Strategic Responses to Regulatory Policies: What Lessons Can Be Learned from the UK Contract Gas Market?

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Abstract :

The gas industry was first privatised in 1986, and the regulator, Ofgas, identified the contract gas market as a possibility for introducing initial competition into the industry. Nevertheless, competing shippers were slow in entering the market. Ofgas introduced a series of pro-competitive policies. It, however, invoked a series of strategic behaviour by the incumbent shipper, British Gas. The effectiveness of these measures are analysed here with respect to the evolving competitive process. The issues it raised, especially when formulating future regulatory policies and theories, are also considered.

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I: Introduction:

The current debates and issues relating to privatisation and regulation policies were identified in Newbery (1997). He maintains that the introduction of competition into previously monopolised and regulated utilities is essential in ensuring that the full benefits of privatisation can be realised. Regulation is basically inefficient and an imperfect substitute to achieving efficient outcomes. Regulatory theorist and policy-makers are currently actively engaged in the determining the optimal way of facilitating effective competition.

Issues to be considered relate to the form and length of regulation in the retail goods market. The form of industry structure is also important, that is whether competition is best facilitates if the industry is vertically integrated or separated. Finally, the network access regime is also crucial when facilitating effective competition in the retail market, especially if the industry is retained as a vertically integrated one.

The present paper examines the competitive market in the privatised UK gas industry, particularly between the time of privatisation in 1986 and 1996. The regulator, Ofgas, pursued a vigorous policy of introducing competition into the gas industry, especially the contract gas market. The policies pursued in this segment are reviewed with respect to these issues outlined above. The effectiveness of the policies are considered in light of the evolving competitive process and reaction of the incumbent (British Gas (BG)) and entrant shippers, particularly the strategic behaviour it invoked. This is done using a unique dataset on the UK contract gas market provided by John Hall Associates, a leading UK gas analyst and broker. Some implications for future competition policy and theoretical work emerge.

The paper is organised as follows; Section II provides some background into the privatisation of the UK gas industry. Section III investigates the policies pursued in the retail, or final, goods market and the ensuing incumbent's strategic behaviour. Section IV examines the regulatory policies relating to network access, that is gas transmission or transportation service. We consider whether they were effective in curbing the strategic advantage of the vertically integrated incumbent. The pricing behaviour of the entrant shippers, in an oligopolistic market, is empirically analysed in Section V. Issues to be considered when formulating future policies and theories in light of the analyse in the preceding sections is discussed in the concluding section.

II. Privatisation and Competition in the Gas Industry: Background

The UK gas industry's purchasing and delivery organisation was unified in 1972, thereby integrating its activity of buying North Sea gas and delivering it to individual consumers throughout the UK. BG also the monopsony of gas found on the UK Continental Shelf.

The Gas Act of 1986 made provisions for BG's privatisation. When privatised, in order to retain industry support and maximise sale proceeds, it was sold as a single monopoly entity (Price (1991)). It was essentially privatised as a wholesaling operation. It bought gas from oil companies and consortia operating in the North Sea and conveyed it via a national transmission network, regional network and low-pressure pipes to final consumers.

The privatised gas industry comprises of two distinct markets; (i) the tariff market and (ii) the contract market. The tariff market comprises of consumers of less than 25, 000 therms per annum. It includes the entire domestic market and a large number of industrial and commercial users. Consumers of firm gas above 25, 000 therms per annum, or contract gas market, negotiate tariffs individually and confidentially. Furthermore, consumers of above 250, 000 therms per annum could have gas supplied on an interruptible basis[1].

The provision for competition in the gas industry started prior to privatisation. The Oil and Gas (Enterprise) Act 1982 first introduced the possibility of third party carriage. Nevertheless, at the time of privatisation, competition was almost non-existent. The Gas Act of 1986 also made provisions for the creation of the gas regulator, Ofgas, outlining their two main duties which were to increase competition in the above 25, 000 therms per annum market and to enforce price regulation in the market for smaller users.

Ofgas (1987) put forward the rationale for promoting greater competition, that is expected to bring about general efficiency gains, provide BG with greater incentives to buy and sell gas at efficient prices and change the structure of the industry so that BG's market powers were considerably diminished. Ofgas (1987) also identified the contract gas market as the best potential for developing competition and gas producers operating in the North Sea as most likely to enter the gas contract gas market. They could hope to sell gas at a higher price than they would receive from BG. Selling directly to industrial users would prove more attractive as their demand for gas has less seasonal variation than residential users and smaller "swing factor" implies supply cost. Eventually, in 1992 the "monopoly threshold"

[1] Gas that is sold on an interruptible basis implies that the supply can be at the discretion of BG to help solve its winter peaking problems.

was reduced to 2, 500 therms per annum. Thereby, extending the competitive market to include some of the tariff gas market.

While pursuing pro-competitive policies in the contract gas market, there were two main regulatory policies that were undertaken by Ofgas. A public pricing policy was introduced in the contract gas market and a formally regulated network interconnection charges was also introduced. The rest of the paper considers the effectiveness of these competitive policies. The relative strategic advantage of the competing shippers have is an important consideration. The main competitors in the contract gas market are North Sea gas producers operate as upstream firms in the final goods market and, hence, has post-entry advantage. BG, on the other hand, being the incumbent and maintained as a vertically integrated industry has first mover and pre-entry advantage.

III. Public Pricing Policy in the Contract Gas Market

At the end of 1987 the Office of Fair Trading (OFT) referred BG to the Monopolies and Mergers Commission (MMC) following complaints about its pricing policy in the contract gas sector. The ensuing MMC 1988 report highlighted that there was a possibility for BG to practise first degree price discrimination in the contract gas market. Prices charged to customers depended on how easily available alternative sources of fuel were. Those with easy access to cheap alternative sources of fuel were charged considerably less. Essentially, the MMC recommended that BG publish their price schedules in the contract gas market. Ofgas fully implemented this recommendation and introduced a public pricing policy requiring BG to publish its pricing schedules in the contract gas market, the first of which appeared on the 1st of May 1989. BG could not alter any particular schedule more than once in any 28 day period without consent of the regulator. Furthermore, the regulator must be given 21 days notice of any change to the classes or description of schedules.

It was anticipated that the transparency imposed by of a public pricing policy would eliminate any abuse and predatory or anti-competitive practises. It is also expected to curb the incumbent's strategic behaviour. In addition, following OFT (1991), BG committed to give up 60% of the competitive market to its competitors. BG also gave an undertaking to participate OFT's "Gas Release Programme" to release at least 500 million therms of gas for the years 92/3, 93/4 and 94/5, and 250 million therms in 95/6 to competing shippers. They were to be sold at BG's overall weighted average cost of gas plus a small margin.

One could expect two possible outcomes to arise in the face of the regulation measures and increased competition from upstream firms. Either contestable outcomes or BG invoking its advantage as the incumbent by pursuing an inter-temporal pricing strategy. Whilst the Cournot model is appropriate for determining the general level of gas prices, prices to different customers at different times is better modelled using the Bertrand framework. Gas can usually be switched between different customers with ease, and some types of customers have relatively low switching costs between suppliers. One of the main aims of the Ofgas regulations was to promote price competition between suppliers in particular sub markets, and the range of markets has been expanding over time.

The switch from a situation in which there is little price competition to one in which there is effective competition would lead us to expect a change in pricing behaviour. For example, in the theory contestable markets, in which incumbent firms can be undercut by actual or potential competitors from related markets, the prediction is that the resultant prices will be Ramsey-optimal, with prices equal to average cost (with non-increasing returns Ramsey-optimality requires price to equal marginal and average cost; with increasing returns, equal to average cost with zero profits). The public pricing policy is important. For markets to be contestable, potential competitors need to know the actual price charged so that can undercut it.

