An Integrated European Electricity Market?

by Dr Spyros Xanthopoulos-Sisinis, Research Fellow at FRC/MSL

Since the early 90's, European electricity markets have been experiencing a gradual but steady transition from government regulated monopolies to open markets. Deregulation in European Union (EU) electricity markets formally commenced with the 96/92/EC electricity directive. The new legislation was aimed at promoting competition in generation and distribution of electricity and aligned with EU's main objective: the creation of an internal competitive electricity market. Legal and functional unbundling of transmission and distribution system operators was set on a new track with 2003/54/EC EU's electricity directive, aimed at ensuring a non-discriminatory access to a common electricity network.

Despite the legislative adoption of the aforementioned directives by the majority of EU countries, the only reliable measure of the extend of European energy markets integration is that which relies on practical evidence. This question is all the more interesting in light of recent evidence that electricity prices posses long memory, i.e. have fractional roots (see Hosking 1981 for a definition). Surprisingly, the integration of European electricity markets has received limited attention and the few relevant publications e.g. in Robinson (2007), Boisseleau (2004) and Bower (2002), do not account for the fractional nature of the original series.

In this study, we examine the presence of statistically significant relationships, i.e. of cointegration, between electricity prices traded in different European electricity exchanges. By considering daily electricity prices over the past five years from the major European electricity exchanges[1], we provide evidence for fractional cointegration between groups of countries, while we identify which countries are still operating as isolated markets. The results presented in this study can help discern whether European electricity wholesale prices tend to follow the law of one price and support further policy evaluation studies. Other interesting areas of application are in modeling and forecasting spot electricity prices and arbitrage and risk management in energy markets.

Initially, we attempt to estimate the integration order of European electricity prices using three traditional unit root tests. In order to strengthen our inference on the stationarity of the observed series, we selected tests representing both types of null hypothesis: the Augmented Dickey Fuller (ADF) test (Dickey and Fuller, 1979) and the Philips Perron (PP) test (Phillips and Perron, 1988), where the null is the presence of a unit root and the Kwiatowski, Phillips, Schmidt and Shin (1992) or KPSS stationarity test, where the null is one of stationarity. They yield however conflicting results, thus hinting that European electricity prices follow fractionally integrated processes.

The long memory property of European electricity prices is established via a refined version of the semiparametric Local Whittle (LW) estimator proposed by Kuncsh (1987) and advanced by Robinson (1995). The Exact Local Whittle (ELW) estimator proposed in Shimotsu and Philips (2005) overcomes the main shortcomings of the LW estimator, namely when the observed series is non-stationary, or when the fractional integration order lies in the interval , or when it has a polynomial time trend of order with . It also overcomes the need for data differencing or tapering when the series is non-stationary and the estimator's asymptotic properties are proven for a wider range of differencing parameter values.

The unit root tests and the ELW estimator results suggest that European electricity prices are fractionally integrated. In particular, Austrian, French, German and Dutch electricity prices possess marginal stationary long memory behavior, while Spanish and UK electricity prices are non-stationary fractionally integrated processes. Nord Pool prices clearly follow a covariance non-stationary, yet mean reverting process. The presence of fractional cointegration between the European energy exchanges is then examined using a Narrow Band Least Squares (NBLS) estimator as in Christensen and Nielsen (2006B). For a series of variables to be fractionally cointegrated, the integration order of the dependent variable in the cointegration equation should be equal to the integration order of at least one of the independent variables. Hence, the integration order of the cointegration residuals is estimated and then is compared to the integration order of the observed series.

The results show that an I(d) - I(0) relation can only be supported for the case of Germany and Austria, where the residuals follow a stationary white noise process. For the rest of the cointegration subsystems, the integration order of the residuals varies from 0.21 to 0.58, indicating either that there is no cointegration or that the strength[2] of the cointegrating relationship is not as high as in the case of Germany and Austria.

France, Netherlands, Germany and Austria belong to the central block of the "Union for the Co-ordination of Transmission of Electricity" (UCTE), an association of transmission system operators in continental Europe. The results show a reduction in the long memory parameter of the residuals, which is in accordance with UCTE's effort towards the creation of internal sub-markets within the European area. Long run equilibrium among these countries may be attributed to the strong interconnections between them.

Spain's effort to create an integrated electricity market with Portugal, along with its geographical distance from Central Europe, justifies the lack of a long term relationship in the electricity prices of Spain with the rest European markets. The lack of fractional cointegration is obvious in the subsystems of Spain - Austria, Spain - France, Spain - UK. The strength of the cointegration relationship for the remainder subsystems (Spain - Germany, Spain - Netherlands) is quite low, so as to robustly support a fractional cointegration relationship.

Footnotes

1. The European electricity exchanges considered are: United Kingdom's UKPX, Nord Pool (linking together Norway, Sweden, Finland and Denmark), Germany's EEX, the French Power Next, the Dutch APX, Austria's EXAA and Spain's Omel.
2. The strength of a cointegration relationship is measured by the difference (Robinson and Marinucci, 1998).

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