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HOW FAR WE ARE FROM PRICE CONVERGENCE IN THE EU ENERGY MARKETS? A TWO-STEP PROCEDURE FOR DEFINING A COMPOSITE INDEX OF ELECTRICITY AND NATURAL GAS PRICES

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Overview
In the European Union, one of the five dimensions of the energy union strategy is to build a fully integrated internal energy market enabling the free flow of energy through the design of common energy market rules and the construction of cross-border infrastructures. In a fully integrated internal energy market, energy can be produced in one country and delivered to industrial and domestic consumers in another thus creating competition between energy suppliers. In turn, competition should force down prices and foster their convergence between countries leading to an increase in efficiency and welfare (Helpman & Krugman, 1985; Miljkovic, 1999).

At policy level, price changes and price dispersion are thus commonly regarded as important indicators of market integration. The European Commission periodically assesses the degree of convergence of retail electricity and gas natural prices for both household and industrial customers by using the relative standard deviation of the prices in individual Member States as a metric (see, for instance, European Commission, 2020a, 2020b). Extent academic research has been devoted to estimate whether the European single market has reduced average prices and price dispersion as we would expect from theory. Results remain mixed (Batalla, Paniagua, & Trujillo-Baute, 2019; Bower, 2002; Castagneto-Gissey, Chavez, & De Vico Fallani, 2014; Dreger, Kholodilin, Lommatzsch, Slacalek, & Wozniak, 2007; Robinson, 2007; Saez, Mochon, Corona, & Isasi, 2019; Telatar & Yaşar, 2020; Zachmann, 2008), thus suggesting the need for further research to measuring impacts on electricity and natural gas prices of EU energy policy. Different methodologies ranging from cointegration techniques to principal component analysis have been applied to analyse price convergence across European electricity and natural gas market. Actually, there are no econometric approaches allow a simultaneous analysis over time and space.

In light of this premise, the purpose of the article is to introduce an innovative two-stage methodology to provide policy makers with a tool for estimating price trends over time in the different countries of the European Union and analysing the price convergence process.

Methods
To analyse price trends over time in the different EU countries, we have firstly computed the purchase power parity (PPP) over time by means of the multilateral Country-Product-Dummy (CDP) price index (see Diewert, 2005; Rao & Hajargasht, 2016) across EU countries for each year. CDP is computed over the electricity and natural gas prices for
domestic and industrial consumers. We focus on this index as it represents the approach used by the International Comparison Program (ICP) at the World Bank. At EU level, the CPD index is employed to study the expenditure behavior of EU households and industries, while the OECD-Eurostat ICP program currently takes advantage of the Gini-Elteo-Kőves-Szulc (GESK) index (Rao, 2013). Then, the EU countries have been clustered according to the values of the CPD index over time, by using the hierarchical Ward method and the Euclidean distance of the PPPs. Finally, the Hodrick-Prescott filter has been applied to estimate the trend component of the PPPs for each country over time. All data are obtained from the official Eurostat statistics and refer to the period 2008–2018 for a total of 44 observations per country. The reference basket is composed of two commodities (electricity and natural gas) for two different type of users (domestic and industrial consumers), with the euro zone (EU-28) chosen as the base country for the study. Greece, Malta and Republic of Cyprus have been excluded from the analysis to avoid distortions, due to an excessive lack of information on energy and gas prices for private and non-private uses. The average national before tax prices paid for electricity and natural gas by medium size industrial consumers (respectively with annual consumption between 500 and 2000 MWh for electricity and with annual consumption between 10000 and 100000 GJ for natural gas) and household consumers (respectively with annual consumption between 2500 and 5000 kWh for electricity and with annual consumption between 20 and 200 GJ for natural gas) have been used.

Results
The methodology introduced in this work allows for the identification of four clusters:
- Cluster 1 (labelled as “Low-priced”) is composed of countries with a constantly below average CPD index and PPP;
- Cluster 2 (“Low average-priced”) includes countries with an average CPD index slightly below average CPD index and PPP;
- Cluster 3 (“High average-priced”) identifies countries with an average CPD index slightly above average CPD index and PPP;
- Cluster 4 (“High-priced”) comprises countries with a constantly above the average CPD index and PPP.

From Figure 1, Bulgaria, Estonia, Finland, and Romania belong to the “Low-priced” cluster, while Denmark, Germany, Ireland, Italy, Portugal, Spain and Sweden are included in the “High-priced” cluster. The remaining fourteen nations: Croatia, Czech Republic, France, Hungary, Latvia, Lithuania, Poland, UK – on the one hand – Austria, Belgium, Luxembourg, Netherlands, Slovakia, Slovenia – on the other hand – form average priced-markets, respectively belonging to Cluster 2 and 3. On a temporal perspective, from 2011 to 2018 Ireland and Spain show a constant increase in the level of CPD index and PPP, while Romania, Estonia and Bulgaria always exhibit the lowest price index levels in the time span 2008-2018. Interestingly, while Luxembourg, Hungary, Netherlands, and Slovakia have experienced a progressive contraction of both electricity and natural gas prices in the whole period, France, UK, Denmark, and Sweden show, especially in the last two years, an opposite trend.

The four clusters so identified are capable of capturing also the group-specific interdependence of electricity and gas natural prices and quantities, over the time span considered. For instance, in all the market a positive correlation exists across energy consumed by households and transport, services, and industries.
Similarly, a positive correlation exists between the consumption of electricity and natural gas for services and industries.

*Figure 1 - Map of the clusterisation*

By applying the Hodrick-Prescott filter for estimating cyclical and trend component of the PPP for each country and cluster (see Figure 2), our findings show that all clusters in 2013 exhibit a within cluster convergence. However, during the following years it seems that a progressively slight disconcertedness of the CPD and PPP trends is revealed. At the same time, both the average trend of CPD and PPP of clusters 1, 2 and 3 highlight a progressive convergence.
Conclusions
The article introduces a novel two-step procedure to analyse the level of electricity and gas natural prices in EU Member States, enriched with the extraction of the trend component via the Hodrick-Prescott filter. As such, the proposed approach can support regulators in comparing trends in electricity and natural gas prices and in exploring convergence patterns in energy prices also at the light of the economic integration of the internal energy market. Notwithstanding significant effort in market harmonization and integration, our findings suggest that electricity and natural gas prices have experienced limited reductions. Moreover, country-specific factors continue to play a major role in determining both the absolute level of retail prices and their trend over time.

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