The increasing competition would lead to two outcomes. Firstly, a reduction in the general level of prices. The possibility of being undercut forces the incumbent to lower prices. Secondly, the structure of pricing would reflect the structure of costs. In particular, cross-subsidisation would become impossible. If all of the various sub-markets are contestable, all prices would be Ramsey-optimal. However, in the case where some markets remain effectively sheltered (for example, domestic gas users), these markets could still face a price in excess of the Ramsey-optimal. One of the main victims of price competition of this nature would be the use of demand based inter-temporal variations in tariffs. In particular, prior to privatisation, gas has had a seasonal tariff, being higher in the winter months when demand is more inelastic. Whilst there is some cost based justification for this (in terms of providing peak capacity), the commercial reason has always been based on the demand side (the elasticity of demand)[2]

On the other hand, given the public pricing policy in place and also the pressure on BG to facilitate competition in the contract gas market, BG being the incumbent monopolists may

[2] As noted in Ofgas (1987), the contract gas market has very low swing factor.

choose to follow an inter-temporal pricing strategy. BG expecting vigorous competition from upstream firms may decide to pursue a monopolistic pricing behaviour and profits for the present while sacrificing some future profits through the inevitable loss of market share. Indeed, BG also may wish to disguise its long-run prices from its rivals. BG following an inter-temporal pricing strategy will maximise profits as;

$$Max \qquad \pi_{BG}(t_0) = \int_{t_0}^{\bar{t}} (p_{BG}^m - c)(Q(p_t) - q_{NBG}) e^{-r(\bar{t}-t_0)} dt \qquad (1)$$

where π_{BG} and p_{BG}^m denotes BG's profits and prices respectively, where prices where at a monopolistic level, *c* denotes its average cost of production which assume to be constant over time, while $Q(p_t)$ refers to total industry demand which is function of average industry price (p_t) and q_{NBG} represents the entrants' output. While t_0 and $\bar{t}$ denote the starting and ending, or target, periods BG chooses to price monopolistically. The rate of entry($\partial q_{NBG} / \partial t$) is an increasing function of the of BG's price;

$$\dot{q}_{NBG} = f(p_{BG}) \qquad (2)$$

where $f'_{p_{BG}} > 0$.

The target period may be when their requirement to publish their prices or public pricing policy is suspended. The corresponding prices are;

$$p^c < p_{BG}^m \quad \text{when } t < \bar{t} \qquad (3)$$

and

$$p^c = p_{BG} \quad \text{when } t > \bar{t} \qquad (3')$$

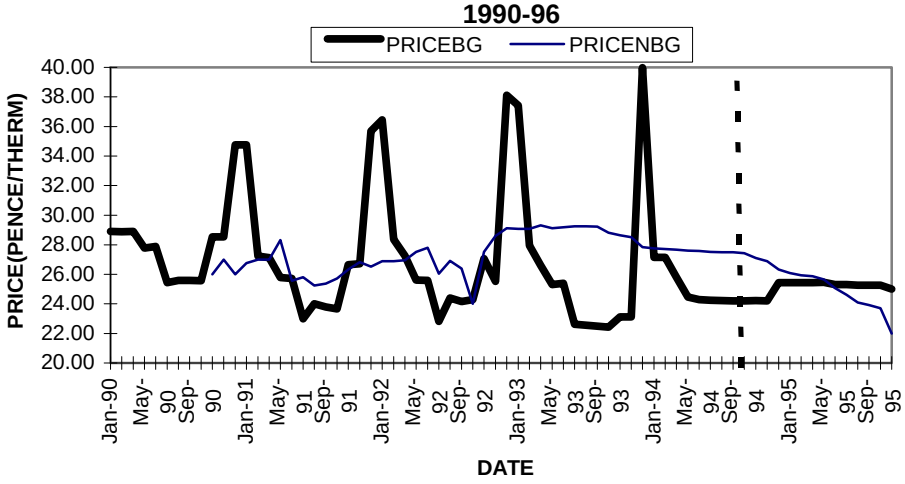
This suggests that BG may choose to continue with its monopolistic pricing policy while the public pricing policy is in place and its profit path is represented by (). Subsequently, they revert to a pricing behaviour (p^c) that is consistent with market conditions. The market conditions that evolved while pro-competitive policy is pursued may facilitate either collusive or non co-operative pricing. Therefore, BG's inter-temporal profit rates could be[3];

$$\pi^m > \pi^c > 0 \qquad (4)$$

where π^m , π^c and 0 denotes monopolistic, collusive and non co-operative profit rates respectively.

BG's and non-BG's pricing behaviour is depicted by Figure 1 below;

FIGURE 1:PRICE OF BRITISH GAS AND NON-BRITISH GAS, 1990-96

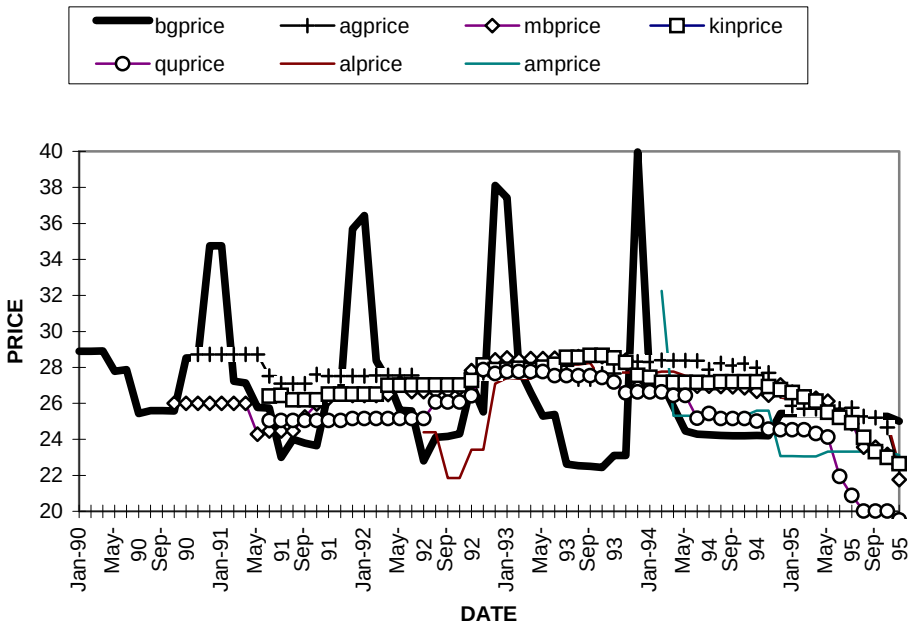


BG's prices have distinct seasonal variations, while non-BG shippers' prices do not display any seasonal variations. BG's non-linear pricing policy of intertemporal, or third degree price discrimination, disappears when the regulatory requirement to publish their price schedules was removed in October 1994 (as depicted by the dotted lines). Subsequently, BG reverts to competitive pricing.

The prices of individual competing shippers given in Figure 2 are consistent with Figure 1, it does not show any distinct seasonal variations and the price dispersion appears low. The John Hall Assoc.'s data set indicates that though between twenty-five to thirty firms have entered the contract gas market towards the end of the period in question, the sector has been dominated by about six main shippers. More significantly, they are partially or wholly owned by North sea gas producers as anticipated by Ofgas (1987). The non-BG shippers' price lies within a narrow band between 26 and 28 pence/therm, except from late 1994 when all the prices start to fall. BG's price is denoted by bgprice, while AGAS, MOBIL, KINECTICA, QUADRANT, ALLIANCE and AMERADA HESS prices are denoted by agprice, mbprice, kinprice, quprice, alprice and amprice respectively

[3] This could equivalently be; $\frac{p - mc}{p}$.

