NETWORK ACCESS REGULATION AND COMPETITION POLICY:
THE UK CONTRACT GAS MARKET

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by

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To my wife, Alma. Whose patience, understanding, calmness and love was a constant source of inspiration throughout this research.
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ABSTRACT

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Increasingly policy-makers and regulatory theorists have focused on network access regulation. This thesis examines the role of network access regulation as part of a regulator’s overall competition policy or strategy to introduce competition into privatised industries. It examines in detail recent theoretical models of network access regulation.

The analysis is undertaken in the context of the UK contract gas market. British Gas (BG) was privatised in 1986, and the gas industry structure remained vertically integrated. The incumbent, or in the present case, BG, retains control of the gas network transmission while competing in the final goods, or retail, market. The present research provides a theoretical framework examining the impact of regulatory and competition policies, with respect to both the final goods market and network access, on the competitive process in the contract gas market. This is done using a unique dataset on the UK contract gas market made available by a leading gas analyst and broker; John Hall Associates. The theoretical analysis distinguishes between the potential strategic advantage of both BG and the main competing shippers. BG, as the incumbent in the vertically integrated industry, has pre-entry advantages, while the main competing shippers who are wholly or partially owned by North Sea gas producers and operate as downstream firms in the retail market potentially have post-entry advantage.

The entrants pricing behaviour followed a distinct and separate path to that of BG’s. An empirical analysis of the entrants’ pricing behaviour is conducted. This is done within the context of supergames or repeated games explanation of dynamic oligopoly behaviour. The relationship between access charges and market structure, or the level of market concentration is also empirically established, which shows the impact of access charges on the competitive process, market structure and final goods prices. The estimates are used to give an empirical application of the “Direct-plus-Opportunity Cost Regime” (DORC) model of access pricing. Consequently, the various policy options and choices open to a policy-maker are considered.
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CHAPTER 1: INTRODUCTION
CHAPTER I: INTRODUCTION

Network access regulation is an integral part of competition policy. Policy-makers have increasingly focused on network access regulation when pursuing pro-competitive policies. Access price regimes have a direct effect on the competitive process of an industry, particularly the market structure and final goods market, or retail market, pricing behaviour.

Regulation in the gas industry, which was privatised as a vertically integrated industry, is not an exception to this trend. Indeed, the network access, or transportation charge, regulation has featured prominently as competition was introduced in the contract gas market. Indeed, as far as Ofgas is concerned, the importance of transportation charges cannot be understated. The opening paragraph of the Ofgas (December 1993) consultation paper, “A Pricing Structure for Gas Transportation and Storage: A Consultation Document” states;

“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.”

This thesis focuses on the UK contract gas market and recent theoretical models of network access pricing. First and foremost, it provides a theoretical analysis of the impact of regulatory and competitive policies, relating to both final goods market and network access regulation, in the contract gas market, and the impact on the competitive process, in particular pricing behaviour and outputs. Ofgas vigorously pursued pro-competitive polices in the contract gas market, while attempting to reduce British Gas’s (BG) strategic advantage. The theoretical analysis is done together with a
unique dataset made available by a leading gas analyst and broker, John Hall
Associates.

Secondly, an empirical analysis of the entrants’ pricing behaviour is undertaken
in the context of the evolving competitive process that followed the introduction of
pro-competitive policies. The theoretical framework is the *supergames* or *repeated
games* models of dynamic oligopoly pricing behaviour. Thirdly, the empirical analysis
of the entrants’ pricing behaviour provides the basis for an empirical application of
network access charges based on “Direct-plus-Opportunity Cost Regime” (DOCR),
enables various policy options or choices to be examined, in particular, comparing the
competitive process outcomes when access prices are based on direct-plus-opportunity
cost and direct cost of provision such as Long-Run Marginal Cost (LRMC).

The main and original contribution of this thesis is as follows;
1. It provides a theoretical and empirical analysis of the competitive process in the
contract gas market as a result of the regulatory policies pursued. This is based on a
unique dataset.
2. An empirical application of access prices based on DOCR is undertaken. The
resultant outcomes enable the policy implications and the various options a
regulator may wish to pursue, while engaging in pro-competitive policies, to be
considered.
3. A non-linear model is developed for estimating time-varying oligopoly pricing
behaviour, which is implied by supergames theories. It is an extension of non-linear
regime switching regression and Generalised Dummy Variable models put forward
CHAPTER I: INTRODUCTION

by Goldfeld and Quandt (1973) and Doran (1985). The extension enabled the impact of market structure, or market concentration, on price rigidity and cyclicality to be examined. Furthermore, the emerging and evolving oligopolistic competition in the contract gas market make it an interesting application.

4. Finally, the insights given by supergames theory and the non-linear estimates, provide a basis for the possibility of re-examining final goods market and access regulation policy. This is discussed in terms of future research to be undertaken.

The summary of the respective chapters is as follows;

Chapter 2:

This chapter conducts a survey and review of recent network access pricing theories. It reviews “direct-plus-opportunity cost” models, those that were put forward by Armstrong and Vickers (1995), Armstrong et al (1996), Baumol and Sidak (1994) and Baumol et al (1997). It also focuses on Ramsey Rule models, put forward by Laffont and Tirole (1994) and (1996). The survey is largely confined to published books and papers published in referred journals and discussion paper series. As access price regulation is part of an overall competition policy, a review of the main issues relating to competition policy is also examined.

Chapter 3:

It examines the regulatory and competition policies undertaken by the policy-makers, such as Ofgas, Monopolies and Mergers Commission (MMC) and Office of Fair Trading (OFT), with regards to the contract gas market. Policies relating to both the final goods market and transportation charges (network access) are also considered. A public pricing policy was introduced to eliminate anti-competitive
practices. BG, the incumbent, was required to publish pricing publishes schedules in the contract gas market, and very stringent conditions were imposed with regard to changing them.

Transportation charges were subject to Rate of Return (ROR) regulation. The allowable rate of return on current assets is higher than the cost of capital. This was to ensure that there was sufficient incentive for BG to invest in its transmission network. Though the overall transportation charge cap is based on ROR, Ofgas introduced a methodology for determining actual access charges based on a LRMC methodology, particularly with respect to the National Transmission System element of the transportation charges, which make up to 70% of total charges.

The theoretical analysis of possible outcomes and scenarios, given the competition policy and relative strategic advantage of the incumbent and entrants, are considered. Distinction is made between pre-entry and post-entry advantage. BG, as the incumbent in a vertically integrated industry, has pre-entry advantage. The main entrant shippers into the contract gas market are either wholly or partially owned by North Sea gas producers and, therefore, operate as upstream firms in the retail market.

Chapter 4:

Chapter 4 examines the competitive process in the contract gas market using the dataset provided by John Hall Associates. BG's and the main entrant shippers' respective volume weighted average prices and outputs are examined. The analysis indicate that BG reacted to the regulatory measures introduced, invoking its strategic advantage to manipulate post-entry outcomes.
BG practised inter-temporal pricing strategies when the public pricing policy was in place. BG used the access regulation adopted to manipulate access prices and make large network capacity pre-commitments to keep its marginal cost in the final goods market low and pre-determine outcomes in the final goods market. Chapters 3 and 4 are the basis of a joint paper with Professor Huw Dixon, a version was presented at the Energy Economics Conference, University of Warwick (see Dixon and Easaw (1997)).

Chapter 5:

The chapter examines the pricing behaviour of the entrant shippers, whose pricing behaviour is distinct and followed a separate path to that of BG. The theoretical framework used to explain entrants' pricing behaviour is based on dynamic oligopoly models, especially supergames or repeated games models.

The empirical analysis takes two forms; (i) a linear or constant parameter model, and (ii) a non-linear model, capturing the time-varying oligopoly pricing behaviour. The linear model is estimated using Ordinary Least Squares estimators and is done in Microfit Version 3.0. The non-linear model is estimated using Non-Linear Least Squares estimators and is estimated in Gauss. The results indicate that the entrants' pricing behaviour is fairly consistent with supergames explanation of dynamic oligopoly behaviour.
**Chapter 6:**

The objective here is to undertake an empirical application of "Direct-plus-Opportunity Cost Regime" (DOCR). This is based on the empirical analysis conducted in the previous chapter. Prior to embarking on the empirical application, the direct impact of access charges on the market structure, or concentration ratio, is established. Subsequently, policy simulations are done using a reduced-form of the linear model estimated in Chapter 5.

The stochastic policy simulation takes a reduced-form as it incorporates the estimated equation which establishes the relationship between concentration ratio and access charges. The results indicate that when access charges based on DOCR are applied, the entrants’ price follows the incumbent’s very closely. Policy implications and options are subsequently considered. Though the policy simulations are conducted with respect to analysis done in the contract gas market, the policy implications are done in a more general context. This is the basis of a paper presented at the *London Business School Regulatory Initiative Seminar* in May 1997. The estimations and simulations undertaken in the chapter was done in *Microfit version 3.0*.

**Chapter 7:**

The concluding chapter gives a summary of the main issues discussed in the thesis. In addition, it considers possible future research with regards regulation theory and direction of competition policy. This is done in the context of the supergames models and empirical results in Chapter 5. The simulations in this chapter were done in *Matlab*. 
CHAPTER 2: NETWORK ACCESS PRICING MODELS AND COMPETITION POLICY: A LITERATURE SURVEY OF RECENT THEORIES AND A REVIEW OF THE RELEVANT ISSUES

Section 1: Introduction

Section 2: Regulator and Policy-Maker’s Objectives and Issues to be Considered

Section 3: Recent Theoretical Models of Access Regimes

Section 4: Reconstruction of Ramsey Rule and ECPR: A Synthesis Approach

Section 5: Wider Considerations and Other Issues: A Policy-Makers Perspective

Section 6: Concluding Remarks and Summary of Literature Review
Section 1: Introduction:

Industries that have expensive reticulated delivery or transmission systems, such as telecommunication, electricity, natural gas, water, railways and postal services, have been heavily regulated since their inception. There are two general reasons for this;

(1) without regulation, monopolies will emerge and maximise profit to society’s detriment, and

(2) social objectives, such as the delivery of universal service, can only be achieved by intervention in the market.

In recent years, the direction of regulatory practice has been to introduce competition into these monopoly industries. Indeed, the traditional view of regulation is that as competition increases government regulation eases or is no longer necessary. Newbery (1997) in his Presidential Address to the European Economic Society states;

“Privatisation of utilities is about ownership rather than control. Liberalisation can induce greater improvements in performance than privatisation alone.”

His basic premise is that introducing competition into previously monopolised and regulated network utilities is the key to achieving the full benefits of privatisation. Privatisation is a necessary but not sufficient condition for increasing efficiency, while;

“Regulation is inevitably inefficient. Replacing regulation by competition for network services can increase efficiency.”
CHAPTER 2: LITERATURE REVIEW

The opening of an industry to competition, however, is not simply a case of deregulation. One may argue that the introduction of competition needs just as much regulatory support, mainly to ensure reasonable access to natural monopoly networks. This is particularly important in reticulated industries where distribution networks are:

1. controlled by incumbents,
2. extremely difficult to reproduce in the short run, and
3. essential for the supply of competitive services.

In addition, regulation may also be required to ensure that in the new competitive environment, social goals, such as universal service obligations, are maintained.\(^1\)

Interconnection charges can be determined in several ways and they differ with the discretion allowed to the integrated firm. The various options include:

1. the regulator determining access terms,
2. the regulator allowing the firm to choose from a series of alternative regulatory schemes,
3. the firm having discretion over aspects of access pricing subject to some overall regulatory constraint, and
4. the firm having discretion over access pricing subject only to the provisions of antitrust law.

The theory of optimal regulation applies when options (1) and (2) are adopted. The theory is also applicable in the last two options, where issues of predatory access pricing can arise.

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\(^1\)This issue and the importance of regulation, beyond network access regulation, when competition is introduced is discussed in greater detail later in this chapter when the application of Efficiency Component Pricing (ECPR) is discussed and again in Chapter 6.
CHAPTER 2: LITERATURE REVIEW

There are certain important issues a policy-maker or regulator needs to consider when determining its competition policy and consequently the forms of regulation to be undertaken with respect to both final goods regulation and access charges. Two issues in particular are;

1. Allocative and Productive efficiency:

Allocative efficiency refers to prices reflecting the marginal cost of provision, \( P \approx MC^2 \). While productive efficiency implies that the entrant into the competitive market must be at least as efficient as the incumbent, \( MC_I \geq MC_E \).

2. Efficiency and Equity:

Efficiency, in the economic sense, relates to allocative and productive efficiency. It implies attaining Ramsey-optimal prices, that is second best prices, in the final goods market as well as the input market, resulting in cross-subsidisation being eliminated. However, the regulator may take into account wider considerations such cross-subsidisation from highly profitable segments to less profitable segments which are distortionary from an economic efficiency point of view. Furthermore, a regulator, when maximising total welfare, may not give equal weight to the net gain in consumer and producer surplus. Indeed, they may pursue pro-competitive policies where net gains in consumer surplus are at the expense of gains in producer surplus, thereby violating the productive efficiency criterion. This is examined again in Section 5. These issues will be a recurring theme throughout the present thesis.

2 This represents first best pricing, however, public utilities pricing theory maintain that second best or Ramsey-optimal is optimal or efficient.
CHAPTER 2: LITERATURE REVIEW

The purpose of the present chapter is to raise some of the main issues to be considered when determining an appropriate access pricing regime, which is highlighted in Section 2. This sets the agenda to review the currently debated theoretical models of access or interconnection charges. These models, their relative strengths and applicability are considered in Sections 3 and 4. Other wider issues and considerations not covered by these models, are examined in Section 5, while a summary with concluding remarks are found in Section 6.

Section 2: The Regulator's Objective and Issues to be Considered:

The present section identifies some of the more important general issues that need to be considered when determining an access price regime. The regulator has several objectives when promoting competition. These are consequently reflected in the methodology for access charging or access price regimes. The main regulator's objectives are;

1. Ensuring Equitable and Efficient Entry:

The current stage of the privatisation programme has been to introduce wide and far reaching competition. One of the key motivations for privatising public utilities in the first instance, is to improve efficiency as well as net welfare benefit. When considering introducing competition, issues such as predatory and discriminatory practises by both the incumbent and entrants need to be accounted for. The key element in the formulation of network access pricing models, is to ensure an equitable and efficient entry for competitors.

3 The analysis is largely confined to published work, in referred journals and discussion paper series.
2. Maximising Total Welfare:

Total welfare comprises of producer and consumer surplus. Any introduction of competition should not erode total welfare, which is a concern of regulators, and needs to be reflected in any access price formulation. It must be noted that regulators need not necessarily give equal weight to the charges of producers’ and consumers’ surplus. Indeed, in many cases they may be compelled to promote consumer surplus at the expense of producer surplus. This issue is examined again in detail in Section 5 in the present chapter.

3. Incumbent’s Balanced Budget:

A recurrent theme in the formulation of access pricing is to ensure that the incumbent is able to break-even⁴. This is the basis of Ramsey- optimal or second best pricing.

⁴ This is examined in detail in Section 4 when the current theoretical models are discussed.
4. Distinction between Competitive and non-Competitive Segments:

Despite the extensive introduction of competition in the profitable segments, there still remain services that are not open to, or desirable for competition, nevertheless, the incumbent is required to provide these services as part of their Universal Services Obligations. Under these obligations, the regulated final goods prices of the incumbent in the competitive sector, may reflect cross-subsidisation that takes place between the competitive and non-competitive sector. Subsequently, regulators, when deciding on a network access regime, have the option of choosing one that reflects optimal or efficient pricing or one that ensures equitable provision, especially in the non-competitive segment. Optimal, or second best pricing, implies that any form of cross-subsidisation, or transfer pricing, is distortionary.

The first objective partially relates to productive efficiency. The second and third objective relates to the issue of optimality; therefore the corresponding access prices should be Ramsey-optimal or second best pricing. The regulator’s final objective raises the conflicting goal of attaining economic efficiency and equity which was highlighted in the introductory section.

Besides the regulator’s aim, there are two other important issues that need to be considered when modelling access pricing policy:

(1) The provision of “bottleneck services”:

The incumbent may be providing “bottleneck” or “essential services”. Network provision is deemed to be a natural monopoly. This, however, is very much technology driven. In industries such as telecommunications, where there are considerable
opportunities for technological innovations, the existence of a natural monopoly network are more tenuous. Therefore, there exist opportunities for alternative networks and the possibility of bypass.

(2) Industry Structure:

The issue of industry structure; “vertical integration or separation” is of crucial importance. The former refers to an industry structure where the incumbent who owns the bottleneck services also provides and competes in the final goods market. Vertical separation relates to the industry structure, where the ownership and the provision of networks and final goods services are separated.

The question of whether a network industry is vertically integrated or separated, basically depends on the extent of vertical economies and on the costs of regulation. A separated industry is easier to regulate, as the issue of the relevant cost is straightforward and relates to direct cost. However, the extent of vertical economies in some industries may be strong, and consequently the additional burden of regulating access prices may be offset by economies in joint production (Caves and Doyle (1994))\(^5\). Vickers (1995) argue that in vertically integrated industries, where the incumbent’s final market prices are regulated, the regulator’s task is more difficult as the possibility of incumbent’s anti-competitive practices has to be dealt with. On the other hand, it may lead to there being fewer firms entering the deregulated sector and less duplication of fixed cost, thereby reducing excess entry.

\(^5\) A more extensive discussion of this basic principle is to be found in Armstrong, Cowan and Vickers (1994).
Newbery (1997) takes a different perspective on what determines industry structure. He maintains that the best way to generate and safeguard rents for distribution to the incumbent interest groups is to maximise the horizontal and vertical extent of the utility's monopoly. Minimising these monopoly extensions, shifts the balance to the consumers. He asserts that well-organised groups have succeeded in capturing the rents at the expense of consumers. However, Newbery (1997) cites three reasons why a vertically integrated industry would not be contrary to consumer interest;

(1) Vertical integration enhances the industry’s ability to control information to defend its interest,

(2) As with Cave and Doyle (1994), the standard argument of economies of scale and scope make integration efficient, and

(3) The disenfranchising of different stages increases risk, as prices for intermediate services reallocate profits up or downstream, while competition increases risk directly.

The last reason is particularly important: a franchise monopoly, protected against entry, lowers the cost of capital by reducing market risk, and enables politically desirable cross-subsidies to be financed directly. As outlined before, this is an important regulatory consideration, if not on economic grounds, definitely on political grounds. The present analysis is confined to vertically integrated industries and access price models that relate directly to this industry structure.

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6 As discussed in detail in the next chapter, the gas industry was privatised as a vertically integrated industry and operated as one until mid 1997. The voluntary demerger of BG's operations could highlight the problems with vertically integrated utilities particularly if the network has a strong natural monopoly status, this is examined in Chapter 2. Indeed, the vertical separation of the
Vertically integrated industry is depicted by the diagram below;

**The Vertically - Integrated Network Access Structure:**

- **I**: Vertically Integrated Incumbent
- **E**: Entrant
- **B**: Alternative source of input (bypass)
- **P**: Incumbent's final goods price
- **p**: Entrant's final goods prices
- **a**: Access price

Electricity industry at privatisation was in part to do with the difficulty faced by competitors needing access to a vertically integrated network monopoly (Newbery (1997)).
The diagram above indicates that, in a vertically integrated industry, the incumbent owns the monopoly input which is used in the production of its output. The entrant, on the other hand, can either interconnect into the existing network by paying an access charge, or invest in an alternative network or bypass. It must be pointed out that the entrant has the option to use both the existing network and bypass. It may be more efficient for it to use the existing network for part of its production process.

Basically, a regulator when determining interconnection policy should endeavour to achieve three main goals;

(1) to ensure access to the bottleneck distribution network at prices likely to lead to effective retail competition.

(2) to ensure competitive returns on investments. In addition, if social objectives are imposed on incumbents, or regulatory change leads to the stranding of assets, interconnection policy may also have to cover these costs or losses.

(3) to provide market incentives to innovate.

Finally, access or interconnection pricing model or regime needs to be scrutinised with respect to; (a) an appropriate theoretical benchmark as its basis, and (b) the ability to adopt it into a practical regulatory framework. Basically, the incumbent provides the essential input which the competitor could use for the production of its final goods. The competitor may also have access to alternative sources of essential inputs, making partial or complete bypass possible. Essentially, the basic access pricing model would be;

\[ a^* = \text{direct cost of provision} + \text{"mark-up"} \]
CHAPTER 2: LITERATURE REVIEW

The main contentious issue in the theoretical models is not the existence of the "mark-up" element, but what form it should take. At a secondary level, the models also differ in the appropriate direct cost of provision to be used. The two options are marginal cost or average incremental cost. These issues are investigated in detail in Section 3.

Section 3: Recent Theoretical Models of Access Regimes:

The present section initially examines briefly two of the more common access price models that have been used. Subsequently, the focus is on the recently debated theoretical models.

3.1. Existing Regimes:

3.1.1. Fully Distributed Costs (FDCs):

Here the common cost is allocated by some standard accounting rule, there are several rules that could be applied. One such rule is to allocate fixed costs proportional to the amount of essential input that is consumed. In the "output-proportional mark-ups", the total incumbent’s profits, from the provision of both non and competitive services and access, cover the fixed cost hence the incumbent’s budget is balanced. Access price, consequently, resembles:

\[ a^* = c_0 + \frac{k_0}{Q} \]  \hspace{1cm} (2.3.1)
where $c_0$ refers to the average incremental cost (AIC)\(^7\) of the non-competitive sector, 

$k_0$ denotes the fixed cost of network and $Q$ refers to the total use of the network and is;

$$Q = q_0 + q_1 + q_2$$ \hspace{1cm} (2.3.2)

where $q_0$, $q_1$ and $q_2$ refer to the portion of the network used for the incumbent’s non and competitive sector output and the entrant’s output respectively.

An alternative mark-up rule, in the FDC regime, is “marginal-cost proportional mark-ups”. The proportion of mark-up is chosen to satisfy the budget constraint;

$$a* = c_0 (1 + \delta)$$ \hspace{1cm} (2.3.3)

where $\delta$ refers to the coefficient of proportion chosen to satisfy the budget constraint.

Both rules associated with the FDC regimes are cost based. The second rule allows for a higher mark-up in the competitive segment than in the non-competitive segment. Furthermore, it does not restrict inefficient entry, hence, allocative efficiency is unobtainable under the “marginal-cost proportional mark-up” rule.

Some deficiencies have been identified with respect to the FDC regime. The two more serious drawbacks are;

1. as both the rules are cost based, there are few incentives for the incumbent to reduce cost and increase its efficiency, and

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\(^7\) AIC is defined and its role explained in the following section.
(2) the FDC regime does not practise any discrimination so consequently it is non-optimal. As it is cost based, there is tendency to subsidise inelastic demand users at the expenses of elastic users.

Under the output-proportional mark-ups, where the non-competitive sector prices may be strictly regulated, it may not be reflective of the actual cost of providing the services in that sector. The need to ensure a balanced budget means a higher mark-up in the competitive sector. The consequences of this non-optimal practice, that is cross subsidisation, is that the competitive segment becomes particularly attractive to entrants seeking highly profitable segments. Under this rule where distinction is not made between the competitive sector this could result in "cream-skimming" with the incumbent left unable to attain productive efficiency.

3.1.2. Access Deficit Contribution (ADC) Rule:

This is a usage based rule that has been adopted by Oftel, and often referred to as the "Oftel Rule". The entrant pays an "access deficit contribution" to the incumbent. This is proportional to the relative profitability per unit made by the incumbent when providing the final goods. The access under this rule would be:

$$a^* = c_0 + \frac{k_0}{q_1} \frac{B_1}{B_0 + B_1 + B_2}$$  \hspace{1cm} (2.3.4)

where $k_0$ refers to the fixed cost, $q_1$ refers to the incumbent's output in the competitive sector, while $B_0$, $B_1$ and $B_2$ refers to the incumbent's profits from the non and competitive segment and the sale access to the entrant respectively. The ADC rule is based on the same principles of Efficient Component Pricing Regime (ECPR)
and, as stated by Laffont and Tirole (1996), has been superseded by it as a theoretical framework and is investigated in the next section.

3.2. Current Debated Theoretical Models of Access Charge:

Recent debates among regulation theorists on the issue of access charges have focused on two particular models; Ramsey Rule and Efficiency Component Pricing Regime (ECPR). Both these theories in their original form differ in focus and theoretical foundations, hence they advocate different objectives and agendas on the practice of regulation in general. Nevertheless, theoretical models have been put forward which attempt to synthesise these models, and bring together their different objectives. This section investigates these models, analysing their objectives, strengths and weaknesses.

3.2.1. Ramsey Rule:

The origins of Ramsey Rule lies in the classical work by Ramsey (1927) advocating an optimal tax policy. This was adapted for public utility pricing by Boiteux (1956) and has been very influential in regulation theory. The main advocates of the Ramsey Rule for network access pricing are Laffont and Tirole (see Laffont and Tirole (1994) and (1996)). The Ramsey Rule is based on two assumptions; firstly, the theoretical foundation of the rule is based on second-best pricing, and is allocatively efficient, and secondly, access input is treated as a final good.

Ramsey rule is formulated by maximising total welfare subject to break-even constraints;
total welfare \( (w) \) = consumer surplus + producers surplus

\[
W = v(p_1, p_2) + \pi_I + \pi_E \quad (2.3.5)
\]

subject to;

\[
\pi_I \geq 0 \quad (2.3.5')
\]

where \( p_1 \) and \( p_2 \) are the competitive segment price of the incumbent and entrant respectively and \( \pi_I \) and \( \pi_E \) are the overall profits of the incumbent and fringe respectively. In a common and straightforward scenario where the entrant is deemed not to have any market power, the entrant would price at;

\[
p_2 = a* + c_2 \quad (2.3.6)
\]

where \( c_2 \) refers to the entrants marginal cost in the competitive sector.

Laffont and Tirole (1994) point out that an alternative way of looking at the maximising problem is to treat the entrant’s output as the incumbent’s output which is supplied at the entrant’s final goods price. This transformation allows the access good to become a final good, and the final good which would have been supplied by the entrant is priced at;

\[
p_2 = c_0 + c_2 \quad (2.3.7)
\]

Therefore, the outcome and assumption here is that the incumbent does not make a profit on the sale of access input\(^8\), hence the maximising problem is now stated as;

\[
W = v(p_1, p_2) + q_0(p_0 - c_0) + q_1(p_1 - c_0 - c_1) + q_2(p_2 - c_0 - c_2)
\]

\[(2.3.8)\]

\(^8\) Indeed, this is in the spirit of second best pricing policy.
subject to;
\[ q_0(p_0 - c_0) + q_1(p_1 - c_0 - c_1) \geq 0 \] (2.3.8')

where \( c_0, c_1 \) and \( c_2 \) refer to the marginal cost of the access input or the incumbent's output in the non-competitive sector\(^9\), marginal cost of the incumbent's output in the competitive sector and the marginal cost of the entrant's output in the competitive sector. From the first-order conditions for the respective prices, one can derive the Lerner indices which, in turn, gives the standard Ramsey-Boiteux formulas;

\[
\frac{p_0 - c_0}{p_0} = \frac{\lambda}{1 + \lambda \hat{\eta}_0}
\]

\[
\frac{p_0 - c_0 - c_1}{p_0} = \frac{\lambda}{1 + \lambda \hat{\eta}_1}
\]

\[
\frac{p_0 - c_0 - c_2}{p_0} = \frac{\lambda}{1 + \lambda \hat{\eta}_2}
\]

where \( \hat{\eta} \) denotes "superelasticities"\(^10\) which are modified elasticities taking into account substitution and complementary goods and \( \lambda \) denotes the shadow price or weight given to the break-even budget constraint. From equation (2.3.6), the access price is;

\[
a^* = p_2 - c_2
\]

(2.3.10)

and therefore from the formula (equation (2.3.9)), the optimal access price is;

\[
a^* = c_0 + \frac{\lambda}{1 + \lambda \hat{\eta}_2} \frac{p_2}{p_0}
\]

(2.3.11)

\(^9\) This relates to the telecommunications industry, therefore the local loop is non-competitive and a necessary input for the long-distance sector which is deemed the competitive sector.

