Electricity retail competition: the case of the UK

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Abstract: The objective of liberalising electricity supply was to create competitive retail markets where asset-light suppliers would compete on price. This paper explores the quantitative and dynamic relationship between domestic retail prices and the wholesale price since one would expect a symmetric pattern with a stable and low retail margin. In this article, taking the UK market for analysis, a time-series approach is applied to calculate the extent and timing of pass through between wholesale and retail price variations. The preliminary results indicate that the impact effect and long-run effects from the wholesale to the retail market is quite low.

Keywords: electricity supply; UK; retail market; competition; time-series; causality; long-run response.


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1 Introduction

The main objective of liberalising electricity supply was to create competitive decentralised retail markets where asset-light suppliers would compete on price (Boroumand and Zachmann, 2012). In countries which have made serious attempts to liberalise their electricity industries, often the development of retail competition has failed to give the expected results, particularly for residential and commercial consumers. In the UK,
residential retail competition does not work effectively for the benefits of consumers, as shown by the British regulator’s inquiry of 2008 (Ofgem, 2008) and its subsequent radical propositions to enhance retail market functioning (Ofgem, 2011). Several studies on the Nordic countries (Johnsen and Olsen, 2008; Olsen et al., 2006; Littlechild, 2006) also point towards difficulties experienced in Swedish and Finnish retail markets due to lack of consumers’ commitment as well as market structure. These are set in stark contrast to the performance of the Norwegian retail market.

The literature on electricity competition can be classified in two categories: an empirical literature on the social efficiency of retail competition (Green and McDaniel, 1998; Joskow, 2000; Littlechild, 2000; Defeuilley, 2009; Price, 2004, 2008; Price and Wilson, 2007) and a theoretical one on models of imperfect competition (Bushnell et al., 2008; Green, 2004).

On the empirical side, the issues of market power and market performance are studied through the level of pass-through of wholesale prices’ variations to retail prices (Johnsen and Olsen, 2008; von der Fehr and Hansen, 2010; Ofgem, 2008; Giulietti et al., 2010). This research and preliminary evidence belongs to this stream. The research thus far shows empirically the low performance of retail competition in the UK. In this study, taking the UK for analysis, a time series approach is applied data collected over the time period 2003 through August 2006. While the methods applied in order to achieve preliminary results are relatively straightforward, it is believed that the models and estimated model coefficients suggest implications providing the basis for further research.

2 Data and econometric procedures

Data are collected on retail and spot prices for the UK. Monthly data on the retail bill for a standard consumption of 4 MWh per year are obtained from the UK Consumer’s Association (Consumerfocus.org) based on the current prices of the six main suppliers (controlling 99% of the market shares). The data have been collected for the three major payment methods (direct debit, standard credit, prepayment) across the fourteen regions. Customer bill is weighted by payment method and market share. Data on the spot price, considered as a reasonable proxy for the wholesale price (Giulietti et al., 2010) as taken from Marex Spectron (one of three major energy data information companies). In addition, we have a series of day averages of spot baseload from the UK Power Exchange (UKPX), collected from Datastream/Thomson Reuters). The period under consideration is January 2003 to August 2009 and monthly spot prices are computed on a monthly basis as mean averages of underlying daily data. Our data starts from January 2003, given that retail prices were regulated until April 2002 for suppliers in their regional zone (Henney, 2006). In the UK, the first year of full price deregulation is 2003.

These time series for the UK retail bill and spot price are plotted in Figures 1 and 2, respectively.
The data plots lead one to suspect that neither series is stationary. Descriptive statistics are shown in Table 1.
Table 1  Descriptive statistics, monthly, January 2003 to August 2009

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of Obs.</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>SpotPrice</td>
<td>80</td>
<td>37.35</td>
<td>19.26</td>
<td>14.81</td>
<td>99.74</td>
</tr>
<tr>
<td>RetailBill</td>
<td>80</td>
<td>390.36</td>
<td>86.85</td>
<td>277.74</td>
<td>544.44</td>
</tr>
</tbody>
</table>

In order to gain insight, the series are divided into two segments of $n_1 = 39$ and $n_2 = 41$. Based on straightforward statistical tests of differences between means and variances both series exhibit pronounced increases in both mean and variance at any reasonable confidence level. However, as indicated by the data plots, the patterns of the series differ significantly with the spot price series exhibiting a cyclical pattern and the retail bill series increasing monotonically over the first $n_1$ observations and according to a discontinuous or step-wise pattern over the $n_2$ sub-period.