FIGURE 2: Prices of 7 Main Gas Suppliers 1990-96



The figures above clearer indicate that BG reacted to Ofgas's regulatory measures, in particular the public pricing policy. BG adopted an inter-temporal pricing strategy while its pricing behaviour was under the scrutiny of Ofgas, the MMC and the OFT. BG used this strategy to disguise its long term pricing behaviour, and together with its strategic advantage as a vertically integrated firm to maintain its high profits rates or price-cost margin in the long run. These issues are discussed in the remainder of the paper.

III. Network Access Regulation:

A key element in formulating pro-competitive policies is network access regulation. It is important when ensuring efficient and equitable entry of competing firms, to ensure effective competition. Though this is especially crucial for vertically integrated industries such as the gas industry, Ofgas was slow in introducing any formal regulation. It was only after the MMC (1988) recommendations were "third-party carriages" formally introduced in October 1989. Nevertheless, the regulation of gas transportation soon became an integral part of Ofgas's pro-competitive policies as stated in Ofgas (1993);

"The gas transportation system is a significant part of the infrastructure of the UK economy. It is important therefore that the structure of prices adopted for the system

encourages, to the maximum extent possible, the efficient use of resources, to the benefit of gas customers and *the economy as a whole*."

There was, however, no separate price control, and access charges were based on allowable rate of return on current assets of 4.5%, which is higher than the cost of capital. Access charges were regulated as part of the average revenue cap which was also applicable to the tariff market. At the time BG was the monopoly supplier in both cases; tariff and transmission network. The transportation charges were split into four parts; National and Regional Transmission System (NTS and RTS), and Medium and Low Pressure Distance System. Charges in the former two parts are based on both geographical distance and peak load factor, while the latter two is based just on peak load factor.

In October 1991 the charges for the four parts, still based on distance and load factor, were quoted showing the split between the capacity and commodity charge element. The former is payable on the peak daily capacity required by the shipper, independent of actual usage, while the latter charge element which is paid on each therm of gas transportation.

Soon after, a consultation process was conducted by both BG and Ofgas on the future approach to gas transportation charge. This culminated in an MMC enquiry and a report in 1993, where matters pertaining to transportation charges were investigated as part of a wide-ranging inquiry into the gas industry. Subsequently, the new transportation charges adopted in October 1994 were based on a separate price control over for both BG's transportation and storage services. The allowable revenues were based on a rate of return on current assets of no greater than 4.5%.

Under the new transportation charges schedule regime, the NTS capacity charges, which makes up approximately 70 per cent of total transportation charges, were calculated based on the long-run marginal cost of providing access. Further, these long-run marginal cost based capacity prices are adjusted downwards so they achieve 50 per cent of required revenue. The remaining 50 per cent is achieved through commodity related charges. The remaining charges, that is RTS and pressure distance system, are based broadly on Average Accounting Cost. Here, again, it is a 50/50 capacity/commodity split.

Table 1 below gives an illustrated example showing the change in transportation charges:

TABLE 1: Transco's Transportation Charges from Bacton to Leeds : 1989-1996[4](Illustrative Load Size: 100 000 th/annum and Load Factor: 60%)

YEAR	PENCE/THERM

[4] Transco publishes its annual charges every September. They also publish an illustrated example of their charges, "Bacton to Leeds" is a commonly used example. The charges given in Table 2.1 are in current terms.

1989/90	10.08p
1990/91	8.64p
1991/92	6.26p
1992/93	6.53p
1993/94	6.53p
1994/95	6.21p
1995/96	6.58p

Source: Gas Transportation Charges, 1989/90 to 1995/96 (BG Transco)

Access charges dropped to meet OFT 1991 recommendations. BG hoped that by dropping access charges, their participation in the "Gas Release Programme" and giving up of their market share, would lead to the easing of the requirement to publish their pricing schedules. In the first three years of formal third party carriage charges, when Ofgas was vigorous in promoting competition, access prices fell by almost 50% in real terms. In addition, in 1992/93 when the monopoly threshold was lowered, distinguishing between large and small sites thereby creating easier access, it is hoped to facilitate more competition.

The rate of return regulation (ROR) where the allowable rate is set higher than the cost of capital can facilitate certain strategic behaviour by a vertically integrated incumbent. One such behaviour is the Averch-Johnson effect; it induces high-capitalisation. BG's use of this form of strategic behaviour is well documented (Price (1994) and Waddams Price (1997)). Indeed, Ofgas (1992) suggests that the 50/50 capacity/commodity charge split, may lead to an over-demand of peak capacity as the transportation charges for peak usage becomes relatively cheaper. Any increase in the demand for peak capacity necessitates expansion of the transmission network. According to the Averch-Johnson effect, greater capitalisation results in higher transportation charges allowed under a ROR form of regulation in the future. Furthermore, the ROR regulation also enables the rebalancing of charges to suit the incumbent (see Sherman (1985)). Indeed, such a split of capacity/commodity charges imply, as anticipated by Ofgas (1992), higher charges for supplying to domestic customers and lower charges for supplying to industrial users.

Here we examine another strategic advantage a vertically integrated incumbent, such as BG, may choose to invoke as a result of the rate of return regulation. We consider the possibility of "high capacity pre-commitment", or the Stackelberg-Dixit entry deterrence

effect, in the privatised gas industry[5]. Both affects the competitive process in the gas industry; the Stackelberg-Dixit effect impacts the incumbent's reaction function, while the Averch-Johnson effect impacts the entrant's reaction function, and both could take place simultaneously.

As highlighted earlier, when analysing the strategic behaviour of both the incumbent and entrant, it is important to distinguish between pre-entry and post-entry advantage. BG being the incumbent gas shipper, and, as a natural monopoly provider of the transmission network in a vertically integrated industry, has pre-entry strategic advantage. Conversely, the main entrant gas shippers, who are North Sea gas producers, operate as "upstream" firms in the contract gas market and have post-entry advantage.

Basically, the Stackelberg-Dixit model states that "sunk cost" is used to deter entry and/or manipulate post-entry outcomes. Firms acquiring large "sunk cost" expects to accrue benefits from it over a long period of time. Therefore, sunk cost has a multi-period dimension. The network in the case of vertically integrated industries such as the gas industry can be deemed as a sunk cost. However, this can be characterised as a "shared sunk cost". The incumbent, such as BG, owns the network but, through regulatory obligations, has to allow entrants to access the network at a pre-determined price. Furthermore, any capacity pre-commitment by the incumbent is not binding with respect to further expansion if the entrants' demand warrants it. However, the cost of the network is part of the incumbent's total cost function and can be used to manipulate it reaction function.

In the case of the contract gas market, we assume a duopoly scenario between BG and a non-BG gas shipper, Mobil, which is the largest non-BG supplier at present and being a North Sea gas producer, operates as an "upstream" firm in the contract gas market. The capacity or transmission network is vertically integrated and prior to entry;

$$n = n_{BG} + x$$

and after entry; (5)

$$n = n_{BG} + n_{NBG} + x$$

where n denotes the transmission network while $n_{BG} = q_{BG}$ and $n_{NBG} = q_{NBG}$ denotes the usage of the network by the incumbent and entrant respectively, and this is dependent on

[5] It must be noted that a vertically integrated incumbent may choose to invoke this strategic behaviour regardless of the form of regulation. Nevertheless, this form of regulation gives it the necessary incentive as discussed later.

their outputs[6]. Furthermore, there may be excess capacity, represented by x, if the network is under utilised.