\(^{10}\) The concept of "superelasticities" and its application in public utility pricing is extensively discussed in Brown and Silbey (1986)
Therefore, the optimal access price is equal to the marginal cost of access input plus a mark-up. The mark-up depends on the shadow price of the incumbent's break-even constraint, the final goods price and, finally, the superelasticity which the entrant faces.

3.2.2 Efficient Component Pricing Rule (ECPR):

ECPR or the Baumol-Willig rule was originally expounded by Willig (1979) and further expanded as an access pricing rule by Baumol and Sidak (1994). Once again when examining ECPR, two crucial issues have to be borne in mind. Firstly, the theoretical foundation of ECPR is the theory of contestability (see Baumol et al (1982)) and secondly, it accepts and works in tandem with the existing final goods regulation and policy, regardless of whether it was optimal or not.

Within the contestable market framework, Baumol and Willig have argued that access price should, as its mark-up, include opportunity cost in the form of loss of profits to the incumbent as a result of entry. Furthermore, the use of contestability warrants that the most appropriate costs are Average Incremental Cost (AIC). Access price according to ECPR is:

\[ a^* = c_0 + (p_1 - c_1) \]  

(2.3.12)

---

11 This relates to the "efficiency versus equity" debate highlighted, and will be dealt in greater detail later in the chapter.

12 The definition of the various types of cost and their appropriateness is examined later. AIC takes into account the firm's total cost. As highlighted in Baumol et al (1982) in a single product case, average cost is appropriate, but in a multi-product case, average cost is not well defined and AIC is deemed more appropriate. A comprehensive discussion on the appropriate type of cost for contestable outcomes is found in Baumol et al (1982) and Reid (1991).
where \( c_0 \) is the direct AIC of providing access, \( p_1 \) is the incumbent’s competitive segment’s price and \( c_1 \) is the incumbent’s AIC for supplying in the competitive segment.

The relevant cost concepts can be referred to as the “competitive-market model of regulation” and, according to Baumol and Sidak (1994), seeks to simulate the outcomes of a perfectly contestable market. They are:

1. **Marginal Cost of \( X \):**
   
   The marginal cost of \( X \) refers to the increase in the firm’s total outlay resulting from a small rise in the output of \( X \). As already noted, in a perfectly competitive equilibrium, the firm will always set the price of \( X \) equal to the marginal cost of \( X \). This price will satisfy the requirements of economic efficiency if it yields revenue sufficient for continued financial solvency of the firm. But such a price will always prevent the earning of revenues sufficient for this purpose where production is characterised by scale economies.

2. **Incremental Cost of \( X \):**
   
   Incremental cost is a generic concept referring to the addition to the firm’s total cost when the output of \( X \) expands. If the increment is large, marginal cost and incremental cost can differ substantially, because the ranges of outputs examined in the two calculations are not the same.
Average Incremental Cost, along with marginal cost, is the concept most frequently cited in the recent discussions of public-interest floors on prices. The AIC of the entire service is defined as the difference in the firm's total costs with and without service X supplied, divided by the output of X. It is the cost per unit of X that is added to the firm's total outlays as a result of its supply of the current output of X.

If, for example, x, y, z,... represents the outputs of the firm's various products, and TC(x, y, z,...) is the total amount the firm must expend in producing that combination of outputs, then AIC of X is;

\[
AIC_x = \frac{TC(x, y, z, ...)}{x} - \frac{TC(0, y, z,...)}{x}
\]  

AIC is similar to average variable cost (AVC) in many ways. However, they differ on three counts. Firstly, AVC cost, on some occasions, refers to short-run cost, while AIC is the lower, long-run figure obtained after the plant and equipment are adjusted so as to minimise the average cost of the pertinent output. Secondly, AIC of a particular output or service includes fixed cost, Thirdly, AVC calculations include past calculation practises of questionable legitimacy, on the other hand, AIC appear less burdened by these practises.

An important outcome of contestability is productive efficiency. As Baumol and Sidak (1994) and Baumol et al (1997) emphasised, only access price set in accordance with ECPR can attain productive efficiency. A formal analysis of this is as follows;
In accordance with ECPR, the entrant's total access payment will be;  

\[(N)(AIC) + \frac{NT}{M}\]  

(2.3.14)

where \(N\) is the entrant's demand for access input\(^{13}\), \(T\) is the total contribution to common fixed cost and \(M\) is the total demand for access input. This gives the incumbent \((X)\) a contribution to profit which equals to;

\[(N)(AIC) + \frac{NT}{M} - \text{the cost of access provision}\]  

(2.3.15)

where \(\frac{NT}{M}\) is the contribution \(X\) receives from \(Y\)'s usage of the network. The contribution that \(X\) will receive from the its own demand \((M - N)\) will equal its own output, multiplied by the contribution per output;

\[(M-N)\frac{T}{M} = T - \frac{NT}{M}\]  

(2.3.16)

Hence, the incumbent's gain from the combined demand for access, after expending \((N)(AIC)\) on the entrant’s usage, will be the sum of the contribution from \(Y\)'s traffic given by equation (2.3.15) and the contribution from its own usage, equation (2.3.16);

\[\left(\frac{NT}{M}\right) + T - \frac{NT}{M} = T\]  

(2.3.17)

Therefore, under ECPR, the incumbent will gain the same total contribution \(T\) whether or not it grants access or not.

In the absence of competition, the incumbent earns profits of;

\[T = M(P - AIC - AIC_x)\]  

(2.3.18)

where \(AIC_x\) is the average incremental cost incurred by the incumbent in the competitive sector while \(AIC\) is the average incremental cost for the network usage.

When competition is introduced, the entrant’s profits are;

---

\(^{13}\) It is assumed that for one unit of output there is a one unit demand for access input.
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\[ Y's\ profit = N(P - AIC - T/M - AIC_y) \]  \hfill (2.3.19)

where \( AIC_y \) is the average incremental cost incurred by the entrant in the competitive sector. Subsequently, substituting the value of \( T/M \) from equation (2.3.18);

\[ Y's\ profit = N(P - AIC - P + AIC_x - AIC_y) \]
\[ = N(AIC_x - AIC_y) \]  \hfill (2.3.20)

Therefore, the entrant \( (Y) \) will only make positive profits in the competitive market if it was more efficient than the incumbent \( (AIC_y < AIC_x) \). If the access charges were less than that prescribed by ECPR the principle of contestability is violated.

3.2.3 Ramsey Rule and ECPR Compared:

ECPR, as highlighted earlier, accepts the existing regulation or policy towards the incumbent’s final goods price. Therefore, it accounts for the regulator’s objectives which may be other than purely achieving efficient pricing in the final goods market. This view was endorsed by the Lords of the Judicial Committee of the Privy Council when reviewing New Zealand Telecom access charges (see Privy Council (1994)). They ruled that by using the ECPR methodology, their charges where neither anti-competitive nor predatory as they reflect the regulator’s aims and objectives, a view reiterated in Baumol et al (1997).

Regulated final goods price in the competitive segment may indeed be unreflective of the direct cost of provision. It may account for Universal Services Obligations and any other considerations the regulator may require the incumbent to maintain or undertake. The primary concern of ECPR, as indicated before, is to ensure productive efficiency.
Ramsey Rule, on the other hand, has a rather different agenda. Its main aim is to ensure optimal regulation or second best policy in the final goods market and consequently in the network access pricing. Its primary concern would be to achieve allocative efficiency, within the constraints of second best pricing. Obviously, if the incumbent’s final goods price in the competitive market reflected second best pricing, the objectives of both ECPR and Ramsey rule would converge. These issues will be examined in detail in the Section 5.

3.2.4. Main Drawbacks of Ramsey Rule and ECPR:

The more serious drawbacks and criticisms of both Ramsey Rule and ECPR are highlighted below,

3.2.4.1. Ramsey Rule

The main intent of the Ramsey rule would also appear to be its main shortcoming. The application of Ramsey rule necessitates optimal regulation; removal of distortionary cross-subsidisation and the practise of price discrimination to ensure efficient pricing. This may not be the objective of the regulator who may have other overriding considerations relating to equity. Indeed, optimal regulation is rarely practised.

Another concern with respect to Ramsey rule in its original manifestation is its practical application. The application of Ramsey rule necessitates comprehensive information, in particular the demand elasticities faced by both the entrant and incumbent.
3.2.4.2. ECPR

ECPR as originally expounded by Baumol and Sidak (1994) is only applicable in very narrow scenarios;
(a) the final goods provided by both the incumbent and entrant are homogenous and perfect substitutes,
(b) the entrant uses “fixed input proportions of network access”, that is the requirement for access as an input varies as a fixed proportion to the output of the final good, and
(c) when there is no alternative source of input, there are no possibilities for bypass.

Furthermore, both Laffont and Tirole (1996) and, more recently, Larson and Lehman (1997), state that only in fully symmetric cases, where the incumbent and entrant face similar demand and cost conditions, is ECPR optimal. “Contestability” also implies “all-or-nothing” entry (see Armstrong and Vickers (1995) and Armstrong et al (1996)). If the entrant is more efficient, it captures that market segment in its entirety.

Finally, there were concerns expressed that ECPR enables the incumbent to retain its monopoly profits⁴ and this contradicts the main purpose of introducing competition. Baumol et al (1997), encouraged by the Privy Council judgement of October 1994, suggests that a regulator could introduce a public pricing policy, which would ask the incumbent to declare a price that yield revenues no higher than the

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⁴ As shown in sub-section 4.2, ECPR ensured that the incumbent retains its profit levels even after entry has taken place.
corresponding "stand-alone cost", high enough that if entry costs were zero it would still be profitable for entry by an efficient rival producer. Indeed, it is felt that the shortcoming is not with ECPR but rather the regulation undertaken.\footnote{It is important to note that this implies Baumol et al (1997) feel that ECPR is suitable for industries that pursue pro-competitive policies as long as the regulator does not allow the incumbent to practise anti-competitive or predatory practises in the final goods market. This is an important point, as pro-competitive policies and deregulation does not imply the withdrawal of a regulatory role or the need to have a public pricing policy. This is discussed in greater detail in the next chapter and Chapter 6 with respect to Ofgas policies and the competitive process in the UK contract gas market. Indeed, the need carry out cross-subsidisation and their USOs possibly imply that the incumbent has to earn monopolistic profits or rents in the profitable sectors.}

Section 4: Reconstruction of Ramsey Rule and ECPR:

A Synthesis Approach

More recently, network access theories have concentrated on reconstructing the Ramsey rule and ECPR. Importantly, a synthesis approach was undertaken, bringing together some of the more important features of both models. The reconstructed Ramsey rule was particularly concerned to provide a framework for practical application. ECPR also addressed its main criticism, and tried to make it more universally applicable.

4.1. Ramsey Rule and Global Price Caps:

Laffont and Tirole (1994 and 1996) put forward a Ramsey rule model developed for regulatory practice. They still insist that distortionary cross-subsidisation should be removed, and that equity objectives of the regulator are better served by having a rebated system for certain target groups in its place.
In their paper they put forward the concept of a “Global Price Cap”. This differs from the current regulatory practice, which is described by Tirole and Laffont as “partial price cap” and which only regulates final goods prices in both the competitive and non-competitive sector. “Global Price Cap”, in the tradition of Ramsey rule, treats access input pricing as a final goods. Furthermore, optimality is attained by weighting these prices to the incumbent’s and entrant’s respective accurately forecasted output or market share;

\[ \bar{q}_0 p_0 + \bar{q}_1 p_1 + \bar{q}_2 a \leq \bar{p} \]  

(2.4.1)

where \( \bar{q}_0 \), \( \bar{q}_1 \) and \( \bar{q}_2 \) denote respectively the forecasted output for the incumbent’s, non and competitive segment and the entrant’s output.

Partial price caps weighted by output tend to favour high prices. By increasing its final goods price, the incumbent is able to charge a higher access price. Though the price increase affects total demand of the competitive segment, in the price cap constraint, this is only reflected through its impact on the incumbent’s demand on the competitive segment, therefore, capping of access price is necessary.

Laffont and Tirole (1994) is basically a antithesis to ECPR. They advocate that by adopting the Ramsey Rule, policy-makers treat access input as a final goods and both attain second-best prices, while ECPR accepts that the policy-maker may wish to incorporate issues other than Ramsey-optimality when regulating final goods price. In Laffont and Tirole (1996), however, they purport a synthesis: an appended ECPR-Global Price cap;
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\[
\bar{q}_0p_0 + \bar{q}_1p_1 + \bar{q}_2(c_0 + [p_1 - c_1]) \leq \bar{p}
\]  
(2.4.2)

Tirole and Laffont are adamant in that in the symmetric case\textsuperscript{16}, ECPR is tautologous, hence redundant, and distortionary if an asymmetric case arises. They felt that the appended version would be useful for two important reasons. Firstly, the price-cap weights need to be proportional to the forecasted output. In the appended version, the regulator only needs to forecast the total demand of the competitive sector as opposed to the individual market shares. The regulator no longer needs to estimate downstream market shares. Secondly, and more importantly, ECPR is an effective means of preventing predatory practice. The incumbent cannot increase access price without increasing its final goods price.

4.2. Augmented ECPR: "Direct-plus-Opportunity Cost" Regime:

A synthesis model, incorporating the main elements of both Ramsey rule and ECPR, under the broad heading of "Direct-plus-Opportunity Cost" Regime was put forward by Armstrong and Vickers (1995) and Armstrong et al (1996). This model differs from the original manifestation of ECPR as it moves away from contestability as a theoretical basis, consequently overcoming the barrier of "all-or-nothing" entry and thereby using Marginal Cost instead of the Average Incremental Cost\textsuperscript{17}. They follow the Ramsey rule methodology of maximising total welfare subject to break-even constraints but, unlike Tirole and Laffont, they accept the existing regulated final goods price is given, regardless of whether it is optimal or not.

\textsuperscript{16} Here it refers to the symmetry in incumbent's and entrants' demand and cost. This was investigated thoroughly in Larson and Lehman (1997).

\textsuperscript{17} Nevertheless, Vickers (1997) reverts to using average incremental cost.
The "Direct-plus-Opportunity Cost" Regime, as outlined by Armstrong et al (1996), is as follows;

The incumbent's cost function is;

\[ C(q, z) \]  \hspace{1cm} (2.4.3)

where \( q \) is the incumbent's own output level and \( z \) is the units of access required by the entrant. The cost incurred by the entrant is;

\[ C(q_2, z) \]  \hspace{1cm} (2.4.3')

where \( q_2 \) is the final goods supplied by the entrant. Both entrant's output and demand for access are functions of the incumbent's price \( (P_1) \) and the access price:

\[ q_2(P_1, a) \text{ and } z(P_1, a) \]  \hspace{1cm} (2.4.4)

The entrant is assumed to be a price taker and the respective profits of the entrant and incumbent are as follows;

\[ \pi_E(P_1, a) = P_1q_2 - az - c(q_2, z) \]  \hspace{1cm} (2.4.5)

and

\[ \pi_i(P_1, a) = P_1[x(P_1) - q_2(P_1, a)] + az(P_1, a) - C(x(P_1), z(P_1, a)) \]  \hspace{1cm} (2.4.5')

where \( x(P_1) \) is the total market output in the competitive segment and the incumbent's output is presented as the difference between total market output and the entrant's output. Total welfare is maximised subject to the incumbent's break-even constraint in the competitive segment, as with the Ramsey rule. The respective first-order conditions with respect to \( P_1 \) and \( a \) are\(^{18}\),

\(^{18}\) Note that the subscripts denote partial derivatives.
\[-(p_1 - c_1)(x' - q_2) - (a - c_0)z_p = \theta(x - q_2) \quad (2.4.6)\]
\[-(p_1 - c_1)q_{2_a} - (a - c_0)z_a = \theta z \quad (2.4.6')\]

where $c_0$ and $c_1$ are the marginal cost for providing access input and the marginal cost of the incumbent's output in the competitive sector respectively, $\theta = \frac{\lambda}{1 + \lambda}$ and $\lambda$ denotes the shadow price of the incumbent's break-even budget constraint.

The break-even budget constraints will always imply that the respective final goods price and access price will be above their respective marginal costs. This is where the synthesis model, presented by Armstrong et al. (1996), differs from the Ramsey rule, and follows in the spirit of ECPR. They assume that the regulated final goods price ($P_1$) in the competitive sector is sufficiently high, taking into consideration the incumbent's break-even constraint and other obligations. It also takes into account the regulator's wider objectives, other than optimal final goods pricing.

If the incumbent's budget constraint is not an issue, then $\theta = 0$ and from equation (2.5.6'), the optimal access charge is;

$$a^* = c_0 + [(p_1 - c_1)\sigma] \quad (2.4.7)$$

where $\sigma = \frac{q_{2_a}}{z_a}$ denotes the "displacement ratio". The displacement ratio measures the change in the incumbent's final goods output divided by the change in access demanded by the entrant. On the other hand, if the incumbent's budget constraint is binding, again from equation (2.5.6'), the optimal access charge is;
\[ a^* = c_0 + \left[ (p_1 - c_1)\sigma \right] + \frac{\sigma z}{-z_a} \]  
(2.4.7')

Hence, the optimal access charge is given by ECPR (the first two terms) plus a positive Ramsey term.

Crucially, the synthesis model incorporates the displacement ratio\(^{19}\). This enables two versions of ECPR (when the budget constraint is not binding); the margin rule and the opportunity cost rule. The margin rule is similar to the original version of ECPR. As highlighted, it is applicable in very stringent circumstances and when the displacement ratio equates to one. However, the opportunity cost rule, is when the displacement ratio lies between zero and one, and it, accounts for product differentiation, variable proportions and bypass. The demand for access is, therefore, not assumed to be one to one with the output. Armstrong et al attempted to clearly define the concept of opportunity cost and how it may differ in the various scenarios. Indeed, they were adamant that if the displacement ratio was not taken into account, an inappropriate notion of opportunity cost will emerge. An important result of this is that the allocative efficiency criteria is no longer applicable.

4.3. Issues Raised and the Stage of the Debate:

Having examined the various recent theoretical models and their different manifestations and modifications, the present sub-section highlights some the important issues and implications raised, as well as the relative strengths and limitations of these models and their applicability.

\(^{19}\) An almost identical model was put forward by Sidak and Spuller (1996) called the "Market Determined ECPR" or M-ECPR.
4.3.1. Bypass and "Cream-Skimming":

A policy-maker or regulator in devising an access price regime needs to account for network bypass and "creamskimming." Laffont and Tirole (1996) suggest that some sort of levy could be charged on those who choose to bypass the existing network. The "Direct-plus-Opportunity Cost" model accounts for bypass through the displacement ratio. With respect to "creamskimming", in Ramsey rule, access price is determined by elasticity of the demand faced by the entrant and its market concentration, and this is reflected in the weights chosen for the Global Price Caps. As for ECPR or "Direct-plus-Opportunity Cost Regime", the nature of the model is that it compensates for the loss of profits to the incumbent.

The appended ECPR-Global Price Cap can be modified to account for bypass by incorporating the displacement ratio;

$$\bar{q}_0p_0 + \bar{q}_1p_1 + \bar{q}_2(c_0 + \sigma[p_1 - c_1]) \leq \bar{p}$$

(2.4.8)

This revised version strengthens the usage based pricing structure of Global Price Cap. Furthermore, as highlighted by Laffont and Tirole (1996), proper Ramsey structure is induced if accurately forecasted weights are fixed, thereby achieving greater allocative efficiency.

4.3.2. Opportunity Cost Redefinition and Symmetric Conditions:

There has been much discussion on the similarities between the Ramsey rule and ECPR, some of which have been highlighted in previous sections. The synthesis

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20 The issue of bypass and "creamskimming" is dealt with in detail in Laffont and Tirole (1990). "Creamskimming" refers to the scenario where entrants into a particular industry, just concentrate on the profitable sectors, subsequently the incumbent looses a large proportion of the profitable market and is left with the unprofitable sector.
models, both Global Price Cap (GPC) and "Direct-plus-Opportunity Cost Regime" (DOCR), attempt to bring together both theories and expound on scenarios where they converge. Indeed, as Armstrong et al (1996) indicate, optimal charges are reflected by ECPR provided the correct definition of opportunity cost is used together with Ramsey mark-ups based on normal elasticities.

As far as Armstrong et al (1996) are concerned the difference between the two approaches is directly to do with the social cost of public funds; whether the incumbent's break-even budget constraint is binding or not. One could argue that this is again dependent on the incumbent's final goods price, where DOCR is accepted as given. If it is high enough then a binding budget constraint is less relevant and vice versa. They are of the opinion that what is crucial is the correct definition and the appropriate use of the opportunity cost element.

A fairly comprehensive study comparing access charges determined by Ramsey rule and DOCR was undertaken by Larson and Lehman (1997). They come to the conclusion that DOCR is only allocatively efficient and optimal, hence similar to Ramsey rule, under very stringent conditions, that is if no bypass and symmetric conditions prevail. The symmetric conditions they refer to is that the entrant faces the same final goods price and elasticity of demand as the incumbent\textsuperscript{21}.

4.3.3: Productive Efficiency:

\textsuperscript{21} The symmetric conditions of Larson and Lehman (1997) are quite different to those of Laffont and Tirole (1996) who refer to similar demand conditions as well, but also cost conditions. Possibly Larson and Lehman (1997) assume that the incumbent practises allocatively efficient prices in the final goods market.
Increasingly, what is emerging is that the productive efficiency criteria of access charges is unsustainable. As discussed earlier, ensuring productive efficiency was never a concern of Ramsey rule. The synthesis models and the redefinition of the opportunity cost element in the DOCR, and consequently the inclusion of the displacement ratio, imply that the application of such models make productive efficiency less of a priority. As highlighted earlier, Armstrong and Vickers (1995) Armstrong et al (1996) criticise the “all or nothing” approach of contestable based theories.

Even in the original version of ECPR, the productive efficiency criteria breaks down in a dynamic context. Baumol and Sidak (1994) do recognise that new entrants to the market could attract new customers and there would be some industry expansion with the introduction of competition. In a dynamic context where market expansion takes place, the productive efficiency criteria of ECPR is no longer applicable, and this can be shown formally as follows;

If the market expansion takes place,

\[ Q > M \]  \hspace{1cm} (2.4.9)

where \( Q \) is the total output after entry takes place and is larger than prior to entry \( (M) \). So the contribution to common fixed cost\(^{22}\) per unit of output is now;

\[ T/Q < TM \]  \hspace{1cm} (2.4.10)

the entrant’s profits are now;

\[ Y’s\ profit = S(P - AIC - T/Q - AIC) \]  \hspace{1cm} (2.4.11)

\(^{22}\) For simplicity, it is assumed that the fixed cost remains. As output varies and expands, it is more likely to affect marginal cost or in the present case average incremental cost.
where $S$ denotes the entrant's new demand for access input. Productive efficiency is no longer a necessary criteria for the entrant to receive positive profits, up to the point where the saving from lower common fixed cost contribution outweighs the entrant’s relative inefficiency.

4.3.4. Universal Applicability:

Though Armstrong et al (1996) in their conclusion admit that ECPR may not always be the appropriate benchmark for access charges, the synthesis model and the redefined version of opportunity cost has a universal appeal. Baumol et al (1997) endorse the point that the DOCR model is universally applicable. Concurring with the Privy Council judgement, they feel that even in pro-competitive scenarios, this model is relevant, provided some sort of public pricing policy is in place to prevent abuse as highlighted earlier\(^23\). Global Price Cap, on the other hand, requires explicit final goods regulation.

4.3.5. Informational Considerations:

Finally, there is the important issue of informational problems. The informational problems relate to the demand on policy-makers and regulators in applying these problems accurately, a point also noticed by Armstrong et al. The need for information about demand and elasticities can be onerous. The estimation and derivation of the displacement ratio is inevitably imperfect and the estimation errors would imply efficiency losses.

\(^{23}\) In the next chapter and again in Chapter 6, with reference to the contract gas market it is shown that pro-competitive and deregulation policies can only be effectively pursued in conjunction with an overall regulatory policy in the final goods market such as a public pricing policy, even if it exists only to ensure that predatory and other anti-competitive practises are eliminated; a point also noticed by the Privy Council judgement.
Ralph (1997) also points out that the application of the Global Price Cap proposed by Laffont and Tirole (1996) is "extremely demanding informationally". It requires fixed quantity weights that are set proportional to realised output levels, that is ex post. These rather difficult forecasts are what deliver Ramsey relative prices. In addition, to ensure the correct price level, and hence optimal Ramsey prices, the incumbent's global costs must also be known. Ralph (1997) maintains that the implementation of Global Price Cap with or without application of the ECPR (the appended ECPR version) is probably too difficult. The strong informational demands required to estimate optimal output and global cost levels are essentially equivalent to those required to directly estimate optimal Ramsey rule, therefore, the application of Global Price Caps may not be any simpler than the original Ramsey rule. Tirole and Laffont suggest that the regulator can iteratively adjust quantity weights, and its cost estimates, until Ramsey prices are achieved.

Section 5: Wider Considerations and Other Issues: A Policy-Makers Prospective

When applying these models, the regulator may wish to take into consideration other wider issues. These are generally overlooked by the main ECPR and Ramsey Rule models, but may be a particular interest to policy-makers. Some of the more important ones are considered here;
5.1: "Pro-Competitive and Net Welfare Gains Vs Efficient Entry Policy:

Increasingly, policy-makers have chosen to pursue pro-competitive policies, which open the competitive sectors to unfettered competition. Increasingly, the policy stance reflects that expressed by Newbery (1997), which is that regulation is essentially inefficient and the most efficient outcomes are best achieved by pursuing pro-competitive policies, which increases competition24.

Economides and White (1995) were concerned whether there is a trade-off between pursuing pro-competitive policy and efficient entry policy which is implied by ECPR. Economides and White (1995) maintain that the original version of ECPR, as advocated by Baumol and Sidak (1994), when applied to public utilities which have opened up to competition, give little incentive to improve allocative efficiency. Hence, the deadweight loss is maintained and they suggest that there is a trade-off between productive and allocative efficiency.

They have defined net welfare gains from entry in terms of gains in consumer’s and producer’s surplus which are respectively,

\[ \frac{1}{2} \Delta P \cdot \Delta Q = \frac{1}{2} [p_I - p_E] \cdot [Q_J - Q_M] \quad (2.5.1) \]

and

\[ t \cdot \Delta Q = t \cdot [Q_J - Q_M] \quad (2.5.2) \]

where \( p_I \) and \( p_E \) denote the incumbent’s and entrant’s final goods price in the competitive sector respectively, \( Q_J \) and \( Q_M \) denote output prior to entry and

\[ ^{24} \text{These issues are investigated in detail with respect to the gas industry in the next chapter and, in particular, in Chapter 6.} \]
output after entry respectively and $t$ is the difference between the entrant's and
incumbent's marginal cost and is a positive value. The net loss of inefficient entry is
defined in terms of the entrant's marginal cost disadvantage, multiplied by the entrant's
production volume;

$$ t \theta Q_J > 0 $$

(2.5.3)

where $\theta$ is the entrant's share of the joint output. Net welfare gains can be positive or
negative depending on;

(a) the relative inefficiency of the entrant,

(b) share of the entrant's market, and

(c) elasticity of demand

Economides and White (1995) extend their analysis into the context of
Bertrand and Cournot competition. In the Bertrand scenario, they suggest that
monopolist practices "limit pricing", that is the incumbent sets its price equal to the
less efficient entrant's marginal cost. Their results indicate that regardless of the
entrant's cost disadvantage, there could be some net social welfare improvement,
which decreases as the entrant's market share increases and the demand is more elastic.

In the Cournot case where each producer adjusts its production quantity on the
assumption that the other's quantity remains unchanged, they determine critical values
of cost disadvantage beyond which the net social gain is negative. These critical values
for the Cournot scenario are less than the Bertrand situation, as the former implies
higher prices and a more substantial market share for the inefficient entrant.
5.2: Network Externalities:

The introduction of competition gives rise to network externalities. Economides (1996) pays particular attention to network externalities in vertically integrated industries, advocating that any access price regime needs to account for these positive externalities and thereby encourages more pro-competitive policies. Essentially, there are two sources of positive externalities, direct and indirect.

