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Abstract

The opening up of the UK residential electricity sector in 1999 prompted several studies of the impact this had on both the level and structuring of retail charges, and on incumbent players' market power. Drawing on observations of regional tariffs for the month of January 2004, this paper supports previous conclusions based on simulated retail charges, looking at the response of real tariffs to distribution and transmission costs, customer density, and the length of low voltage underground circuit. We also investigate whether vertically integrated suppliers have a particular effect on charges *ceteris paribus* the effect of cost drivers and supplier-related factors.

Keywords: Energy Competition, Retail Pricing, Vertically Integrated Firms

JEL Classification:C31, L22

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1. Introduction

The GB residential electricity market was opened to competition in May 1999. This had an immediate impact on the level of tariffs and services offered to consumers. The wave of mergers and acquisitions which followed raised concerns about the potential detrimental effect on end-customers. Although much research has been devoted to switching behaviour (Giulietti *et al*., 2006; Waterson, 2003; Ofgem, 2001, 2002, 2003), third-degree price discrimination and incumbents' market power (Otero and Waddams Price, 2001), little information is available about the effect of ownership structures on tariffs.

Oligopoly models show that the proposition that a merger enables firms to exploit economies of scale is not convincing if the merger does not also generate technical synergies. These synergies would lead to lower charges to customers (Spector, 2003; see also references herein). A study by Azzam and Rosebaum (2001) which considers the link between efficiency to concentration points out however that it is difficult to discriminate empirically between collusion and cost-efficiency as variables relating to price and profitability. The retail electricity market is a case in point, as high switching costs favour collusive behaviour, thus maintaining high prices.

Using 2002 price data Salies and Waddams Price (2004) examine similarities between the effects of brand coefficients on retail electricity prices within existing ownership groups but find that evidence of this is weak. Relying on tariffs levels from January 2004, the present paper contributes to the discussion by highlighting the effect of mergers on tariffs in a more efficient way. We test for the specific average effect of several ownership groups on regional electricity retail charges after controlling for cost drivers, economies of scale and customer density. Particular attention is given to the effect of the creation of EDF Energy, the merged London Electricity and SEEBOARD group of companies. In broad terms, we conjecture that if technical synergies exist between distribution networks owned by EDF Energy (situated in contiguous regions: London, East and South-East England), they should result in lower prices.

This paper is structured as follows. Section II briefly reviews the changes in ownership structures that occurred in the GB electricity sector between May 2002 and January 2004. We focus on the probable effect of these changes on the degree of competition and remaining incumbents' market power. We then introduce data, an econometric model and the hypotheses to be tested in section III. Results are given and discussed in section IV, before the conclusion in section V.

2. Changes in market structure

The ownership structure of each supplier is summarised in Table 1 compared with that of April-May 2002, being the period analysed by Salies and Waddams Price (2004). A more detailed picture of the ownership structures of residential distributors and suppliers in GB as at January 2004 is given in the **Table 4** (see also Electricity Association, 2003a, b). At the intersection of any given row and column one can see whether a supplier (row) is an incumbent in the distribution region (column). A supplier may not be present in the selected region, as is the case for Basic Power.

Concentration increased from April 2002 as a result of acquisitions, with at the most five ex-Public Electricity Suppliers and three new entrants in most areas, in addition to internet and other suppliers (ex-Public Electricity Suppliers, hereafter "ex-PES", are also known as Regional Electricity Companies). Almost all suppliers operate in the 14 distribution regions that make us England, Scotland and Wales. For reasons unknown to the authors, Basic Power was not operating in Scotland at the time of the study, which remains the case.

In April 2004 Scottish Hydro Electric-Southern Electric (SSE) acquired Atlantic Electric and Gas. Powergen purchased TXU's British generation and retail operations. These mergers raise competition concerns although they may have different detrimental effects given that they involve firms with significantly different market shares. A merger between two firms, each with relatively high market share, may have less impact on competition than one in which a large supplier merges with a smaller rival (RBB, 2002). The magnitude of the coefficient applied to the ownership group dummies in comparison with the coefficient of other groups will help us to test the data for particular merger effects.[1]

3. Data and econometric model

The retail charges pertain to 14 regions, with up to eight brand names per region. We consider here a single payment method (standard credit) at three levels of consumption. The distribution charges were taken from distributors' published statements of charges for connection to and use of the distribution system (Ofgem, 2004). Constituting 15-30% of a customer's final bill, these vary across the distribution regions according to the charges levied by the local distribution company, but are levied in the same manner to all suppliers using that distribution network. Generally the tariffs have two components: a charge per consumer and a charge per unit of electricity carried. We note that prepayment distribution charges differ from credit and direct debit charges.[2] Transmission charges form approximately 13% of the invoice and vary from region to region. Charge levels are taken from the National Grid Transco web site (see National Grid Transco, 2003), and are those levied for the period 16:00 hours to 19:00 hours. Descriptive statistics are shown in **Table 2**.