The main determinant of the gas network capacity is peak demand[7]. Any expansion in networks usually involves large capital cost. Therefore, unit cost of any expansion, if there are no excess capacity, is more likely to remain constant rather than fall. The entrant shipper's cost function is;

$$C_{NBG} = f_{NBG} + (b_{NBG} + a_{NBG})q_{NBG} \qquad (6)$$

where a_{NBG} refers to the access price and b_{NBG} refers to average variable cost of entrant's output[8]. The incumbent's cost function is as follows;

when $q_{BG} + q_{NBG} > \bar{n}$, the network has to expand beyond the pre-committed level;

$$C^1_{BG} = f_{BG} + (b_{BG} + a_N)q_{BG} + a_N q_{NBG} \qquad (7)$$

where a_N refers to the unit cost of the network and b_{BG} refers to average variable cost of BG's output. When $q_{BG} + q_{NBG} \leq \bar{n}$, there may be a possibility of excess capacity;

$$C^2_{BG} = f_{BG} + b_{BG}q_{BG} + a_N\bar{n} \qquad (8)$$

The marginal cost of entrant's output is;

$$mc_{NBG} = b_{NBG} + a_{NBG} \qquad (9)$$

While the marginal costs of the incumbent's output in the final goods market, when network expansion does not matter and when it does respectively, are;

$$mc^2_{BG} = b_{BG} \qquad (10)$$

and an additional marginal cost thereafter;

$$mc^1_{BG} = b_{BG} + a_N \qquad (11)$$

When network expansion does not matter, network cost is independent of output, taking into account the possibility of excess capacity. The cost is incurred prior to output production and becomes part of fixed cost. Conversely, when network expansion takes place, network cost

[6] In case of gas production, there is a one-to-one relationship between the final goods market output and the use of transportation services.

[7] This is not unusual, it would be the case for most networks for goods with daily variations in demand. The network has to have sufficient capacity to meet the peak or largest daily demand.

[8] The access charge is constant over a period of a year, as it depends on the competing firms output for that year and the methodology for charging for that particular year. The average variable cost, b_E, can vary and, as seen later, affects of the entrant's marginal cost and reaction function. This does not alter the outcome of the analysis which essentially is dependent on the incumbent's ability to manipulate it own marginal cost and reaction function.

incurred becomes dependent on output and the unit cost of capacity becomes part of marginal cost[9].

The impact on reaction functions and final goods output is as follows;
the incumbent's respective profits when expansion does matter and when it has engaged in large capacity pre-commitment are;

$$\pi^1_{BG} = q_{BG}(c - d(q_{BG} + q_{NBG}) - C^1_{BG}) \qquad (12)$$

and

$$\pi^2_{BG} = q_{BG}(c - d(q_{BG} + q_{NBG}) - C^2_{BG}) \qquad (12')$$

where industry price , $p = c - d(q_{BG} + q_{NBG})$, is a function of industry output. The respective reaction functions are;

$$R^1(q_{NBG}) = \frac{(c - dq_{NBG} - (b_{BG} + a_N))}{2d} \qquad (13)$$

and

$$R^2(q_{NBG}) = \frac{(c - dq_{NBG} - b_{BG})}{2d} \qquad (13')$$

where $R^2(q_{NBG}) > R^1(q_{NBG})$ and the respective incumbent's outputs are;

$$q^1_{BG} = \frac{c - 2(b_{BG} + a_N) + b_{NBG} + a_{NBG}}{3d} \qquad (14)$$

and

$$q^2_{BG} = \frac{c - 2b_{BG} + b_{NBG} + a_{NBG}}{3d} \qquad (14')$$

Though the incumbent, using its pre-entry advantage, engage in Stackelberg pre-commitments in "shared sunk-cost" capacity, the final goods outcome is more likely to depict a Cournot-Nash outcome. Hence, the outputs from equations (14) and (14') indicate that $q^2_{BG} > q^1_{BG}$.

If, on the other hand, the entrant has post-entry advantage and chooses to practice it, the large pre-commitment of capacity by the incumbent affects its profits;

$$\pi_{NBG} = f(q_{NBG}, R(q_{NBG})) \qquad (15)$$

[9] It may be more realistic to allow unit cost of output to vary. However, once again, this does not alter the analysis as long as the marginal cost when expansion matters is greater than marginal cost when output is within pre-committed network, that is equation (11) > (10), which is more than likely.

Its profit is a function of its own output and the incumbent's reaction function. Consequently;

$$\pi_{NBG} = q_{NBG}(c - d(q_{BG} + R(q_{NBG})) - C_{NBG}) \quad (16)$$

Therefore, the entrant's profits, even if it practises its post-entry advantage, is manipulated by incumbent's pre-entry advantage, that is it is reduced if the incumbent is operating on $R^2(q_{NBG})$ rather than $R^1(q_{NBG})$.

As the vertically integrated firm, BG is able to precommit the capacity, in the present case the transmission network. Consequently, it is able to predetermine the games "played" and outcomes during post-entry. The form of rate of return regulation also gave incentives to the incumbent to make large capacity pre-commitments. As the rate of return regulation is set higher than the cost of capital, it would be relatively "costless" for BG to pre-commit large transmission capacity, keeping the cost of excess capacity down.

There is every likelihood that both the incumbent and entrant's output would be within the precommitted capacity ($n_{BG} + n_{NBG} \leq \bar{n}$) and with the greater possibility of excess capacity ($x \geq 0$). Consequently, BG has lower marginal cost and operates on the *JJ'* reaction function in Figure 3. This considerably limits the entrant's post-entry advantage. In addition, the higher access price as result a increased capitalisation, or the Averch-Johnson effect, shifts the entrant's reaction function from RR' to *SS'*.

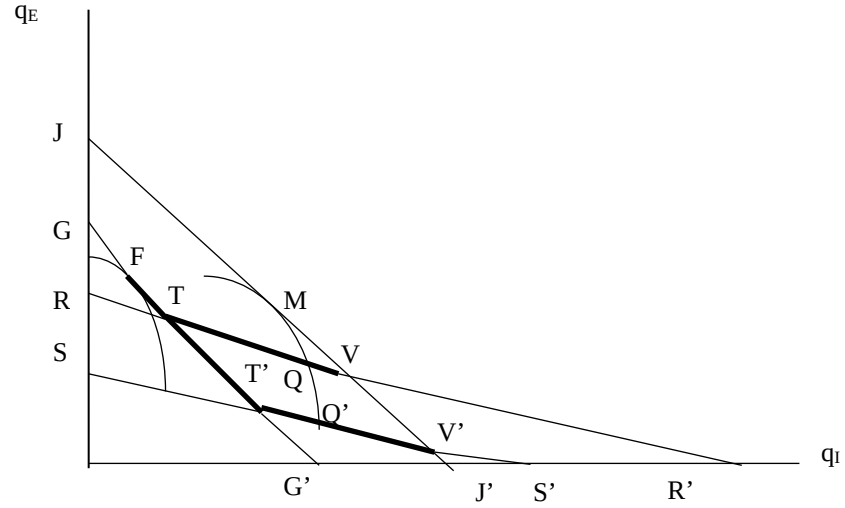


FIGURE 3: Stackelberg-Dixit and Averch-Johnson Effects

The issue of excess capacity is an important one for the Stackelberg-Dixit model. Large pre-commitment of capacity by an incumbent implies that there is excess capacity. Spence (1977) is unequivocal that an incumbent holds capacity idle to manipulate post-entry outcomes. However, Dixit (1980) suggest that this occurs when the equilibrium is not perfect equilibrium, in a game theory sense. Nevertheless, he maintains that with a concave demand

any capacity held by the incumbent is to manipulate post-entry outcomes. Though, excess capacity is sub-optimal, it is a by-product of the incumbent invoking its pre-entry strategic advantage. In Ofgas's review of transportation charges for 1997 (Ofgas (1996)), it proposed to reduce the valuation of Transco's asset base by 8%. One of the main reasons cited for such a move is its under utilisation[10]. Furthermore, in the early and mid-90s BG attempted to secure fixed gas supply, and engaged in "take-or-pay" contracts. They anticipated only small loss of market shares in the long run despite the public pricing policy, its participation in the "Gas Release Programme" and agreeing to give up a fair size of the contract gas market.