Direct externalities arise from "two-way networks". Here an additional customer provides direct externalities to all customers in the network by adding potential new goods through the provision of a complementary link. A good example of a "two-way network" is telecommunications. The value of the network to those who are already connected to it increases as more people join. The subscribers can make telephone calls to more subscribes, as well as receive calls from them. This does not arise in the energy industry where the transmission is only possible from supplier to consumer.

"One-way networks" could, on the other hand, be a source of possible indirect externalities. As more customers use the service, economies of scale could arise, driving down the cost of provision. Baumol and Sidak (1994) recognise the existence of positive network externalities but, nevertheless, they felt when there is market expansion, the profits made in the expansions may be sufficient compensation for the entrant's relative inefficiency.

5.3. Access Pricing under Rate of Return (ROR) Regulation:

ROR is a common form of regulation, and regulators, such as Ofgas, have extended this form of control to the regulation of interconnection charges. This is to
ensure some form of incentive based regulation within an overall cap. Though regulatory theorists have extensively expounded the virtues and vices of this form of regulation with regards to final goods regulation, the only exposition of ROR regulation for access charges was analysed in a recent paper by King (1997). Within the overall cap, the actual structure and form of the access charges is another issue\(^{25}\). King (1997) advocates second best pricing.

The regulator aims to formulate access prices that;

(i) satisfy the access provider’s ROR constraint,

(ii) provide non-negative profits for firms competing in the final goods in equilibrium, and

(iii) maximise the sum of consumer and producers surplus from the vertical chain of production.

It is equitable and economically sensible to allow infrastructure owners to earn a reasonable return on investment. Without such incentives, future infrastructure development will be severely retarded. Explicit and implicit ROR procedures are unavoidable when considering the dynamic effects of access prices. ROR is popular amongst regulators for two reasons; firstly, it is easy to apply, and secondly, regulating access provider’s profits offer direct, pragmatic solutions to natural monopoly problems, while allowing considerable freedom to set access prices and encourage competition.

\(^{25}\) The practise of ROR as an overall cap and the form and methodology of access charges are particularly relevant to the gas industry and are discussed in detail in Chapter 3.
Access charges will be governed by either an explicit or implicit ROR regulation. Infrastructure assets will be valued and translated into an allowable return for the owners. They are a convenient and practical way to limit monopoly abuse, but setting an allowed return is only the first part of the regulatory process, there is still a need to fix the exact charges. What are the optimal prices once a ROR constraint is in place?

King's (1997) analysis evaluates the application of "second best" access price under ROR. The optimal access price will be dependent on the degree of the final goods market, or downstream, competition. If there is imperfect price competition and a fixed number of firms in the final goods market, optimal access prices will "mimic" final goods market competition and, consequently, reduce final goods market profits. With free entry downstream, optimal access should determine an optimal level of downstream participation. Access provider's incentives to introduce optimal access price will depend on the degree of vertical integration.

King (1997) gives five broad conclusions;

(1) If there is a fixed number of downstream competitors, that is restricted entry, then second best access prices will "mimic" final goods market competition. The access price should be set to drive down the final product price until either final goods market profits are driven to zero or price is equal to marginal cost.

(2) When there is free entry downstream, competition drives downstream profits to zero. Setting optimal access prices involves choosing the optimal downstream participation level.

King, though acknowledging the drawbacks of ROR regulation, does not address these problems.
industry configuration. In some situations, social welfare is imposed by allowing the upstream, or vertically integrated firm, to earn above its regulation ROR.

(3) Second best access pricing under ROR requires considerable industry specific information²⁷.

(4) If the access provider is vertically separated, or if there is free entry downstream, then the upstream firm will be indifferent to the access tariff and will have no incentive either to oppose or set the socially optimal access price.

(5) If there is a fixed number of downstream competitors in a vertically integrated industry, there will be conflict between the regulator and the access provider; socially optimal access is not equal to what is preferred by the access provider.

King (1997) maintains that ROR regulation must be accompanied by second best access pricing. The setting desirable access price may be easier if there is free entry downstream and/or a vertically separated industry structure.

Section 6: Concluding Remarks and Summary of Literature

Review

In this concluding section, the main arguments and the stage of the debate is reviewed. As discussed earlier in the chapter, the regulators objectives may not concur with the aim of achieving economic efficiency. Issues such as cross-subsidisation is contrary to Ramsey-optimal and second best pricing. Indeed, as Newbery (1997)

²⁷ The analysis in the preceding section show that this is the case for all applications of second best pricing.
points out;

“Cross-subsidies buy political support to protect the franchise (vertical
integration)”

The case relating to AT&T in the US illustrates the point. Technical progress lowered
the cost of providing long-distance service, relative to local calls. Nevertheless,
regulation kept long distance tariffs high to allow cross-subsidisation. This was put at
risk when the Federal Communication Commission allowed competition in 1959.
Consequently, AT&T responded by engaging in Ramsey pricing but the Justice
Department filed suit for monopolising interstate communications. AT&T eventually
came to the conclusion, in 1984, that the only solution to the problem of cross-subsidy
and interstate competition was to divest the local operating companies.

Hence for these reasons, ECPR or DOCR is more practical and applicable than
Ramsey rule, as they accept the incumbent’s final prices as given, regardless of whether
it conforms to optimality criteria, so long as it is implemented with the approval of the
regulator. They only converge in very narrow scenarios as outlined by Larson and
Lehman (1997) and, of course, when the incumbent practises Ramsey-optimal prices in
the final goods market, but as Tirole and Laffont (1996) point out, the application of
ECPR, or DOCR in such situations would be tautologous.

Informational requirements for applying either interconnecting price regimes
and their various manifestations, such as “direct-plus-opportunity cost” and Global
Price Cap, is demanding. Nevertheless, the accurate forecast of the market share
required by Global Price Cap is not only demanding but can be also self-defeating. The
less than accurate forecast would imply that the main motive of the model, which is to

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achieve Ramsey-optimal prices is unattainable. Such precise requirement make the application of the model onerous.

In its defence, Vickers (1997) suggest that Global Price Cap may be less onerous informationally that it appears. He suggests that Global Price Cap allows for the prices to vary within the cap, enabling discretionary pricing. Indeed, this not unusual as most regulatory caps, such as RPI-X or Rate of Return (ROR) regulation, allow this.

The crux of the problem lies with predatory pricing. Laffont and Tirole (1996) were aware of such problems and, hence, suggested the appended ECPR-Global Price Cap regime. The incumbent is unable to increase the access charge without increasing its final goods price, likewise the incumbent cannot engage in unfair "price-cutting" or "price war" without having to decrease it access charge\(^{28}\). Subsequently, at least, a public pricing policy as that suggested by Baumol et al (1997) is needed to prevent anti-competitive practices. Therefore, complete discretion is not feasible, neither is the information requirements of the regulator any less onerous\(^{29}\).

\(^{28}\) The incumbent may choose not to compete in the goods market and just receive monopolistic rents for network provision. Conversely, the incumbent may choose incur short-term losses to keep entrants out. These are, however, extreme cases which policy-makers are unlikely to tolerate.

\(^{29}\) The next chapter discusses the introduction of a public pricing policy in the contract gas market by the gas regulators (Ofgas) on the advice of the Monopolies and Mergers Commission (MMC). This was primarily undertaken to reduce the discretion of BG's pricing policy.
CHAPTER 2: LITERATURE REVIEW

The issue is not whether the respective model is informationally demanding to implement. They are onerous in their own way. The issue is which of these models when implemented best represent the policy-maker’s objectives. The more important ones are outlined in the present chapter. The Ramsey rule unequivocally advocate optimal or second best outcomes. Therefore, the final goods market must be consistent with this.

This is, however, less of a concern for ECPR and "Direct-plus-Opportunity Cost Regime". As stated by Armstrong and Vickers (1995) and Armstrong et al (1996), the DOCR model accepts the final goods prices of the incumbent, which is set with the explicit approval of the regulator, as given. Indeed, as highlighted by Baumol et al (1997) and the judgement of the Privy Council (1994), the main concern of regulators should be to ensure that anti-competitive and predatory practises are eliminated. Therefore, the ECPR and DOCR models are more applicable if the regulator wants to incorporate wider obligations and issues other than optimal or second best outcomes, and this is reflected in the incumbent's pricing policy. These issues and others are discussed in detail in Chapter 6.

The theme of regulators engaging in pro-competitive policies and attaining allocative and productive efficiency and maximising total welfare is pursued in Chapters 6 and 7. The incentive issues relating to the application of "Rate of Return" regulation is examined in the next chapter in the context of the competitive gas market.
CHAPTER 3: REGULATION AND COMPETITION POLICY IN THE COMPETITIVE GAS MARKET, 1986-1996:
A THEORETICAL ANALYSIS

Section 1: Introduction
Section 2: Regulation and Competition Policies in the Competitive Gas Market
Section 3: British Gas's Pricing Policy and Behaviour: A Theoretical Analysis
Section 5: Conclusion
CHAPTER 3: COMPETITIVE PROCESS: THEORETICAL ANALYSIS

Section 1: Introduction

The present chapter begins to evaluate the regulation and competitive policies introduced into the competitive segment of the gas industry and the ensuing competitive process. A theoretical explanation for the relative effectiveness and the impact of these pro-competitive policies is given, taking into account the strategic advantage of both the incumbent and entrants. The subsequent chapter continues to evaluate the competitive process in the gas industry while the dataset is examined in detail.

Since the regulator attempted to introduce competition into the contract gas market in the late 1980s, various measures were pursued. Ofgas initially focused on the final goods market and subsequently concentrated on network access. The present chapter examines the various strategic reactions to these policies by both the incumbent and entrants. BG, as the incumbent and a vertically integrated firm while operating in the contract gas market, has pre-entry strategic advantage. On the other hand, the main entrants operate as upstream firms in the contract gas market and potentially have post-entry advantage\(^1\).

Section 2 examines in detail Ofgas's policies with regards to the competitive market in the gas industry. BG's pricing policy is deemed to be a reaction to the regulatory policies introduced relating to the final goods market, and Section 3 considers some of the theoretical issues relating to BG's pricing behaviour. Section 4 provides a theoretical framework that is representative of a vertically integrated

\(^1\) The post-entry advantage is between the main entrants and BG, and not between the main firms. Therefore, it may not be invoked.
industry where the network access price is set by Rate of Return (ROR) regulation.

This is applied to the gas industry and the impact on the incumbent and entrants' strategic behaviour and the competitive process is also discussed.

Section 2: Regulation and Competitive Policies in the Competitive Gas Market

2.1. Introduction:

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. British Gas also enjoyed the monopsony of gas found on the UK Continental Shelf (UKCS). When BG was privatised in 1986, in order to retain industry support and maximise sale proceeds, it was sold as a single monopoly entity (see Price (1991a)). Figure 3.1 is a schematic representation of the industry.

![Figure 3.1 Schematic representation of the gas industry](image)
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, negotiate tariffs individually and confidentially. Furthermore, consumers of above 250,000 therms per annum could have gas supplied on an interruptible basis².

² Gas that is sold on an interruptible basis implies that the supply can be interrupted at the discretion of BG to help solve its winter peaking problem. Primarily to users buying more than 250,000 therms per annum.
Figure 3.2 above gives the breakdown of the various segments in the UK gas industry at the time of the MMC review in 1988.

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 nonexistent. The gas regulator, Ofgas, created at the time of privatisation, undertook two main duties:\(^\text{3}\);

(a) to increase competition in the above 25,000 therms per annum market, as explicitly stated in the Gas Act of 1986;
CHAPTER 3: COMPETITIVE PROCESS: THEORETICAL ANALYSIS

"enable persons to compete effectively in the supply of gas through pipes at rates that, in relation to any premises, exceed 25,000 therms a year."

and

(b) to enforce price regulation in the market for smaller users.

Formal price regulation does not exist in the contract gas market, as it was hoped that the ensuing competition would keep prices sufficiently low. Nevertheless, a public pricing policy was introduced by Ofgas in March 1989 to ease the introduction of competition and prevent any anti-competitive practices by the incumbent, this will be discussed further later in the chapter. In the tariff market, average revenue was subject to a cap, RPI - 5, and could not rise by more than X% in real terms in any year. Ofgas, on the recommendation of the MMC Report of 1988 undertook three regulatory objectives; (1) prevent abuse,

(2) promote competition and

(3) manage the market.

Since the early 1990s the government tried to create conditions to intensify and extend competition in the contract gas market, which will be investigated in the present chapter. In 1992 the competitive segment was extended by lowering its threshold to above 2,500 therms per annum and consequently included part of the tariff market as well. The domestic gas market was to be opened for competition; initially with a pilot scheme which started in the South West of England in May 1996 with the intention of full competition by 1998.

3 The Gas Act of 1986 which privatised BG also made provisions for OFGAS and its duty.
Latterly, much of the focus of the regulator in facilitating greater competition has been via interconnection into the network; this led to the restructuring of BG\textsuperscript{4}. Following MMC review of 1993\textsuperscript{5}, "accounting separation" has been maintained between BG’s main operations and its transportation/storage wing. Business Gas was created to undertake operations in the competitive segment while TransCo had sole responsibility to provide the transportation and storage facilities. Consequently, from 1994 Business Gas was liable for transportation and storage charges as well.

More recently, however, BG divested its operations creating a separate company for transportation and storage; Transco International came into effect in May 1996. The anticipation of intense competition in the domestic market, and regulation to facilitate this, incited BG to this restructuring. The more profitable sections, such as transportation and storage and international ventures, were separated from the less profitable sections such as the supply of gas to the domestic and competitive segment. Table 3.1 below gives the chronology of the main events in the gas industry;

\begin{table}[h]
\centering
\begin{tabular}{|c|c|}
\hline
Year & Event \\
\hline
1993 & Restructuring announced by Board of Trade \\
1993 & MMC review recommended vertical separation \\
1994 & Business Gas liable for transportation and storage charges \\
1996 & Transco International comes into effect \\
\hline
\end{tabular}
\caption{Chronology of Main Events in the Gas Industry}
\end{table}

\textsuperscript{4} The President of the Board of Trade announced the restructuring in December 1993. This is examined in greater detail later in this Section.

\textsuperscript{5} In fact, the MMC review of 1993 recommended vertical separation but this was ignored.
### Table 3.1 Chronology of Main Events in the Gas Industry

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982</td>
<td>Oil Gas (Enterprise) Act removes BG’s statutory first-right of purchase from UK gasfields, and gives other suppliers right to use BG’s pipeline network.</td>
</tr>
<tr>
<td>1986</td>
<td>Gas Act: preparation of the privatisation of BG as BG plc, with the flotation of stock in December of the same year.</td>
</tr>
</tbody>
</table>
| 1987 | **Jul**                                      
|      | Ofgas report, “Competition in Gas Supply” concludes that only small amounts of gas to become available for competitive supply to users in the contract sector, mainly because all available gas already contracted to BG. |
|      | **Nov**                                      
|      | OFT refers BG to the MMC following complaints about its pricing policy in the contract gas segment. |
| 1988 | **Oct**                                      
|      | First MMC report                           |
| 1989 | **Feb**                                      
|      | BG agree to participate in a public pricing policy and publish its pricing schedules.         |
|      | **May**                                      
|      | First price schedules introduced.                                                       |
|      | **Jun**                                      
|      | BG publishes details of third-party carriage terms and illustrative charges. This was based on the allowable rate of return on current assets of 4.5%. |
|      | **Dec**                                      
|      | BG publishes new contract-price schedules, following extensive criticism of May schedules. |
| 1990 | **Dec**                                      
|      | Ofgas warns that “time is running out for BG”. Proposes target of 30 per cent competitive market share to be reached by October 1993. |
| 1991 | **Apr**                                      
|      | Ofgas and BG agree new pricing agreement for the tariff sector, pegs price increases to RPI-5 for period April 1992-97. |
|      | **Oct**                                      
<p>|      | Completion of OFT progress report on market for industrial gas supply. MMC enquiry threatened BG and Ofgas agree to compromise on MMC Report’s (1988) proposals by the end of 1991. |</p>
<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>“Monopoly threshold” reduced to 2,500 therms p.a.. Second referral to the MMC. Series of consultations, initiated by BG, started between BG and Ofgas regarding the form of transportation charges.</td>
</tr>
<tr>
<td>1993</td>
<td>The MMC report recommends breaking up BG before liberalising the entire market. It also recommended establishing a separate price control over BG’s transportation and storage charges in the form of RPI-X, within the overall cap based on rate of return of 4.5% on existing assets. Claire Spottiswoode succeeds Sir James McKinnon as DG of Gas Supply. Government rejects MMC recommendations and announces rapid introduction of competition.</td>
</tr>
<tr>
<td>1994</td>
<td>Full liberalisation confirmed in the Queen’s Speech. A new form of transportation charges was introduced following the consultation process that begun in 1992.</td>
</tr>
<tr>
<td>1995</td>
<td>Gas Act allowing competition in the residential market. Following the MMC (1993) recommendations, Ofgas initiated a consultative process on Transco’s transportation and storage charges.</td>
</tr>
<tr>
<td>1996</td>
<td>First phase of competition in the domestic market took place in the south-west of England. New Transco charges were published which would come into effect on April 1997 for five years.</td>
</tr>
<tr>
<td>1998</td>
<td>Full competition throughout Great Britain.</td>
</tr>
</tbody>
</table>

The gas regulator, Ofgas, together with the Office of Fair Trading (OFT) and the Monopolies and Mergers Commission (MMC), embarked on a series of regulatory and competitive policies to increase competition in the contract gas market. Policies pertaining to the final goods market are examined in sub-section 2.2 and subsequently, the regulation of transportation charges is investigated in sub-section 2.2.2.
CHAPTER 3: COMPETITIVE PROCESS: THEORETICAL ANALYSIS

2.2: Competition Review and Regulation:

2.2.1: Ofgas report “Competition in Gas Supply”:

Ofgas in its report, “Competition in Gas Supply” (Dec 1987), put forward the rationale for promoting greater competition. Firstly, it would bring about general efficiency gains. Secondly, it would give BG greater incentives and effectiveness to buy and sell gas at efficient prices. Thirdly and most importantly, it would change the structure of the industry so that BG’s market powers were considerably diminished.

At the time of privatisation the Ofgas identified the contract gas market as the best potential for developing competition. Ofgas (Dec 1987) felt that gas producers operating in the North Sea were most likely to enter the gas contract market for three main reasons. Firstly, they could hope to sell gas at a higher price than they would receive from BG. Secondly, selling directly to large industrial users would prove more attractive; industrial users demand for gas has less seasonal variation than residential users and the smaller “swing factor” implies lower supply cost. Lastly, gas producers might be able to bring a given oil field on stream more quickly by supplying directly to end users.

2.2.2. MMC Report (1988)

In November 1987 the OFT referred BG to the MMC following complaints about its pricing policy in the contract sector. The MMC report highlighted that there was a possibility for BG to practise first degree price discrimination in the contract market. Prices charged to customers depended on how easily available alternative sources of fuel were. Those with easy access to cheap alternatives to gas supply were
charged considerably less; they were charged prices that were comparable to the price of substitute fuels. As the MMC report pointed out;

"the range of prices for firm gas contracts has widened since the fall in oil prices in 1986. British Gas reduced the prices to those customers well placed to switch to potentially cheaper fuels. . . but maintained its prices to other customers."

They concluded that there was;

"systematic and extensive discrimination in the pricing of firm gas, and discrimination in willingness to supply interruptible gas."

The recommendations put forward by the report sought to achieve three regulatory objectives; prevent abuse, promote competition and to manage the market. The main recommendations were;

(i) BG had to publish their price schedules in the contract market,
(ii) publish further information on the common carriage terms, and
(iii) BG was limited to initially contracting no more than 90 per cent of any new gas fields.

As a direct response to the MMC report, in March 1989, Ofgas, determined to eliminate abuse and anti-competitive practises, required BG to publish its pricing schedules of the contract market. The first set of such schedules was published on the 1st of May 1989. BG cannot alter any particular schedule more than once in any 28 day period without the consent of the DGGS. Furthermore, the DGGS must be given 21 days notice of any change to the classes or description of schedules.
2.2.3. Office of Fair Trading (OFT) Gas Review Oct 1991

This review primarily assessed the effectiveness of remedies applied following the MMC 1988 report. The OFT was adamant that there were no reasons for discontinuing BG's commitment to publishing price schedules, and that in addition BG should release a significant proportion of its contracted gas. It also proposed the establishing of a separate subsidiary for gas transmission and storage system on a non-discriminatory basis which enabled all potential suppliers an equal access to BG. This led to the creation of Transco.

BG (Mar 1992) responded by committing to give up 60% of the competitive market to its competitors;

"creating the conditions by which suppliers other than British Gas should be able to supply at least 60 per cent of the gas provided in therms in Great Britain to contract customers during the calendar year 1995"

BG also gave an undertaking to the OFT under the "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. As Ofgas (Mar 1995) highlighted this was to be sold at;

"a price equal to British Gas' overall weighted average cost of gas (WAGOC) plus a small margin."

2.2.4. Gas (Modification of Therm Limits) Order 1992 (SI 1992/1751)

This order extended the competitive segment of the gas market beyond the contract gas market. The threshold for competition was lowered from above 25 000 to
above 2 500 therms per annum. This had the effect of expanding the market in which customers choose their supplier by around 200,000 customers, or in terms of sales volumes, by around one quarter (Ofgas (Sep 1994)).

2.2.5. MMC Report (1993)

In July and August 1992, four references were made to the MMC; two by DGGS under the Gas Act 1986 and two by the Secretary of State for Trade and Industry under the Fair Trading Act 1973. While the lowering of BG’s monopoly threshold from 25,000 to 2,500 therms per annum was announced which widened the competitive process to include the tariff segment, the tightening of the tariff cap took place. The accounting separation between BG’s transportation and retailing operations and the ensuing disagreement between Ofgas and BG led to another MMC review. MMC recommended that:

(i) the market share target be extended to above 2,500 therms per annum, it suggested that BG’s share of the market should be limited to 55% of sales to all users of 2,500 therms and above.

(ii) vertical separation of British Gas.

(iii) no suspension of the price schedules, concluding;

"Immediate relaxation of the requirement to publish price schedules would be premature, but we do see scope, in the longer term, to replace the requirement to charge on the basis of published price schedules, by a more general requirement not to discriminate unduly in pricing. We do, however, see a need for a degree of flexibility in interpreting the requirement to publish price schedules: it may not, for example, be appropriate in the context of new or
previously unpredicted uses or of high-volume, longer term uses for gas or in those sectors of the market where competition is clearly self-sustaining.”

2.2.6. President of BOT’s December 1993 Announcement

The government rejected the recommendation to vertically separate BG’s operations. However, they decided to introduce “accounting separation” on the following terms;

“Once the details of separation, and of the post-separation relationship between the transportation and the trading businesses, are settled and seen to operate to the DGGS’s satisfaction, she will release the company from the existing regulatory constraints on its ability to compete in the contract market.”

BG consequently restructured its gas supply business into five separate national business; (1) TransCo, (2) Public Gas Supply, (3) Contract Trading (Business Gas), (4) Retail and (5) Service.

2.2.7. Ofgas Review 1994 (Ofgas (1994))

Ofgas conducted a review of its competitive policy through a consultation document; “Competition and Choice in the Gas Market: A Joint Consultation Document” (Ofgas (May 1994)) and a policy document; “Regulation of the Competitive Gas Market: The Way Forward” (Ofgas (Sep 1994)). In Ofgas (May 1994) outlines how competition will work;

a. Basic Model:

The basic approach advocated is to separate the functions of transport and supply, and to encourage competition in the supply market.
b. BG:

Though, BG is not required to divest as recommended by the MMC report (1993), they were expected to maintain full and strict separation of its Transco operations.

c. Future Shape of the Market:

Ofgas continue to maintain its commitment to increasing competition. Ofgas feel that opening the market to competition will provide an opportunity to develop a more flexible market where the consumer can choose between a range of services offered at different prices. While new suppliers will provide opportunities to market new and improved services at competitive prices. Nevertheless, they feel that special considerations apply to the domestic gas market where safety is paramount.

d. “Level Playing Field”

Ofgas intend that all suppliers should have the opportunity to supply the market on fair and equal terms. They insisted that during the transitional period to fully developed competition, it may be appropriate in framing the regulatory regime to impose different obligations on BG to those imposed on other suppliers to ensure the growth of competition. BG is at present the dominant purchaser of gas, primarily the UK Continental Shelf (UKCS). Normal Competition law will ensure that BG does not use its dominant position in a way which confers an unfair advantage upon other suppliers.

Ofgas (Sep 94) proposed a temporary suspension of six months starting from the 1st of October 1994 of BG’s obligation to publish price schedules in the contract market. BG, in turn, was expected to conduct its pricing policy in the firm contract market in a non-discriminatory manner. Ofgas also reserved the right to check and withdraw the suspension if complaints received were well-founded.
2.2.8. The Competitive Market Review (Ofgas (March 1995))

Ofgas in defining the competitive market maintains that;

a. the gas market is not a natural monopoly,

b. over time, a competitive market is more likely to evolve rather than a monopolistic market, attaining both productive and allocative efficiency,

c. at the time of privatisation, Ofgas recognised, that BG had certain competitive advantages, pre-entry advantages that could prevent significant new entry into the market for a long period of time and, therefore, the aim of regulation is to reduce these advantages.

Ofgas conducted a survey of the competing shippers and identified three significant barriers of entry into the competitive segment;

(i) generally poor quality of service offered by TransCo, especially in respect of nominations and meter readings which deterred customers from changing shippers,

(ii) a barrier to entry into the interruptible gas market was created by the combination of (a) BG's monopoly in the domestic market and (b) existing arrangement under which Public Gas Supply buys peak gas from Business Gas, and

(iii) the possibility that BG could use its relationship with Accord Energy to undermine competition in the retail gas market.7

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6 Competing shippers interconnecting to BG's transmission network can nominate the amount of peak time capacity it requires.
Furthermore, Ofgas would consider extending the suspension period of the BG price schedule if the following conditions were met;

(i) TransCo puts in place what Ofgas considers appropriate financial compensation to shippers for unsatisfactory service,

(ii) BG and Ofgas have to reach an agreement on the undertakings which BG will make on how gas is sold by BG Plc into the wholesale gas market,

(iii) Agreements between Ofgas, Public Gas Supply and Business Gas on how the supply of peak gas to Public Gas Supply is open to other suppliers and the introduction of Network Code and daily balancing is not reached.

(iv) BG agrees to a licence condition which prohibits undue discrimination in the supply of gas to customers.

In a later policy document; “The Competitive Market Review: Proposed Basis for Suspending the Requirement to Price According to Published Schedules”(Ofgas (May 1995)), Ofgas reported;

“As regards the large firm segment, on the basis that there was no firm evidence that British Gas had pursued a discriminatory or predatory pricing policy, Ofgas decided not, at this stage, to restore the obligation (publish its pricing schedules).”

In another policy document; “The Competitive Market Review: Decision to Suspend the Requirement to Price According to Published Schedules” (Ofgas (June 1995)),

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7 Accord Energy is a 50/50 joint venture between BG and National Gas Clearinghouse (US). It is a market maker in the short term traded wholesale gas. There is a suggestion that the net sales of Accord
Ofgas announced its proposal to extend the suspension for a period of 12 months starting 23 June 1995.

Ofgas tried to pursue a policy of easing regulation as competition increased. This was not lost on BG, it accommodated Ofgas's wishes and by participating in the "Gas Release Programme" and giving up its market share it appeared to be pro-competition. BG hoped and anticipated that this would lead to the suspension of the requirement to publish its pricing schedules.

