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Abstract

As residential energy markets open to competition, consumers can choose from a range of tariffs offered by different suppliers. We examine the relationship between the fixed charge levied on each consumer, and the variable charge per unit of energy used across all these tariffs. Data are the tariffs offered in April 2002 in the 14 electricity regions of Great Britain by seventeen suppliers, seven of whom operate nationally. Our analysis focuses on the revenue trade-off for the company. We identify the effect of payment method on the relationship between fixed and variable charge. We find significant effects of the distribution and transmission charges which the suppliers pay in each area, as well as the size of the market both by number of customers and area; and confirm that incumbents charge significantly more that entrants. We also find significant differences between the prepayment and credit tariffs.

JEL : D430, L940, C310.
Key words : Energy Competition, Non Linear Pricing, Simultaneous Equation Models

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1. Introduction

Public utility monopolies have traditionally raised revenue through a two-part tariff consisting of a standing charge or line rental, which must be paid to gain access to the utility; and a unit price or running rate for each unit consumed. This was virtually universal in UK utilities at the time of their privatisation in the eighties and nineties. However the opening of the telecoms and energy markets has resulted in a variety of tariff structures offered by different suppliers. This paper analyses the electricity tariffs offered by suppliers in different regions across the UK to identify a relationship between the running rate and the fixed element of the tariff. We identify how this relationship varies according to regional characteristics and costs in different markets and according to different payment methods. We also identify the impact of incumbency on price.

Utilities constitute an important part of the economy, both for industry and households. The products which they supply have important and sensitive environmental effects. In particular the energy industries are responsible for half the carbon dioxide emissions, and constitute the main focus in the UK of attempts to reduce such emissions to comply with the Kyoto commitment. In this context, the structure of tariffs is an important signal to consumers about the costs of the resources which they are consuming.

As for all necessities, low income groups spend a higher than average proportion of their income on utilities. Price levels and structures therefore also have important and politically sensitive distributional consequences, witnessed by a history of political interference in nationalised industry tariffs, and a combination of government and regulatory influence in their privatised successors. Ofgem currently has an active Social Action Programme which addresses such distributional aspects. In his seminal article on two-part tariffs, Oi (1971) recognised the importance of income redistribution effects in determining the superiority of two part to uniform tariffs in a monopoly setting (see also Brown and Sibley, 1986).

The electricity supply industry is vertically divided into four stages: generation; high voltage, long distance transmission; regional distribution; and the retail function (sales and billing). At privatisation the distribution and retail functions were jointly vested in fourteen regional companies, but these functions have recently been divided into separate organisations and haved subsequently devolved to different owners in many regions. A company retailing electricity pays charges to the three upstream providers, i.e. to a generator for the energy, to National Grid Transco for transmission through the network, and to a distribution company for local transport (the supply company may be vertically integrated with either a distribution or a generation provider, or both). Costs of residential energy have traditionally been classified as fixed, consumer related or consumption related. The consumer related costs are those of metering and billing, together with any consumer specific equipment, such as the exclusive pipe or wire into the house.

When the retail part of energy markets were first opened to competition (from 1998 for households) most commentators predicted that prices would become more cost reflective. The nationalised area boards, predecessors to the regional electricity companies, had interpreted their 'public service' obligations by implementing widespread cross-subsidies through average cost pricing. This meant that consumers with high costs (those living in rural areas, consuming at times of peak demand, paying late or using more expensive prepayment meters) were subsidised by those with lower costs. Once the retail market was separated from distribution (which remains a monopoly), the cross-subsidies in the retail sector would be eroded (see Waddams Price and Hancock, 1998). This has occurred most obviously for payment method in energy.

Before competition was introduced it was generally accepted that the fixed charge did not reflect the full costs of remaining attached to the system and the gas incumbent itself predicted a substantial rise in consumer charges in the very similar gas market (MMC, 1993). However since the market was opened experience has been otherwise, with an erosion rather than an increase in the standing charge. In April 2000 the same incumbent, British Gas, removed standing charges from its gas and electricity tariffs (replacing them with a two tier tariff with a higher per unit charge for the first few units than for subsequent consumption). This move initiated a considerable widening in the variety of tariffs available from different companies. This paper examines the relationship between unit price and standing charge, how it is affected by regional characteristics and by payment method. We identify the effect of distribution and transmission costs, and of incumbency, on price structures. In this way we are able to test earlier studies on market power (e.g. Otero and Waddams Price, 2001a). We also explore whether tariffs with two running rates but no standing charge, like that initiated by British Gas, have a fundamentally different relationship between the fixed element (captured by the higher charge for early units) and the effective marginal price which most consumers pay.

In the next section we explore the nature of the two part tariff in more detail, and describe the data and its representation. Section 3 presents the econometric model and the data, section 4 the results and section 5 the conclusions.

2. Pricing structure and tariffs

We approach this analysis from the point of view of the firm and its revenue, its cost structure and some market characteristics which it faces. In the areas where they are incumbent, companies retain over half the consumers (Ofgem, 2001), suggesting considerable market power, a factor which we explore in our analysis; the market can be typified as a dominant incumbent in each area, with a competitive fringe. Early competition in these markets has been based on price savings available, compared with the incumbent, and indeed such savings form the main material supplied by energywatch in advising people to switch. We are unable to identify marketing expenditure by firm and region, and focus on price. However we also observe increasing attempts to differentiate what is essentially a homogeneous product through service provision.