For each level of consumption q = 1650, 3300, and 4950 kWh, we estimate the following model:

(1) $$c_{rj}(q) = \alpha_1 d_r(q) + \alpha_2 t_r(q) + \alpha_3 n_r + \alpha_4 u_r + \alpha_5 i_{rj} + \sum_g \alpha_{6g} o_{gj} + \varepsilon_{rj}$$

where indices *r* and *j* denote distribution region and supplier, respectively. The payment method is standard credit. "(*q*)" specifies variables the value of which varies with *q*.[3] In addition:

c_{rj} = retail charge in region r from supplier *j*

d_r = distribution charge in region *r*

t_r = transmission charge in region *r*

n_r = total number of distribution customers per km^2 in region *r* (density)

u_r = length of underground circuit in region *r*

i_{rj} = 1 if supplier *j* is the incumbent in region *r*; 0 otherwise (incumbency dummy)

o_{gj} = 1 if supplier *j* belongs to ownership group *g*; 0 otherwise (group dummy)

We estimate three regression equations, one for each simulated level of annual demand, relating retail charges to the cost elements which we could identify, to market characteristics and to incumbency and group dummies.

Salies and Waddams Price (2004) estimated a model similar to (1) with brand instead of group dummies. Brand dummies capture any effect of suppliers reflected in tariffs (including costs of purchasing electricity). Our model gives us an opportunity to test whether suppliers that are not vertically integrated with other market participants tend to price less compared with integrated suppliers. In this model we replaced brand dummies with fewer group dummies that measure the impact on retail charges of the various ownership groups present in the market at the time of the analysis. There are five mutually exclusive ownership groups: Powergen, Scottish Hydro Electric and Southern Electric, Scottish Power, EDF Energy, and Innogy, plus the three non-ex-PES companies, as listed in **Table 1**.

Given the findings of Salies and Waddams Price (2004), we expect costs variations across regions to be closely mirrored in tariff variations (α_1 to be close to 1, and α_2 not exceeding one third, reflecting the shorter consumption period to which transmission charges correspond). We allow for both the number of customers and the distribution area using a ratio of the two. It is expected that denser (urbanised) areas allow suppliers to reduce per-customer marketing costs for a given network size, which would be indicated by a negative value for α_3. The length of low voltage underground circuit is used as a proxy for the size of the network. Underground circuit length has a very close correlation to the number of distribution customers (the correlation coefficient equals 0.88). Its effect on charges shall be measured by α_4. A negative value for this coefficient would more generally indicate economies of scale.

The additional power of incumbents (the ex-PES), who had retained a market share of between 50% and 85%, would be reflected in higher tariffs and a positive coefficient for the incumbency dummy, α_5. A positive and significant value for this coefficient may reflect the positive costs of switching from one ex-PES to another.

Using data from April 2002, Salies and Waddams Price (2004) test for heterogeneity between suppliers by examining the significance of brand dummy coefficients. Here, we test the hypothesis of whether vertical integration has a relatively significant effect on charges using α_6. Unlike the previous study which relied on signs of the estimated coefficients on brand dummies, the present analysis shows some improvement as it statistically tests for the significance of group dummy coefficients; group dummies replace brand dummies. We note that our model may be seen as a constrained version of a model with brand dummies.

We have not included a constant; thus, no base group is considered. This allows us to avoid near-colinearity problems and vacuous interpretation of the constant. Following the Salies and Waddams Price (2004) we estimated a two-equation seemingly unrelated regression equation (SURE) model for standard and direct debit tariffs. We only report results of the standard credit equation.

As there is a possibility of non-constant residual variance within each equation resulting from the spatial dimension of our data, we tested for conditional heteroskedasticity of unknown form within each equation using White's (1980) test. We reject homoskedasticity at the 5% level of significance in the direct debit equation at 1650kWh. We may interpret this result as a stronger attempt from supply businesses to differentiate their tariffs in this market. As will be shown later, this result shows regional incumbents still enjoy market power, particularly in the direct debit market where most switching has occurred. The model's coefficients are reported in **Table 3**.

