and within the 0.22 to 0.29 range. Compared to previous findings, our preferred estimation shows some variation regarding price elasticities of natural gas demand.

1. Introduction

Manufacturing industries account for nearly one third of world energy consumption, and demand in the sector has increased by 60% since 1970. Regarding energy sources, oil consumption by the industrial sector has fallen since the early 1970s in OECD Europe, due to switching to other fuels and generally improved energy efficiency. In contrast, consumption of electricity and natural gas (the focus of this paper), as well as their shares of total energy consumption, increased substantially over the 1978–2003 period (Andersen et al., 2011).[1]

End-use energy consumption by the Spanish industrial sector amounted to 21 million tons of oil equivalent (toe) in 2011, i.e. about one-fourth of total energy consumption in the Spanish economy. Natural gas (36%) and electricity (29%) account for about two-thirds of total energy consumption in industry (IDAE, 2012). In 2011, industry used 54% of the natural gas consumed and 30% of the electricity produced in Spain. The consumption of natural gas and electricity rose by 138% and 48%, respectively, in the 1995–2010 period. As a result, Spain has been increasingly dependent on gas imports. Two major apparent drivers of this consumption are energy prices and industrial production needed to meet a growing demand for industrial products. In this sense, the gross value added of the manufacturing sector has increased overall by 31% (in constant prices),[2] with significant differences across the sectors, whereas electricity and gas prices have risen by 31% and 38%, respectively.[3] The aim here is to analyse electricity and gas consumption patterns by the Spanish manufacturing sector, based on

* Corresponding author.
E-mail addresses: cristina.penasco@csic.es (C. Peñasco), Pablo.delrio@csic.es (P. del Río), Desiderio.Romero@urjc.es (D. Romero-Jordán).

[1] These changes in the manufacturing fuel mix can be largely attributed to three factors: changes in relative fuel prices, shifts in industry structure and technological processes, and the implementation of environ mental legislation that favors the use of cleaner fuels (Andersen et al., 2011).

[2] Due to the economic crisis, electricity and gas demand and industrial gross value added reached a peak in 2007, and experienced a reduction afterwards. However, in the last years of the period (2009–2010), the demand for electricity and gas has increased by 2.5% and 9.7%, respectively, whereas the gross value added in constant terms has risen by 1.9%.

[3] According to Eurostat, Spanish electricity prices for industrial consumers in 2010 were slightly above the EU-27 average (0.135 vs. 0.127 €/kWh, all taxes and levies included) whereas gas prices were below such average (0.0322 vs. 0.0369 €/kWh).

http://dx.doi.org/10.1016/j.jup.2017.01.005
0957-1787/

data for 11 industrial sub-sectors from 1995 to 2010. We use both homogeneous and heterogeneous estimators (allowing for cross sectional dependence) for this purpose. Analysis of the industrial elasticities of demand in specific countries is recommended. As argued by Iimi (2010), industrial energy demand appears to be country-specific and dependent on production technologies in the economy, and this is not generalizable. Several reasons make Spain an interesting case worth studying in this context. It is the second largest EU country, 5th in population, one of the largest economies in the world (13th), with one of the highest renewable energy penetration levels, several features that make it a distinctive electricity market[4] and good databases that allow the calculation and comparison of elasticities for electricity and gas demand in the industrial sector. Most relevant for the calculation of price and income elasticities of demand, as mentioned, is that the prices of electricity and gas have significantly increased in the analysed period. Gross Domestic Product (GDP) has also risen considerably during the period (by an accumulated 130%, compared to the EU28 average of 75%), with considerable ups and downs (maximum annual GDP growth rates of 5.3% in 2000 and 4.2% in 2006, and a minimum growth rate of −3.6% in 2009).

Factors influencing electricity and natural gas demand include price behaviour, the recession, industrial consolidation, electricity substitution, technological improvements, and environmental regulations (Pirog, 2011). When energy prices increase, companies can respond in different ways: (1) they can change their product mix toward less energy intensive products; (2) they may invest in new technology that is less energy intensive[5]; (3) they may be able to switch their energy input for a relatively cheaper fuel; or finally (4) they can reduce manufacturing output (Andersen et al., 2011; MIT, 2011).

From a public policy perspective, when implementing industrial and energy policies, policymakers should pay attention to industrial energy demand. In particular, the implementation and design of energy policies in the industry realm should take into account the response of electricity and gas demand to income and energy prices, which are affected by public policies. This information is also relevant for decision makers in industry.