Figure 4 gives both BG and non-BG outputs. The entrants' output appears to expand at an increasing rate in mid/late 1992 and early 1993. This is consistent with the fall in access charges. Furthermore, BG's also participated in the "Gas Release Programme" and when they undertook to give up 60% of their market share. Both BG and non-BG outputs do not appear to have any distinct seasonal variations, confirming Ofgas's (1987) position that the demand for gas in the industrial and contract market has a low swing factor.

FIGURE 4:Outputs of British Gas(BG) and Non-British Gas(NBG)

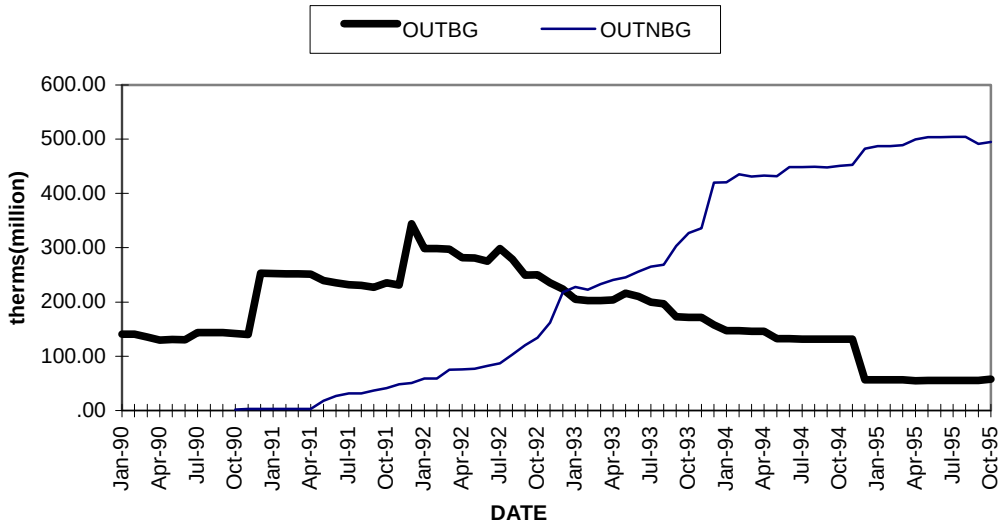
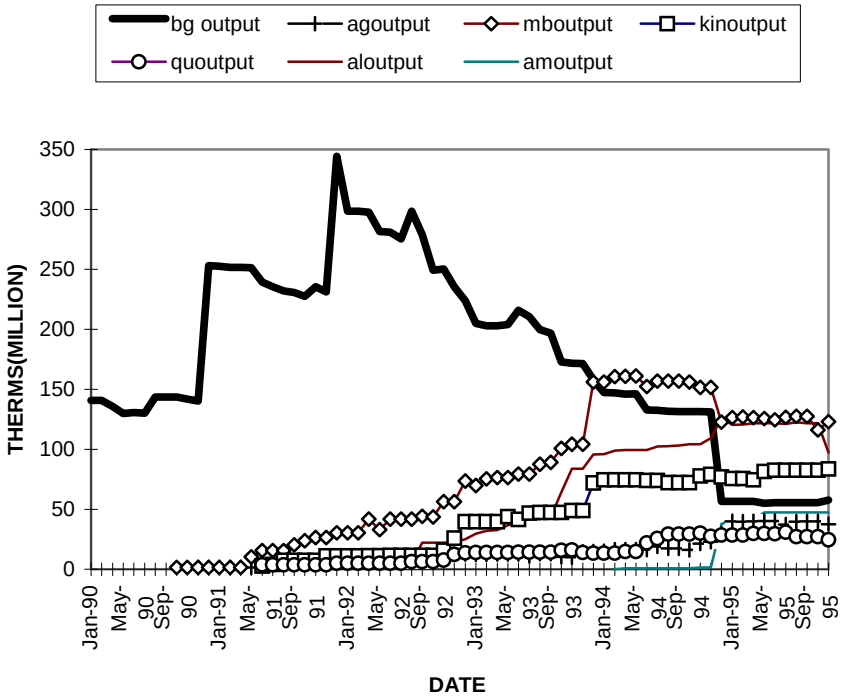


Figure 5 below gives a breakdown of the output of the main seven contract gas shippers; BG and six non-BG shippers.

[10] By the nature of peak related transmission services, there may be imbalances between the demand and utilisation of transportation networks during peak and off-peak periods, where the latter will be relatively under utilised. The regulator would be aware of this and take into account in its policies.

FIGURE 5:OUTPUT OF 7 MAIN GAS SUPPLIERS: 1990-1996



The dominant competing shipper is Mobil Gas whose output has consistently increased. The output of the other five competing shippers, including BG, have more or less remained around the same levels since mid/late 1994.

BG is able to limit the entry and regain any market share it lost by making large pre-commitments of capacity. Figure 4 and 5 indicates, as expected, BG experienced a dramatic fall in its output as it faced stiff competition from upstream firms. Nevertheless, from late 1994 and throughout 1995, this fall was halted and held constant around 50 million therms. More importantly, Figure 4 indicate that the sharp increase in entrant's output slows down to a constant from late 1993. In Figure 5, Mobil's, the main entrant shippers, output also slows down during the same period to a constant and subsequently falls. Though, BG started to price competitively at this time, Figures 1 and 2 indicate that there was no comparative advantage with respect to non-BG prices. Essentially, BG was able to limit the entrant's post-entry advantage while halting the fall in its market share, and subsequently regaining some loss ground.

The form of rate of return regulation adopted in a vertically integrated industry, clearly could give the incumbent undue post-entry strategic advantage. It enables the incumbent to manipulate both its own and the entrant's reaction function, that is the Averch-Johnson and the Stackelberg-Dixit effect. Distinguishing between the two effects is not straightforward.

The Averch-Johnson effect, in the context of the gas industry, implies that relatively lower peak related charges induces greater demand for interconnection. The greater capitalisation of the network to facilitate this increased demand implies higher access charges, and there is also the possibility of rebalancing within the cap. As indicated earlier, these are not issues that went unnoticed by Ofgas. However, this suggests that there should not be any significant excess capacity. More importantly. the incumbent, in this case, is interested in accumulating monopolistic rent for the provision of access, as the allowable rate of return is higher than the cost of capital, rather than deterring entry. The Stackelberg-Dixit effect, on the other hand, clearly seeks to deter entry and/or reduce an upstream firm's post-entry advantage and excess capacity is more than likely. As both models affect the entrant's and incumbent's reaction functions respectively, they could operate in tandem.

The two main strategic policies adopted by BG complemented each other. BG's adopts an intertemporal strategic behaviour. In the first period, they pursue a monopolistic pricing behaviour, and in the second period they have lower marginal cost, operating on a lower reaction function consistent as result of large capacity pre-commitments in the previous period. BG was able to disguise its long run behaviour[11].