BG wanted the regulation in the tariff market to be relaxed, as the competitive market threshold was extended to include part of the tariff market and they suffered loss of market share in the high-quantity tariff market. As Price (1994) points out, average revenue cap has a contrary effect when an incumbent lowers price and loses market share as result of competition. The price cap is applied to all tariffs, weighted by the amount of gas purchased from BG at each price level; prices are lower for high-volume consumers. When BG loses these customers to competing firms their lower prices become less heavily weighted, so the 'average' price for all consumers apparently rises, even if the tariff for each individual remains unchanged. To keep within the original cap, prices to other consumers have to be lowered. The MMC appreciated this dilemma and recommended a straightforward rate-of-return regulation estimate for the company as a whole. Furthermore, the MMC was concerned about the appropriateness of regulating markets where competition has been established and Ofgas concurred.

is included in BG's market share targets. This creates an oversupply, lowering beach head prices and undermines the viability of competitors that have made long term gas purchase commitment.
As various Ofgas reviews indicate that while pursuing pro-competitive policies, they sought to reduce BG’s pre-entry strategic advantage. BG was encouraged to give up its market share and participate in the “Gas Release Programme”. The “accounting separation” of TransCo and the requirement to publish its prices had also considerably reduced its strategic advantage.

The public pricing policy pursued by Ofgas was potentially the most effective in reducing BG’s strategic advantage. Indeed, its participation of the “Gas Release Programme” and giving up of its market share was a direct result of this (see Price (1994)). Given that the main competitors in the contract gas segment, who are wholly or partially owned by North Sea gas producers, operate as upstream firms. The impact of these policies on the strategic behaviour of both BG and non-BG is examined in detail in Section 3 and 4, and the next chapter.

Ofgas primarily adopted a “carrot and stick” approach, with the support of the MMC and OFT, in regulating the gas industry. Ofgas appreciated the intense competition that was developing in the contract gas market and removed a crucial disadvantage BG faced by suspending the requirement to publish their price schedules. Nevertheless, Ofgas subsequently turned its attention to the network access which became an integral part of its pro-competitive policies. This is reviewed in the following sub-section.

* BG’s strategic reaction to regulatory policies in the final goods is discussed in Section 3 and again in the next chapter.
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2.2. Regulation and Structure of Transportation Charges:

The measures undertaken to prevent abuse by BG, promote competition and manage the market, as suggested by MMC (1988), outlined in the previous subsection considerably reduced BG’s pre-entry advantage. However, despite MMC (1993), BG still maintained its status as a vertically integrated operator in the gas industry. Nevertheless, both the MMC reports, as pointed out by Price (1994), changed the environment and responses of BG, not least with respect to the role of transportation charges in BG’s strategic behaviour.

The regulation of network access, therefore, is an integral element in effectively reducing BG’s pre-entry strategic advantage. As far as Ofgas is concerned the importance of transportation charges cannot be understated. The opening paragraph of Ofgas (Dec 1993) consultation paper; “A Pricing Structure for Gas Transportation and Storage: A Consultation Document” states;

“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.”

Even though competition was allowed in the contract gas segment as early as 1982 (Oil Gas (Enterprise) 1982 Act) and BG was privatised in 1986, BG was only required to provide indicative prices for transportation and storage. The 1988 MMC Report found that BG practice of discrimination in the contract market operated against public interest. It advocated direct gas-to-gas competition as ultimately the only effective means of remedying the adverse effect of the monopoly position held by
BG to publish more information about terms of access to its network and set-up “Chinese walls” (accounting separation) between BG staff involved in access negotiation and those involved in purchasing and supplying gas, to prevent discrimination against potential competitors.

Ofgas’s first intervention to achieve third party agreement in BG’s network, following a referral of dispute terms to the DGGS, resulted in a set of guidelines which were published by Ofgas in May 1989. This led to the first formal “third party carriage” and was introduced in October 1989. The remainder of the sub-section examines the evolving regulation relating to transportation charges in the gas industry; examining the consultation process that took place leading to the policies implemented and the structure of the transportation charges.

2.2.1. 1989/90:

There was no separate price control and access charges were based on allowable rate of return on current assets of 4.5%. 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; the tariff market and transmission network.

The charges were split into four parts;

1. National Transmission System (NTS):

The NTS operates at high pressures up to 1,000 psi. The major factors affecting the charge are geographical distance and the peak load factor.

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9 New transportation charges are usually published every September and comes into effect on the 1st of October and applicable until the end of September the following year.
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2. Regional Transmission System (RTS):

The Transmission System in each Region of British Gas operates typically at pressures in excess of 100 psi. Once again the major factors affecting the charge are distance and the peak load factor.

3. Medium Pressure Distance System:

The charge for using this part of the system is not distance related as costs are postalised, the major variable being peak load factor.

4. Low Pressure Distance System:

The charges for the use of this system is similar to the Medium Pressure Distribution System.

2.2.2. 1990/91:

The basis of the charges were as in 1989/90 but at a reduced rate.

2.2.3. 1991/92:

In October 1991, the OFT published a review of the industrial and commercial market for gas, in which it found that the remedies applied following the 1988 MMC Report had not been particularly effective in encouraging competition. The OFT recommended that BG restructure to establish a separate gas transportation and storage subsidiary which was to provide access on a non-discriminatory basis, including access to BG’s trading business, and agree the regulation of charges with Ofgas.

BG undertakings were put in place in March 1992. These included an agreement to set up BG Transportation (including storage) as a separate business unit...
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with separate accounts, operating at arm’s length from its trading business, with Ofgas regulating charges for the use of BG’s transportation and storage.

An additional fixed charge part was introduced for 1991/92 transportation charges; the *customer charge* is site specific, reflecting the cost of administration and provision of site-based facilities. Though the charges for the original four parts are still based on distance and load factor, it is now quoted showing the split between the *capacity charge* element, which is payable on the peak daily capacity required by the shipper, independent of actual usage, and the *commodity charge* element which is paid on each therm of gas transported. Therefore, the formulae used to calculate carriage charges are:

\[
Total\ Charge = \text{Sum of } \{\text{Capacity Charges} + \text{Commodity Charges}\} \text{ for each tier used} + \text{Customer Charge}
\]

BG initiated a consultative process by publishing two consultation documents on the future approach to gas transportation charging; “Gas Transportation: A Public Consultation Document” (BG (March 1992)) and “Submission to Ofgas on the Rate of Return for Gas Transportation and Storage” (BG (July 1992)). This led to the MMC enquiry and report in 1993 where matters pertaining to transportation charges were investigated as part of a wide-ranging inquiry into the gas industry.

2.2.4. 1992/93:

While an extensive enquiry and consultative process was taking place, a broadly similar methodology to 1991/92 was applicable for transportation charges 1992/3. Nevertheless, a major departure did take place, where the capacity/commodity
split of NTS charges were readjusted downwards from 90/10 to a 50/50 split. Furthermore, as the competitive market threshold was lowered, a distinction was made between large and small sites. This distinction enabled greater administrative efficiency and easier access, in tune with the spirit of encouraging competition.

In response to BG’s consultative documents, Ofgas produced a discussion document; “Gas Transportation and Storage: A Discussion Document” (Nov 1992). The document set out to review BG’s proposals. BG’s proposed tariffs were chosen according to the stated criteria:

1. cost recovery,
2. equitability, meaning that the tariff should be applicable to all shippers, including BG and should vary only according to use made of the transmission and distribution system,
3. economic efficiency, by providing appropriate price signals reflecting costs,
4. acceptability to shippers, by virtue of being clear, predictable and arrived at by a fair and reasonable methodology, and
5. efficiency of implementation, as a result of simplicity of structure and application and minimisation of transaction costs.

BG feel that the first two are essential, and the remaining three “desirable”.

BG’s criteria broadly concurred with that of Ofgas’s whose criteria for appraising the relative merits of a transportation pricing regime are:

1. allocative efficiency, that is the prices charged give appropriate signals to existing and potential shippers and their customers, so that resources are expended only
where the benefit they create for customers is greater than, or equal to, the cost incurred,

2. non-discrimination between customers, and especially between BG and other shippers, other than grounds of cost, and

3. ease of implementation, administration and regulation, so that the cost incurred in calculating, maintaining and applying the chosen tariffs are minimised.

Ofgas, on the other hand, strongly feel that allocative efficiency is a primary consideration, that is "economic efficiency" as far as BG's is concerned.

BG's proposals for transportation is fairly significant departure from the existing system. Their proposals are as follows;

1. NTS Transmission Charges:

   The NTS Transmission charges are to be set on the basis of;

   a. calculating capacity (peak day therm) charges are calculated using long-run marginal cost on an entry/exit basis (LRMC/EE), and

   b. adjusting downwards these LRMC/EE based capacity prices so that they achieve 50 per cent of required revenue. The remaining 50 per cent is achieved through a single commodity (therm) related charge.

   The long-run marginal costs (LRMC) relates to the costs of sustaining indefinitely a unit increase in the capacity and throughput of the NTS transmission network. This includes the cost of any increase in the capital stock required as well as any consequent changes in other overheads and in running costs. BG argue in their consultation documents that, based on planned NTS investment over the next ten years;
"current LRMC analysis produces capacity charges which recover approximately 70 per cent of total cost."

There are three ways of estimating LRMC prices for BG Transmission and Distribution are;

a. notional path - which is the approach currently used by BG. It bases charges on the shortest interconnected distance between input and offtake points;

b. full matrix - uses network analysis to identify the actual incremental impact of a particular marginal input/offtake combination. These are, currently, five input points to the NTS, the beach terminals, but a large number of offtake points which are partially aggregated, for reasons of practicality, into 30 groups;

c. entry/exit - is a simplified approximation to the full matrix approach. The full matrix would produce 5 x 30 = 150 prices, one of each input point/offtake group combination. Entry/exit reduces this to five input point charges and 30 offtake point charges by conducting an ordinary least squares regression of the 150 full matrix prices, in the form;

\[ N_i + X_j + d_{ij} = F_{ij} \]

where; \( F_{ij} \) is the full matrix LRMC charge for input at i and offtake at j;

\( N_i \) is the entry charge for input at beach terminal i;

\( X_j \) is the exit charge for offtake in zone j; and

\( d_{ij} \) is the difference between \( F_{ij} \) and \( N_i + X_j \)

The process of regression calculates the values of the entry and exit charges which minimise the sum of the squares of \( d_{ij} \).
The relative merits and demerits of the various methods are as follows;

a. In general, the pattern of gas displacement resulting from an incremental input of gas at one point and offtake at another may have cost consequences in parts of the system other than those which lie on the shortest route between the input and offtake points. Therefore, it is desirable to model the impact on the whole system of a particular incremental input and offtake. Once this modelling has been undertaken it provides the basis for LRMC pricing which would more accurately reflect the effect of a marginal demand for transportation.

b. The full matrix approach is the "correct" method because it identifies explicitly the cost consequences of incremental input at any point which combines with offtake at any point. There are some practical difficulties. The input point from which gas is supplied to any specific customer, or indeed to any particular NTS offtake zone, cannot be identified.

c. From the practical point of view, the entry/exit LRMC pricing is an acceptable approximation to full matrix LRMC, even though the simplification implies a slight loss of sensitivity to the precise impact that any particular demand on the gas network might have.

The LRMC is generally calculated as the present value of the incremental costs incurred expressed as an annuity over the life of the assets. BG methodology the present value cost of meeting an increment of demand over a 10 year period is defined as the cost of meeting the demand increment from year 1 to infinity less the cost of meeting the demand increment from year 10 to infinity. This involves annuitising the cost over 10 years to give;
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\[ LRMC(BG)_j = \frac{1}{\delta} \times A \times C_i \times D_i \]

where \( C_i \times D_i \) gives the discounted cost for the year, with \( \delta \) denoting the discount rate, while \( A \) is the 10 year annuity factor. Ofgas’s calculations, on the other hand, assumes 20 years life for investment appraisal and LRMC is given as;

\[ LRMC_i = \frac{1}{\delta} \times A \times C_i \times D_i \]

The two approaches are clearly different from each other. Assuming no incremental expenditure (other than replacement expenditure) after year 10, they yield the same result only if all expenditure occurs in year 1. If incremental expenditure occurs between years 2 and 10 the BG’s approach results in a lower LRMC than Ofgas’s.

In addition, BG wanted to readjust the capacity and commodity split of the NTS charges from a 90/10 split to a 50/50. BG in its public consultation document (March 1992) states;

“from an LRMC economic efficiency perspective, it is fairly clear that peak flow requirement is the important cost driver.”

and that;

“NTS costs are predominantly fixed (i.e. very few costs actually vary directly with throughout)”.

On that basis, transportation charges should, on grounds of pure economic efficiency, be predominantly a function of the peak day capacity demanded by shippers. Ofgas (Nov 1992) expressed some reservations;
"this would mean increased prices for shippers with, in aggregate, low load factor customers (mainly domestic) and reduced prices for shippers with, in aggregate, high load factor (predominantly industrial) customers. Shippers would then be likely to pass on the transportation cost consequences of different load factors of demand to their customers."

and furthermore, they feel that the proposed split;

"may imply that peak capacity could be over-demand."

2. Regional Transmission and Distribution Charges:

BG’s proposals for charging for the use of RTS and RDS, are as follows;

a. Average Accounting Costs (AAC) based prices;

b. national postalisation, that is the same distribution tariff in all parts of the country;

c. no variation in distribution charges according to the pressure tier at which gas is delivered, merging of the pressure tiers and the merging of Regional Transportation with the Regional Distribution System;

d. charges are based on the amount of capacity booked, rather than the amount actually used.

BG rejected LRMC pricing for distribution, even though they proposed it for transportation. The reason cited was;

"practical infeasibility to calculate a point-to-point (or even zone-to-zone) LRMC in the way that it is possible for the transmission system."

A summary of Ofgas’s position is as follows;

1. broadly accept BG’s proposal that transmission tariffs should be based on LRMC/EE;
2. the split between capacity and commodity elements should be considered further;
3. transmission costs recovery should be via a uniform percentage increase on both capacity and commodity elements of transportation tariffs, if necessary;
4. BG’s proposal for volume related distribution pricing seems broadly acceptable, although further work must be done;
5. sub-national postalisation of distribution charges, in particular distinguishing between tariffs charged for offtake in urban, suburban and rural areas, should be considered further, although there are major problems over the present availability of data.

A further consultation document was released. The difference was that this time it was a joint BG and Ofgas consultation process; “Gas Transportation and Storage - A Joint Consultation Document” (Feb 1993).

2.2.5. 1993/94:

In the meanwhile, a new structure for transportation charges was being considered, the methodology for 1992/93 was applicable for 1993/94, pending considerable methodological changes in 1994/95. In the Ofgas’s consultation document; “A Pricing Structure for Gas Transportation and Storage: A Consultation Document” (Dec 1993), attention is paid to Regional Transmission and Distribution System and Low Pressure System (LPS).

Ofgas reached preliminary conclusions on the Regional Transmission and Distribution System;

a. It is reasonable for BG to set national postalised prices on the basis of AAC.
b. It is reasonable for BG to merge the RTS with the Regional Distribution System for charging purposes.

c. They were broadly content with BG's proposal to merge pressure tiers for charging purposes.

The main factors determining the LPS system are:

a. length of pipe,
b. diameter of pipe,
c. surface conditions, and
d. system configurations

Unit cost for pipelaying can be expected to decline over time as a result of technology, new pipelaying techniques and improvements in efficiency. There are, however, limited economies of scale with regard to the length of the pipe laid, it is more costly per customer to lay a system serving widely dispersed customers, other factors being equal. Nevertheless, there are significant economies of scale as regards pipe diameter.

BG proposes to split the LPS into two parts. One section consists of mains greater than 4" diameter and the other mains less than 4". These two sub-tiers are then treated separately in the following way. Costs are divided by total LPS throughput to produce a unit charge. A charge is then calculated for each Regional user by multiplying the unit charge by the probability that a customer of that size uses the LPS. This separation allows for the fact that larger customers do not generally use the less than 4" sub-tier, which accounts for 24% of the total cost of the LPS. BG feels that this approach has the merits of transparency, ease of implementation and administration, applicability to all users and continuity. In BG's view, pricing on this
basis is equitable in that it reflects the expected cost to the system of the individual end-users by-passing tiers of the system.

Ofgas (Dec 1993) identified that the proposed charges for LPS would imply a 20% increase in transportation charges for small sites (between 2,500 and 25,000 therms per annum) and 18% increase for large sites (above 25,000 therms per annum). Both Ofgas and BG, realising the disruption of a sudden increase in transportation cost implied by the proposed charges, agree it should be phased in if they are implemented.

The MMC Report (1993) gave particular attention to transportation charges which were influential and formed the basis for Ofgas’s future regulation of Transco charges. The recommendations are as follows;

1. Form and Basis of Control:
   Establishing a separate price control over BG’s transportation and storage activities and recommended this to be of the form RPI-X. It also suggested allowable revenues be based on a rate of return on current assets of no greater than 4.5%. However, the MMC did not recommend a value of X for Transco.

2. Standards of Service:
   The MMC recommended that quality of service standards for transportation and storage should be instituted.

3. Separate Price Control for Storage:
   The MMC said there was potential for competition in storage and suggested consideration be given to a separate formula for the control of storage prices.

4. Competition in Metering and Meter Reading:
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The MMC suggested that there should be an obligation on Transco to enable there to be competition in the provision and reading of meters.

5. Network Code:

The MMC also recommended the development of a Network Code by Transco with the aim of ensuring fair and non-discriminatory access to the system for all users.

2.2.6. 1994/95:

Following a series of consultation process between Ofgas, BG and the competing shippers, and the MMC (1993) recommendations, outlined earlier, Ofgas put in place new methods for transportation charges which came into effect on the 1st of October 1994. This was outlined in detail in; “Pricing Methodology for Gas Transportation and Storage” (Ofgas, (Oct 1994)). The overall level of charges for transportation and storage will be subject to price control. In line with the MMC’s recommendations, this control will take the form of RPI-X, where X was set at 5, and allow a reasonable rate of return.

Broadly, BG’s proposals were adopted despite the expressed reservation of Ofgas. The summary of the new charges are as follows;

1. NTS:
   a) entry/exit pricing;
   b) prices to be set using long run marginal costs;
   c) 50/50 capacity/commodity split.

2. Regional Transmission and Distribution System:
   a) national postalised prices to be set using Average Accounting Cost;
b) merging of the Regional Transmission System with the Regional Distribution System for charging purposes;

c) merging of pressure tiers for charging purposes;

d) a pricing function for the Low Pressure System related to pipe size;

e) 50/50 capacity/commodity split.

3. Customer Charge:

   a) prices to be set in relation to an allocation of average accounting costs into load bands;

   b) a cap on domestic customer charges to be set having regard to the importance of retaining the overall RPI cap on domestic standing charges.

   Soon after instituting the new charges for 1994/95, Ofgas initiated a consultation process through the publication of a consultation document; “Price Control Review: British Gas’s Transportation and Storage: A Consultation Document” (June 1995). The responsibilities of Ofgas in promoting competition was a prime consideration for the consultation process;

   “Given the duties placed on the DGGS by the existing and anticipated new legislation, the principle that will drive the setting of the Transco price control is that the regulator needs to seek to promote competition where feasible and regulate as a surrogate for competition where it is not. Whilst competition can be promoted in some services offered by Transco, its main pipeline network is likely to remain subject to regulation for the foreseeable future. This is because Transco’s extensive pipeline system is probably an example of a so-called natural monopoly. Where natural monopolies exist, entry by competitors, even
if free, are unlikely to be effective, because of economies of scale (or scope) enjoyed by the incumbent.”

The focus is on Transco’s allowed revenue within the rate of return cap. The starting point is to establish a long term Net Present Value calculation. As Ofgas point out;

“The essence of an incentive-based control is to set a tough but attainable forward target revenue over a set period. An important feature of deciding the Transco control will therefore be the future required cash flow. Due account must be taken of the required rate of return on capital expenditure which will feature as part of the future cash outlays.”

The framework which Ofgas intends to use to set Transco’s allowable revenue in the forthcoming review will have the following main elements;

a. forward-looking operating and capital expenditure cash flows (set at efficient levels) covering both the next control period itself and beyond, and recognition of the need for those forward looking cash flows to yield a rate of return equal to Transco’s cost of capital;

b. allowance for reasonable shareholder expectations;

c. consideration of the extent to which allowable revenue can be lower in the next control period as a result of the likely profile of future major capital expenditure.

2.2.7. 1996:

The 1994/95 charges ran on until new charges were introduced on the 1st of February 1996. The new charges had three elements; NTS, Local Distribution Zones
(LDZs) and customer related activities. The LDZs replaced the Regional Transmission and Distribution Systems. Essentially, the methodology for transportation charges were similar to that introduced in 1994/95 and kept within the RPI-X price cap and rate of return on current assets. LDZs following what was agreed in 1994 for Regional Transmission and Distribution Systems, phased the higher charges for Low Pressure Systems. The functions for use of the low pressure system to apply from February 1996 will be two-thirds of the way towards the final price levels, which will be achieved in October 1996.

In the meanwhile, Ofgas's consultation process which began in June 1995 was taking shape. The new price controls to be implemented from April 1997 for five years until March 2002 was outlined in; “1997 Price Control Review British Gas’s Transportation and Storage: The Director General’s final proposals” (Ofgas (August 1996)). The new control was divided into two elements; the framework of control and setting Transco’s allowed revenue.

The framework of the control is essentially along the lines decided after the 1993/94 consultation process, that is on the basis of a RPI-X form of control. Additional forms of control include;

a. Structure of Control:
Adopting a price cap with a 50:50 split between fixed revenue and per therm revenue.

b. Coverage of Control:
The competitive service of storage will be removed from the coverage of the control.
Other competitive services, such as meter provision and installation, and the provision
of new connection and extension to Transco’s system, will remain within the price control but be separately priced.

The setting of Transco’s allowed revenue was the prime consideration of the consultation process and review and consequently of the new charging methodology. The key elements are;

a. Operating Expenditure:
Ofgas was to allow Transco an operating cost of about £88m per year based on the actual operating expenditure for 1995. Furthermore, their projections assume efficiency gains on controllable costs through the control period of 3.8% a year.

b. Capital Expenditure:
On new capital expenditure we propose to allow an amount related to actual past expenditure rather than to Transco’s projections, against which they are historically underspent.

c. Cost of Capital:
Following responses to the initial review, Ofgas propose to base the price control on a real, pre-tax, cost of capital of 7%. This is, they deem, consistent with the position of other regulators.

d. Opening Regulatory Asset Value:
The “initial market value” of Transco is based on Ofgas’s calculations on a market value at December 1991. They used the same Market to Assets ratio of 60% as the MMC used, that is, a discount of 40% to book value.

As highlighted, transportation charges were an integral part of Ofgas’s regulatory and competitive policies in the gas industry. However, their initial instincts
were to focus on the final goods market. First formal third party carriages were not introduced until October 1989. The form of regulation was rate of return on current assets which also covered the tariff markets where BG was the monopoly supplier. This continued until 1993/94. In the meanwhile, BG initiated a consultative process and suggested a set of proposals for transportation charges, which were broadly implemented in 1994/95. As Waddams (1995b) points out, one could view this as BG's response to the threat of competition. Furthermore, the rebalancing of the charges was in line with BG's pricing and constraints in the domestic market.

The new methodology for transportation charges in 1994/95 incorporated the MMC(1993) recommendations. A separate regulation was to be set for transportation charges, from other BG services. The form of control was to take the form RPI-X while allowing a reasonable rate of return. The MMC was obviously keen to balance between the need to provide incentive to invest and to ensure that efficiency attained and passed on to customers.

Soon after the implementation of the new methodology in 1994/95, a new consultative process began in June 1995. This time it was initiated by Ofgas. As outlined, Ofgas had some serious reservations about the methodology implemented, despite giving in to most to BG's proposals. The review and the eventual new methodology concentrated on Transco's allowed return. They were concerned with the problems associated with rate of return regulation; balancing between incentive to invest and to innovate and abuse their strategic advantage, these issues are discussed in section 4.
CHAPTER 3: COMPETITIVE PROCESS: THEORETICAL ANALYSIS

Table 3.2 below gives an illustrated example showing the change in transportation charges:

TABLE 3.2: Transco’s Transportation Charges from Bacton to Leeds: 1989-199610 (Illustrative Load Size: 100 000 th/annum and Load Factor: 60%)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>PENCE/THERM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989/90</td>
<td>10.08p</td>
</tr>
<tr>
<td>1990/91</td>
<td>8.64p</td>
</tr>
<tr>
<td>1991/92</td>
<td>6.26p</td>
</tr>
<tr>
<td>1992/93</td>
<td>6.53p</td>
</tr>
<tr>
<td>1993/94</td>
<td>6.53p</td>
</tr>
<tr>
<td>1994/95</td>
<td>6.21p</td>
</tr>
<tr>
<td>1995/96</td>
<td>6.58p</td>
</tr>
</tbody>
</table>

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

C. Waddams (1995b) maintained that BG responded to regulatory change via access charges. There have been four main changes: the requirement to publish schedules; the target for divesting the industrial market; the introduction of rate of return determined price cap on the access charge, and the introduction of competition in the domestic market.

Access charges dropped dramatically to meet OFT 1991 recommendations, BG hoped that this, their participation in the “Gas Release Programme” and giving up of their market share would ease the requirement to publish their pricing schedules. In the first three years of formal third party carriage charges, when Ofgas was keen to promote competition, access prices fell by almost 50% in real terms. Furthermore, by

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10 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.
CHAPTER 3: COMPETITIVE PROCESS: THEORETICAL ANALYSIS

distinguishing between large and small sites thereby creating easier access, it is hoped to facilitate more competition.

A brief summary of the regulatory policies are as follows;

1. Final Goods Market:

   Ofgas introduced a public pricing policy which required BG to publish its pricing schedules in the contract gas market. In addition, BG agreed to participate in the “Gas Release Programme” and to give up 60% of its market share.

2. Network Access Charges:

   The first formal “third party carriage charges” were introduced in October 1989. The regulation took the form of Rate of Return (ROR) on current assets, which were higher than the cost of capital. The subsequent three years saw the access charges fall by up to 50% in real terms. In 1993, BG initiated a consultative process to review access charges. The resulting access prices implemented were; NTS element of access charges, which made up 70% of total cost of transportation. While the RTS element was based on accounting costs. New transportation charges reflected some rebalancing peak and off-peak charges, making the former relatively more expensive.

   Subsequently, 1995 Ofgas undertook a complete review of Transco’s operations. Following the MMC (1993) report, the form of control of access charges was now RPI-X, while allowing a reasonable rate of return. Balance need to be struck between the need to provide incentive to invest and to ensure that efficiency attained and passed on to customers.
Section 3: British Gas’s Pricing Policy and Behaviour: A Theoretical Analysis

The present section investigates BG’s pricing policy. It has to be borne in mind that BG as the incumbent has pre-entry advantage and the main entrants, who operate as upstream firms in the contract gas market, potentially have post-entry advantage. Together with the analysis undertaken in Chapter 4, it will be shown that BG’s pricing behaviour is a reaction to Ofgas’s regulatory and competition policy in the final goods market. As highlighted earlier, BG’s pricing behaviour was under some scrutiny, as Ofgas required BG to publish their pricing schedules to eliminate any possibility of the practice of first degree price discrimination. In addition to the requirement to publish the pricing schedules, BG responded to OFT (1991) by undertaking to give up 60% of their market share and participate in the “Gas Release Programme”.

The introduction of a public pricing policy has two effects: first and foremost, it prevents abuse; it ensures that the incumbent does not engage in any predatory or anti-competitive practises, and secondly it affects the incumbent’s strategic behaviour. These effects imply that the publishing of BG’s pricing schedules have two possible outcomes with respect to the pricing behaviour in the final goods market of the competitive sector;

i. contestable markets, or

ii. incumbent adopting an inter-temporal pricing strategy.
CHAPTER 3: COMPETITIVE PROCESS: THEORETICAL ANALYSIS

3.1: Contestable Markets:

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 of contestable markets (see Baumol et al (1982)), 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 equal to 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 they 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 were 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).\(^{11}\)

3.2 Inter-temporal Pricing Strategy:

On the other hand, the incumbent, BG's, pricing behaviour can be explained
by inter-temporal pricing strategy or dynamic limit pricing model (see Gaskin (1971)).
An incumbent, or dominant firm, in the face of inevitable competitive entry into the
market chooses monopolistic pricing behaviour and profits for the present while
sacrificing some future profits through the loss of market share.