Our paper contributes to the literature on several fronts (see the next section for a review). A comparative analysis on electricity and gas demand in the industrial sector over a long period of time appears to be absent in the literature. In fact, while there are some studies on electricity demand in the industrial sector, gas demand has not been well researched (Sánchez-Úbeda and Berzosa, 2007). According to Kani et al. (2013, p.149) "no major study has so far tried to estimate natural gas demand for the industry sector. This may be due to the fact that natural gas plays a minor role in providing the energy for industry sector in most of the countries." Second, and most importantly, homogenous and heterogenous estimators have not been used in the past to analyse the price elasticities of demand for gas and electricity in any country (to our knowledge). Finally, an analysis of gas and electricity demand in the industrial sector in Spain (and, thus, the comparison between each other) is needed. Regarding electricity, the only exception is Labandeira et al. (2012), who state that "there is almost nothing on Spanish industrial and commercial demand for electricity" (Labandeira et al., 2012, p. 628). We are not aware of any study on industrial demand for gas in Spain.[6] For our purposes, we use a wide array of estimators, homogeneous (traditional and based-GMM ones) and heterogeneous (including a set of estimators that allow for common shocks), and discuss their pros and their cons in estimating electricity and gas demand.

Accordingly, the paper is structured as follows. The next section discusses previous research in the realm of energy demand estimation, with a focus on the industrial sector. Our model is showed in Section 3. The data for our study are described in Section 4 and Section 5 provides the estimation strategy and the results. The paper closes with some concluding remarks and a discussion of policy implications.

2. Literature review

Following Andersen et al. (2011), econometric energy demand studies based on annual data face several challenges. Given structural variation across industry sectors and countries, reliance on homogeneous type estimators of demand could be inappropriate. Short time periods (i.e., the small number of time observations within each cross-section) also make individual regressions problematic. Among others, Maddala et al. (1997), Baltagi and Griffin (1997), Baltagi et al. (2000) and Asche et al. (2008) have demonstrated that individual cross-section regression models too often provide implausible estimates. For example, they have led to positive own-price elasticities, as well as larger variations between cross-sections than are implausible from an energy economic perspective. Although homogeneous model parameters provide a higher degree of freedom, they lead to a loss of information by imposing homogeneity across cross-sections and fail to include the potential structural variation among them. Typical homogenous estimators include the least squares, the fixed effects or the first difference estimators.[7] As shown in Table 1, studies on the estimation of industrial energy demand elasticities have used different homogeneous estimators.

The existing literature reveals that elasticities have a wide variation and are difficult to compare with one another. Of course, the analysed data and the estimation methods vary. However, particularly for industrial demand, it is difficult to find consistent evidence on price elasticities (Iimi, 2010). The range of estimates is too wide to agree on the norm. The wide variation suggests that industrial energy demand is country- and location-specific (Iimi,

[4] Spain is virtually an electricity island, with limited interconnection or trading with neighboring countries (about 3 per cent of electricity demand was imported in 2011). As a result, virtually all domestic electricity production has to be consumed within Spain, given that electricity cannot be stored. This fact, along with poor long-term planning, high growth of electricity demand at the start of the period, followed by large investments in two generation technologies (renewable and natural gas) and a substantial reduction of electricity demand since 2007, has resulted in the Spanish electricity system having significant excess electricity generation capacity. In 2009, installed capacity was around 93,000 MW, while maximum peak demand was only around 44,000 MW. Finally, Spain had accumulated a huge tariff deficit as a result of regulated prices being lower than the regulated costs (28,000 M€ in 2010, about 3% of GDP).

[5] In the gas sector, fuels are used to fire boilers and provide process heat. In the U.S., the former accounts for 60% of manufacturing gas consumption for energy uses, whereas process heat accounts for the rest (MIT, 2011). Some of the more promising technologies include combined heat and power (CHP), low temperature heat recovery, use of oxygen to supplement or replace combustion air, biomass integrated gasifier combined cycle, and municipal solid waste used to fuel generation or CHP (NPC, 2011).

[6] Studies on gas demand have been carried out in the Spanish context. For example, Sánchez-Úbeda and Berzosa (2007) built a model to forecast industrial end-use natural gas consumption, applying it to Spain. Gutiérrez et al. (2005) examined the possibilities of using a Gompertz-type innovation diffusion process as a stochastic growth model of natural-gas consumption in Spain. Honoré (2011) investigated the state of the Spanish gas market and its potential for growth. Federico (2010) provided an analysis of the Spanish gas and electricity markets. However, there is not an analysis of price elasticities or income elasticities of demand in those studies.

[7] There is a debate about the advantages of using heterogeneous estimators (Maddala, 1991; Maddala et al., 1997; Pesaran and Smith, 1995; Baltagi and Griffin, 1997; Baltagi et al., 2000; Asche et al., 2008).

Please cite this article in press as: Peñasco, C., et al., Gas and electricity demand in Spanish manufacturing industries: An analysis using homogeneous and heterogeneous estimators, Utilities Policy (2017), http://dx.doi.org/10.1016/j.jup.2017.01.005