V. Entrant Shippers Pricing Behaviour: An Empirical Analysis

The main entrant shippers into the contract gas market were, as anticipated by Ofgas, either wholly or partially owned by North Sea gas producers. Therefore they operate as upstream firms in the final goods, with post-entry advantage. In addition, non-BG entrants had "perfect" knowledge of BG's pricing due to the public pricing policy, and since formal third party carriages were introduced transportation charges fell continuously. Similar to the regulator, however, the entrant shippers would have been unaware of BG's intertemporal strategy.

The regular publication of BG's market share by Ofgas indicated that BG's market share fell dramatically, indicated in Figure 6 below. Given the post-entry advantage of the main entrant shippers and together with the existence of a public pricing policy and the fall in BG's market share, main entrant shippers' would identify each other as their main competitors in

[11] For example BG's relative "mark-up" or Lerner index, $\frac{p_{BG} - mc_{BG}}{p_{BG}}$, becomes higher.

the UK contract gas market. They would be concerned with each others strategic pricing behaviour while the “game” is being played.

FIGURE 6:BG'S MARKET SHARE,1990-1996

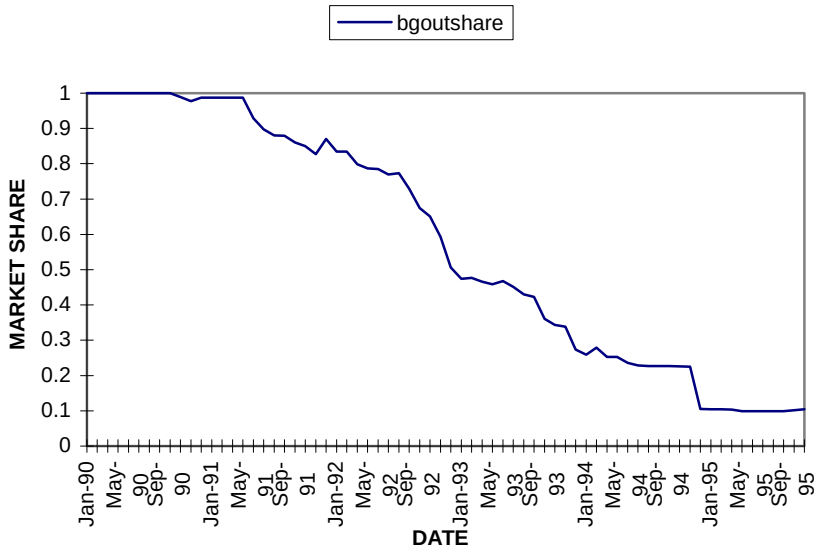


Figure 7 shows that the market share of the main four entrant shippers increased steadily, and had up to 50% of the contract gas market.

FIGURE 7:MARKET SHARE OF MAIN FOUR NON-BG SHIPPERS,1990-1996

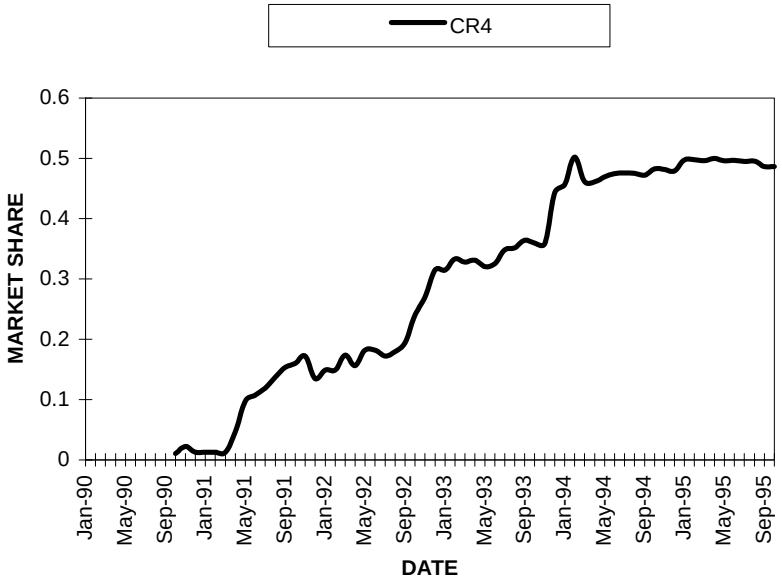
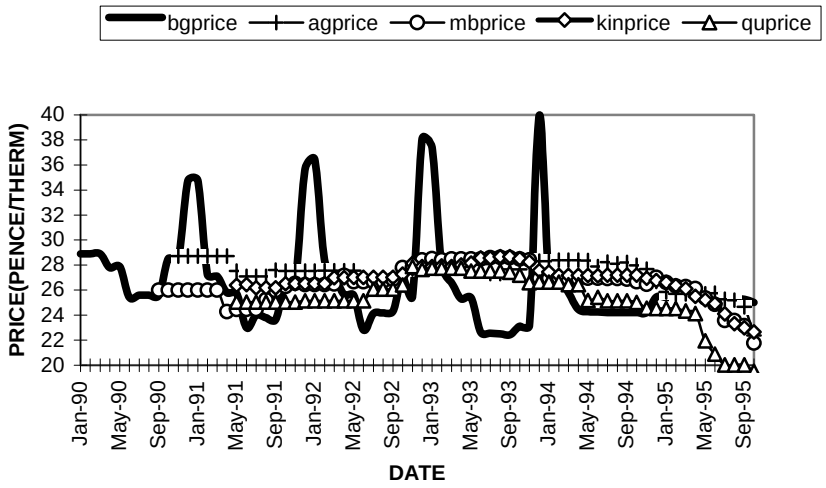


Figure 8 below depicts the volume weighted average of the main four entrant shippers. The price dispersion of the main four entrant shippers prices are low and close follow the average non-BG prices (see Figure 1)[12].

FIGURE 8:PRICES OF BG AND 4 MAIN ENTRANT SHIPPERS, 1990-1996



Besides being concerned about the behaviour of rival entrant firms, during the early stages of entering a new market some amount of uncertainty may prevail, such as market penetration or the willingness of consumers to switch.

The present section, empirically analyses the entrant shippers' pricing behaviour, and the impact of evolving market structure. This would give further insights into the evolving competitive process; market power and consequent pricing, thereby the future direction of competition and regulation policy.

Vi. Theoretical Considerations: Dynamic Economics

It assumed that, though, shippers had "perfect" knowledge industry demand, it had "imperfect" knowledge of rival entrants pricing behaviour, which it infers via a changing market structure[13]. In the present scenario, the state vector, x_t, consist of concentration ratio, demand and costs conditions which evolves according to the equations of motions,

$$CR_{t+1} = C\bar{R} + \rho_a(CR_t - C\bar{R}) + \eta^a_{t+1} \qquad (17.1)$$

$$Dd_{t+1} = D\bar{d} + \rho_b(Dd_t - D\bar{d}) + \eta^b_{t+1} \qquad (17.2)$$

[12] This consist with dynamic monopolistic or oligopolistic pricing behaviour, where the dominant firms would take the lead in price setting (Arrow (1959)).

[13] Dominant firms are able to infer their market power via the industry demand and its own output.

$$MC_{t+1} = \overline{MC} + \rho_c(MC_t - \overline{MC}) + \eta^c_{t+1} \qquad (17.3)$$

where $-1 < \rho_i < 1$ denoting autoregressive parameters, while η^i_{t+1} are zero-mean serially uncorrelated random variables, $i = a,b,c$. $\overline{CR}, \overline{Dd}$ and $\overline{MC}$ denotes the critical concentration ratio, average demand and marginal cost respectively.