The tradition of two part tariffs in this industry has been based on efficiency rather than on extracting consumer surplus (Train, 1991). A necessary condition for efficient pricing when the companies were monopolised was that price in each category (in this context predominantly consumer and energy related) should at least cover marginal costs, with fixed costs recovered through some form of Ramsey-Boiteux pricing. This principle continued to be applied to regulated industries with market power, even after competition was introduced, for example the gas regulator's rulings 1995-98 (see Otero and Waddams Price 2001b for a review of this process and the cost allocation involved). In this context the presence of consumer related costs is crucial in determining the optimality of any two part tariff.

For most utilities, consumer demand is likely to be more responsive to changes in the usage rate than in the fixed customer charge. While some consumers might choose to do without gas and telephones, most would prefer to stay connected, and there is very little alternative to electricity. Therefore a Ramsey-Boiteux rule would suggest that a higher proportion of fixed charges should be recovered through the fixed consumer charge than through the usage charge. Similar incentives apply to private monopolies maximising profit (Wilson, 1993), and these can be exacerbated by the particular form of regulation adopted for most UK utilities (Bradley and Price, 1988). However there is little empirical evidence that regulated privatised companies responded to such incentives before competition threatened (Giulietti and Waddams Price, 2000). In telecoms, line rentals did increase significantly relative to unit charges, but technological change was probably the main impetus.

The superiority of optional two part tariffs has long been known in a regulated or state owned monopoly setting (e.g Willig, 1978). Wilson (1993) points out that such tariffs are common in competitive industries such as airlines and for advertising space, as well as in rental of photocopying machines. A model with Bertrand competition would match the observations of firms in retail electricity both in offering unlimited quantities and in their attempts to differentiate the product.

We use the following notation to denote the two-part tariffs which are offered. J companies $j=1,\ldots,J$ offer customers a quantity $q \in [0,\infty)$ kWh. Consumers pay a price per unit RC_j plus a standing charge SC_j so that $T = SC_j + RC_j q$ represents a potential customer's total bill for consumption level q. We estimate the relation between UP_j and RC_j over a sample of seventeen different brand names in fourteen different regions, and for three methods of payment. Many of the distinct brand names have evolved from local incumbent suppliers who have since been taken over or merged with others.

Investigating the relationship between SC_j and RC_j raises the issue of simultaneity, given that both *SC* and *RC* are means by which the firm raises revenue, and are therefore likely to be determined together. The way in which tariffs are marketed suggests that the flat rate is determined first. (Many companies advertise tariffs on the basis of low or zero standing charge, some on the basis of total bill but very few on the basis of low marginal energy costs[1]). We therefore model the relationship as unit charge dependent on a standing charge which is determined by marketing strategy. A general test of misspecification and a test of exogeneity of standing charges is used to test this intuition.

We included tariffs with no standing charge, but with a high unit charge for the first few units, and tariffs with a standing charge and two running rates. We have reconfigured these tariffs as having 'virtual' standing charges and a single energy charge for consumption levels above that where the

[1] An exception is TXU's staywarm tariff, where charge is determined by size of house and household rather than consumption, but which is only available to pensioners. This tariff has not been included in the analysis.

lower unit charge is applicable. We compare results from these 'virtual' standing charges with those of the more conventional two part tariffs (a description of how we obtain this virtual standing charge is given in appendix B).

The companies whose tariffs we examine are the surviving electricity incumbents and some new entrants to the industry. Not all companies operate in all regions, but there were seven former Public Electricity Suppliers operating nationwide, using thirteen of the brand names. The other four brands are entrants to the market, by far the largest of which, British Gas, is the incumbent in the gas market. The fourteen regions are those in England, Scotland and Wales which were formerly defined by Public Electricity Suppliers. Retailers must pay for the energy they supply, but costs for individual retailers are confidential. Distribution costs form 25-30% of the final bill and vary across regions according to the charges levied by the local distribution company, but are levied equally on all suppliers using that distribution network. Distribution charges are generally in the form of a two part tariff, a charge per consumers and a charge per unit of electricity carried, and are usually higher for prepayment than for other consumers (see below for definition of payment methods). Transmission costs account for about 10% of residential final bills and vary by region. Both distribution and transmission costs are included in our analysis.

Costs of retailing depend on payment method, quite apart from any additional prepayment element in the distribution charge. The three payment methods are standard credit (payment in arrears after receipt of a quarterly bill); direct debit (monthly amounts deducted directly from a consumer's bank account); and prepayment, where supply is activated by insertion in the meter of a precharged 'smart card' or key. Automated direct debit is the cheapest for the retail company to operate, and prepayment the most expensive because of the cost of handling frequent small cash transactions. We estimated three regressions relating unit prices to standing charges, one for each payment method.

The fourteen areas effectively constitute separate markets (resale of electricity is impractical and usually illegal); we include characteristics of these markets, viz. the total number of consumers, the average income in that region and the geographical area covered. We allow for brand dummies that will capture any supplier specific factors which are reflected in tariffs, and test for significant differences between brands which are owned by the same company. We use British Gas, the most successful entrant, which offers tariffs in all regions, as our base case in the non parsimonious model.