3  Preliminary empirical results

Prevalent issues in estimating models such as those applied in this paper are those of endogeneity and omitted variables. In this case endogeneity refers to the case in which there is reverse causation from the dependent variable to one or more of the explanatory variables. Following Granger (1969) a variable $x$ is said to Granger cause another variable $y$ if past values of $x$ help predict the current level of $y$ given all other appropriate information. Theoretically, two variables may be contemporaneously correlated by chance, but it is unlikely that the past values of $x$ will be useful in predicting $y$, given all the past values of $y$, unless $x$ does actually cause $y$. If $y$ in fact causes $x$, then given the history of $y$, it is unlikely that information on $x$ will help predict $y$. Granger causality is not identical to causation in the classical philosophical sense, but it does demonstrate the likelihood of such causation or the lack of such causation more forcefully than does simple contemporaneous correlation (Geweke, 1984).

In the former case, the direction of causality may not be clear, and in the second, although there could be a correlation it might simply be due to a third omitted variable that influences both the explanatory and dependent variable. If instead the classical regression conditions hold true, we can give the regression equation a causal interpretation. The explanatory variables will be exogenous or not caused by the dependent variable $y$ and there will be no omitted variables correlated with the explanatory variables.

Applying Granger causality tests can be useful for testing for causality given some assumptions (Granger, 1969). Admittedly, theory is of paramount importance in determining the endogeneity of variables and ensuring that there are no confounding omitted variables (Heckman, 2008). Nevertheless, in this paper Granger causality tests are applied and the issue of fixed effects due to seasonality is considered.

The autocorrelation (ACF) and partial autocorrelation functions (PACF) for the data series are estimated (Granger and Newbold, 1986). As might reasonably be expected based upon Figures 1 and 2, the autocorrelation functions (ACF) for the UK spot price and retail bill series show significant autocorrelations at high order lags and the partial autocorrelation functions (PACF) show significant values at lags one and two. The ACF shows significant values at long lags, while PACF exhibits a significant value at lag 1. The clear indication is that the data series are non-stationary, and hence, are transformed
by first-differencing in order to achieve stationarity. The autocorrelation and partial autocorrelations do not indicate the presence of systematic behaviour such as seasonality, although based on the recommendation of an anonymous referee, the results from additional testing are reported below.

**Figure 3** Period-to-period percentage changes, UK retail bill and spot price, monthly, January 2003 to August 2009

**Figure 4** Autocorrelations of period-to-period percentage changes, UK retail bill and spot prices, monthly
For purposes of this paper, to achieve stationarity and facilitate interpretability period-to-period, percentage changes are computed for the retail bill and spot price series. The transformation also addresses the well-known issue of spurious correlations arising from estimation on price levels. The transformed data are shown in Figure 3. Figures 4 and 5 show the autocorrelation and partial autocorrelations for the period-to-period percentage changes. The ACF has a significant value at lag 1 and the PACF decays sinusoidally although the PACF is quite noisy after lag 20. The Phillips-Perron test for a unit root leads to rejection of the null hypothesis, i.e., that the variable contains a unit root.

Granger causality tests (Granger, 1969) on the transformed UK series indicate the significance of the one-period lagged retail bill series on itself. There is no evidence that the transformed spot price series is causally related to the retail series.

The model to be estimated is given by
\[
\Delta \%\text{RetailBill}_t = \alpha + \phi \Delta \%\text{RetailBill}_{t-1} + \beta \Delta \%\text{SpotPrice}_{t-1} + \varepsilon_t
\]
and
\[
\varepsilon_t = \rho \varepsilon_{t-1} + \eta_t, \quad \eta_t \sim N(0, \sigma^2).
\]

The variables are defined to be consistent with the discussion above and the model specification is well-known in economics and finance as a lagged dependent variable (LDV) model, or more specifically, 1) is a restricted form of the autoregressive distributed lag (ADL). The specification above implies an infinite geometric lag on the variable SpotPrice based upon application of a Koyck transformation. A more detailed discussion of the infinite geometric lag is provided by Judge et al. (1985).