Each period the managers' choices prices, the control variable, to maximise the industry's expected discounted net-profit stream

$$\max_{p_t} \Pi = E_t[\sum_{t=0}^{T} \beta^t \pi_t] \qquad (18)$$

where $0 < \beta < 1$ is the managers' discount factor. The optimal-value function, which satisfies

$$V(x_t) \max_{p_t} \pi(x_t, p_t) + \beta E_t[V(x_{t+1}|p_t), x_t] \qquad (19)$$

is continuous and concave, and the problem is a well behaved dynamic-programming exercise[14].

The optimal decision rule is similar to that shown in Vial (1972) and Slade(1998),

$$p_t = \delta_t(x_t) = p_{t-1} \quad \text{if } CR_t < \overline{CR}$$
$$p_t = \delta_t(x_t) = p^* \quad \text{if } CR_t \geq \overline{CR} \qquad (20)$$

The threshold is the critical concentration ratio ($\overline{CR}$). The current price would be set equal to lag prices when concentration ratios are low. On the other hand, managers' set prices at the equilibrium level (p^*), when the concentration ratio is at its critical level and beyond[15]. Therefore, the dynamic price path can be depicted as,

$$p(CR_t)dCR_t = \int_{CR_0^L}^{CR_t^L} \hat{p}(CR_t)dCR_t + \int_{CR_0^H}^{CR_t^H} p(CR_t)dCR_t \qquad (21)$$

Prices are set consistent with constrained and unconstrained optimisation during low and high concentration ratios.

[14] See Bertsekas (1987), pp. 65-67, where an analysis of a similar problem was undertaken.

[15] The equilibrium level prices refer to prices being set taking into account demand and cost condition. This is based on the constrained and unconstrained optimisation behaviour explaining monopolistic pricing behaviour outlined in Barro (1972). A more comprehensive analysis is done in Easaw and Smyth (1998).

V.ii Empirical Analysis and Results

The empirical analysis attempts to distinguish between periods of non-collusive, or low concentration ratio, and tacit collusion, or high concentration. Subsequently, examining the responsive of pricing behaviour to contemporaneous demand and cost conditions. The entrants shippers pricing behaviour is modelled and estimated as a non-linear switching regression. This, as suggested by equation (17), would enable us determine whether pricing behaviour changes when the industry is in periods of non-cooperative and collusive, associated with constrained and unconstrained optimisation. We use the Generalised Dummy Variable (GDV) version of non-linear switching regressions as outlined by Goldfeld and Quandt (1973). Here it set in a dynamic context, that is time-varying parameters;

$$y_t = \beta_0(1-D_t) + \gamma_0(D_t) + \sum_{j=1}^{k} (\beta_j(1-D_t) + \gamma_j(D_t))x_{j,t} + \varepsilon_{1,t}(1-D_t) + \varepsilon_{2,t}(D_t) \quad (22)$$

It assumed that there is an identifiable extraneous variable, which is defined as $D(z_t)$, a step or binary dummy variable function of z_t. When z_t is less than or equal to the unknown value z_0, then $D(z_t) = 0$, and if $z_t > z_0$, then $D(z_t) = 1$. $x_{j,t}$ is a vector explanatory variables, while β_j and γ_j denote the time parameters.

Rather than estimating equation (20) by treating $D(z_t)$ as a binary dummy variable, the problem is considerably simplified if $D(z_t)$ could be approximated by a continuous function of z_t. One such functional form, representing a continuous function, is the cumulative normal integral;

$$D(z_t) = \int_{-\infty}^{z_t} \frac{1}{\sqrt{2\Pi\sigma}} \exp\{-\frac{1}{2}(\frac{\xi-\mu}{\sigma})^2\} d\xi \quad (23)$$

where μ and σ are unknown. Importantly, μ plays the role of the unknown cut-off value z_0. On the other hand, σ express the tightness of the approximation to the ideal shape; as σ tends to zero, the approximation approaches the binary dummy variable or step-function.

An extension to the GDV version of non-linear switching regression modelling was put developed by Doran (1985). The first of these changes is to introduce another functional form representing a continuous function or an *S*-curve. The variable in question (z_t) is replaced by a logistic function. The GDV is determined as follows;

$$L_t(\mu,\sigma) = \{1 + \exp[\pi(\mu - Y_t) / \sigma\sqrt{3}]\}^{-1} \quad (24)$$

Secondly, the equation is estimated using a non-linear least squared estimator, rather than the maximum likelihood estimator which maximises the log-likelihood function[16].This enables a dynamic equation to follow a non-linear path (S-curve shape). The low and high levels of the extraneous variable, which follows a logistic function, are defined respectively as[17];

$$z_t^1 = \mu - 2.02\sigma \text{ and } z_t^2 = \mu - 2.02\sigma \quad (25)$$

where μ and σ are the "cut-off" value and smoothness of distribution respectively are to be estimated, as with the original model.

If the estimated $\hat{\mu}$ is non-zero and $\hat{\sigma}$ is not significantly different from zero, the logistic function reduces to the step function as with the ordinary binary dummy variable case. More importantly it implies there is only a single CCR. At the point of CCR, the firm ceases to behave competitively or uncooperatively and starts to collude tacitly. By allowing the slope to vary over time, we are able to observe what happens to price rigidity and demand cyclicality during periods when firms are behaving competitively and collusively.

If, on the other hand, the estimated $\hat{\sigma}$ is significantly different from zero, the CR can be characterised by three structural groups rather than two, and this implies that there is more than one CCR. At low levels of CR, below CR_t^1 where GDV is equal to zero, the firms behave non-cooperatively. Conversely, at high levels that is above CR_t^2 where GDV is equal to one, the firms behave collusively. However, at CR levels between CR_t^1 and CR_t^2, the price-concentration relationship is characterised by continuously increasing levels of collusion.

Pricing behaviour set in a dynamic context has to take into account disequlibium and adjustment analysis,

$$P_{NBG,t} = (\lambda) P_{NBG,t-1} + (1-\lambda) P^*_{NBG,t} \quad (26)$$

while equilibrium prices in logarithm,

$$P_{NBG,t} = \alpha_0 + \alpha_1 CR_{4,t} + \alpha_2 MC_t + \alpha_3 Dd_t \quad (27)$$

where α denotes constant elasticities, and when set in a dynamic context,

$$P_{NBG,t} = \beta_0 + \beta_1 P_{NBG,t-1} + \beta_2 CR_{4,t} + \beta_3 MC_t + \beta_4 Dd_t \quad (28)$$

[16] The use of a logistic distribution rather than a normal distribution and non-linear least squares estimator is mainly for computational convenience for practitioners.

[17] This refers to the confidence level constructed for the "cut-off" level, which is set at 95%.

where $\beta_1 = \lambda$ refers to price rigidity and $\beta_{2,3,4} = (1-\lambda)\gamma_{2,3,4}$.

In the present case when investigating oligopoly price movements between equilibrium or optimal points, it assumed that adjustment cost remains constant in the both non-collusive and collusive periods. However, with the practise of constrained and unconstrained profit maximisation, the cost of disequilibrium, that is the cost of being a non-optimum position differs. In the collusive periods, the cost should be higher than in the non-collusive periods when unconstrained profit maximisation is practised by the industry. Consequently, price rigidity is lower in the collusive period.