In the present case, BG, if it chooses an inter-temporal pricing strategy, will
maximise profits as;

\[
\text{Max } \pi_{BG}(t_0) = \int_{t_0}^{t} (p_{BG}^m - c)(Q(p_i) - q_{NBG}) e^{-r(t-t_0)} dt \tag{3.3.1}
\]

where \(\pi_{BG}\) 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 \(Q(p_i)\) refers to total industry demand which is function of
average industry price (\(p_i\)) and \(q_{NBG}\) represents the entrants' output.

\(^{11}\) As noted in Ofgas(1987) and seen in the next chapter, the contract gas market has very low swing
factor. The issue of contestability is investigated further in Chapter 6.
The rate of entry \( \frac{\dot{q}_{\text{NBG}}}{\alpha} \) is an increasing function of the of BG's price;

\[
\dot{q}_{\text{NBG}} = f(p_{BG}) \quad (3.3.2)
\]

where \( f_{p_{BG}} > 0 \). It follows, from the solution to the model, that BG's market share must disappear. As \( t \) approaches infinity, its market share becomes zero. More realistically, BG may wish to set a target time or market share, as suggested by the original Gaskin model. This target may be when their requirement to publish their prices or public pricing policy is suspended. As discussed, the introduction of a public pricing policy severely restricts BG's strategic advantage. BG may choose to react to regulatory and pro-competitive policies and maximise their inter-temporal profits within these constraints, especially as they are aware that the main entrants into the contact gas market are upstream firms\(^2\). Therefore, the inter-temporal pricing strategy, BG may pursue is;

\[
\text{Max } \pi_{BG}(t_0) = \int_0^t (p_{BG}^m - c)(Q(p_t) - q_{\text{NBG}})e^{-r(t-t_0)}dt \quad (3.3.3)
\]

the infinity time period is replaced by a target time period \( (\tilde{t}) \), which represents the suspension of public pricing policy. The corresponding prices are;

\[
p^c < p_{BG}^m \quad \text{when } t < \tilde{t}
\]

and

\[
p^c = p_{BG} \quad \text{when } t > \tilde{t}
\]

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 (3.3.3). Subsequently, they revert to pricing behaviour \( (p^c) \) that is consistent with market
CHAPTER 3: COMPETITIVE PROCESS: THEORETICAL ANALYSIS

conditions. The market conditions that evolved while pro-competitive policy is
pursued may facilitate collusive or non co-operative pricing. Therefore, BG’s inter-
temporal profit rates could be\(^{13}\);

\[ \pi^m > \pi^c > 0 \]

where \( \pi^m, \pi^c \) and 0 denotes monopolistic, collusive and non co-operative profit rates respectively.

Section 4: The Impact of Network Access Price Regulation and

Industry Structure on the Competitive Process in

Competitive Gas Market: A Theoretical Framework

The strategic advantages of both BG and the main entrant shippers highlighted
in the previous section are also of particular importance for the analysis in the present
section. Furthermore, as the gas industry was retained as a vertically integrated
industry, whereby BG owned the gas transmission network while competing in the
final goods market, BG’s pre-entry advantage was strengthened.

The effect of the rate of return regulation where the allowable rate is set higher
than the cost of capital on capitalisation, the Averch-Johnson effect, in particular with
respect to the UK gas market is well documented (see Price (1994) and Waddams
Price (1997)). As pointed out in sub-section 2.2 earlier, Ofgas (November 1992) felt
that the 50/50 capacity/commodity charge split, which was eventually introduced,

\(^{12}\) The next chapter, discusses why the regulator allowed them to pursue this behaviour, while trying to eliminate predatory practise.
implies that it would be an over-demand of peak capacity. Any increase in the demand for peak capacity necessitates expansion of the transmission network; the NTS costs are primarily fixed. 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 suggested by Ofgas (November 1992), higher charges for supplying to domestic customers and lower charges for supplying to industrial users.

The present section, examines another possible effect of rate of return regulation; capacity pre-commitment, and the Stackelberg-Dixit model, with particular reference to a vertically integrated industry such as the gas industry. Both effects on the competitive process in the gas industry are considered; 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.

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. This enables them to make quantity precommitments in the final market, by opting to sell

\[ \text{This could equivalently be; } \frac{p - mc}{p}. \]
directly to end users rather than BG. The upstream firms have an intrinsic first mover advantage.

The present analysis is set in a duopoly scenario; a vertically integrated incumbent and an entrant operating as an upstream firm. The first sub-section, briefly outlines the Stackelberg-Dixit model which is the basis of the present analysis. The subsequent sub-section applies the model to the competitive gas market.

4.1. Stackelberg-Dixit Model:

Spence (1977) was concerned with the issue of entry. Irrevocable investment decisions can be used as a form of entry deterrent. He assumed that an entrant would believe that post-entry output would equal the incumbents' pre-entry capacity. Furthermore, one could expect an incumbent exercising such a strategic advantage to have excess or under utilised capacity. This was the basis of the Stackelberg-Dixit model (Dixit (1980)). It showed that the incumbent exercising its post-entry advantage could considerably limit the entrant's pre-entry output, even if the entrant had an pre-entry advantage.

The essential part of the present analysis relates to the costs of production, where each firm is assumed to have; (a) constant average variable cost of output, (b) constant unit cost of capacity expansion and (c) set-up costs. The total cost per period of the ith firm which has a capacity $n_i$ while producing an output level $q_i$ ($q_i \leq n_i$) is;

$14$ These cost assumptions are to simplify the analysis and do not affect the outcomes or results by the relaxing of these assumptions as discussed in Section 4.1.
Special Note

Page 99 missing from the original
Up to output level $\bar{n}_1$, where there is possibility of spare capacity, marginal cost is equal to $b_1$ and when there is an expansion beyond the precommitted capacity, the additional marginal cost is equal to $(b_1 + a_i)$. The corresponding reaction functions are depicted in Figure 3.4 with $JJ'$ and $GG'$ representing the respective positions.
CHAPTER 3: COMPETITIVE PROCESS: THEORETICAL ANALYSIS

The entrant firm, with no prior commitment in capacity, has a reaction function $RR'$. The incumbent firm has the privilege of choosing $\bar{n}_i$ in advance and the reaction function it will have in post-entry duopoly (see Fig. 3.5).

The entrant firm, with no prior commitment in capacity, has a reaction function $RR'$. The incumbent firm has the privilege of choosing $\bar{n}_i$ in advance and the reaction function it will have in post-entry duopoly (see Fig. 3.5).
Firm 1 and 2 will have an equilibrium at either $T$ or $V$. The former represents the Nash equilibrium when capacity expansion costs matter for the incumbent and later when they do not. Therefore, the post-entry equilibrium is:

If $\bar{\bar{n}} \leq T$, then $T$

and

If $\bar{\bar{n}} \geq V$, then $V$.

And, if $T \leq \bar{\bar{n}} \leq V$, it will occur at the appropriate point on the heavy line segment of the entrant's reaction function lying between $T$ and $V$. Firm 1 can exercise leadership over a limited range by using its capacity choice to manipulate the initial condition (pre-entry) of that game.

The above analysis could be extended to a scenario where the entrant is able to exercise post-entry Stackelberg leadership. The rules of the game are such that it enables the entrant to exercise quantity leadership.
In Figure 3.6 above, point $F$ is the ordinary Stackelberg point where firm 2 is the leader, when there are capacity expansion costs. The corresponding firm 1's reaction function is $GG'$. If $\bar{n}_1 < F$, firm 1's reaction function shifts from $JJ'$ to $GG'$. With $\bar{n}_1$ to the left of $F$, the incumbent's profit is maximised at $F$. If $\bar{n}_1$ is between $F_i$ and $T$, there will be a maximum at the kink in firm 1's reaction function when it meets $GG'$. The equilibrium is at an appropriate point along segment $FT$. If $\bar{n}_1 > T$, the tangency solution is along $TV$, an iso $\pi_2$ contour being tangential to the vertical portion of firm 1's reaction function. At point $M$, the iso $\pi_2$ is tangential to $JJ'$ and, this contour meets $RR'$ at $Q=(Q_1, Q_2)$. The vertical tangency the best choice for 2 if $\bar{n}_1 \leq Q$ and if $\bar{n}_1 > Q$, tangency at $M$ is preferred.

The incumbent by choosing its capacity in advance, can secure post-entry equilibrium along kinked $FTQ$. Even though the rules of the game require it to surrender post-entry quantity leadership, the incumbent firm can use its commitment to capacity to seize a limited initiative back from the entrant.

4.2. Application to the Competitive Gas Market:

Basically, the Stackelberg-Dixit model states that "sunk cost" is used to deter entry and/or manipulate post-entry outcomes. The main difference between "sunk" and "fixed" cost is that the latter is sunk cost only in the "short-run". Sunk costs are those investment costs that produce a stream of benefits over a long horizon but can never be recouped. As Tirole (1989) points out that the "short-run" is difficult to define and suggest that fixed cost pertains to the rental of machinery for a limited period of time, while purchasing of the machinery implies that the firm is stuck with
and expects to accrue benefits from it over a long period of time. Therefore, sunk cost has a multi-period dimension.

In light of this, 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 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, I 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;

\[ n = n_{IC} + x \]  

(3.4.5)

and after entry;

\[ n = n_{IC} + n_{NIG} + x \]  

(3.4.6)

where \( n \) denotes the transmission network while \( n_{IC} = q_{BG} \) and \( n_{NIG} = q_{NBG} \) denotes the usage of the network by the incumbent and entrant respectively, and this is dependent on their outputs. 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\(^{15}\). 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;

\[
C_{NBG} = f_{NBG} + (b_{NBG} + a_{NBG})q_{NBG}
\]

(3.4.7)

where \(a_{NBG}\) refers to the access price and \(b_{NBG}\) refers to average variable cost of entrant’s output\(^{16}\). The incumbent’s cost function is as follows;

when \(q_{ik} + q_{NR}; > \bar{n}\), the network has to expand beyond the pre-commited level;

\[
C_{BG} = f_{BG} + (b_{BG} + a_{N})q_{BG} + a_{N}q_{NBG}
\]

(3.4.8)

where \(a_{N}\) refers to the unit cost of the network and \(b_{ik}\) refers to average variable cost of BG’s output. When \(q_{ik} + q_{NR}; \leq \bar{n}\), there may be a possibility of excess capacity;

\[
C_{BG} = f_{BG} + b_{BG}q_{BG} + a_{N}\bar{n}
\]

(3.4.9)

The marginal cost of entrant’s output is;

\[
m_{c_{NBG}} = b_{NBG} + a_{NBG}
\]

(3.4.10)

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;

\[
m_{c_{BG}} = b_{BG}
\]

(3.4.11)

and an additional marginal cost thereafter;

---

\(^{15}\) 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.

\(^{16}\) 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, \(b_{ik}\), 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.
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 incurred becomes dependent on output and the unit cost of capacity becomes part of marginal cost\(^1\) 7.

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;

\[
\pi_{BG}^1 = q_{BG} (c - d(q_{BG} + q_{NBG}) - C_{BG}^1) \quad (3.4.13)
\]

and

\[
\pi_{BG}^2 = q_{BG} (c - d(q_{BG} + q_{NBG}) - C_{BG}^2) \quad (3.4.13')
\]

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

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

and

\[
R^2(q_{NBG}) = \frac{(c - dq_{NBG} - b_{BG})}{2d}
\]

\(^17\) 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 (3.4.12) > (3.4.11), which is more than likely.
where \( R^2(q_{NBG}) > R^1(q_{NBG}) \) and the respective incumbent’s outputs are;

\[
q_{BG}^1 = \frac{c - 2(b_{BG} + a_N) + b_{NBG} + a_{NBG}}{3d}
\]

and

\[
q_{BG}^2 = \frac{c - 2b_{BG} + b_{NBG} + a_{NBG}}{3d}
\]  (3.4.15)

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 eq (3.4.15) indicate that \( q_{BG}^2 > q_{BG}^1 \).

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;

\[
\pi_{NBG} = f(q_{NBG}, R(q_{NBG}))
\]  (3.4.16)

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

\[
\pi_{NBG} = q_{NBG}(c - d(q_{BG} + R(q_{NBG})) - C_{NBG})
\]  (3.4.17)

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. These issues relating to the
CHAPTER 3: COMPETITIVE PROCESS: THEORETICAL ANALYSIS

competitive market, particularly the contract gas market, are examined in detail in the following sub-section.

4.3. Possible Impacts of Ofgas’s policies:

The form of access price regulation, where the allowed rate of return on capital base was higher than the cost of capital, has two implications; (i) increased capitalisation and (ii) large capacity precommitment by the incumbent. They affect the reaction functions of both the incumbent and entrants.

The former, the Averch-Johnson effect, can potentially shift the entrant’s reaction function to the left, the rebalancing and a larger capital base result in a higher access charge. The latter Stackelberg-Dixit effect, implies lower marginal cost and shifts the incumbent’s reaction function to the right as large capacity pre-commitment is likely to occur.

The rate of return regulation meant that as long as it is higher than the cost of capital, there is an incentive for increased capitalisation and rebalancing within the cap, (see Averch and Johnson (1961)). During the 1994 access charge consultations, BG was insistent on rebalancing its charges so that capacity elements were undercharged. Their request to change the 90:10 split between capacity and commodity charges to 50:50 was conceded by Ofgas, as discussed in Section 2.2. BG hoped that by increasing its capital base, it could increase its access charges in the future (see Sherman (1989), Price (1994) and Waddams Price (1997)).
The relatively lower peak charges increased demand and induced over-capitalisation. Such rebalancing, the undercharging of geographical distance and peak usage, suits BG's own operations, while increasing demand and encourages over-capitalisation. In the short term, BG would want to retain its most profitable markets. Uniform prices meant that these are low-cost customers, with a high-load factor and close to a beachhead. In the longer term, BG might have thought such temporary profits were worth sacrificing, particularly as the entrants were not large enough to be a threat. However, what was profitable to BG proved to be similar to the entrants, particularly as it continued to practise geographical cross-subsidy.

Furthermore, BG reacted to the introduction of domestic competition by increasing entrants' fixed cost and bringing charge structures in line with its own final goods price. In addition, by making Low and Medium Pressure charges relatively more expensive, smaller consumers would become less attractive to entrant shippers.

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 \( n_{BG} + n_{N_{hg}} \leq \bar{n} \) 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 3.7. This, as implied by the Stackelberg-Dixit model, considerably limits the entrant's post-entry advantage. In addition, the higher access
price as result a increased capitalisation, shifts the entrant’s reaction function from 
RR’ to SS’.

![Diagram](image)

**FIGURE 3.7: 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 byproduct of 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.

In general, the incentive to precommit capacity has an impact on network bypass. Entrants would be deterred from investing in alternative networks. In some
cases, with evolving technology which requires large initial investments, it may be optimal to build competing networks and therefore, such deterrence may be inefficient. Such a scenario may not be directly relevant to the UK gas industry.

A summary of the theoretical issues are as follows;

1. The incumbent, reacting to public pricing policy, could either follow a pricing policy consistent with contestable outcomes or practise inter-temporal pricing strategy. Both of which are consistent with its pre-entry advantage. The latter, however, would be consistent with a scenario where the entrant has post-entry advantage and, together with the regulator pursuing pro-competitive polices, the incumbent faces the prospect of losing its dominant position.

2. The network in a vertically integrated industry is a "share sunk cost". It implies that the incumbent pre-commit large capacity affecting its marginal cost and reaction function.

3. An outcome of using sunk cost capacity to manipulate post-entry outcomes is excess or under-utilised networks. This results in wasteful usage of resources. It is the responsibility of regulators of vertically integrated industries to ensure that this is minimised. Ofgas's review of Transco's operations proved crucial in reducing wasteful usage of resources. The regulatory pressure by Ofgas to reduce BG's advantage as "share sunk cost" owner, led to the demerger of BG and Transco in mid 1997. Does this suggest that the gas market is a "natural vertically separated" industry and that is the optimal way to promote competition in the gas industry?\(^\text{18}\)

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\(^{18}\) Newbery (1997) argue that one of the reasons why privatisation in the electricity industry followed vertical separation path is because of the difficulties in introducing competition in the vertically integrated gas industry.
4. Access price regimes that allow charges above the direct cost of provision only exacerbates the scenario, as it keeps the cost of excess capacity down.

The two main strategic policies adopted by BG complemented each other. While the public pricing policy was in operation they exercised a monopolistic pricing policy, acquiring monopolistic rates. Subsequently, when BG adopted competitive pricing behaviour, they faced lower marginal costs as a result of large capacity pre-commitment in the previous periods. BG used Ofgas's regulatory policies to their advantage. When the public pricing policy was in place they disguised their prices from their rivals, who had post-entry advantage, by practising an inter-temporal pricing behaviour. In the meanwhile, the form of network regulation adopted (that is rate of return regulation above the cost of capital and a vertically integrated industry structure), gave BG the necessary incentive to pre-commit its capacity to keep its marginal costs low.

The impact of Ofgas's policies on the competitive process, in particular the contract gas market, is investigated further in the next chapter when the competitive process and the data set is examined in detail. Essentially, BG was able limit the entrant's post-entry advantage, as a rate of return regulation gave it sufficient incentive to make substantial transmission network pre-commitment.
Section 5: Conclusion:

Ofgas tried to avoid any formal regulation in the final goods market of the competitive sector. They took a similar position to that echoed by Newbery (1997), that is regulation is essentially inefficient, and optimal outcomes are best achieved by increased competition. They introduced a public pricing policy as part of their pro-competitive policy. The public pricing policy was expected to prevent abuse while facilitating contestable outcomes in the final goods market in the competitive segment. Nevertheless, Ofgas was concerned about the implications of this on cross-subsidisation. In consultation document; “Competition and Choice in the Gas Market: A Joint Consultation Document” (Ofgas (May 1994)), Ofgas pointed out;

“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. Such a strategy is often known as “cherry-picking”. To the extent the strategy is successful, the previous monopolist (in this case BG) risks being left increasingly with the less profitable, or cross-subsidised, areas of the market. In the absence of countervailing action, there would be pressure for relative prices to rise in these previously cross-subsidised areas of the market, where prices may have been below cost.”

In addition, as highlighted in sub-section 2.2, Ofgas was under the impression that their pro-competitive policies would result in the evolving of a competitive market. This issue is examined further in the concluding chapter.
CHAPTER 3: COMPETITIVE PROCESS: THEORETICAL ANALYSIS

Transportation charge regulation evolved from non-existence to that where it became an integral part of competition policy in the gas industry. Initially, regulation, using the rate of return on current assets, sort to ensure that there was sufficient incentive to invest and therefore improve and modernise the existing transmission network. Subsequently, following the MMC(1993) report, an additional regulatory cap was introduced to ensure that efficiency gains were maintained and passed on to the competing shippers.

Evidently, both Ofgas’s and BG’s main criteria when determining transportation charges is allocative efficiency, thereby providing appropriate price signals reflecting costs. The main cost for the provision of network services is the National Transmission System, it comprises up to 70% of the total cost of provision, and its charge is based on long-run marginal cost. The rest of the transportation charges are also based on the direct cost of provision.

Further deregulation took place in the gas industry, much of this centred around the residential gas market. The first phase of competition was introduced in the south-west of England in 1996 and was extended to a large number of consumers in the south of England in 1997. Full competition throughout Great Britain is expected in 1998.

The consultative process initiated by Ofgas in 1995 and the eventual methodology for transportation charges introduced in April 1997 was distinctly concerned with balancing the strategic advantage BG could exercise as a vertically integrated firm, that is preventing abuse, while providing an incentive-based control.
Ofgas, as highlighted in sub-section 2.2, had serious reservations on the methodology for transportation charges introduced in October 1994, which were mainly based on BG’s proposals and initiative.

Meanwhile, BG succumbed to the inevitable, by implementing the separation between their transportation and supply operations in 1997. This led to the creation of a separate supply company, Centrica, and BG Transco. BG’s attitude towards access cost recovery changed when the demerger took place. As Waddams (1997) points out, Transco moved away from the 50:50 split between the capacity and commodity elements of the transportation charges position which it maintained so adamantly in the 1994 consultations and to which Ofgas relented. As the transportation operations and the rest of BG’s operations demerged and since lower peak charges do not benefit Transco, this implied that the undercharging directly benefited BG’s own supply arm.

In the present chapter, a theoretical analysis of the competitive process in the gas industry between 1986, when privatisation took place, and 1996 is given. Ofgas pursued a pro-competitive policy by introducing various regulatory measures relating to both the final goods market and network access. An analysis is made of the possible reactions of both BG and the leading entrant shippers to the regulatory measures, given their respective strategic advantages. Though latterly Ofgas focused its pro-competitive policy on network access, BG persuaded them to introduce regulatory measures which enabled BG to limit non-BG post-entry advantage, resulting in the October 1994 transportation charges. The next chapter examines the competitive process that took place in the contract gas market between 1990 and 1996 using John Hall Associates data set. The competitive process is examined in light of the
CHAPTER 3: COMPETITIVE PROCESS: THEORETICAL ANALYSIS

regulatory measures introduced and the theoretical analysis outlined in sections 3 and 4.

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 as shown sub-section 4.3.

It has been argued in Sections 3 and 4 that BG could exercise various strategic advantages within the regulatory measures introduced in the contract gas market,
which is discussed in Section 2. To a large extent, the strategic behaviour
complements each other. On the one hand, it could maximise profits or accrue
monopoly while losing its market shares. Subsequently, when it begins to follow
pricing policy in the final goods market consistent with the evolving market
conditions it could use its manipulation of the "shared sunk cost" pre-determine
competitive post-entry outcomes\(^{19}\).

Finally, the introduction of a public pricing policy in the competitive sector
was to prevent abuse and anti-competitive practices, and BG was not allowed
discretionary pricing. The next chapter, on other hand, also shows that BG’s was
allowed a pricing policy that was far from being Ramsey-optimal and was
distortionary while under regulatory scrutiny, implying that Global Price Cap
regulation is not appropriate. Furthermore, their concern with eroding cross-
subsidisation and “cherry picking” by entrant shippers make the application of ECPR
and its later manifestation, “direct-plus-opportunity cost”, more appropriate and
possible, as (see Baumol and Sidak (1994) and Baumol et al (1997)). These issues are
examined in detail in Chapter 6.

\(^{19}\) For example BG's relative "mark-up" or Lerner index, \(\frac{P_{BG} - mc_{BG}}{P_{BG}}\), becomes higher.
CHAPTER 4: A DESCRIPTIVE ANALYSIS OF THE
COMPETITIVE PROCESS IN THE CONTRACT GAS MARKET

Section 1: Introduction

Section 2: A Review of the Competitive Process: Official Data Source

Section 3: An Analysis of Outputs in the Contract Gas Market

Section 4: An Analysis of Volume Weighted Average Prices in the Contract Gas Market

Section 5: Final Goods Market Outcomes and Strategic Behaviour

Section 6: Conclusion
CHAPTER 4: COMPETITIVE PROCESS: DESCRIPTIVE ANALYSIS

Section 1: Introduction

This chapter analyses the data set which is used in the thesis. This is done in the context of the regulatory and competition policies pursued in the contract gas market and the theoretical analysis outlined in the preceding chapter.

The data set is part of John Hall Associates data base for the period January 1990 to October 1995. They are a leading UK gas analysts and brokers and their data base represents between 15% and 20% of the actual contract gas market, excluding Power Generation. Their data base is fairly comprehensive; giving the breakdown of both BG and the entrant shippers’ output and volume weighted average price on a monthly basis. Approximately 80% of the data set represents fixed price contractual agreements of one year long. On the other hand, as a result of commercial sensitivity and the nature of the contract gas market where negotiations are conducted privately, data from official sources are sparse. The occasional study and competitive review conducted by OFGAS and the Department of Trade and Industry (DTI) can be at best described as anecdotal.

Section 2 outlines the limited data available relating to the contract gas market from official OFGAS and DTI publications. Nevertheless, they provide a useful background for examining John Hall Associates’s data set. Section 3 and 4 analyses the evolving output and market share and price movements respectively. Section 5

---

1 In John Hall’s dataset competing firms do not appear until around October 1990 and, furthermore, the first formal third party agreements were only introduced in October 1989.
examines market outcomes in the final goods market with respect to the possible strategic behaviour outlined in the last chapter and the main conclusions are drawn in Section 6.

Section 2: A Review of Competitive Process: Official Data Source

At present, data from official sources such as OFGAS and DTI relating to the contract gas market has been fairly anecdotal. Essentially the only data available from official publications have been the average prices of gas in the industrial sector and BG's market shares on an annual basis. OFGAS (1994 and 1996) provides some indicative figures on BG's market shares given in Table 4.1. These figures relate to the competitive sector of the gas market which was above 25,000 therms/annum until the end of 1992, and subsequently the monopoly threshold was reduced to above 2,500 therms/annum. Even though the contract gas market comprises entirely of the above 25,000 therm/annum sector, the figures below indicate BG's eroding position in the competitive market in general they, however, regaining some loss ground in 1995 and 96.

Please note that in the present chapter the average prices given are in current terms. However, when empirical analysis is undertaken the average prices are in real terms, this is elaborated further in Chapter 4.
Table 4.1: BG’s Share in the
Competitive Market,
1990-96

<table>
<thead>
<tr>
<th>DATE</th>
<th>MARKET SHARE(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct 90</td>
<td>93</td>
</tr>
<tr>
<td>Oct 91</td>
<td>80</td>
</tr>
<tr>
<td>Oct 92</td>
<td>57</td>
</tr>
<tr>
<td>Oct 93</td>
<td>32</td>
</tr>
<tr>
<td>Mar 94</td>
<td>20</td>
</tr>
<tr>
<td>Dec 94</td>
<td>9</td>
</tr>
<tr>
<td>Apr 95</td>
<td>10</td>
</tr>
<tr>
<td>Jun 96</td>
<td>19</td>
</tr>
</tbody>
</table>

Source: Ofgas (1994 and 1996)

The DTI publishes average industrial gas prices in the *Digest of UK Energy Statistics*. Table 4.2 gives the average industrial gas prices of large (which includes interruptible gas) and firm gas users;

Table 4.2: Industrial Gas Prices (pence/therm);
1990-96

<table>
<thead>
<tr>
<th>DATE</th>
<th>LARGE</th>
<th>FIRM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>20.88</td>
<td>27.97</td>
</tr>
<tr>
<td>1991</td>
<td>20.29</td>
<td>27.32</td>
</tr>
<tr>
<td>1992</td>
<td>20.53</td>
<td>27.67</td>
</tr>
<tr>
<td>1993</td>
<td>20.88</td>
<td>27.29</td>
</tr>
<tr>
<td>1994</td>
<td>21.61</td>
<td>26.18</td>
</tr>
<tr>
<td>1995</td>
<td>18.68</td>
<td>23.16</td>
</tr>
</tbody>
</table>

Source: *Digest of UK Energy Statistics (1990 - 1995)*
The actual average price has been falling steadily, particularly in 1994 and 1995. Although the data from official sources are sparse, they provide a useful yardstick for examining the more comprehensive dataset provided by John Hall Associates which follows.

Section 3: An Analysis of Outputs in the Contract Gas Market (therms in millions):

This section undertakes to examine the output of BG and the main competing shippers in the contract gas market in detail.

