THE ECONOMICS OF DAILY NATURAL GAS DEMAND IN FRANCE AND IN THE UK

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Overview

Because of the rise of intermittent renewable energy sources of electricity, natural gas-based thermal generation is increasingly used as a back-up technology. The output of these thermal plants is highly variable and uncertain so is their consumption of natural gas. For natural gas infrastructure operators (TSO), this evolution adversely raises the cost to operate and balance the pipeline infrastructure as it imposes to increase the gas pressure within the pipeline system in order to maintain a suitable amount of "linepack". The application of efficient load forecasting techniques is expected to substantially lower that cost. Therefore, European regulators are increasingly requiring TSOs to improve the performance of their load forecasting techniques. In some countries (e.g., the UK), a dedicated incentive regulatory mechanism has even been implemented and a similar policy is currently examined in several countries (e.g., France).

Against this background, TSOs have begun to heavily invest in the development of modern forecasting tools. Though their work is not public, they are reputed to have implemented advanced nonlinear forecasting techniques which have provided substantial improvements. Yet, significant load forecasting errors still prevail.

Building on the seminal work of Forbes & Zampelli (2014), our approach to load forecasting begins by recognizing that the informational content of day-ahead prices. In case of efficient wholesale markets, it should thus be possible to model the quantity of natural gas demanded in a given day using two variables: the day-ahead price of natural gas (to model the reaction of both industrial users and households) and a spark ratio (i.e., the day-ahead price of electricity divided by the day-ahead price of natural gas) reflecting the economics of gas-based thermal generation.

The ambition of this paper is two-fold as it: (i) shows that the estimation of a simple specification can be sufficient to challenge the performance of the TSOs' forecasting models, and (ii) documents the short-run and long-run reaction of the daily consumption of natural gas to both the natural gas and electricity day-ahead prices by measuring the price elasticities.

We detail an application to the cases of major European gas markets: the two load balancing zones in France (North and South) and the 12 distribution zones that exist in the UK.

Methods

We consider the period covering 2014-2017 and assemble a data set comprising natural gas consumption data and daily transaction price data for day-ahead wholesale natural gas and wholesale electricity for peak periods traded during working days. As a learning-validation procedure will be used, our dataset is divided in two parts.

Our econometric methodology is based on the Autoregressive Distributed Lag (ARDL) modelling approach (Pesaran et al., 1997) and the associated bounds testing approach which is aimed at testing the long term relationship between the volume of natural gas demanded and its drivers. The ARDL approach allows to treat the case where time series do not have the same properties of stationarity.

Results & Conclusions

Our results are five-fold. First we deal with model hypothesis on variables. All variables have different integration orders but in each country, they are at least I(1) that ensures ARDL estimation choiceinstead of VECM estimation. Moreover that ensures the convergence of bound testing cointegration method.

Secondly, we check the endogeneity of the regressors in the model. Wu-Haussmann tests confirm non-endogeneity of day-a-head price and spark ratio that's the reason why we can use day-a-head price as regressor in each country to forecast the day-ahead load.

Third, in each case, we find that's a simple ARDL specification verify all the diagnostics tests, all tests about stability (CUSUM and CUSUM SQUARE), heteroscedasticity (ARCH test, Box-test) and autocorrelation (Box-test) are highly significant.

Fourth, the bound testing procedure reveals the existence of a long run relationship between the load and the day-ahead prices in each country and each zone. This findings allows us to contribute to the literature by providing for the first time, a measure of the price elasticity of the demand for natural gas which is derived from daily data.

Finally, we have compared the forecasting performance of our models to those of the TSOs. Our findins consistently indicates that our simple ARDL approach provides significantly improved forecasts. This is also the case in the UK despite the presence of an adapted incentive policy which is supposed to provide a strong incentive for the TSO to invest time and efforts into that issue.

References

Bernstein, R., Madlener, R., (2015). Short- and long-run electricity demand elasticities at the subsectoral level : a cointegration analysis for German manufacturing industries. Energy Economics.

Forbes, K., Zampelli, E., (2014).Do Day-Ahead Electricity Prices Reflects Economic Fundamentals? Evidence from the California ISO. The Energy Journal, 35(3).

Kofi Adom, P., Bekoe,W., (2012). Conditional dynamic forecast of electrical energy consumption requirements in Ghana by 2020: A comparison of ARDL and PAM. Energy.

Pesaran, M., Shin, Y., (1997), An Autoregressive Distributed Lag Modelling Approach to Cointegartion Analysis. Chapter 11 in Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium, Strom S (ed). Cambridge University Press: Cambridge.

Pesaran, M., Shin, Y., Smith, R., (2001). Bounds Testing Approaches to the Analysis of Level Relationships. Journal of Applied Econometrics, 16: 289-326.