3 Econometric model and data

We suggested above that there is an implicit function relating the two components of the tariff, standing charge and unit charge. Given the affine structure of the two part tariff, we construct a simple functional relationship. This could be considered as the trade-off between the two parts of the tariff, where one must be increased if the other is reduced, to maintain the same level of revenue (Gibson and Price, 1986) In this paper we specify that function, assuming initially that it is linear. We use the running charge as the primary endogenous variable and standing charge as the endogenous control variable. The statistical significance of a linear relationship would confirm the substitutability of two part tariff structures in contributing to revenue. A single price would not have this flexibility. Companies who add a second unit rate to their tariff might do so to increase the flexiblility of their pricing policy even further. This is of particular interest at a time of deregulation, when competition may induce innovative tariff structures (Bennett et. al., 2002)._

The generic model is

$$RC_{j,r}^{m} = \alpha_{11}^{m} SC_{j,r}^{m} + \alpha_{12}^{m} VSC_{j,r} + \sum_{j=1,\ldots J} \alpha_{2}^{m} S_{j} + \alpha_{3}^{m} VDC_{r}^{m} + \alpha_{4}^{m} FDC_{r}^{m} +$$

$$\alpha_{5}^{m} TC_{r} + \alpha_{6}^{m} CUS_{r} + \alpha_{7}^{m} INC_{j,r} + \alpha_{8}^{m} ARE_{r} + e_{j,r}^{m},$$

$$r=1,\ldots,R_{j}, j=1,\ldots J, \quad m = \text{standard credit, direct debit, prepayment} \qquad (1)$$

We denote by $T = \sum_{j=1,\ldots J} R_{j}$ the number of observations in each equation with R_{j} the number of regions (distribution areas) where a supplier *j* offers its tariffs. Our formulation accounts for the fact that though we have the same number of observations in each payment method equation, we do not have an identical number of regions for each supplier.

$RC_{j,r}^{m}$ = unit price in pence per kWh of a two part tariff for the payment method *m* offered in region *r* by supplier *j*, or the final running rate where there is more than one;

$SC_{j,r}^{m}$ = annual standing charge in pence;

$VSC_{j,r}^{m}$ = dummy which takes the value 1 for tariffs having more than one unit price and for which a "virtual" annual standing charge was computed, otherwise 0;

S_j = company dummy which takes the value 1 if the tariff belongs to supplier *j* ;

VDC_r^m = distribution charge in pence per kWh;

FDC_r^m = annual distribution charge in pence;

TC_r = transmission charge in pence per kWh;

CUS_r = number of distribution customers in region *r* for all payment methods;

$INC_{j,r}$ = dummy which takes the value one if the tariff is offered by a company *j* that is incumbent in the corresponding region *r*;

ARE_r = size of the distribution region *r*

I_r = gross income per head in region *r*

$e_{j,r}^m$ = residual of the equation corresponding to the payment method m.

Each equation estimates the rate at which companies substitute unit price for standing charges, which we expect to be negative since they are complements for the company in terms of raising revenue. Firms facing higher costs (distribution or transmission) would charge a higher unit price for any given standing charge, so we would expect the coefficients on these costs to be positive. Costs, especially marketing costs, may also be increased (with similar consequences) for markets with larger physical areas. A higher number of consumers may allow for some economies of scale in retailing, which would lead to lower unit charge for any level of standing charge, i.e. be associated with a negative coefficient.

In terms of market characteristics, areas with higher income may be associated with higher standing charges, since consumption is positively related to income, but at a decreasing rate. The prepayment market caters for lower income consumers than other tariffs, and so the relationship between standing charge and unit price may be different. However we expect a tariff for a given supplier in a particular region to be correlated across the three payment methods, and this affects the methodology used.

Market power of incumbents, all of whom had retained a market share of more than 50%, would be reflected in higher *level* tariffs, and a positive coefficient for the incumbency dummy. Since we have identified suppliers by the brand names used, we also test for similarities in the relationship bewteen different brand names used by the same company in different regional areas.

We rewrite (1) in compact form for each payment method equation

$$y^{m} = X^{m} \beta^{m} + e^{m}, \quad m = \text{standard credit, direct debit, prepayment} \qquad (2)$$

3.1 Data

We have 152 sets of pricing data relating to 14 regions, 17 brand names and three payment methods. The pricing data are from the ***energywatch*** website. Transmission charges are available from the National Grid Transco web site (National Grid Transco, 2002). Distribution use of system charges are published by the Electricity Association (Electricity Association 2001) and comprise fixed and variable elements, the former charged per consumer and the latter per unit of energy distributed. We use the total annual charge levied for a typical domestic customer with a demand of 3300kWh per year. The transmission charges are those levied during the period 16:00 hours to 19:00 hours. Figures for both distribution and transmission charges were for the year 2002.

Table 1 shows descriptive statistics for the main variables of the models.

Table 1 about here

Because we expect similarities in the relationship across the three tariffs for a given market and supplier, we ran a least squares regression for each payment method separately and investigated the correlation between the estimated residuals of the three equations. Correlation between the residuals for the standard credit and direct debit equations is significant at 1%; for prepayment and standard credit at 10% and between prepayment and direct debit at 20%. Because of this correlation between the residuals we use a Seemingly Unrelated Regressions (SUR) approach. Before estimating the SUR we tested for conditional heteroskedasticity within each equation in the model including all continuous variables using White's (1980) asymptotic χ^2 test, and do not reject homoskedasticity for the first and third equation. The result of the test also supports the linear model specification for these equations. However, for direct debit, we reject this hypothesis. A computation of the coefficient of variations of the running charges show that this element of the two-part tariffs vary more across companies and regions, perhaps reflecting an attempt by suppliers to differentiate their tariffs more in this more actively competitive market. In the non parsimonious model (shown in the appendix as table 4) we chose British Gas as the base group since it is the major non incumbent player. To derive the parsimonious version, reported in table 2, companies were eliminated through a stepwise regression in each equation before estimating the pooled sample regression. It is this group of 'excluded companies' which forms the base case for the parsimonious version.