The assumption of first-order serial correlation is taken a priori and the model is estimated using ordinary least squares. In the presence of autocorrelated residuals, it is well-known that the ordinary least squares estimates are biased and inconsistent. In order
to test for the presence of serial correlation, Durbin’s h-statistic is calculated. Under the null hypothesis of no autocorrelation the estimated $h = .137$ indicating the absence of serial correlation.

Table 2  
<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-value</th>
<th>p-value</th>
<th>Adj-R$^2$</th>
<th>$\chi^2$ (Durbin-h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta%$RetailBill$_{t-1}$</td>
<td>.391</td>
<td>.107</td>
<td>3.67</td>
<td>0.00</td>
<td>.130</td>
<td>.137</td>
</tr>
<tr>
<td>$\Delta%$SpotPrice$_{t}$</td>
<td>.003</td>
<td>.010</td>
<td>.25</td>
<td>0.81</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The ACF of the residuals variable is shown in Figure 6, indicating the series is essentially white noise. Results in Table 2 indicate that for the UK only the lagged percentage change in RetailBill is significant and, in fact, there appears to be no empirical relationship with the transformed variable in the SpotPrice variable. Under the null hypothesis of no serial correlation, there is no evidence that the residual series is other than white noise.

Figure 6  
Autocorrelations of residuals, monthly

In order to further address the issue of possible systematic behaviour in the residuals owing to an omitted seasonal factor, an indicator variable was introduced into the model. The results are shown in Table 3 indicating that the variable December is insignificant by any reasonable standard.

Table 3  
<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-value</th>
<th>p-value</th>
<th>Adj-R$^2$</th>
<th>$\chi^2$ (Durbin-h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta%$RetailBill$_{t-1}$</td>
<td>.388</td>
<td>.108</td>
<td>3.61</td>
<td>0.00</td>
<td>.119</td>
<td>.107</td>
</tr>
<tr>
<td>$\Delta%$SpotPrice$_{t}$</td>
<td>.003</td>
<td>.011</td>
<td>.23</td>
<td>0.82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>December</td>
<td>−.294</td>
<td>.832</td>
<td>−.35</td>
<td>0.73</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Further interpretation of the results shown in Table 3 suggests that the impact, or one-period effect, of the $\Delta \%\text{SpotPrice}$ variable on $\Delta \%\text{RetailBill}$ is very small (and statistically insignificant). In this case, the implied long-run response is on the order of .01. The median lag in this case (the fraction of the adjustment completed is .5) is approximately .3. So, the extent of the impact is very small, and for the most part, it plays out over a very short time interval. Autocorrelations of the residuals from the estimated regression are shown in Figure 6.

4 Conclusion

The empirical analysis in this research has considered the quantitative and dynamic relationship between the retail and wholesale prices for electricity in the UK. The focus of this preliminary study is to understand competitiveness based upon a relatively simple, but statistically valid model. The results above indicate that the impact effect and long-run effects from the spot or wholesale to the retail market is quite low. It seems that the primary driver of the retail price in the UK market is the previous period’s observation(s) or trend. This research presents preliminary results and future research will analyse more extensive comparative data sets both over time and national markets.

Specifically, future research must consider alternative time series structures for the series in question. In this regard, both it is reasonable to consider applications of transfer function models to address the apparent changes in the underlying structure of the data over the later months of the sample period. Further, volatility models such as GARCH (Nelson, 1991; Engle, 2002) should be entertained.

Perhaps most important, and methodological issues aside, future research, will compare the levels, speed, and timing of pass-through of wholesale prices to retail prices for the UK relative to other countries such as Norway as such markets are considered traditionally as mature and competitive (Henney, 2006). The extension of our study will compare the UK with results for other markets. It is thought that comparative results will clarify differences in competitive dynamics leading to subsequent policy remedies.

It is thought that comparative results will clarify differences in competitive dynamics leading to subsequent regulation remedies to prevent any exercise of collective market power through tacit collusion. With no proper price competition, the contribution of electricity retail markets to the global performance of the electricity industry will remain uncertain.

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