3.1: Illustrations of Outputs of the Main Contract Gas Shippers:

Figure 4.1 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. As Waddams (1997) points out, transportation charges fell by as much as 50% in real terms during the first three years of formal regulation. BG’s strategic advantage was also reduced when they 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 4.2 below gives a breakdown of the output of the main seven contract gas shippers; BG and six non-BG shippers. BG’s output is denoted by bgoutput, while AGAS, MOBIL, KINECTICA, QUADRANT, ALLIANCE and AMERADA HESS outputs are denoted by agoutput, mboutput, kinoutput, quoutput, aloutput and ampoutput respectively. The John Hall Associates’ data set indicates that though between twenty-five to thirty firms have entered the contract gas market over the period in question, the sector has been dominated by these six or seven main shippers. The six main entrants not only have the largest output but also appeared the longest in the data set.
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. As identified and anticipated by OFGAS (1987), the main entrants; Mobil Gas, Alliance Gas (ALL), Kinectica (KIN), AGAS and Amerada Hess (AMER) and Quadrant (QUAD), are either wholly or partially owned by North Sea gas producers.
As indicated by OFGAS’s figures given in Table 4.1, BG’s market share eroded considerably. John Hall Associates’ figures show a similar trend. Indeed, Figure 4.3 above also shows that BG’s market share is just below the 60% mark in late 1992 and around 10% in mid 1995 which corresponds closely to the official figures.

Figures 4.4 and 4.5 give the market share of the main six and four entrant shippers in the whole contract gas market respectively. As competition evolves the main six non-BG appear to accumulate large market shares. Figure 4.4 indicates that
the main six entrants have accumulated up to nearly 80% of the market.

Similarly Figure 4.5 shows that the main four non-BG shippers have acquired up to 50% of the market. The main four entrants, are those firms which have been the earliest to enter the market, and maintained their market share consistently and longest, and they are Mobil Gas, AGAS, Kinectica and Quadrant.
These figures suggest that as pro-competitive policies were pursued a oligopolistic market with high levels of concentration evolved.

3.2: Descriptive Statistics of the Main Shippers:

Table 4.3 provides some descriptive statistics relating to the main shippers in the contract gas market. It not only examines the individual firms' outputs but also the total market and non-BG outputs as a whole as well. It indicates that BG has the largest mean of the individual shippers of the period in question, but the standard deviation shows that it has the highest variability too. Mobil Gas has by far the largest mean of the non-BG shippers, particularly given the number of observations.
Table 4.3: Descriptive Statistics of Main 7 Contract Gas Shippers' Output

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
<th>Std Dev</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>394.52</td>
<td>411.30</td>
<td>129.77</td>
<td>584.38</td>
<td>155.01</td>
<td>70</td>
</tr>
<tr>
<td>BG</td>
<td>178.04</td>
<td>171.55</td>
<td>55.04</td>
<td>344.11</td>
<td>75.89</td>
<td>70</td>
</tr>
<tr>
<td>NBG</td>
<td>249.25</td>
<td>240.42</td>
<td>1.5</td>
<td>504.16</td>
<td>190.84</td>
<td>62</td>
</tr>
<tr>
<td>AGAS</td>
<td>15.36</td>
<td>12.57</td>
<td>1.7</td>
<td>40.10</td>
<td>12.26</td>
<td>60</td>
</tr>
<tr>
<td>ALL</td>
<td>77.70</td>
<td>97.3</td>
<td>5.6</td>
<td>125.93</td>
<td>40.57</td>
<td>41</td>
</tr>
<tr>
<td>AMER</td>
<td>23.81</td>
<td>37.87</td>
<td>0.11</td>
<td>47.31</td>
<td>22.56</td>
<td>21</td>
</tr>
<tr>
<td>KIN</td>
<td>46.44</td>
<td>47.27</td>
<td>2.6</td>
<td>83.51</td>
<td>29.73</td>
<td>54</td>
</tr>
<tr>
<td>MOBIL</td>
<td>79.44</td>
<td>76.53</td>
<td>1.5</td>
<td>161.18</td>
<td>55.28</td>
<td>62</td>
</tr>
<tr>
<td>QUAD</td>
<td>15.72</td>
<td>14.05</td>
<td>3.8</td>
<td>30.97</td>
<td>9.74</td>
<td>54</td>
</tr>
</tbody>
</table>

Notes: \( N \) denotes the number of occasions the respective firm appears in the data set

Section 4: An Analysis of Volume Weighted Average Prices in the Contract Gas Market (pence/therm)

The present section examines the BG and the individual non-BG entrants pricing behaviour and policies in detail.

4.1: Illustrations of Average Prices of the Main Contract Gas Shippers:

Both BG and non-BG pricing patterns, depicted in Figure 4.6, differ considerably. The incumbent's prices have distinct seasonal variations. The entrant non-BG shippers are not price followers, and their pricing behaviour appears to be
independent of BG's. This behaviour concurs with Figures 4.1 and 4.2, which indicate that there appears not to be any distinct seasonal variation in the outputs, and Ofgas's (1987) position.

Importantly and interestingly, 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 4.7 are consistent with Figure 4.6, it does not show any seasonal variations and the price dispersion appears low. Indeed, after BG's requirement to publish its prices was suspended, the prices in general appear to fall steadily.
CHAPTER 4: COMPETITIVE PROCESS: DESCRIPTIVE ANALYSIS

FIGURE 4.7: Prices of 7 Main Gas Suppliers
1990-96

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. This conforms very closely with DTI's firm gas price figures given in Table 4.2, especially the steady fall in 1994 and 1995.

Table 4.4 below gives the descriptive statistics of the respective prices. As BG practised a non-linear pricing policy, inter-temporal price discrimination, the mean prices of BG as indicated is irrelevant. The mean of non-BG prices over the period is 26.9 pence/therm and the median. The main entrant's mean also closely approximates this price. Furthermore, variability of BG's prices, that is the standard deviation, are considerably higher than that of the main competing shippers.
Section 5: Final Goods Market Outcomes and Strategic Behaviour:

Chapter 3 discusses the possible impact of a regulator introducing a public pricing policy. One could expect perfectly contestable outcomes, where final goods prices are Ramsey-optimal and the elimination of cross-subsidisation and inter-temporal price discrimination. On the other hand, there is a possibility that the incumbent invokes its pre-entry advantage by exercising dynamic or inter-temporal limit pricing.
A possible target for BG could be the removal of the public pricing policy and/or the level of market share that it agreed to give-up. Figure 4.7 clearly indicates that after the removal of public pricing policy in October 1994, BG reverts to behaving competitively. Contestable outcomes did not occur during the existence of public pricing policy, as BG's pricing indicate distinct seasonal variations rather than Ramsey-optimal. Particularly as there are no cost based justifications for it. While BG was required to publish its pricing schedule in the competitive sector, it practised monopolistic pricing and priced considerably higher than that of the non-BG entrants. Taking into account seasonal variations, the difference between BG and non-BG can be shown as follows:

The volume weighted annual prices can be calculated taking into account seasonal variation in annual output. In the case of low swing factor, as with the case of the contract gas market, it is assumed an average of 45/55 split of annual consumption of gas between the low and high demand seasons. Therefore, the respective prices of BG and average non-BG prices faced by their respective customers are;

1. BG;

\[ 38\text{p/therm} \times 0.55 + 23\text{p/therm} \times 0.45 = 31.25\text{p/therm} \]

2. non-BG;

\[ 27\text{p/therm} \times 0.55 + 27\text{p/therm} \times 0.45 = 27\text{p/therm} \]

When BG was practiseing seasonal pricing, it was roughly 15% higher than the average non-BG prices. If the seasonal variation in demand is higher, and there is a higher swing factor, this difference would be even greater.
CHAPTER 4: COMPETITIVE PROCESS: DESCRIPTIVE ANALYSIS

Given that Ofgas desires to eliminate abuse, the obvious question was why BG was allowed to practise third degree price discrimination while Ofgas attempted to eradicate any possibility that BG may practise first degree price discrimination. Particularly, as Ofgas (1987) points out that demand in the contract gas has a "low swing factor" and Figure 4.1 shows that outputs do not indicate any distinct seasonal variations. It could be argued that regulators are less concerned with the practise of third degree price discrimination than first degree price discrimination.

On the other hand, seasonal variations are evident in domestic gas demand, where BG has monopoly powers. Therefore, it can be reasonably assumed that Ofgas, as seen in the previous chapter was concerned about the loss cross-subsidisation in the non-competitive sectors, tolerated it on the grounds that BG were obliged to provide Universal Service Obligations (USOS) and maintained cross-subsidisation to the domestic markets. This may be an important consideration, especially as a firm commitment to liberalising the domestic market was only made in the Queen’s speech in 1994. The practise of third degree price discrimination assumes that price is equated to overall average marginal cost; both the competitive and non-competitive sectors. Nevertheless, BG’s pricing behaviour while the public pricing policy was in operation and after clearly indicate that they used their position as the incumbent monopolist to react strategically to the regulator measures introduced.

This begs another important question; why did BG choose to practise such a pricing policy. BG was aware of the post-entry advantage of the main competing shippers in the contract gas market, this was further compounded by the introduction of the public pricing policy as BG’s pre-entry advantage as an incumbent was severely
CHAPTER 4: COMPETITIVE PROCESS: DESCRIPTIVE ANALYSIS

curtailed. Subsequently, BG exercised its pre-entry advantage as a vertically integrated industry.

Ofgas (1987) anticipated that North Sea gas producers would find it more profitable to sell directly to end users and operate as upstream firms in a contract gas market. This appears to be borne out as the main entrant shippers, which are subsidiaries of North Sea gas producers, provide the main competition. They operated as upstream firms in the contract gas market. Nevertheless, as pointed out in the previous chapter, BG retained its main pre-entry strategic advantage because it was maintained as a vertically integrated firm. Furthermore, the initial form of access charge regulation was based on the rate of return on current assets. As this was higher than the cost of capital, in theory this could enable the incumbent to manipulate post-entry outcomes.

BG was a vertically integrated firm; owner of the "shared sunk cost" network. BG is able to limit the entry and/or regain any market share it lost by making large pre-commitments of capacity. Figure 4.3 indicates, as expected, BG experienced a dramatic fall in its market share as it faced stiff competition from upstream firms. Nevertheless, from late 1994 and throughout 1995, this fall was halted and held constant around the 10% mark. Furthermore, the official figures given in Table 4.1 concur that the fall in BG's market share in the competitive sector was halted. Indeed, BG went on to regain some loss ground in 1996.

More importantly, Figure 4.1 indicate that the sharp increase in entrant's output slows down to a constant from late 1993. In Figure 4.2, Mobil's, the main
entrant shippers, output also slows down during the same period to a constant and subsequently falls. Figures 4.4 and 4.5 confirms the trend. Though, BG started to price competitively at this time, Figures 4.6 and 4.7 indicate that there was no comparative advantage with respect to non-BG prices.

Section 6: Conclusion

The current chapter, while reviewing the data set and competitive process, also examines the possible theoretical explanations for the strategic behaviour adopted by the main shippers in the contract gas market and BG’s pricing policy. These were outlined in the previous chapter.

BG exercised its pre-entry strategic advantage while reacting directly to regulatory and competition policies adopted by Ofgas. First and foremost, they appear to have practised inter-temporal pricing strategy. BG had resigned to losing its market share in the face of Ofgas’s determined pursuit of pro-competitive policies, as highlighted in Chapter 3. BG wanted to be seen to be in tune with Ofgas’s pro-competitive policy. Primarily, as Price (1994) pointed, BG wanted the strategic disadvantage imposed by the requirement to publish their pricing schedules to be removed. Consequently, in the initial years of formal third party carriage regulation, they agreed to lowering access charges, participate in the “Gas Release Programme” and give up two-thirds of its market share. It must be pointed out that these measures would have marginal consequences on main entrants, who operate as upstream firms,
compared to small firms. What was more important is the introduction of a public pricing policy and network access regulation, which reduced BG’s pre-entry strategic advantage.

BG was also not averse to using its advantage as a vertically integrated firm. As seen in the previous chapter, they used the form of regulation to their advantage. They rebalanced the access charges which made transportation charges to some sectors such as the domestic sector more expensive, in anticipation of competition there. They reduced the relative price of peak related transportation charges. The increased demand, necessitated increased capitalisation of Transco’s operations, implying that higher charges were possible in the future. Furthermore, as seen in the present chapter, there is some evidence that it used its vertically integrated position to enable Stackelberg-Dixit outcomes, BG was not only able to halt the dramatic fall in its market share in the competitive market but regain some loss ground in the face of competition form upstream firms.

Clearly, BG’s pricing behaviour was a reaction to regulatory policies, invoking their strategic advantage to maximising their profits over the period in question. On the other hand, entrant’s pricing behaviour was quite separate and independent from BG’s. The question is whether their behaviour is consistent with oligopolistic competition conditions and theory. This is investigated in the next chapter.

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3 Judging from Figures 4.5 and 4.6, they appear to have only peripheral market shares.
4 Furthermore, in Chapter 3 it was highlighted that there was considerable excess capacity in Transco’s network transmission.
CHAPTER 5: DYNAMIC OLIGOPOLISTIC COMPETITION

PRICING: THE ENTRANT'S PRICING BEHAVIOUR

Section 1: Introduction

Section 2: A Theoretical Framework for Entrant's Pricing Behaviour

Section 3: Empirical Analysis of Entrant's Final Goods Pricing

Section 4: Market Structure, the Adjustment Process and Cyclical Behaviour, a Supergames Explanation: An Empirical Investigation

Section 5: Conclusion
CHAPTER 5: DYNAMIC OLIGOPOLY PRICING: ENTRANTS’ PRICING BEHAVIOUR

Section 1: Introduction

The previous two chapters have examined the competitive process in the contract gas market, given the potential strategic advantage of the incumbent and entrant, that is BG and main non-BG shippers, respectively. It tries to establish that BG used its pre-entry advantage; reacting to regulatory policies. The entrants’, on the other hand, pursued a distinct and unrelated pricing policy to that of BG over the period between 1990, when competing shippers entered the contract gas market, and 1996. The present chapter empirically investigates the entrants’ pricing behaviour over the period in question. The question is whether their pricing behaviour is consistent with the evolving market conditions, that is market structure, or the level of concentration, and industry demand conditions.

The organisation of this chapter is as follows: Section 2 outlines a possible theoretical framework for entrants’ pricing behaviour. It is a model of oligopoly behaviour based on the theory of collusion. Section 3 empirically tests the entrant’s pricing behaviour in a dynamic context. Section 4 examines the supergames or repeated games explanation of oligopoly behaviour in a dynamic context. It provides an explanation of how firms or “players” react to exogenous cost and demand shocks with the related price movements or adjustment processes. The theory suggests a non-linear relationship which is estimated using non-linear techniques. Finally, Section 5, sets out the conclusions drawn from the chapter.
Section 2: A Theoretical Framework for Entrant’s Pricing Behaviour:

As Fisher (1989) aptly points out, there is no single or dominant “theory of oligopoly” even to the extent of providing a unifying framework for empirical study. Shapiro (1989b), however, strongly advocates that within whatever boundaries are imposed for theoretical discussion, oligopoly theory should provide predictions with respect to the relationship between market structure and firm conduct and performance, as a measure of the behaviour of prices and price-cost margins. Domowitz (1992) endorses these views, and maintains that even those who argue the value of game theory in the analysis of oligopoly pricing agree that game theoretic analysis teaches the importance of the context within which a firm must operate.

2.1. Oligopoly Price and Price-Cost Margin Model:

Traditional oligopoly models were based on Stigler’s (1964) classic work on the theory of collusion (see Cowling and Waterson (1976), Waterson (1984) and Tirole (1989)). Market structure, or industry concentration, and industry demand conditions, best explain oligopoly market outcomes. The profit function of each firm in a particular industry is:

\[ \pi_i = pq_i - C_i(q_i) \]  \hspace{1cm} (5.2.1)

where \( i = 1, \ldots, n \), in an \( n \) firm industry, \( q_i \) is the output of the respective firm, \( P \) is the price, and the inverse market demand function is:

\[ p = f(Q) = f(q_1 + q_2 + \ldots + q_n) \]
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The assumption is that there can only be one "market" price. Firms, therefore, have no direct control over the price of their output, only an indirect control via the effect that changes in their own output have on the total industry output. \( Q = \sum q_i \) is the total industry output and \( C_i \) is the total cost which is dependent on the firm's output.

Differentiating with respect to \( q_i \);

\[
\frac{\partial \pi_i}{\partial q_i} = p + q_i \frac{\partial p}{\partial Q} \frac{\partial Q}{\partial q_i} - C_i' = 0 \tag{5.2.2}
\]

and from \( Q = \sum q_i \), we obtain;

\[
\frac{\partial Q}{\partial q_i} = \frac{\partial q_i}{\partial q_i} + \frac{\partial q_i}{\partial q_i} = 1 + \mu \tag{5.2.3}
\]

where \( Q_i \) denotes the output of other firms in the industry and \( \mu = \frac{\partial Q_i}{\partial q_i} \) is the conjectural variation term between the individual firm and the rest of the industry.

Rearranging equation (5.2.2);

\[
p - C_i' = -q_i \frac{\partial p}{\partial Q} \frac{\partial Q}{\partial q_i}
\]

and substituting equation (5.2.3), we obtain;

\[
p - C_i' = -q_i \frac{\partial p}{\partial Q} (1 + \mu) \tag{5.2.3'}
\]

then dividing throughout by \( p \);

\[
\frac{p - C_i'}{p} = -\frac{q_i}{p} \frac{\partial p}{\partial Q} (1 + \mu) \tag{5.2.3''}
\]
and finally multiplying LHS by 1 and RHS $Q/Q$;

$$\frac{p-C'_i}{p} = -q_i \cdot \frac{Q}{p} \cdot \frac{\partial p}{\partial Q} \cdot (1 + \mu)$$

$$= \frac{s_i}{\eta} (1 + \mu)$$

(5.2.4)

where $s_i$ is the share of the $i$th firm in the industry’s output and $\eta$ is the industry’s elasticity. Hence, the price-marginal cost ratio (eq. (5.2.4)) can also be expressed as;

$$\frac{p-C'_i}{p} = \frac{s_i}{\eta} (1 + \mu) = \varphi_i$$

(5.2.5)

This also known as the Lerner Index which measures monopoly power. Equilibrium price, after rearrangement, is therefore;

$$p^* = \frac{1}{(1 - \varphi_i)} C'_i$$

(5.2.6)

The above analysis refers the $i$th firm’s pricing behaviour in a $n$ firm industry.

The analysis can be extended to an aggregate level. When examining collusive behaviour, oligopoly pricing is examined at an industry level, that is the actions or behaviour of the main firms ($j$) in the industry, as is done in Cowling and Waterson (1976). Hence, the aggregate profit of the $j$ firms is;

$$\pi_j = p_j Q_j - mc_j Q_j - F_j$$

(5.2.7)
where the average price of the \( j \) firms is \( P_j \equiv P \), and their aggregate output

is \( Q_j = \sum_{j \neq i} q_j \). The average marginal cost and total fixed cost are denoted by \( mc_j \) and \( F_j \) respectively. The marginal cost faced by the firms would be similar. The input materials used by the respective firms would be identical and the unit labour cost would be the same for all firms in a particular industry. However, the fixed cost may be different, which possibly reflects their different sizes. Maximising profits with respect to output; \( Q_j \), we obtain;

\[
\frac{\partial \pi_j}{\partial Q_j} = P + Q_j \frac{\partial P}{\partial Q} \cdot \frac{\partial Q}{\partial Q_j} - mc_j = 0
\]

(5.2.8)

where,

\[
\frac{\partial Q}{\partial Q_j} = \frac{\partial Q_j}{\partial Q_j} + \frac{\partial Q_i}{\partial Q_j} = 1 + \mu_j
\]

where \( \mu_j \) denotes the conjectural variation between the group of firms in question and the rest of the industry. As before, rearranging the equation (5.2.8), we derive the price-marginal cost margin;

\[
\frac{p_j - mc_j}{p_j} = -\frac{Q_j}{Q} \cdot \frac{\partial P_j}{\partial Q} \cdot (1 + \mu_j)
\]

(5.2.9)

---

1 Later in the chapter collusive behaviour is examined in a dynamic context. Issues such as price rigidity, and both cost and demand shocks are considered. This introduces disequilibrium behaviour into the analysis. Classical works such as Arrow (1959) suggests that it is the main firms that may have to make both price and quantity decisions. This depends on the level of collusion, co-ordination and information. A position agreed by more recent supergames explanations of dynamic collusive behaviour. Furthermore, applied and empirical analysis is easier and more common at an aggregate level. Hence following theories of collusion, it is assumed that average industry price follows the average price set by the main firms.
where \( CR_j = \sum_{i \neq j} s_j \). Consistent with Cournot outcomes, \( \mu_j \) is assumed to be equal to zero:

\[
\frac{CR_j}{\eta} (1 + \mu_j) = \varphi_j
\]

When the analysis is extended to a dynamic context, as is done later in the section, and in Section 4 when the supergames approach is introduced, the conjectural variation approach becomes theoretically satisfactory. As pointed out by Tirole (1989), the conjectural variation approach, which is set in a static context, is by definition, a game in which each firm’s choice is independent of its rival’s choice. By the very timing and information structure of the game, firms cannot react to one another. Therefore, any conjecture about one’s opponents’ reaction that differs from no reaction is irrational and, thereby, theoretically unsatisfactory. Nevertheless, the conjectural variations approach is used to empirically estimate the degree of non-competitiveness, but the empirical definition of conjectural variation does not coincide with the theoretical definition (see Bresnahan (1987)). For these reasons, it may be theoretically more accurate to assume \( \mu_j = 0 \) at a static analysis to ensure a more consistent transition to the dynamic analysis.

Furthermore, as the average price is identical to the average industry price, the industry demand elasticity is still applicable. Therefore the equilibrium price is determined;
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\[ p_j^* = \frac{mc_j}{1 - \varphi_j} \]  (5.2.10)

2.2. A Disequilibrium Model:

The above model, as pointed out by Dormberger (1983), only describes a static equilibrium without elaborating on how it is achieved. The movements between equilibrium points are ignored. Introducing disequilibrium analysis, enables the incorporation of the firms' movements between equilibrium points.

Arrow (1959) points out that in the absence of a perfectly competitive or an auction market, there exists disequilibrium, that is excess supply or demand. In such circumstances at least some firms must make price as well as quantity decisions. Since total supply may not equal demand, they face a downward sloping demand curve and the current price may be a disequilibrium one. When prices are set in a dynamic context, disequilibrium analysis has to be incorporated. Furthermore, when analysing “disequilibrium price adjustment”, the collusive nature of oligopolies becomes more apparent. The concentration ratio (CR) is allowed to evolve over time, which enables the distinction between periods where they may behave non-collusively or when tacit collusion is practised. The issue is further examined in Section 4.

In a dynamic context, the firm in disequilibrium faces two costs; the “cost of disequilibrium” and the “cost of adjustment”. Hence “disequilibrium price adjustment” is the interplay between these costs. Prices are selected so as to minimise the weighted sum of “disequilibrium” and “adjustment” costs. Barro (1972) outlined a
theoretical model which examined the trade-off between “disequilibrium” and “adjustment” costs when a firm has to make disequilibrium adjustment decisions.

This follows from Arrow’s (1959) suggestion that firms have to make both prices or quantity decisions imperfectly competitive markets. Barro assumes that the equilibrium point is the industry profit maximisation point. Disequilibrium costs arise when firms are unable to react optimally to changes in cost and demand conditions, and subsequently move to the new profit maximising position. The present exposition examines disequilibrium process, that is either excess demand or supply, and price adjustment.

The theory of price adjustment is based on the idea that prices increase with excess demand, and decrease with excess supply. The rate of price changes is directly proportional to the amount of excess demand;

$$\frac{1}{P} \frac{dP}{dt} = k(Q^d - Q')$$

(5.2.11)

where $k$ is a positive constant. Firstly, the gains/losses in profits when a firm adjusting prices is examined. Subsequently, the optimal trade-off between disequilibrium and adjustment cost is examined.

2.2.1: Gains from Price Adjustment:

The disequilibrium cost is best shown when comparing profits from optimal adjustment of prices to that when prices are rigid. The cost is a function of current output;
where \( C'(Y) > 0 \). The firm faces a downward sloping demand curve of which it is aware;

\[
Y^d = Q(P) + u
\]  

(5.2.13)

where \( Q'(P) < 0 \) and \( u \) is an additive term and is treated as a stochastic element. The firm maximises profit subject to the demand conditions;

\[
\pi = PY - C(Y)
\]  

(5.2.14)

\[
Y = Y^d = Q(P) + u
\]  

(5.2.15)

The first order condition, equating marginal revenue and marginal cost is;

\[
P + \frac{Q(P) + u}{Q'(P)} = C'(Y)
\]  

(5.2.16)

Differentiating \( \pi \) with respect to \( u \) and from equations (5.2.15) and (5.2.16);

\[
\frac{d\pi}{du} = P - C'(Y)
\]

\( u \) is allowed to vary from an initial value \( u_0 \) and \( u_l \) and the profits vary with it;

\[
\Delta \pi_{(u_0, u_l)} = \int_{u_0}^{u_l} \left( \frac{d\pi}{du} \right) du = \int_{u_0}^{u_l} (P - C'(Y)) du
\]  

(5.2.17)

demand is assumed to be a linear function of price;

\[
Q(P) = \alpha - \beta P
\]  

(5.2.18)

where \( \alpha, \beta > 0 \) and cost relates to current output, as a quadratic functional form;

\[
C(Y) = a + bY + cY^2
\]  

(5.2.19)

where \( a, b > 0 \). Setting \( u_0 = 0 \) and \( u_l = u \), the solution to equation (5.2.17) is;

\[
\Delta \pi_{(u_0, u_l)} = \frac{(\alpha + b\beta)}{2\beta(1 + c\beta)} u + \frac{1}{4\beta(1 + c\beta)} u^2
\]
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Profit changes correspond to a continuous adjustment of prices to movements in \( u \).