4. Results and discussion

First we consider the responses of retail charges to distribution and transmission charges. As expected, the coefficient on distribution charges is significantly different from zero at the 5% level of significance. If we assume a 95% confidence interval centred about one, distribution costs are almost fully passed on to customers, except in the direct debit and prepayment equations at 1650kWh. With regard to transmission charges, our results are also similar to Salies and Waddams Price (2004), with a coefficient about one third due to the short consumption period to which these charges correspond (peak period from 16:00 to 19:00 hours). If in each equation at 3300kWh we multiply by three the estimated coefficient on the transmission variable then we obtain a value that ranges from about 0.7 to 0.8.

We find economies of density at 1650 kWh and less significantly at 3300 kW. Closely related, the negative impact on retail charges of the length of the underground circuit in all markets would reflect economies of scale: a customer's bill is lower in distribution regions that have more kilometres of circuit underground. The low significance of the coefficient applied to density might result from the excessive correlation between this variable and circuit's length variables. The existence of those economies leads us to reject the hypothesis that urban and rural customers benefit equally from competition. In any event, NAO (2001, p.8) reported that rural customers are less likely to change their electricity supplier than those who live in urban areas because many customers change their supplier in response to a visit from a sales agent, and direct marketing of electricity has so far been less intensive in rural areas.

This negative relationship between retail charges and both the size of the network and the number of customers per km^2 reflects first technical economies at the distribution stage: heavy investments create an incentive for distributors to spread their costs among a large number of connected households. This situation could support the increasing concentration through horizontal integration in the retail sector; given the existence of decreasing per customer distribution charges paid by suppliers, they have an interest in servicing a large number of customers. The two-component structure of distribution tariffs in all but the Sweb regions implies technical economies of scale, in that the "per unit" distribution charge necessarily decreases when the amount of energy supplied to consumers increases.

As expected, Atlantic Electric and Gas and Basic Power have the lowest impact on charges with potential average annual savings (see Waterson, 2003) of up to £50, as between the cheapest and the most expensive supplier. Note that these savings do not account for consumer perception of switching costs. This difference was highest in the

direct debit market at 4950kWh (we do not report this result). Conversely, the effect of Innogy and Powergen groups on charges is greater or equal to the average effect. This seems consistent with integrated suppliers charging higher prices raising competition concerns. It is well known that the existence of consumer switching costs creates a further incentive for firms to grab more customers, which necessarily gives an advantage to older suppliers in the market (Farrell and Klemperer, 2004).
Ofgem (2003, p.38) reports that more households are switching to non-prepayment markets and low-income customers switch less often.

Interestingly, EDF Energy group has, on average, a lower impact on charges than SSE and Innogy. We suspect a more efficient vertically integrated structure and pricing strategy. Note that EDF Energy includes the Seeboard and Eastern distribution businesses that are in neighbouring regions. It is worth noting, as Spector (2003) emphasises, that the proposition that a merger allows firms to exploit economies of scale is not convincing if the merger does not also generate technical synergies, through learning for example. Technical synergies may exist between distribution networks owned by EDF Energy because they are in contiguous regions (London, the East and South East). In addition, EDF Energy holds generation assets, giving it the ability to bypass the volatile and often illiquid electricity exchanges in order to hedge its customer base.

SSE also seems efficient at low consumption levels compared with Powergen, Scottish Power, Innogy and British Gas, but overall less efficient than the EDF Energy group. Unlike this latter entity, SSE owns very distant networks, one in Scotland and the other in the South of England, which, in accordance with our previous discussion, would not favour technical synergies.

5. Conclusion

Using regional observations on tariffs offered in December 2003, the present paper set out to investigate the particular effect of various integrated structures on the relationship between annual retail charges and cost drivers. We find evidence of different pricing strategies by the various ownership groups, which suggests that the effect on retail charges of integrated suppliers varies depending on the spatial dispersion of the merged networks.

Overall these results support Salies and Waddams Price (2003, 2004) who also pointed out the negative (respectively positive) effect on unit rates and bills of a change in the number of customers (respectively the distribution area). Our density variable, however, provides a more flexible interpretation as the particular influence on charges in rural (less dense) areas proves to be significant. Alongside this variable, the size of the underground network leads to a similar result as the number of customers: coefficient estimates range from –0.7 to –0.3. For example, if the underground circuit increases by 3,000 km, then retail charges would decrease by £1 in the standard credit market at 1,650kWh.

We could bring more information to the discussion by extending the range of consumption levels considered or using longitudinal data. This would have the further advantage of increasing the number of observations for brands such as Manweb, SWEB, Swalec, and Seeboard.

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Endnotes

[1]. This group acquired SWALEC in 2000 thus we do not ignore the influence of the SWALEC acquisition.