We investigated the exogeneity of standing charge in the three equations simultaneously. There might be obvious reasons to think that standing charges in a two part tariff are not exogenous. This non-exogeneity could explain the failure of the White misspecification test for the direct debit equation, reported above. In order to test simultaneously for the exogeneity of standing charges in the three equations of the SUR model we used the level of standing charges for the first period for which this was available. In most cases this was February 1999, but for companies such as Amerada, Basic Power who entered the market later, we used the first published tariff. We employ the Hausman (1978)'s endogeneity test on the pooled sample regression of the SUR model. The motivation is that if there is a misspecification due to the non exogeneity of one standing charge in a particular equation, this misspecification would be transmitted throughout the system, so it is more relevant to test for the exogeneity on the pooled estimates[2]. We did not find evidence of endogeneity even at 10 per cent (the results are available upon request from the authors).

4. Results

Table 2 about here

As expected, we see a negative relationship between unit price and standing charge. For each one hundred pounds higher annual standing charge, the unit rate decreases by two and a half pence for standard credit and direct debit tariffs. The estimates of the coefficient of standing charges are not significantly different from each other in these two equations. This is a direct result of the structure of the discounts given for direct debit payment. Discounts for direct debit are shown in the lower value of the constant, while the slope coefficient relating running and standing charges remains the same. The relationship between the tariffs for different payment methods is shown in figure 1.

figure 1 about here

For prepayment tariffs the coefficient of standing charge is just over a third of that for the credit tariffs. For a household using the average annual consumption of electricity, 3,300 kWh, a pound

[2] In each equation of the SUR we inserted the estimated residual from a regression of SC^m on the exogenous variable of the mth equation plus our instrument variable. We then estimated this augmented SUR model.

decrease in the standing charge would be balanced by about an extra eighty pence energy charge for those on quarterly credit or direct debit tariffs. However a prepayment consumer with the same consumption would save only 30 pence on fuel charges by switching to a tariff with a one pound higher annual standing charge. Since average consumption of prepayment consumers is likely to be slightly less than for those on credit tariffs, the reduction in fuel charges would be even less.

The summary statistics in table 1 show that the average levels of both standing charge and unit price are higher for prepayment than for other payment methods, and this is reflected in the higher constant, and illustrated in figure 2. The constant could be regarded as the average running rate that would be charged if there were no standing charge. But in practice we see that such tariffs have two running rates, so this interpretation is misleading, and effectively there is always at least a 'virtual' standing charge. We would expect the final running rate to be a little higher for tariffs with no standing charge, to compensate for the lower revenue from consumers who use small amounts of electricity. We find that this is indeed the case for direct debit tariffs where the running rate is on average 0.14 pence higher for the same (implied) standing charge. We now identify the other factors that affect this trade off between standing charge and running rate.

An increase in any of the costs paid by supply companies for distribution and transmission raises the running rate paid for any given standing charge to the same extent on both credit and direct debit tariffs. Almost 90% of an increase in the variable distribution charge, and a quarter of an increase in transmission charge is passed on in the unit price. A one pound increase in the annual distribution charge per customer translates into about an increase of about a fortieth of a penny on the running charge, and annual cost of about 80 pence for the average user.

However for prepayment customers only the variable distribution charge seems to affect the running rate, and of this only 60% is passed on directly in the charge per kWh (compared with about 90% for the credit tariffs). The lower direct feed through into unit rates is partly reflected in the higher constant in the equation for prepay tariffs.

In markets which cover a greater area, there is a small but significantly higher unit charge for credit consumers, but not for prepayment customers. This is consistent with higher marketing costs in large areas, since there is much less aggressive marketing of prepayment tariffs. Higher consumer numbers (i.e. a bigger total market of consumers paying by all payment methods) lead to some reduction in unit prices to the same extent in all three payment methods, suggesting some economies of scale which are passed on in lower tariffs. The average income in an area does not affect the price relationship for any of the three payment methods.

We see that wherever a consumer is, the unit energy charge (for any given consumer charge) is likely to be significantly greater if bought from the local incumbent. The mark up varies between payment methods in a rather surprising way. It is highest for direct debit consumers (about 0.7 pence, twelve per cent of the average unit price), where consumer switching has been highest, 44% in 2001, the latest date for which such detailed figures are available (Ofgem, 2001). Just under a third of credit and prepayment consumers had switched at this time, where the incumbency markups are three fifths and one fifth of a penny, 7% and 2% respectively.

While electricity is essentially a homogeneous product, companies make great efforts to differentiate their services, and we explored whether the price relationship varies between brands, apart from incumbency. In the parsimonious equation, five brands act as the base group, namely Scottish Power, SWALEC, SWEB, SEEBOARD and Yorkshire. All had been regional incumbents, but SWALEC, SWEB, and Yorkshire were offering tariffs only in their local areas, and operating under other brand names elsewhere. The two brands with close to national coverage who form the base group are Scottish Power and SEEBOARD, and brand dummies indicate differences from this base pair.