The clearest way to derive disequilibrium costs is to compare the above profit changes to those where a firm does not adjust to changes in demand. Let us assume that the price is fixed at a level which equates marginal revenue to marginal cost for \( u=0 \). The new constrained price is therefore;

\[
\hat{P} + \frac{Q(\hat{P})}{Q'(P)} = C'(Y)|_{Y=Q(\hat{P})} \tag{5.2.21}
\]

From the new price \( \hat{P} \) and corresponding output \( \hat{Y} \), the firm now maximises profit as;

\[
\hat{\pi} = \hat{P} \hat{Y} - C(\hat{Y}) \tag{5.2.22}
\]

\[
\hat{Y} \leq Y^d = Q(\hat{P}) + u \tag{5.2.23}
\]

The condition for optimal output is (ignoring demand conditions for the moment);

\[
\hat{P} = C'(Y)|_{Y=\hat{Y}} \tag{5.2.24}
\]

Given a new constrained profits, equation (5.2.22), the change in profit with respect to \( u \) is;

\[
\frac{d\hat{\pi}}{du} = \hat{P} = C'(Y)|_{Y=\hat{Y}}
\]

and as profits varies with \( u \);

\[
\Delta \hat{\pi}_{(u_i, u_f)} = \int_{u_0}^{u_f} \left[ \hat{P} = C'(Y)|_{Y=\hat{Y}} \right] du
\]

\[
= \hat{P}(u_f - u_0) - C'(Y)|_{Y=Q(\hat{P}) + u_0} + C'(Y)|_{Y=Q(\hat{P}) + u_f}
\]

Given the assumed demand and cost functions (equation (5.2.18 and 19)), the new solution is;

\[
\Delta \hat{\pi}_{(0, u_i)} = \frac{(\alpha + b\beta)}{2\beta(1 + c\beta)} u - cu^2
\]
and the gain in profits from price adjustment;

$$\Delta \pi_{(0,u)} - \Delta \hat{\pi}_{(0,u)} = \frac{(\alpha + b \beta)}{2 \beta (1 + c \beta)} u^2 = \theta u^2$$  \hspace{1cm} (5.2.25)

where \( \theta = \frac{(1 + 2c \beta)^2}{4 \beta (1 + c \beta)} > 0, \) if \( c \beta > -1 \)

2.2.2: Optimal Trade-off between Disequilibrium and Adjustment Cost:

Firms may choose to change their prices given a continuous changing demand. It is assumed firms will adopt a policy of "Ss^n2 form. Accordingly, the firm selects ceiling and floor values for demand, \( d_c \) and \( d_f \) respectively. Subsequently, the new "effective" demand function after the ceiling is attained;

$$Y^d = Y^d_0 + d_c = \alpha_0 - \beta_0 P + d_c$$ \hspace{1cm} (5.2.26)

The firm sets a new higher price level, equating marginal revenue to cost, which is maintained until a new ceiling or floor is hit. The linear demand function (equation (5.2.18)) can be viewed as a shift in the constant term;

$$\alpha_t = \alpha_0 + d_c$$

Therefore, letting \( m \) represent the number of price adjustments which occur over a particular time interval \( T \), the total expected cost per unit of time is expressed as;

$$E\left[ \frac{\text{Cost}}{\text{Time}} \right] = \gamma . E\left( \frac{m}{T} \right) + E(\Delta \pi - \Delta \hat{\pi}) = \gamma . E\left( \frac{m}{T} \right) + \theta . E(u^2)$$  \hspace{1cm} (5.2.27)

The first expression on the LHS denotes adjustment cost and the second denotes disequilibrium cost. The firm selects ceiling and floor values of demand that minimises the expected cost per time. The disequilibrium cost is symmetric in \( u \), and

\[2\] In other words, a firm will adjust its nominal price so as to achieve a real value of \( S \) every time this real value has been eroded down to \( s < S \).
likewise, the optimal solution is also symmetric; \( d_e = d_f = d \). Hence, the main concern

is to relate total cost expectations to the choice of \( h \). Both the adjustment and
disequilibrium cost to demand is related below;

i. Adjustment Cost:

The expected duration and the expected amount of time between price adjustments
can be represented as;

\[
D = d^2 r
\]

where \( r \) is the amount of time per step. The expected number of price adjustments per
unit time approaches \( 1/D \) as the planning horizon becomes large, therefore the
expected number of price adjustments and change in demand is inversely related.

\[
E\left(\frac{m}{T}\right) \approx D = \frac{1}{h^2 r}
\]

The total elapsed time since the start at time zero is denoted by \( t \) and subsequently the
“daily” variance is;

\[
\sigma^2 = \sigma_i^2 (t = 1) = \frac{1}{r}
\]

where \( \sigma^2 \) can be reflected as a measure of the demand variability and therefore
adjustment cost per unit time can be expressed as;

\[
y E\left(\frac{m}{T}\right) \approx y \sigma^2 / h^2
\]

ii. Disequilibrium Cost

As disequilibrium cost in equation (A5.1.18) is a function of \( u \), it can be calculated by
deriving the density function of \( u \). The difference equation and boundary conditions
which determine \( f(u) \) are;

\[
f(u) = \frac{1}{2} [f(u + 1) + f(u - 1)] \quad (-h + 1 \leq u \leq h - 1; u \neq 0)
\]
\[ f(h) = f(-h) = 0 \]
\[ f(u) = \frac{1}{2} [f(1) + f(-1) + f(h-1) + f(-h+1)] \]
\[ \sum_{u=-h}^{h} f(u) = 1 \]

The density function is derived by solving the differencing equations:
\[ f(u) = \frac{1}{h} \frac{(1-u)}{(1+u)} \]

where \( 0 \leq u \leq h \) and \(-h \leq u \leq 0 \). \( E(u^2) \) can be now determined, given the above and \( h \geq 1 \), as:
\[ E(u^2) \approx h^2 / 6 \]

Consequently, the expected disequilibrium cost can be expressed as:
\[ \theta E(u^2) \approx \theta h^2 / 6 \]

and total expected cost is:
\[ E \left[ \text{Cost} \right] = \frac{y \sigma^2}{h^2} + \frac{\theta h^2}{6} \]  \hspace{1cm} (5.2.29)

The value of demand, \( \hat{h}^2 \), that minimises the expected cost per time is:
\[ (\hat{h})^2 = \sigma \sqrt{\frac{6y}{\theta}} \]

where \( \theta = \frac{(1 + 2c \beta)^2}{4 \beta (1 + c \beta)} \). A particular firm is assumed to select critical ceiling and floor values for the demand it faces according (5.2.29). Its reaction to changes in \( u \) depends on the position of \( u \) relative to \( \hat{h} \). An increase in \( u \) produces a contact with the upper barrier, the firm will react with a discrete upward shift in price. A decrease in demand that reaches the floor will result in an, an equal size fall in price change.
The "cost of disequilibrium" relates to profits foregone when not adjusting prices immediately and in full, in order to maximise profits, following a change in cost or demand conditions. As cost accounting between firms may vary, the cost of disequilibrium is specific to individual firms or industry (see Okun (1981)), however, the use of historic accounting is fairly widespread. The implication is that there is an inverse relationship between the length of production and, of disequilibrium costs. Firms with shorter production periods are able to incorporate increases in input prices to their manufacturing process more rapidly that firms with longer production periods because they are able to see more quickly that their costs have changed and that their profitability has fallen.

The "costs of adjustment" traditionally reflected "menu or administrative costs" incurred by firms. These costs refer to the cost of informing customers of imminent price rises, for example, or the distribution of new price lists. Nevertheless, as Dormberger (1983) asserts, it may be more useful to view the cost of adjustment as a consequence of implementing the decision to change prices. This is again specific to individual firms or industry.

As each firm makes adjustment decisions it takes into account its competitors' disequilibrium pricing. This raises informational problems and uncertainty, and the cost of adjustment arises directly from this, which is based on Stigler's (1964) analysis of the theory of collusion. A firm "overadjusting" its price, relative to the rest of the industry, is open to the possibility of destroying its long-term customer relations. The
market structure, or the level of industry concentration, has a direct bearing on
uncertainty and the cost of adjustment. Higher concentration levels enables some tacit
collusion, which in turn impacts the cost of adjustment and cyclical pricing behaviour.
These issues will be examined in greater detail in Section 4.

In the contract gas market, where the prices are fixed for the duration of the
contract, changes in costs and demand conditions cannot be readily incorporated into
final goods prices. Indeed, Charlton (1979) and (1986) indicate that there is a positive
relationship between the level of price rigidity and the length of contracts.
Furthermore, coupled with the relatively short production process the entrant gas
shipper faces, the incurring cost of disequilibrium is both real and relevant.
Administrative cost is incurred when shippers renegotiate terms at the end of
contracts. The problems of uncertainty and the lack of information that generates costs
of adjustment would arise. This is further illuminated as the evolving relationship
between the market structure and price rigidity is examined in Section 4.

As mentioned earlier, prices are selected so as to minimise the weighted sum
of “disequilibrium” and “adjustment” costs. The first to demonstrate the relationship
between “disequilibrium” and “adjustment” cost was Griliches (1967). He
demonstrated that when the adjustment costs are higher, relative to disequilibrium
costs, so the price rigidity or the speed of adjustment is slower in a partial adjustment
process;

\[ C_t = a_1 (p_t - p^*_t)^2 + a_2 (p_t - p_{t-1})^2 \]  (5.2.30)

\(^1\) The literature on menu cost, stems from Barro (1972) which is has been outlined earlier in the section.
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this represents the cost incurred for deviating from the optimum or desired position \( p^* \), where \( a_1 \) and \( a_2 \) are proportional to the marginal disequilibrium and adjustment cost. The quadratic cost function implies that over-shooting is as costly as undershooting. The value of \( p_t \) that minimises \( C_t \);

\[
\frac{\partial C_t}{\partial p_t} = 2a_1(p_t - p_t^*) + 2a_2(p_t - p_{t-1}) = 0
\]

rearranging;

\[
p_t = (\lambda) p_{t-1} + (1 - \lambda) p_t^*
\]

(5.2.31)

where \( \lambda = \frac{a_2}{a_1 + a_2}, 1 - \lambda = \frac{a_1}{a_1 + a_2}, \lambda \) depends on the weight of adjustment costs relative to disequilibrium costs and as its value nears 1, higher price rigidity, relatively slow adjustment is implied and vice versa. Substituting equilibrium price into partial adjustment equation (5.2.31);

\[
p_{j,t} = \lambda_t p_{j,t-1} + (1 - \lambda_t)(\frac{1}{(1 - \varphi)})mc_n
\]

(5.2.32)

Section 3: Empirical Analysis of Entrant's Final Goods Pricing

Allowing for disequilibrium price adjustments and cyclical behaviour, pricing behaviour to be tested is a function of;

\[
P_j = f (P_{j,t-1}, CR_{j,t}, MC_t, Dd_t)
\]

(5.3.1')

where \( j \), in the present context is 4, pertaining to the main four non-BG shippers\(^4\) and

\(^4\) Appendix 5.1 gives a thorough data description.

\(^5\) They are Mobil Gas, AGAS, Kinectica and Quadrant as indicated in the previous chapter.
MC\textsubscript{1} refers to marginal cost which comprises of access price/therm, beach head gas price/therm and unit labour cost. The variable $Dd_t$ relates to the industry demand conditions and industry elasticity ($\eta$) may vary through business cycles\textsuperscript{6}. Therefore, the industry demand variable acts as a control variable for capturing the varying industry elasticity.

Equation 5.2.10 which represents oligopoly pricing behaviour suggest a non-linear relationship (see Cowling and Waterson (1976) and Reid (1991)). Hence, the appropriate function form specification to be estimated would be a log-linear one;

$$P_{4,t} = \alpha_0 + \alpha_1 P_{4,t-1} + \alpha_2 CR_{4,t} + \alpha_3 MC_{t} + \alpha_4 Dd_t + \varepsilon_t \quad (5.3.2)$$

where $\alpha_1 = \lambda$ refers to price rigidity and $\alpha_{2,3,4} = (1 - \lambda)\beta_{2,3,4}$, as $\beta$ represents constant elasticities. Table 5.1 below gives the coefficient estimates using OLS estimators\textsuperscript{7};

\textsuperscript{6} This view was originally put forward by Harrod (1936) and has become an important concern of economists in more recent times; Green and Porter (1984) and Rotemberger and Saloner (1986). These issues are discussed further in Section 4.

\textsuperscript{7} The time series properties and exogeneity and seasonality test relating to the estimated equation is conducted in detail in Appendices 5.2 and 5.3 respectively.
Table 5.1: Linear Estimation of Dynamic Oligopoly Pricing

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>OLS Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha_0$</td>
<td>1.0132$^a$</td>
</tr>
<tr>
<td></td>
<td>(2.1459)</td>
</tr>
<tr>
<td>$\alpha_1$</td>
<td>0.87947$^a$</td>
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<tr>
<td></td>
<td>(20.0362)</td>
</tr>
<tr>
<td>$\alpha_2$</td>
<td>0.050584$^a$</td>
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<tr>
<td></td>
<td>(5.1884)</td>
</tr>
<tr>
<td>$\alpha_3$</td>
<td>0.11142$^a$</td>
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<tr>
<td></td>
<td>(1.89098)</td>
</tr>
<tr>
<td>$\alpha_4$</td>
<td>-0.18944$^a$</td>
</tr>
<tr>
<td></td>
<td>(2.8669)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of observations</th>
<th>49</th>
<th>Log-likelihood</th>
<th>133.0948</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\overline{R}^2$</td>
<td>0.92608</td>
<td>$\chi^2_{SC(1)}$</td>
<td>3.1586</td>
</tr>
<tr>
<td>F-statistic</td>
<td>151.3290</td>
<td>$\chi^2_{N(1)}$</td>
<td>0.034146</td>
</tr>
<tr>
<td>Std Error</td>
<td>0.016885</td>
<td>$\chi^2_{RESET(1)}$</td>
<td>1.9060</td>
</tr>
<tr>
<td>RSS</td>
<td>0.012544</td>
<td>$\chi^2_{N(2)}$</td>
<td>97.434$^a$</td>
</tr>
<tr>
<td>Mean of Dep. Variable</td>
<td>3.2</td>
<td>DF</td>
<td>-5.6390$^a$</td>
</tr>
<tr>
<td>S.D. of Dep. Variable</td>
<td>0.062101</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Figure in parentheses are (absolute) t-values.

$a$ denotes significance at the 5% level for a 2-tailed-test and a $\chi^2$ distribution.

$DF$ relates to test of non-stationary in the regression residuals (Dickey-Fuller Test)

$SC,H,RESET$ and $N$ denotes test for serial correlation$^8$, heteroskedasticity$^9$, misspecification and/or non-linearity and normality test$^{10}$ respectively, which follows a $\chi^2$ distribution.

The results indicate that the price rigidity ($\hat{\alpha}_1$) is fairly high. The market structure, or the of level market concentration, and industry demand have a significant impact on entrants pricing behaviour, which is consistent with theory. The estimated CR variable ($\hat{\alpha}_2$), as anticipated, is positive but fairly inelastic.

---

$^8$ The first-order serial correlation test is done using the Langrange Multiplier Statistic. This is appropriate in the case of a partial adjustment model which includes a lag dependent variable as an explanatory variable.

$^9$ The most common form of heteroskedasticity for time series data, particularly high frequency data, is Autoregressive Conditional Heteroskedasticity (ARCH) (see Engel (1982)). Therefore, the ARCH test is used here.

$^{10}$ The normality test is discussed in detail in Appendix 5.4.
The industry demand, on the other hand, has a negative effect on pricing policy. The theory pertaining to the impact of industry demand on oligopoly behaviour is neither consistent nor universal. Conflicting theories were put forward by Green and Porter (1984) and Rotemberg and Saloner (1986). The former suggesting the demand has positive, or pro-cyclical effect on prices, while the latter suggest a negative, or anti-cyclical, effect on prices. The linear estimation given in Table in 5.1, suggests demand has a negative effect on the entrants' prices in the contract gas market, and that market structure has a significant impact on price determination. These issues are further illuminated in the next section when the theory and empirical testing is conducted using supergame theory.

**Section 4: Market Structure, the Adjustment Process and Cyclical Behaviour, a Supergames Explanation: An Empirical Investigation**

In Section 2.2, uncertainty and informational gaps were identified as the main determinants of adjustment cost. In line with the position of Stigler (1964), the implication is that as the industry becomes more concentrated, there will be greater interaction and tacit collusion which encourages more co-ordination and reduces uncertainty. Dominant firms are also able to take a lead with respect to price and/or quantity setting. Subsequently, as costs of adjustment reduces, the speed of convergence to the equilibrium price increases. In this section, the relationship between concentration ratio and price rigidity and cyclical pricing behaviour is
investigated empirically, within the context of supergames approach to oligopoly behaviour, using a non-linear model.

Tirole (1989) points out that following the Chamberlinian tacit collusion theory (see Chamberlin (1929)), collusion is only enforceable by the threat of retaliation. Retaliation can only take place when deviation is detected, so therefore, informational and, subsequently, detection lags are important. Tirole (1989) is adamant that oligopoly pricing behaviour set in a dynamic context is best explained by supergames or repeated games theory. In particular, the adjustment process, following an exogenous demand or cost shock, is aptly explained by game theory. The present section briefly examines these theories and its implications for empirical modelling. The theories suggest that a non-linear model best depicts the relationship between market structure and price rigidity and demand changes.

4.1. Supergames Theory and Oligopoly Pricing:

4.1.1. Trigger Strategies and Market Concentration:

A repeated game scenario can facilitate tacit collusion. Each firm charges monopoly prices in period zero and this is maintained in subsequent periods. If any firm deviates from this strategy in the subsequent periods, then prices are set competitively, that is price is equal to marginal cost.

These strategies are called “trigger strategies”, that is, a single deviation triggers a halt in the co-operation. These strategies are equilibriums if the discount factor is sufficiently high. By charging monopoly prices, a firm is able to earn half the
monopoly profits. On the other hand, if a firm deviates it can earn the full monopoly profits, but in subsequent periods it receives zero profits. So, present value of collusive profits ($\frac{\pi^m}{2}$) that are received over a period of time, is higher than receiving monopoly profits ($\pi^m$) in the present and zero profits in the future;

$$\frac{\pi^m}{2} (1 + \delta + \delta^2 + \ldots) \geq \pi^m$$

(5.4.1)

where $\pi^m$ and $\delta$ depict monopoly profits and the discount rates respectively. This follows if $\delta \geq \frac{1}{2}$ and the trigger strategies would be equilibrium ones.

The trigger strategies approach is particularly applicable to the relationship between high concentration ratio and collusion. This relationship was first advocated by Bain (1956). Tacit collusion is easier to sustain with a higher concentration, or a smaller number of firms\(^{12}\). Per-firm profit is; $\frac{\pi^m}{n}$ and decreasing function of $n$.

The short-run gain from undercutting the monopoly price slightly is;

$$\pi^m(1-\frac{1}{n}) - \varepsilon$$

(5.4.2)

Discount factor must exceed $1-\frac{1}{n}$ for collusion to be sustainable. In this sense, as Tirole (1989) states, high market concentration facilitates collusion. The high prices or

\(^{11}\) As Tirole (1989) points out in a repeated game scenario "Bertrand paradox" prices can also result.

\(^{12}\) This is a common linkage, on a theoretical level, between the number of firms and industry concentration (see Davies (1979) and McCloughan (1995)).
profits associated with high market concentration make the cost of undercutting high. This suggests a non-linear relationship between market concentration and oligopoly prices. Empirical analysis undertaken by Domowitz et al (1986a, 1986b and 1987) and Domowitz (1992) distinguishes between low or high price or price-cost margin "trigger-strategy groups".

4.1.2 Markov Reaction Functions and Price Rigidities:

Here again, the supergames theory explains price rigidities, except the assumption of asynchronicity replaces synchronicity with regards to how firms react to shocks¹³ (see Maskin and Tirole (1988). The formal analysis of Markov reaction functions are as follows;

A simple model; two firms producing perfect substitutes and prices $P_{i,t}$ are chosen by firm $i$ at date $t$, and the pricing process is as follows;

$$P_{i,t+1} = P_{i,t}$$

(5.4.3)

price chosen by firm $i$ at date $t$ is fixed for two periods. Firms look for a perfect equilibrium, that is the firm's price choices are simple, in that they depend only on the "payoff-relevant information". Therefore, for example firm 2, in time, $2k+1$, is committed to the previous period price ($P_{2,2k}$). This, in turn, affects firm 1's profits in that period ($2k+1$). Therefore, this affects "payoff-relevant information". Lets assume;

$$P_{1,2k+1} = R_1(P_{2,2k})$$

(5.4.4)

¹³ This explanation is similar to Dormberger (1983), that is information and co-ordination are important considerations to firms reacting to cost and demand shocks. However, the outcome differs to that from Markov reaction explanations as outlined by Tirole (1989).
that is firm 1’s strategy is conditional on as little information as is consistent with rationality and likewise with firm 2;

\[ P_{2,2k+2} = R_2(p_{1,2k+1}) \]  

(5.4.4')

\( R_1() \) and \( R_2() \) are called the Markov reaction functions and the Markov perfect equilibrium is a perfect equilibrium in which the firms use Markov strategies. The current price \( P_{2,2k} \) at the time \( 2k+1 \), firm 1’s reaction must maximise its objective function given that firms will react according to \( R_1() \) and \( R_2() \) in the future.

Mathematically, firm 1’s intertemporal profit from the date \( 2k+1 \) when it reacts to \( P_{2,2k} = P_2 \) by choosing \( p_{1,2k} = p_1 \) is;

\[ V^1(p_2) = \max_{p_1} \left[ \pi^1(p_1, p_2) + \delta \pi^1(p_1, R_2(p_1)) + \delta^2 \pi^1(R_1(R_2(p_1)), (R_2(p_1)) + \ldots \right] \]

(5.4.5)

As firm 2 will react with \( R_2(p_1) \) in the next period, and then firm 1 will react in two periods to \( R_2(p_1) \) with \( R_1(R_2(p_1)) \) and so on. In equilibrium, \( p_1 = R_2(p_1) \) must maximise the expression in the brackets for all \( p_2 \) and likewise for firm 2. This basically depends on the “one-period-deviation criterion”, as it is necessary for an equilibrium that no firm wants to deviate from the reaction rule for one period and then decide to conform to the rule.

Once again, the simple Markov strategies indicate that multiple equilibria could exist. Nevertheless, it can be shown that in any Markov perfect equilibrium, profits are always bounded away from the competitive profit levels. For example, average industry profit in a symmetric equilibrium is equal to at least half of the monopolistic profits for a discount rate (\( \delta \)) close to 1.
The implication here is that if stuck in the competitive price region, with the prospect of small profits in the future, a firm could raise its price dramatically and lure its rival to charge a high price for at least some of the time, and the rival would not hurry back to nearly competitive prices. Therefore, as in the case with the trigger strategies approach, tacit collusion is not only possible, it is a necessity.

4.1.3. Trigger Strategies and Exogenous Demand:

A paper by Green and Porter (1984) is an important and influential work which explains oligopoly pricing with respect to demand shifts. It also uses a model which applies the trigger strategy approach. In a quantity-setting supergame model, firms cannot perfectly observe industry demand in each period, nor can firms perfectly observe the output choice of competitors. Shifting demand makes it difficult to discriminate between unexpected drops in demand, for example, and cheating on the part of the firms. The model posits discrete shifts in conduct between collusive and non-co-operative price regimes, via a trigger strategy. If the market price remains above the tacitly agreed trigger price at the time production decisions were made, firms produce at a collusive level. If the price drops below the trigger price, all firms agree to revert to a static Cournot equilibrium for some period of time. Any firm which considers a secret expansion of output above the collusive level, must trade-off immediate profit gains against the increased probability that the market price may fall below the trigger price, which in turn would increase the likelihood of an industry reversion and lowering profits. Reversionary episodes, however, could occur simply because of low demand.
An antithesis to the Green and Porter position was put forward by Rotemberg and Saloner (1986). Tacit collusion in their supergame model takes place in the presence of observable temporary shifts in demand. In periods of low demand, firms agree to choose a price low enough for the rewards of reneging to be sufficiently reduced so that co-operation is the optimal strategy. The most difficult time to maintain collusion is during a boom or high demand period, because the discounted loss from cheating is independent of current demand, which in turn implies that the gain from defection is increasing in the level of current demand. As Domowitz (1992) indicates, the empirical implications of both the Green-Porter and Rotemberg-Saloner position is that the former suggests a pro-cyclical behaviour while the latter indicates counter-cyclical behaviour when tacit collusion is in place.

As pointed out by Maskin and Tirole (1988) the implication of price rigidity suggests the possibility that price adjustment is more sluggish during periods of high demand than during low demand periods. During low demand periods, price adjustments operate downwards and this results in a temporary increase in the market share. While during boom periods, each firm is reluctant to adjust upwards because this results in a temporary loss of market share.

4.2: A Non-Linear Empirical Analysis: Critical Concentration Ratio, Price Rigidity and Cyclical Behaviour:

The supergames explanation of oligopoly pricing behaviour suggests the relationship of oligopoly prices and market concentration is a non-linear one, via price
rigidity and response to industry demand. The trigger strategies approach explaining tacit collusion indicates that high prices and profits, which are the result of high concentration, ensures that reneging would be costly. In a dynamic context, non-linearity suggests that tacit collusion evolves with market concentration, and this has an impact on price rigidity and cyclical behaviour.

The empirical model estimated here, tries to establish whether there is a single critical concentration ratio (CCR), this distinguishes the period when the industry concentration is low and high as suggested by Domowitz (1992)\(^{14}\). Subsequently, the time-varying oligopoly pricing behaviour can also investigated empirically.

4.2.1. Non-Linear Switching Regression:

In many cases an economic relationship is best represented by a non-linear relationship, or two equations or regimes;

\[ g_{i,t} = \beta_1 x_{i,t} + e_1, \quad i=1,\ldots,n \quad (5.4.6) \]

\[ g_{i,t} = \beta_2 x_{i,t} + e_2, \]

where \( \beta_1 \) and \( \beta_2 \) are the vector of coefficients, where \( x_{i,t} \) is the vector of \( n \) independent variables and where \( e_1 \) and \( e_2 \) are the respective error terms, while \( \sigma_1^2 \) and \( \sigma_2^2 \) are the respective standard deviation of the error terms. In some of these cases, the issue is a “multi-switching” problem where the switching between regimes is determined by some exogenous variables. The non-linear relationship may be more

\(^{14}\) He distinguishes between “low” and “high” price or price-cost margin, where the latter refers to collusive outcomes.
accurately represented by a *S-curve*, such as a logit or probit distribution, rather than a binary dummy.

The multi-switching problem was first introduced in Goldfeld and Quandt (1972 and 1973). The switching between regressions is determined as follows:

\[ g_t = \beta_1 x_{i_t} + e_{1_t}, \quad \text{if} \quad \sum_{j=1}^{p} \Pi_j z_{j,t} \leq 0 \]  \hspace{1cm} (5.4.7)

\[ g_t = \beta_2 x_{i_t} + e_{2_t}, \quad \text{if} \quad \sum_{j=1}^{p} \Pi_j z_{j,t} > 0 \]

where \( z_j \) is the vector of exogenous variables that determine the multi-switching and \( \Pi_j \) unknown coefficients to be estimated.

The exogenous switch equation is estimated by a continuous approximation, hence it follows a normal or probit distribution;

\[ d(z_{j,t}) = \frac{1}{\sqrt{2\pi}\sigma} \int_{-\infty}^{\sum \Pi_j z_{j,t}} \exp \left\{ -\frac{1}{2} \frac{z^2}{\sigma^2} \right\} dz \]  \hspace{1cm} (5.4.8)

Let \( G \) be the \( n \times l \) vector of observations on the dependent variable and \( X \) be \( n \times k \) matrix of observations on the independent variables. The issue of estimating the two separate regimes is then equivalent to estimating the \( 2k\beta \)'s, \( 2\sigma^2 \)'s and \( n \) \( d \)'s of the composite regression equation:
CHAPTER 5: DYNAMIC OLIGOPOLY PRICING: ENTRANTS' PRICING BEHAVIOUR

\[ G = (I - D)X\beta_1 + DX\beta_2 + W \]

(5.4.9)

where \( W = (I - D)E_1 + DE_2 \) is the vector of unobservable and heteroskedastic error terms\(^{15}\). Denoting the covariance matrix of \( W \) by:

\[ \Omega = (I - D)^2 \sigma_1^2 + D^2 \sigma_2^2 \]

(5.4.10)

The switching equation (composite regression equation) is estimated using maximum likelihood estimators by maximising the log likelihood function:

\[ L = \beta_0 - \frac{1}{2} \log \Omega - \frac{1}{2} \left[ (G - (I - D)X\beta_1 - DX\beta_2) \times \Omega^{-1} (Y - (I - D)X\beta_1 - DX\beta_2) \right] \]

(5.4.11)

The non-linear switching regression model has been used to estimate a variety of non-linear economic problems\(^{16}\), not least to estimate the existence of a Critical Concentration Ratio (CCR) (see White (1986)).

4.2.2. Generalised Dummy Variable Approach:

In some cases the non-linear equation may be represented by either an S-curve or binary dummy variable approach. The “Generalised Dummy Variable” (GDV) developed by Doran (1985) is based on the non-linear switching regression technique described above. GDV allows for the possibility of either an S-curve or binary dummy

\(^{15}\) If \( \sigma_1^2 \neq \sigma_2^2 \).

\(^{16}\) The original model was developed for cross-sectional analysis. An application of this version of the non-linear switching regression, D-method, and an extension to time series analysis is found in Easaw and Garratt (1997).
variable approach to estimation. The variable in question ($Y_t$) is replaced by a logistic function\(^{17}\). The GDV is determined as follows;

$$L_t(\mu, \sigma) = \left\{1 + \exp\left[\frac{\pi(\mu - Y_t)}{\sigma\sqrt{3}}\right]\right\}^{-1} \quad (5.4.12)$$

This enables the dynamic price equation to follow a non-linear path (S-curve shape) where the concentration ratio is the GDV. The low and high levels of the CR variable, which follows a logistic function, are defined respectively as\(^{18}\);

$$CR_t^1 = \mu - 2.02\sigma \quad \text{and} \quad CR_t^2 = \mu - 2.02\sigma \quad (5.4.13)$$

where $\mu$ and $\sigma$ are the CCR and smoothness of distribution, that is whether CCR follows a S-curve or an ordinary binary variable, respectively are to be estimated.