[2]. For Scottish Power and Scottish Hydro regions, we employed data from the 2002-03 period as this was the only data available to us in the appropriate format (p/kWh) when completing the present study. Prepayment distribution standing charges were replaced with their non-prepayment equivalent when the data was missing, which occurs in four regions. At 1,650kWh, this substitution is fairly accurate, as the extra charge for prepayment customers does not exceed £10, i.e. 15% of distribution charges (or less than 3% of retail charges).

[3]. Given the non-linear structure of most tariffs offered by network utilities (see Wilson, 1997), these models have some advantage over models considering a single mean level of consumption. V.-Cervera and J-Málaga (2001) and Ofgem's works also consider more than one level of annual demand. This methodology is appropriate as most tariffs intersect at some level of consumption reflecting various pricing strategies and tactics to attract targeted consumers; some suppliers prefer to target low energy demand customers while others offer attractive tariffs to customers whose annual demand exceeds an average level known to suppliers.

Appendix

Table 1. Ownership structure for main supply brands in April 2002 and January 2004 [(a)]

April 2002	January 2004
Ex-PES	
London Electricity (SWEB)	EDF Energy (London Energy, SWEB Energy, SEEBOARD Energy) [(b)]
SEEBOARD	
ScottishPower (Manweb)	ScottishPower (Manweb)
Npower (Northern, Yorkshire)	Npower (Northern, Yorkshire)
Scottish Hydro Electric and Southern Electric (SWALEC)	Scottish Hydro Electric and Southern Electric (SWALEC)
Powergen	Powergen (Eastern, Norweb)
TXU-Europe (Eastern, Norweb)	
Non ex-PES	
Amerada, Atlantic Electric and Gas, Utility Link (Basic Power), British Gas	[(c)] Atlantic Electric and Gas, Utility Link (Basic Power), British Gas

(a) Mergers are underlined, and acquisitions represented with parentheses, with the name of the owner before the parenthesis.

(b) LE Group completed its acquisition of SEEBOARD in July 2002. Before that date, SEEBOARD was held by American Electric Power. It became SEEBOARD Energy Ltd in 2002. LE Group changed its name to EDF Energy in 2003, and its supply brand, London Electricity, changed its name to London Energy.

(c) Amerada became part of Powergen and was re-branded Powergen in 2003.

Table 2. Descriptive statistics - January 2004 [(a)]

	Mean	Std. Dev.	Minimum Value	Maximum Value
Total charge per annum for standard credit				
1650 kWh	14 593	1244	12 300	17 900
3300 kWh	24 553	1906	21 100	29 500
4950 kWh	34 520	2927	29 700	42 000
Total charge per annum for direct debit				
1650 kWh	13 470	1145	11 400	16 300
3300 kWh	23 215	2036	19 300	28 000
4950 kWh	32 939	19 077	27 200	39 700
Total charge per annum for prepayment				
1650 kWh	15 922	1885	11 800	22 000
3300 kWh	26 547	2308	21 900	33 900
4950 kWh	37 187	2890	31 000	45 900
Distribution charge per annum, non prepayment				
1650 kWh pa	3793	632	2687	4735
3300 kWh pa	5919	1079	4275	7933
4950 kWh pa	8044	1732	5720	11 449
Distribution charge per annum for prepayment				
1650 kWh pa	4045	891	2687	5833
3300 kWh pa	6170	1128	4275	7933
4950 kWh pa	8296	1680	5720	11 449
Transmission charge per annum				
1650 kWh	2009	957	136	3478
3300 kWh	4018	1915	272	6956
4950 kWh	6028	2873	409	10 434
Distribution customers, 000	1961	679	673	3381
Size of distribution area, in km^2	15 928	11 300	667	54 500
Density (distribution customers / km^2)	356	780	12	3124
Underground circuit (km)	22 081	8466	8917	36 302

(a) Charges are inclusive of VAT.