Across the market as a whole the model identifies a little more brand differentiation for standard credit than for the other two payment methods, with eight brand dummies significantly different from the base group rather than six. The maximum spread between company dummies is greater for prepayment than for the other payment methods, both including and excluding the smaller entrants. Of the incumbent brands with wide coverage who are not in the base group, London and npower charge less for standard credit and prepayment than the base pair, but there is no difference in direct debit charges; TXU charges more for both standard credit and direct debit, with no difference for prepayment; while Powergen charges more for standard credit and direct debit and less for prepayment. Manweb and Northern both have higher charges for one payment group, and Scottish Hydro for two, but are marketed only in their original incumbency region.

We compare these tariff differences with the percentage of consumers who have switched away from the incumbent suppliers in each area. Of those companies whose brands are associated with higher tariffs (Northern, TXU, Manweb and Scottish Hydro), the first three have experienced consumers leaving at above average rates (41% and 39% compared with an average of 36%), while the fourth has a very low switching rate (19%) probably because of the particular characteristics and loyalty in that part of Scotland and the vertical integration of the Scottish electricity industry. Similarly London, associated with lower prices, has experienced lower than average switching rates in its incumbent area (32%). This provides some evidence that consumers may respond to incumbent prices in deciding whether to switch.

The main entrant into the market is British Gas, which charges less for prepayment, but has similar tariffs (when everything else is taken into account) to the base group. Other entrants (Amerada, Atlantic and Basic Power) all show some differences. Basic Power is cheaper for standard credit and prepayment consumers, but more expensive for direct debit; while Atlantic is cheaper for both credit tariffs, and Amerada is more expensive for prepayment users.

Since there has been rapid consolidation in the electricity supply industry, we used the brand dummies to explore whether those in similar groups demonstrated more similar tariffs than those outside the groups.

Table 3 about here

We see from tables 2 and 3 that some but not all members of four of the groups (A, B, C and D) are included in the base, and therefore not significantly different from each other. Within group A, London charges significantly different tariffs from SWEB and SEEBOARD (both part of the base group), although London has owned SWEB for three years. In group B, Manweb charges significantly higher direct debit tariffs than Scottish Power (which is in the base group). In group C, npower has national coverage, while both Northern and Yorkshire charge significantly higher standard credit tariffs, and Yorkshire charges higher standard and prepayment tariffs than its parent. In group D it is Scottish Hydro which is the outlier, charging higher prices than others in its group in the standard credit and direct debit markets. Powergen and TXU, who amalgamated about six months after these price data, now in group E, are both outside the base group, and show dummy coefficients significantly different from each other in the direct debit and prepayment markets. This suggests little evidence that brands within the same group are more similar than brands under different ownership.

5. Conclusions

The most remarkable difference in the general pattern is that between the two credit and the prepayment tariffs. There is no significant difference between the coefficients of any of the cost and market variables in the credit and direct debit tariff. The only differences are in the constant, the incumbency coefficient and the shift associated with multipart tariffs. The smaller constant for direct debit reflects the lower costs associated with such payment, but is partly a reflection of the (necessarily arbitrary) choice of the base group.

The significance of the virtual standing charge coefficient for direct debit but not for other payment methods is somewhat surprising. If the role of the higher 'final' running rate in such tariffs is to recoup revenue lost by those who use little electricity, and so do not fully cover the fixed costs of supply, then prices would be higher for tariffs where such low demand is more likely. Since average consumption of direct debit consumers is higher rather than lower than those on other tariffs, this may indicate some cross subsidy of low consumption prepay and credit consumers by high consumption direct debit users. Most intriguing is the relative size of the incumbency coefficients for different payment methods. A positive coefficient could be interpreted as indicating some continuing market power of incumbents, identified in Otero and Waddams Price (2001a), and in Giulietti et al (2001), both using 1999 data. However we note that the mark ups are higher both in absolute and relative terms for those payment methods where most switching has occurred, suggesting that caution is needed in interpreting the results as a direct indication of market power. In a dynamic market of this kind, it may be that that the lower mark up by incumbents for prepayment reflects the fact that incumbents' prices have been more recently regulated, and that entrants have not yet significantly undercut these prices.

Prepayment tariffs are much less sensitive to changes in costs than prices for other payment methods. Indeed differences in transmission charges and the fixed element of distribution costs seem to have no impact on tariffs, while only 0.6 of any increase in unit distribution charges are passed on, compared with about 0.9 for credit tariffs, a considerable difference even allowing for a one per cent higher average cost for prepayment. Similarly, the area of the distribution market has no effect on prepayment tariffs, while increasing the charge for credit tariffs, perhaps reflecting higher marketing costs across larger market area. The higher the number of distribution customers in a market the lower the tariffs, with similar coefficients across payment methods, suggesting some economies of scale in billing activities in larger markets (the numbers are for all payment methods, since we did not have separate figures for each payment method). The average income per head in a region did not have a significant effect on the tariffs charged. While some brands have consistently higher or lower tariffs for some payment methods across markets, there seems little relationships between ownership of a brand and the tariffs it charges, even after several years of common ownership.

We see that while tariffs with fixed charges may be unpopular, they persist in these industries to reflect the predominance of costs associated with being a customer, rather than how much is consumed. Where they have been replaced by tariffs with an initial high running rate, the final running rate is rather higher for credit and direct debit tariffs. This is part of convincing evidence that the credit market (including direct debit) is a separate market from that for prepayment. Across the variables we see considerable similarity between direct debit and standard credit tariff structures, and corresponding differences between them and the prepayment structure. Cost differences which can be observed (transmission and distribution) are reflected much more closely in the credit tariffs. If higher area implies larger marketing costs, these seem not to be recovered from the prepayment market, either because they are not incurred for these consumers or because of allocation decisions within the firm. Demand characteristics of areas such as average income levels do not seem to affect any of the tariffs. However the effect of incumbency, while raising prices for all payment methods, does so much more for credit than for prepayment tariffs, although competition for credit customers has been much fiercer in the early days of the competitive electricity market.