Following the exogenous non-linear switching regression, the equation to be estimated is as follows,

$$P_{NBG,t} = \beta_0 + \gamma_0 L(\mu,\sigma) + \sum_{j=1}^{k}[\beta_j + \gamma_j L(\mu,\sigma)]X_j + \varepsilon_t \quad (29)$$

where $k = 3$ and X_j are $P_{NBG,t-1}$, MC_t and Dd_t respectively. The analysis is extended here to a dynamic context, allowing for time-varying parameters. This not only establishes whether there is a single CCR, distinguishing between non-collusive and collusive periods, but also the time-varying oligopoly behaviour, such as price rigidity and cyclical behaviour when firms behave non-collusively and collusively respectively. Table 2 below gives the estimates using Non-Linear Least Squares estimators.

Table 2: Non-Linear and Time-Varying Estimation of Dynamic Oligopoly Pricing

Coefficients	Non-linear LS Estimation
μ	-1.1769[a]
	(4.5656)
σ	0.2288
	(0.6829)
β_0	-0.0088
	(0.0190)
γ_0	1.2302[b]
	(1.6486)
β_1	0.8799[a]
	(9.7027)
γ_1	-0.3178[a]
	(2.3652)
β_2	-0.0252
	(0.4079)
γ_2	0.3073[a]
	(2.5301)
β_3	0.1036

	(1.4090)		
γ_3	-0.2374[a]		
	(1.8972)		
No. of observations	49	Log-likelihood	152.7826
$\overline{R}^2$	0.9627	$\chi^{2\,LM}_{SC(1)}$	0.9260
F-statistic	138.4956	$\chi^{2\,LM}_{H(1)}$	0.1500
		$\chi^{2}_{RESET(1)}$	115.2395[a]

Notes: Figure in parentheses are (absolute) t-valves.
a denotes significance at the 5% level for a 2-tailed-test and a χ^2 distribution.
b denotes significance at the 10% level for a 2-tailed-test
SC,H,RESET and *LR* denotes test for serial correlation, heteroskedasticity, non-linearity

The non-linear estimates indicates the evolving nature of dynamic oligopoly behaviour. As $\hat{\sigma}$ is insignificant, the GDV now behaves as an ordinary binary variable. The results clearly indicate that there is only a significant single CCR ($\hat{\mu}$) and this is approximately 0.3. This the "cut-off" point, and beyond this point the firms behave collusively.

There is a positive intercept shift ($\hat{\beta}_0 + \hat{\gamma}_0$) at this point. At high levels of CR, price rigidity falls considerably as is indicated by; ($\hat{\beta}_1 + \hat{\gamma}_1$). Consistent with the dramatic reduction in price rigidity, is the responsiveness of prices to changes in cost. At low levels of CR, prices are not significantly responsive to changes in marginal cost, contrary to when the CR is high ($\hat{\beta}_2 + \hat{\gamma}_2$).

The impact of industry demand is unequivocal. At high levels of industry concentration, demand has a counter-cyclical effect($\hat{\beta}_3 + \hat{\gamma}_3$) (Rotemberg and Saloner (1986)). Conversely, at low levels of CR, the pricing behaviour does not respond to changes in industry demand($\hat{\beta}_3$). Similarly with respect to marginal costs of production, when firms are practising constrained optimisation, prices are not responsive to cost changes and the time varying price rigidity is consistent with this.

As discussed at the start of the section, at the non-cooperative period firms practise constrained optimisation, and as outlined in Barro (1972) they are not responsive to contemporaneous demand and cost changes or shocks. On the other hand, during the collusive phase, firms optimise fully, responsive to current demand and cost. Consequently, price rigidity is lower during the collusive periods. As stated earlier we assume that the cost of adjustment is constant, but cost of disequilibrium varies. The time preference for

optimising behaviour is lower during the non-cooperative periods as firms have less information of other firms behaviour. In the collusive phase, the main firms take the lead in price setting (Arrow (1959)). Therefore, the cost of disequilibrium, or not responding to market changes is higher.

VI. CONCLUSION: ISSUES FOR FUTURE POLICIES AND THEORIES

Price (1994) argued that Ofgas adopted a "carrot and stick" approach. Ofgas appreciated the competition that was developing in the contract gas market and removed a crucial disadvantage BG faced by suspending the requirement to publish their pricing schedules. Subsequently, Ofgas turned its attention to network access which became an integral part of its pro-competitive policies. The present analysis, however, argues that BG reacted to Ofgas's policies, manipulating the policies to invoke their strategic advantage. BG's intertemporal strategic behaviour implied that they were able to maintain a constant and fairly high level of price-cost margin throughout the period concerned. BG 's behaviour provide credence to Newbery's (1997) dictum that regulation is essentially inefficient.

Nevertheless, regulators are justifiably concerned with the transitory phase from a privatised monopoly to fully competitive market. Ofgas (1994) makes the case;

"Competition tends to eliminate cross-subsidies. It is natural for new entrants into a previously monopolistic market to target its most profitable, or cross-subsidising area first. To the extend the strategy is successful, the previous monopolists (in this case BG) risks being left increasingly with less profitable, or cross-subsidised, areas of the market. In absence of countervailing action, there would be pressure for relative prices to rise in these previously cross-subsidised areas of the market, where may have been below cost."

This may be a possible explanation why Ofgas did not object to BG's practise of third degree price discrimination, especially as Ofgas anticipated contestable outcomes in markets that where opened to competition. Therefore, policy-makers may be less concerned about third degree price discrimination in the transitory period, while wanting to eliminate first degree price discrimination. Clearly, BG gambled on this.

Essentially, the public pricing policy had important during the transitory period as competition increased and intensified when it was in operation. More importantly, as pointed out by Newbery (1997) the industry structure is crucial consideration, whether it a vertically integrated or separated industry. BG's use of entry-limiting strategic behaviour via capacity

pre-commitment was facilitated by a vertically integrated industry structure. Ofgas between the 1995 and 1997 engaged a very active policy towards BG's transportation operations. They adopted a very stringent policy, such as reducing BG Transco's allowable asset base. These policies eventually lead to the demerger of BG's operations in 1997. The creation of separate entities; Centrica Plc which controlled gas supply, while BG Plc concentrated on the transportation and storage operations. This effectively meant that the gas industry became vertically separated.

The form of access price regulation within a vertically integrated framework is also important. The form of regulation used in the gas industry, that is rate of return regulation higher than the cost of capital, gave the incumbent the necessary incentive to practise capacity pre-commitment. Furthermore, the network access price regulation such Efficient Component Pricing Regime (ECPR), put forward by Baumol and Sidak (1994), the access price comprises of the direct cost of providing access plus the incumbent's loss of profits[18], could also give an incumbent the incentive to engage in entry-limiting strategy.

While treating networks as a "sunk cost" or "shared sunk cost", it must be borne in mind that the short run cost network provision may diverge considerably from the long run cost. The object would be to bridge the gap, giving the necessary incentive to improve its efficiency while giving disincentives to invoking strategic behaviour. Such behaviour could lead to the wasteful use of natural monopoly resources or discouraging the entry of optimal network bypass.

Finally, the present analysis clearly shows that in the case of the contract gas market, when competition fully evolves, an oligopolistic market emerges, with high market concentration ratio. Clearly there are a few shippers that dominate the market which has lead to collusive outcomes. This raises doubts whether the pursuit of unfettered competitive would result in competitive outcomes. The analysis in Section V suggests that prices increases market concentration.

The outcomes and competitive process that result from pursuing deregulatory and a pro-competitive policies in the UK contract gas market are similar to that suggested by Norman and Thisse (1998). They maintain that in scenarios where firms may tacitly collude, it may be more efficient to regulate market concentration to improve welfare gains.

[18] Access prices determined by ECPR are; $A=AIC_N + (P_I-AIC_I)$, where AIC_N denote the Average Incremental Cost of providing network access and (P_I-AIC_I) denotes the incumbents profit rates in the retail market.

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