Table 3. Standard Credit; Dependent variable: annual bill

	Annual consumption					
	1650kWh		**3300kWh**		**4950 kWh**	
Distribution Charge	.86	***	1.03	***	.89	***
	(.12)		(.07)		(.07)	
Transmission Charge	.54	***	.26	***	.16	***
	(.08)		(.03)		(.03)	
Density (customers / km^2)	–.23	**	–.16	*	–.20	
	(.09)		(.08)		(.13)	
Underground Lines (×1000)	–.32	***	–.38	***	–.69	***
	(.09)		(.09)		(.13)	
Incumbent	7.51	***	18.69	***	29.74	***
	(2.64)		(1.82)		(2.63)	
Suppliers (£)						
Sempra Energy, etc. (Atlantic Electric and Gas)	101.46	***	167.07	***	256.51	***
	(7.65)		(6.41)		(8.16)	
Utility Link (Basic Power)	116.68	***	176.89	***	260.51	***
	(7.64)		(6.34)		(8.06)	
Powergen	111.06	***	191.49	***	296.07	***
	(7.44)		(6.40)		(8.14)	
SSE	104.51	***	182.75	***	284.68	***
	(7.46)		(6.43)		(8.19)	
Scottish Power	119.88	***	186.18	***	276.83	***
	(7.44)		(6.40)		(8.15)	
EDF Energy	103.30	***	175.69	***	272.72	***
	(7.48)		(6.44)		(8.20)	
Innogy	111.94	***	182.27	***	286.07	***
	(7.58)		(6.40)		(8.14)	
Centrica (British Gas)	113.74	***	179.28	***	270.44	***
	(7.45)		(6.41)		(8.16)	
Adj. R^2	.731		.909		.919	

Notes: *standard errors* in parentheses. '*' = significant at the 10% level. '**' = significant at the 5% level. '***' = significant at the 1% level.

Table 4. Ownership structure in the UK residential electricity market at December 2003

		Ultimate Owner	EDF	E. ON	EDF	Public	Aquila Inc. First E. Corp.	Owned Private	Public		Public	EDF		Investor Owned	Investor Owned	Owned Private
		Owner	EDF Energy	Powergen	EDF Energy	Scottish Power	Aquila Sterling First Energy	Mid American	United Utilities	SSE Power Distribution	Scottish Power	EDF Energy	SSE Power Distribution	PPL	PPL	Mid American
		Distributor	EDF Energy Networks	East Midlands Electric	EDF Energy Networks	Scottish Power Manweb	Aquila Networks	Northern Electric Distribution	United Utilities Electric	Scottish H. Electric Power Distribution	Scottish Power Distribution	EDF Energy Networks	Southern Electric Power Distribution	Western Power Distribution	Western Power Distribution	Yorkshire Electric Distribution
		Trading Name	EPN	EME	LPN	SP Manweb	Aquila	NEDL	United Utilities	S+S	SP Distribution	SPN	S+S	WPD	WPD	YEDL
Ultimate Owner	Owner	Region / Supplier	Eastern	E. Midlands	London	Manweb	W. Midlands	North East	North West	Scottish Hydro	Scottish Power	South East	Southern	South Wales	South West	Yorkshire and Humber
E. ON	Powergen	Powergen	I	I	E	E	E	E	I	E	E	E	E	E	E	E
EdF (State)	EDF Energy	London Energy	E	E	I	E	E	E	E	E	E	N	E	E	N	E
Public	Scottish Power	ScottishPower Manweb	N	N	N	I	N	N	N	N	N	N	N	N	N	N
RWE	Innogy	npower	E	E	E	E	I	N	E	E	E	E	E	E	E	N
RWE	Innogy	Northern Supply	N	N	N	N	N	I	N	N	N	N	N	N	N	N
Public	SSE [a]	Scottish Hydro Electric	E	E	E	E	E	E	E	I	E	E	N	N	E	E
Public	Scottish Power	ScottishPower Energy Retail	E	E	E	N	E	E	E	E	I	E	E	E	E	E
EdF	EDF Energy	Seeboard Energy	N	N	N	N	N	N	N	N	N	I	N	N	N	N
Public	SSE [a]	Southern Electric	E	E	E	E	E	E	E	N	E	E	I	N	E	E
Public	SSE	SWALEC	N	N	N	N	N	N	N	N	N	N	N	I	N	N
EdF	EDF Energy	Sweb Energy	N	N	N	N	N	N	N	N	N	N	N	N	I	N
RWE	Innogy	Yorkshire Supply	N	N	N	N	N	N	N	N	N	N	N	N	N	I
Sempra Energy, John Shannon, etc.		Atlantic Electric and Gas	E	E	E	E	E	E	E	E	E	E	E	E	E	E
Utility Link		basicpower	E	E	E	E	E	E	E	N	N	E	E	E	E	E
Centrica		British Gas	E	E	E	E	E	E	E	E	E	E	E	E	E	E
		Number of Suppiers	8	8	8	8	8	8	8	7	7	8	8	8	8	8

I = Incumbent, E = Entrant, N = Neither. [a] SSE counts for one supplier

Manweb region = Merseyside, Cheshire, North Wales. Scottish Hydro region = North Scotland. Scottish Power region = South and Central Scotland