After allowing for all these differences the unit charge for a prepayment consumers is higher, and does not fall so quickly if standing charge increases as for the credit tariffs. This may partly reflect the higher supply costs of prepayment, through handling cash. But it is also probably a reflection of

the more recent regulation of these tariffs. As the final price controls are removed from retail electricity tariffs, these results raise important issues for future regulation of the market under the provisions of the Competition Act 1998. The regulator needs to monitor both the mark ups which incumbents are able to charge, and the trend of this price differential over time, as well as how active consumers are in switching. Incumbent mark ups may be a disequilibrium sign of vigorous discounting by entrants, and their absence, as in the prepayment market, may indicate only lackadaisical rather than enthusiastic competition. However continuation of incumbent mark ups in equilibrium would raise two sets of concerns. First, If the market does not erode such price differentials it suggests that incumbents are able to abuse market power. Secondly, if particular groups of consumers are less likely to switch away from incumbents charging higher prices, it raises distributive concerns. This will be of particular concern to the regulator and the consumer watchdog, both of whom have statutory duties to take account of the needs of certain potentially vulnerable categories households. The different market structures also suggest that the regulator needs to continue separate monitoring of the prepayment market, where tariffs show very different characteristics from those in credit markets, and whose consumers have lower than average income.

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Appendix A.

Table 1. Descriptive statistics

	Mean	Std. Dev.	Minimum Value	Maximum Value
Unit price p/kWh :				
Direct debit	5.648	.566	4.61	7.07
Standard credit	5.816	.557	4.72	7.28
Prepayment	6.390	.605	4.86	7.28
Global	5.951	.657	4.61	7.28
Standing Charge ps pa :				
Direct debit	3854	1166	1432	7008
Standard credit	4367	1076	1432	7008
Prepayment	5649	1788	1153	12201
Global	4623	1571	1153	12201
Unit distribution Charge p/kWh :				
Non prepayment [a]	1.300	.369	.86	2.02
Prepayment	1.343	.350	.86	2.02
Fixed distribution Charge ps pa per consumer :				
Non prepayment	1495	658	0	2471
Prepayment	2563	1144	1139	4000
Transmission Charge p/kWh :	1.138	.472	.178	1.998
Distribution Customers, 000 :	1804	663	592	3261
Size of distribution area, sq kms :	16028	11405	665	54390
Average gross income/head, £spa :	15232	1959	12743	20300

Table 2. Parsimonious SUR results

	Standard Credit	Direct Debit	Prepayment
Standing Charge	-2.49×10^{-4} *** (1.23×10^{-5})	-2.55×10^{-4} *** (1.28×10^{-5})	-9.12×10^{-5} *** (1.61×10^{-5})
Virtual Standing Charge		.139 *** (.016)	
Amerada			.817 *** (.067)
Atlantic	-.111 ** (.044)	-.292 *** (.045)	
Basic Power	-.216 *** (.050)	.183 *** (.053)	-.933 *** (.081)
London	-.103 *** (.023)		-.191 *** (.068)
Manweb		.269 *** (.073)	
Northern	.162 ** (.075)		
npower	-.190 *** (.023)		-.529 *** (.097)
Powergen	.191 *** (.045)	.302 *** (.048)	-.443 *** (.067)
Scottish Hydro	.277 ** (.113)	.326 *** (.117)	
TXU	.278 *** (.044)	.180 *** (.045)	

British Gas					$-.400^{***}$ (.066)
Constant	5.22^{***} (.169)		4.80^{***} (.145)		6.48^{***} (.169)
Variable Distribution Charge	0.871^{***} (.054)		0.894^{***} (.056)		0.603^{***} (.063)
Annual Distribution charge	$2.41\times10^{-4\,***}$ (2.54×10^{-5})		$2.52\times10^{-4\,***}$ (2.60×10^{-5})		
Transmission charge	$.270^{***}$ (.028)		$.257^{***}$ (.029)		
Distribution customers	$-1.38\times10^{-4\,***}$ (2.73×10^{-5})		$-1.29\times10^{-4\,***}$ (2.77×10^{-5})		$-1.50\times10^{-4\,***}$ (3.51×10^{-5})
Distribution area	$5.04\times10^{-6\,***}$ (1.26×10^{-6})		$5.54\times10^{-6\,***}$ (1.30×10^{-6})		
Incumbency	0.579^{***} (.045)		0.701^{***} (.045)		0.191^{***} (.066)
Adj. R^2	.911		.913		.848

Notes: standard errors in parentheses. *. Significant at 10%. **. Significant at 5%. ***. Significant at 1%.

Brands eliminated from parsimonious estimation: Southern, Scottish Power, Swalec, SWEB, SEEBOARD, Yorkshire. Gross income per head and annual distribution charges for prepayment consumers were not significant at 10%.

Table 3: Electricity supply brand names within the same ownership group

Group Identity	
A	London, SWEB, SEEBOARD*
B	Manweb, Scottish Power
C	Northern, npower (incumbent in Midlands), Yorkshire
D	Scottish Hydro, Southern, SWALEC
E	PowerGen (incumbent in East Midlands), TXU* (incumbent in Eastern and North West regions)

* acquired after the data analysed here

Table 4. Non parsimonious SUR results of Unit prices for Standard Credit, Direct Debit and Prepayment (base company: British Gas)

	Standard Credit	Direct Debit	Prepayment
Standing charge (*SC)*	-2.63×10^{-4}*** (1.22×10^{-6})	-2.49×10^{-4}*** (4.05×10^{-6})	-8.39×10^{-5}*** (4.15×10^{-6})
Virtual Standing Charge (*VSC)* dummy	.233*** (.003)	.220*** (.013)	.114*** (.03)
Suppliers(*S*)			
Amerada	.190*** (.004)	-.054*** (.016)	1.311*** (.035)
Atlantic	.099*** (.004)	-.219*** (.016)	.594*** (.033)
Basic Power	-.006 (.004)	.239*** (.017)	-.456*** (.036)
London	.021*** (.005)	.019 (.019)	.285*** (.035)
Manweb	.355*** (.007)	.497*** (.025)	.496*** (.04)
Northern	.409*** (.006)	.266*** (.020)	.375*** (.025)
npower	-.029*** (.005)	.007 (.020)	-.079* (.041)
Powergen	.379*** (.004)	.378*** (.015)	.058 (.034)
SEEBOARD	-.058*** (.003)	-.004 (.009)	.376*** (.013)
Scottish Hydro	.488*** (.010)	.408*** (.032)	.430*** (.037)
Southern	.170*** (.004)	.100*** (.016)	.386*** (.032)
Scottish Power	.258*** (.005)	.093*** (.021)	.538*** (.033)
SWALEC	.326*** (.007)	.032 (.026)	.640*** (.041)
SWEB	.214*** (.007)	.123*** (.025)	.200 (.043)
TXU	.251*** (.003)	.177*** (.009)	.367*** (.016)
Yorkshire	.103*** (.007)	.200*** (.025)	.332*** (.040)
Constant	5.103*** (.010)	4.756*** (.033)	6.00*** (.087)
Per unit distribution charge (*VDC*)	0.875*** (.003)	0.881*** (.011)	0.566*** (.024)

Annual Distribution charge (*FDC)*	$2.53x10^{-4}$ *** (1.60×10^{-6})	2.54×10^{-4} *** (5.74×10^{-6})	1.51×10^{-6} (4.92×10^{-6})
Transmission Charge (*TC*)	.284 *** (.002)	.284 *** (.008)	.06 *** (.012)
Distribution customers *(CUS)*	-1.30×10^{-4} *** (1.73×10^{-6})	-1.20×10^{-4} *** (5.87×10^{-6})	-1.51×10^{-4} *** (9.00×10^{-6})
Distribution area *(ARE)*	5.44×10^{-6} *** (9.26×10^{-8})	6.08×10^{-6} *** (3.40×10^{-7})	$-.25\times10^{-6}$ *** (4.40×10^{-7})
Gross income/head (*Y*)	-4.97×10^{-6} *** (3.38×10^{-7})	-5.5×10^{-6} *** (1.13×10^{-6})	-4.81×10^{-6} (3.02×10^{-6})
Incumbent (*INC*)	0.521*** (.004)	0.65 *** (.016)	0.228*** (.018)
Adj. R^2	.913	.910	.841

Notes: *standard errors* in parentheses. *. Significant at 10%. **. Significant at 5%. ***. Significant at 1%.
The *t*- statistics are computed using robust standard errors (White, 1980).

Appendix B. Computing the Virtual Standing Charge

Consider the most complex tariff we have in the sample. It has two blocks, with the first steeper than the second, and has a standing charge. This tariff and hence the bill takes the form of a piecewise continuous function in q, the level of consumption. Denote $T(q)$ the corresponding function

$$T(q) = \begin{cases} C_1 + p_1 q \text{ if } 0 \le q \le \tilde{q}, \\ c_2(c_1, \Delta p, \tilde{q}) + p_2 q \text{ if } q \ge \tilde{q} \end{cases},$$

where c_1 is the standing charge, p_1 the initial running or per kWh charge, p_2 the per unit charge for consumption above quantity $\tilde{q}$, $p_2 <. p_1$. The 'virtual' standing charge c_2 is defined as the standing charge which, if it were charged, would give the same total bill T(q) for consumption of q=$\tilde{q}$ and a single running rate p_2. c_2 is found from the following equality $c_2 + p_2\tilde{q} = c_1 + p_1\tilde{q}$ which implies that $c_2 = c_2(c_1, \Delta p, \tilde{q}) = c_1 + \tilde{q}\Delta p$. Accordingly, if there is no initial standing charge ($c_1 = 0$), then $c_2 = c_2(0, \Delta p, \tilde{q}) = \tilde{q}\Delta p$. If there is a single block, then $c_2 = c_1$ since $\Delta p = 0$.

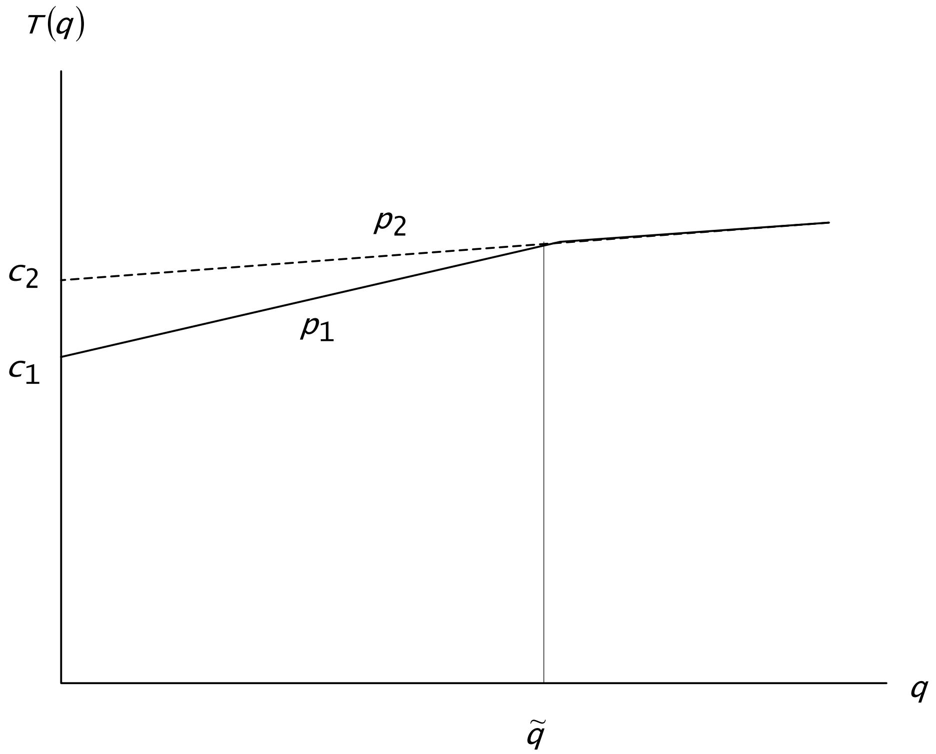

Fig. 2 'Virtual' standing charge

Figure 1: relation between running rate and standing charge for prepayment and credit tariffs

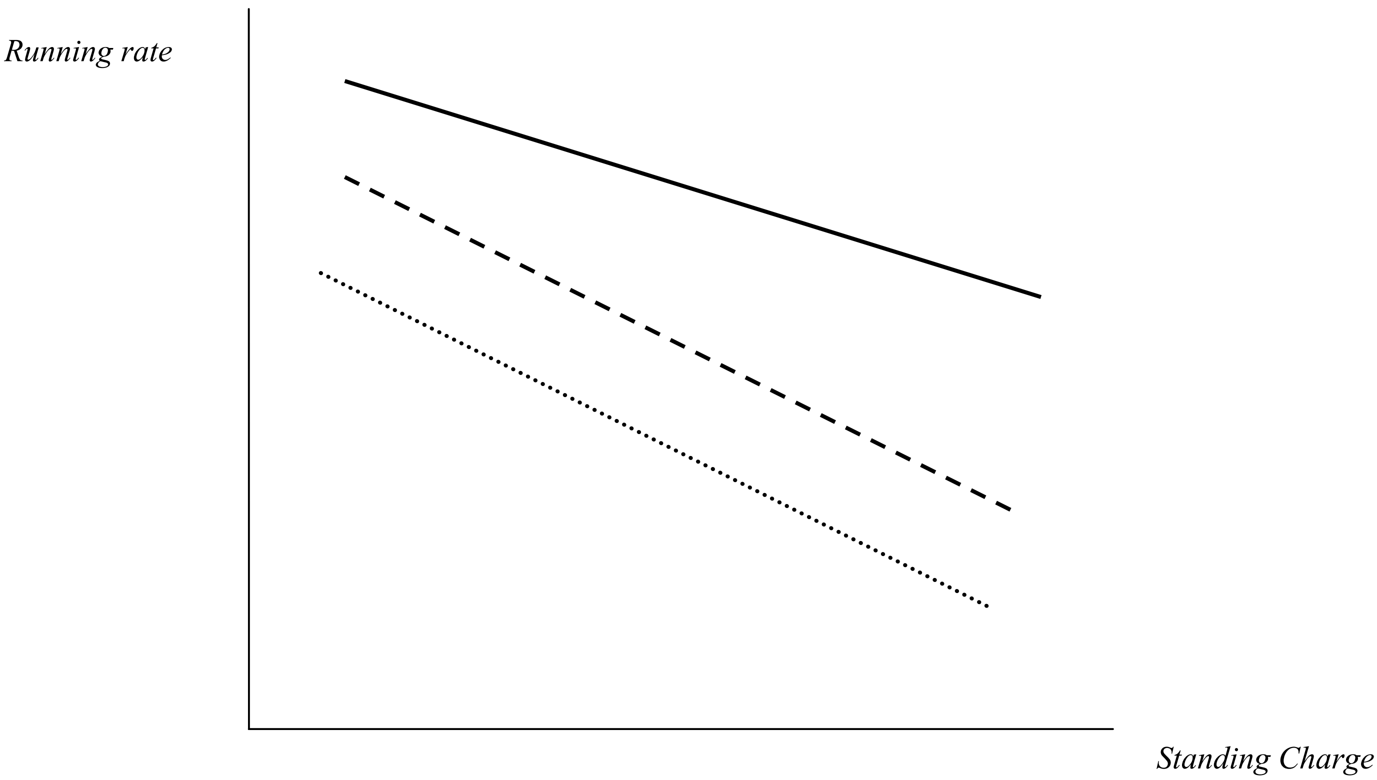

Fig. 1 Relationship between Running rate and Standing Charge
Prepayment ——— Standard Credit - - - - Direct Debit ....