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 (see Azzam et al (1996)). At the point of CCR, the firm ceases to behave competitively or unco-operatively 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

\(^{17}\) Please note that Doran's version uses a logistic distribution rather than a normal distribution used by Goldfeld and Quandt. This is simply for computation convenience.

\(^{18}\) This refers to the confidence level constructed for the CCR level, which is set at 95%.
equal to zero, the firms behave competitively. 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. The pricing model (eq. (5.3.2)) is set as a non-linear switching regression:

$$P_{4,t} = \beta_0 + \gamma_0 L(\mu, \sigma) + \sum_{j=1}^{k} [\beta_j + \gamma_j L(\mu, \sigma)] X_j + \varepsilon_t$$

where $k = 3$ and $X_j$ are $P_{4,t-1}$, $MC_t$ 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 5.2 below gives the estimates using Non-Linear Least Squares estimates;
### Table 5.2: Non-Linear Estimation of Dynamic Oligopoly Pricing

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Non-linear LS Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \mu )</td>
<td>-1.1769(^a) (4.5656)</td>
</tr>
<tr>
<td>( \sigma )</td>
<td>0.2288</td>
</tr>
<tr>
<td>( \beta_0 )</td>
<td>-0.0088 (0.6829)</td>
</tr>
<tr>
<td>( \gamma_0 )</td>
<td>1.2302(^b) (1.6486)</td>
</tr>
<tr>
<td>( \beta_1 )</td>
<td>0.8799(^a) (9.7027)</td>
</tr>
<tr>
<td>( \gamma_1 )</td>
<td>-0.3178(^a) (2.3652)</td>
</tr>
<tr>
<td>( \beta_2 )</td>
<td>-0.0252 (0.4079)</td>
</tr>
<tr>
<td>( \gamma_2 )</td>
<td>0.3073(^a) (2.5301)</td>
</tr>
<tr>
<td>( \beta_3 )</td>
<td>0.1036(^c) (1.4090)</td>
</tr>
<tr>
<td>( \gamma_3 )</td>
<td>-0.2374(^a) (1.8972)</td>
</tr>
</tbody>
</table>

**Notes:** Figure in parentheses are (absolute) t-values.

- \(^a\) denotes significance at the 5% level for a 2-tailed-test and a \( \chi^2 \) distribution.
- \(^b\) denotes significance at the 10% level for a 2-tailed-test
- \(^c\) denotes significance at the 15% level for a 2-tailed-test

**SC, H, RESET and LR** denotes test for serial correlation, heteroskedasticity, misspecification and/or non-linearity and Likelihood Ratio Test for restrictions\(^{19}\), which follows a \( \chi^2 \) distribution, respectively.

---

\(^{19}\) As discussed in the text, the supergames explanation of oligopoly pricing behaviour suggest a non-linear relationship between market structure and pricing behaviour. Therefore, the linear estimations in Table 5.1 is a restricted version and the appropriate diagnostic test to test these restrictions would be the Likelihood Ratio Test.
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The non-linear estimates indicate 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.

There is a positive intercept shift ($\hat{\beta}_0 + \hat{\gamma}_0$) at this point. At high levels CR$^{20}$, price rigidity falls considerably as 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 do not significantly respond to changes in marginal cost, contrary to when the CR is high ($\hat{\beta}_2 + \hat{\gamma}_2$). As we have seen in the preceding sections, theory suggest that price rigidity is high when firms do not respond optimally to cost changes and shocks, incurring disequilibrium cost.

The impact of industry demand is unequivocal. At high levels of industry concentration, demand has a countercyclical effect ($\hat{\beta}_3 + \hat{\gamma}_3$), as suggested by Rotemberg and Saloner (1986). Conversely, at low levels of CR, the pricing behaviour response positively to changes in industry demand($\hat{\beta}_4$). At low levels of CR where informational gaps exist and no co-ordination to achieve collusive outcomes, the respective firms assume that other competing firms also behave pro-cyclically.

---

$^{20}$ It is tempting to suggest that firms practise tacit collusion at this stage but it is probably more accurate to suggest that high concentration levels facilitate collusive behaviour. Whether this results in co-operative outcomes is less certain, even from a theoretical point of view.
Empirical investigations by Domowitz et al (1986a, 1986b and 1987) suggest that countercyclical behaviour is found in durable goods industry. These empirical results are not universal; Haskel et al (1995) produced contrary results. The universal applicability of these conflicting theories is less certain. However, this only enhances the fact that different industries do behave differently. Furthermore, this behaviour is an evolving one in a dynamic context.

4.3: Market Structure and Oligopoly Pricing Behaviour

The supergames explanation of collusion shows that collusive outcomes, such as pricing behaviour and price-cost margins, are varied;

1. Following the “trigger strategies” approach, industry concentration gives rise for greater collusive behaviour and affects pricing behaviour or price-cost margin.

2. The role of information in collusive models is important, early models of collusive behaviour have given considerable emphasis to this (see Stigler (1964) and Dormberger (1979)). This is reflected by the level of price rigidity. As firms behave more collusively, they are able to react to cost and demand shocks with greater co-ordination, thereby keeping the profit losses minimal. Furthermore, Benabou (1988) and Benabou and Gertner (1993) argue that concentration ratios affect price dispersion and increase prices and price-cost margins.

3. The impact of greater co-ordination and the reduction of price rigidity creates conditions that facilitate either collusive or competitive or non-collusive behaviour. Indeed, as Tirole (1989) points out the discount rates and the number of periods the game is played can result in competitive outcomes.
4. More recently, there has been much focus on the impact of industry demand on collusive behaviour. As discussed in earlier sections, conflicting theories have been put forward. Basically, the differences hinge on the informational structure and the levels of incentive to maintain collusive behaviour.

The impact of the level of industry concentration and industry demand on average prices in the contract gas market, was empirically examined in sections 3 and 4. The estimated coefficients can be used to simulate average prices in the contract gas market at different concentration levels. Therefore, the different levels or stages of oligopoly pricing behaviour, that is collusive and non-collusive pricing behaviour, can be examined. The impact of industry demand at different stages of oligopoly behaviour is also examined.

In an oligopoly market, average pricing is a mark-up on marginal cost. The average prices reflect collusive behaviour which, in a dynamic context, is dependent on the evolving market structure, or industry concentration, market demand, marginal cost and lagged prices which accounts for rigidity:

\[ P_t = f(CR_t, Dd_t, MC_t, P_{t-1}) \]  (5.4.15)

where \( f'_{MC} > 0 \) and \( f'_{CR} > 0 \). The cyclical behaviour of prices is less straightforward. Following the “trigger strategy” approach, when the levels of concentration are high and firms behave collusively. However, according to Rotemberger and Saloner (1986) they have a greater incentive to renege and behave countercyclically, therefore \( f'_{MC} < 0 \). Conversely, at low levels of concentration the

\[ It is uncertain whether gas falls in this category. \]
lack of co-ordination entails that firms do not benefit from behaving countercyclically,

\[ f'_t \partial_d t > 0. \]

From the estimates given in Tables 5.1 and 5.2, the average prices are simulated given different market structures: high, critical and low concentration ratios. At the high and low levels of concentration, the CR is allowed to increase and decrease respectively, while at the critical concentration level it is held constant. The industry demand is allowed to increase marginally over the time period. The average price equations to be simulated are:

\[
P_{i,t} = \varphi_0 + \varphi_1 CR_{i,t} + \varphi_2 Dd_t + \varphi_3 MC_t + \varphi_4 P_{i,t-1} \quad (5.4.16)
\]

\[
P_{3,t} = \varphi_1 CR_{i,t} + \varphi_2 Dd_t + \varphi_6 P_{3,t-1}
\]

where; \( P_{i,t} \) = 1 and 2, denote the average prices at high and critical concentration ratios respectively, while \( P_{3,t} \) denote low concentration levels. \( MC_t \) is assumed to be constant and slightly lower at high concentration levels, as only more efficient firms remain. The coefficients are: \( \varphi_0 = 1.2302 \) and \( \varphi_1 = 0.050584, \varphi_2 = -0.1338, \varphi_3 = 0.3073, \varphi_4 = 0.5621, \varphi_5 = 0.1036 \) and \( \varphi_6 = 0.8799 \). The coefficients refer to the estimates in Tables 5.1 and 5.2; \( \varphi_0 = \varphi_0 + \varphi_2 + \varphi_3 + \varphi_4 + \varphi_5 + \varphi_6 \)

Figure 5.1 gives the respective simulated results;

---

22 This is based on the assumption that the introduction of competition creates positive externalities and inertia for the industry's expansion. Most importantly, firms would have little incentive to enter the market if the industry's demand is stagnant or shrinking. The difference in average prices will, however, remain, even if the industry's demand is falling, except at an extremely low or no demand.
Average prices in high and critical levels of concentration, $P_1$ and $P_2$, respectively, appear to be much lower than average prices at low levels of concentration. Furthermore, $P_2$ is falling at a faster rate and therefore lower than average prices in high levels of concentration.

As the industry becomes more concentrated, tacit collusion takes place and the level of uncertainty decreases. This could lead to higher average prices. On the other hand, as tacit collusion increases, greater are the possibilities to engage in counter-cyclical behaviour and an ensuing “price war” (see Rotemberg and Saloner (1986) and Slade (1989)). Essentially in an oligopolistic market, as uncertainty reduces, conditions and incentives for the firms to behave more competitively is created. Important theoretical work on the subject was conducted by Rosenthal (1980) and Stahl (1989). They argue that an increased number of sellers in the presence of
uncertainty could lead to monopolistic pricing. Indeed, in Chapter 4, Figures 4.6 and 4.7 show that prices begin to fall despite the industry concentration levels remaining high.

As deregulation takes in a particular public utility and the competitive process evolves, an oligopoly market structure could result, as suggested by the analysis with respect to the UK contract gas market. The view that perfectly competitive or contestable markets emerge due to deregulatory policies (see Newbery (1997)) is not borne out. This has certain implications for regulatory policy, particularly as the market structure has an impact on the final goods price and welfare outcomes. These issues are discussed in the concluding chapter, where possible future research and direction of regulatory policy is considered.

Section 5: Conclusion

As advocated by Domowitz (1992), the basic theoretical framework of a collusive pricing policy is a mark-up on marginal cost. This mark-up is dependent on market concentration and industry demand in both the static and dynamic context. Nevertheless, supergames theory best explains dynamic price movements and adjustment to cost and demand shocks.

Theoretical explanations of oligopoly models are evolving all the time. It is difficult to assess which theory or model gives a clear and consistent explanation of price rigidity and cyclical behaviour. However, the important factor is the information
structure and the consequent ability of firms to co-ordinate their respective outcomes. For example, the asynchronicity approach of Markov reaction function theory is akin to the explanations given for the empirical results in Dormberger (1979) and (1983) which is based on the original theory of tacit collusion by Stigler (1964); the key element is informational gaps and co-ordination. Dormberger suggests that as market concentration increases and tacit collusion takes place, uncertainty reduces and the ensuing greater co-ordination between the main firms facilitates a reduction in price rigidity. Indeed, the Markov reaction function suggests that higher discount rates result in greater price rigidity with tacit collusion.

Domowitz’s et al(1986a, 1986b and 1987) and Domowitz’s (1992) empirical analysis of Green-Porter and Rotemberg-Saloner hypothesis, suggests that countercyclical behaviour is consistent with higher price rigidity. Maskin and Tirole (1988) are unequivocal that, when tacit collusion takes place, prices become more sluggish during booms. They do not suggest, however, that a price war is engaged. Indeed, for a price war as suggested by Rotemberg and Saloner to be facilitated, increased price sluggishness would be theoretically contradictory.

Nevertheless, as maintained by Domowitz (1992) different industries could react differently. However, some theoretical work examining the evolving nature of market structure in a dynamic context, and the informational structure and its impact on price rigidity and industry demand, would be interesting. The level of the discount rate and periods, that is whether it is a finite or infinite period game, has a bearing on

---

23 A claim which concurs with Rotemberg and Saloner’s (1986) position, though this is not entirely obvious in the original paper.
the outcomes. As Tirole (1989) points out, that in a repeated game scenario Bertrand paradox and competitive outcomes are also possible. Reduced uncertainty and price rigidity sets the stage for both competitive or oligopolistic outcomes. These issues are discussed again in the concluding chapter.

The empirical analysis, both linear and non-linear analysis, suggests that the entrants' behaviour is consistent with dynamic oligopoly theory. The evolving market structure, or CR, and demand conditions has an impact on their pricing policy and price rigidity. The price rigidity behaviour in the contract gas market is best represented by the traditional view of price rigidity, as expounded by Grilliches (1967) and Dormberger (1979 and 1983) rather than the Markov-reaction function approach suggested by Maskin and Tirole (1988). The empirical analysis undertaken here are used as the basis for policy simulations in Chapters 6 and 7. The linear estimates are used to undertake an empirical application of access charges based on DOCR, and the ensuing policy implications are discussed in the chapter to follow. The non-linear analysis and results based on supergames theory is the basis of possible future directions of research in regulation, which are considered in the concluding chapter.
Appendix 5.1: Data Description

\( P_n \):
Volume weighted average price/therm of the main four entrant non-BG shippers. This is in real terms, deflated by Retail Price Index for gas products with Oct 1990 as the base month.

\( CR_i \):
Market share of the main four non-BG shippers

\( MC_i \):
The marginal cost comprises of "materials" and unit labour cost; access price/therm, beach head gas price/term and "unit labour cost ratio". Access price, the annual transportation charges/therm, is based on figures published by Transco of a typical load size and factor and distance; Bacton to Leeds. The annual rates are published every Sept. The beach head gas prices are based on UK Continental Shelf gas prices. This deemed most appropriate as the top non-BG shippers are gas producers in the North Sea. This variable is also based on annual figures supplied by DTI, Energy Price Statistics, Energy Policy and Analysis.

Both transportation charges and beach head gas prices are smoothed using a centred moving average (13 period). The 13 period centred moving average enable shippers to take into account prices of the last and next six months. The discussions pertaining to access pricing regulation and other general regulatory policies between OFGAS, MMC, OFT and BG are well publicised hence forecast of the directions prices are
possible. Both variables are deflated by Retail Price Index for gas products with Oct 1990 as the base month.

The unit wage cost for the Energy and Water sector was only available annually and, furthermore no figures are available for 1995. However, *The Monthly Digest of Statistics* (CSO) publishes *Average Earnings Index* (Table 18.10) and *Output per Employee Index* (Table 7.2) for the Energy and Water sector. The “unit wage cost ratio” is created by dividing the two indices. Again Oct 1990 is the base month.

\[ D_d: \]

This demand variable is specific to the contract gas industry whose vast majority of customers are industrial users; it is the “Primary Fuel Input Index” (*Natural Gas*). They are seasonally adjusted figures are published by the Office of National Statistics in *Economic Trends* (CSO) under “Selected Output and Demand Indicators: Inland Energy Consumption” (Table 4:10). The base month is also Oct 1990.
Appendix 5.2: TIMES SERIES PROPERTIES

In this appendix the time series properties of the variables used in the estimations are examined; firstly, whether the variables are stationary or non-stationary and whether there is a cointegrating relationship. Even though, the period in question is relatively short, it may still be worth examining the time series properties of the variables. In the main text, in Table 5.1, a Residual-based approach (Engel and Granger (1987)) cointegration result is given. Here, the Johansen Maximum Likelihood method (Johansen (1988 and 1989) is used to establish how many of the non-stationary variables are cointegrated in the model estimated.

I. Augmented Dickey-Fuller (ADF) Test for Unit Roots:

In general, the ADF regression can be written as;

\[ \Delta y_t = \beta_0 + \beta T + \beta_2 y_{t-1} + \sum_{i=1}^{m} \beta_i \Delta y_{t-i} + \epsilon_t \]  

(A5.2.1)

where \(T\) denotes time trend and \(y\) denotes the variable to be tested. The choice of \(m\) depends the serial correlation that may be present in the residuals.

1. \(P_{A,i}\):

\[
\Delta P_{A,i} = -0.0017952 -0.2544 + 0.0017543 0.14266 0.088697 2.4
\]

\(DW\)-statistic: 1.9913 \(ADF\) Statistic: 0.41313(3.4875)\(^2\)

2. \(CR_t\):

\[
\Delta CR_t = -0.31099 0.0041373 -0.15392 0.32914 -0.032530
\]

\(DW\)-statistic: 2.2174 \(ADF\) Statistic: 3.5695(3.4875)

\(^2\)Absolute t-ratios given in parentheses.

\(^2\)The 95% critical values are given brackets.
CHAPTER 5: DYNAMIC OLIGOPOLY PRICING: ENTRANTS’ PRICING BEHAVIOUR

3. $MC_t$;

$$\Delta MC_t = -2.4783 - 0.0047138 - 0.76594 + 0.26603 \cdot MC_t + 0.24072 \cdot \Delta MC_{t-1} + 0.18730 \Delta MC_{t-2}$$

$D^2 \text{-statistic: 1.8469 ADF Statistic: 4.6748(3.5088)}$

4. $Dd_t$;

$$\Delta Dd_t = -1.7814 + 0.0028001 - 0.39380 + 0.11580 \cdot MC_t + 0.90156 \cdot \Delta MC_{t-1}$$

$D^2 \text{-statistic: 2.0420 ADF Statistic: 3.8285(3.4862)}$

The ADF regressions indicate that, with the exception of $P_t$, the variables are non-stationary with a trend.

II. Johansen Maximum Likelihood (JML) Approach:

As pointed out by Charemza and Deadman (1997), the Engel-Granger and Johansen procedures are grounded within different econometric methodologies. Notably, in the Engel-Granger modelling approach, the endogenous-exogenous division of variables is assumed. Therefore, there might only be one cointegrating relation. On the other hand, the Johansen methodology is based on the VAR modelling (Sims’s methodology, see Sims (1980), there are no exogenous variables.

Nevertheless, the statistical properties of the Johansen method are generally better and the power of cointegration test is higher than the Engel-Granger approach. Furthermore, in a multivariate cases it may be useful to examine how many of the variables are cointegrated, this may have some bearing on the theoretical underpinnings of the model estimated. If there are $n$ explanatory variables ($X_t$);
matrix $\beta$ is called the cointegrating matrix and has property that

$$\beta'x_t \sim I(0), \text{ while } x_t \sim I(1)$$

therefore;

variables in $x_t$ are cointegrated, with cointegrating vectors $\beta_1, \beta_2, \ldots, \beta_r$ (particular columns of the cointegrating matrix)

JML procedure used to determine the rank of the cointegrating matrix $= r (< n)$, which in turn determines the number of cointegrating vectors (ie columns of the cointegrating matrix)

Johansen Maximum Likelihood Procedure (Trended Case, trend in DGP)

Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

Maximum lag in VAR = 3.
List of variables included in the cointegrating vector:
$MC_t, D_d, CR_t$
List of additional I(0) variables included in the VAR:
$P_t$
List of eigenvalues in descending order:
0.40157  0.29143  0.7092E-3

<table>
<thead>
<tr>
<th>Null</th>
<th>Alternative</th>
<th>Statistic</th>
<th>95% Critical Value</th>
<th>90% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$r = 0$</td>
<td>$r = 1$</td>
<td>24.8204</td>
<td>21.0740</td>
<td>18.9040</td>
</tr>
<tr>
<td>$r = 1$</td>
<td>$r = 2$</td>
<td>14.1786</td>
<td>14.900</td>
<td>12.9120</td>
</tr>
<tr>
<td>$r = 2$</td>
<td>$r = 3$</td>
<td>0.38160</td>
<td>8.1760</td>
<td>2.6870</td>
</tr>
</tbody>
</table>

The results indicate that there is two cointegrating relationship amongst the three non-stationary variables. The lag of the VAR was determined using one of the methods suggested by Hall (1991), using various lags to determine which generated the least or

\[26\] See Appendix 5.3 for the relevant exogeneity test of variables used for testing.
no first order serial correlation. Nevertheless, if the exercise is concerned with just identifying a cointegrating vector, the usual practice is to allow for relatively long lags, since these might approximate the autocorrelation structure of the error terms. In the present case, higher lags indicate that there is at least one cointegrating vector amongst the non-stationary variables, confirming the Engel-Granger approach.
Appendix 5.3: EXOGENITY AND SEASONALITY TEST

I. Exogeneity Test:

The Wu-Hausman Test was used to test simultaneity. Variables tested are \( CR_t, MC_t \) and \( DD_t \), and the instrumental variables used are the lagged variables (disturbance contemporaneously uncorrelated): \( CR_{t-1}, MC_{t-1}, DD_{t-1}, \) and \( P_{4,t-1} \). Firstly, the variables being tested are in turn regressed on the instrumental variables and subsequently a variable addition test is done with the original specification (equation (2.6)) and the respective residuals (\( RES_{1,t}, RES_{2,t}, \) and \( RES_{3,t} \))

\[
RES_{1,t} = CR_t - \beta_0 + \beta_1 CR_{t-1} + \beta_2 MC_{t-1} + \beta_3 DD_{t-1} + \beta_4 P_{4,t-1} \quad (A5.3.1)
\]

\[
RES_{2,t} = MC_t - \beta_0 + \beta_1 CR_{t-1} + \beta_2 MC_{t-1} + \beta_3 DD_{t-1} + \beta_4 P_{4,t-1} \quad (A5.3.2)
\]

\[
RES_{3,t} = DD_t - \beta_0 + \beta_1 CR_{t-1} + \beta_2 MC_{t-1} + \beta_3 DD_{t-1} + \beta_4 P_{4,t-1} \quad (A5.3.3)
\]

Variable Addition Test (OLS Case):

Dependent Variable: \( P_{4,t} \)

Variables Added: \( RES_{1,t}, RES_{2,t}, \) and \( RES_{3,t} \)
<table>
<thead>
<tr>
<th>Coefficients</th>
<th>OLS Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha_0$</td>
<td>0.87241</td>
</tr>
<tr>
<td></td>
<td>(1.2887)</td>
</tr>
<tr>
<td>$\alpha_1$</td>
<td>0.0097142</td>
</tr>
<tr>
<td></td>
<td>(0.41193)</td>
</tr>
<tr>
<td>$\alpha_2$</td>
<td>-0.045694</td>
</tr>
<tr>
<td></td>
<td>(0.45712)</td>
</tr>
<tr>
<td>$\alpha_3$</td>
<td>0.14225</td>
</tr>
<tr>
<td></td>
<td>(1.4211)</td>
</tr>
<tr>
<td>$\alpha_4$</td>
<td>0.98524</td>
</tr>
<tr>
<td></td>
<td>(15.7866)</td>
</tr>
<tr>
<td>RES$_{1,t}$</td>
<td>-0.0020517</td>
</tr>
<tr>
<td></td>
<td>(0.5601)</td>
</tr>
<tr>
<td>RES$_{2,t}$</td>
<td>0.14708</td>
</tr>
<tr>
<td></td>
<td>(1.0181)</td>
</tr>
<tr>
<td>RES$_{3,t}$</td>
<td>0.14941</td>
</tr>
<tr>
<td></td>
<td>(1.2291)</td>
</tr>
</tbody>
</table>

Joint test of zero restrictions on the coefficients of additional variables:

$$\chi^2_{LM} (3) = 2.3179$$

$$\chi^2_{LR} (3) = 2.3758$$

$$F(3,40) = 0.67654$$

The Wu-Hausman statistic (Wu's $T_2$ stat) is equal to the $F$ statistic (LM and LR statistic are asymptotically equivalent). The joint zero restrictions cannot be rejected.

II. Seasonality Test:

In Chapter 3, it was shown that neither the entrants' prices nor its outputs indicate any distinct seasonal pattern as suggested by Ofgas (1987). The seasonality conducted her confirms this. Seasonal dummies ($D_i$) represents the respective months of the year is incorporated into the original specification (eq (5.3.3)). None of the base
months indicated any seasonality. Here, two regression are given; the first which uses the winter months January and February as the base months and the second regression uses the summer months July and August. In both cases there are no indications that \( P_{4,t} \) following any seasonal pattern. Multiplicative seasonality test was attempted on Microfit, but the estimations were abandoned due to multicollinearity, implying no seasonality.

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONS</td>
<td>.9466</td>
<td>1.9863</td>
</tr>
<tr>
<td>( P_{4,t} )</td>
<td>.90344</td>
<td>20.8947</td>
</tr>
<tr>
<td>( CR_t )</td>
<td>.043461</td>
<td>4.3230</td>
</tr>
<tr>
<td>( MC_t )</td>
<td>.084035</td>
<td>1.3822</td>
</tr>
<tr>
<td>( Dd_t )</td>
<td>-.17650</td>
<td>-2.6250</td>
</tr>
<tr>
<td>( D3 )</td>
<td>-.5668E-3</td>
<td>-.057119</td>
</tr>
<tr>
<td>( D4 )</td>
<td>-.019772</td>
<td>-2.0398</td>
</tr>
<tr>
<td>( D5 )</td>
<td>-.0029598</td>
<td>-.29029</td>
</tr>
<tr>
<td>( D6 )</td>
<td>.9684E-3</td>
<td>.096537</td>
</tr>
<tr>
<td>( D7 )</td>
<td>.0074332</td>
<td>.73810</td>
</tr>
<tr>
<td>( D8 )</td>
<td>.0099675</td>
<td>.98793</td>
</tr>
<tr>
<td>( D9 )</td>
<td>.0097382</td>
<td>.96708</td>
</tr>
<tr>
<td>( D10 )</td>
<td>.014181</td>
<td>1.4242</td>
</tr>
<tr>
<td>( D11 )</td>
<td>.0051016</td>
<td>.51273</td>
</tr>
<tr>
<td>( D12 )</td>
<td>-.0032044</td>
<td>-.32038</td>
</tr>
</tbody>
</table>

\[ R^2 .93208 \quad D_{h}-statistic .88057 \]

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONS</td>
<td>.95478</td>
<td>2.0016</td>
</tr>
<tr>
<td>( P_{4,t} )</td>
<td>.90283</td>
<td>20.9055</td>
</tr>
<tr>
<td>( CR_t )</td>
<td>.043685</td>
<td>4.3509</td>
</tr>
<tr>
<td>( MC_t )</td>
<td>.085220</td>
<td>1.4067</td>
</tr>
<tr>
<td>( Dd_t )</td>
<td>-.17665</td>
<td>-2.6297</td>
</tr>
<tr>
<td>( D1 )</td>
<td>-.0067761</td>
<td>-.67448</td>
</tr>
<tr>
<td>( D2 )</td>
<td>-.0160653</td>
<td>-1.0554</td>
</tr>
<tr>
<td>( D3 )</td>
<td>-.0092863</td>
<td>-.92133</td>
</tr>
<tr>
<td>( D4 )</td>
<td>-.028401</td>
<td>-2.9708</td>
</tr>
<tr>
<td>( D5 )</td>
<td>-.011689</td>
<td>-1.1707</td>
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<tr>
<td>( D6 )</td>
<td>-.0077312</td>
<td>-.77129</td>
</tr>
<tr>
<td>( D9 )</td>
<td>.0010116</td>
<td>.10170</td>
</tr>
<tr>
<td>( D10 )</td>
<td>.0054931</td>
<td>.54367</td>
</tr>
<tr>
<td>( D11 )</td>
<td>-.0035945</td>
<td>-.35401</td>
</tr>
<tr>
<td>( D12 )</td>
<td>-.011897</td>
<td>-1.1570</td>
</tr>
</tbody>
</table>

\[ R^2 .93221 \quad D_{h}-statistic .90005 \]

27 Rather than giving the results all twelve months as bases, none of which indicate seasonality, the results for the main winter and summer bases are given to confirms Ofgas's (1987) position.
Appendix 5.4: NORMALITY TEST AND ASSUMPTIONS:

The Jarque-Bera's test not only test for non-normality in the residuals but also give insights into outliers. The first diagram shows that the residuals generally oscillate around the zero mark, except for the period 1994M4. The second diagram indicate that there is a single outlier in the dependent variable ($P_{it}$) as the prices fall sharply at the period in question. This is further confirmed in Figure 4.7 in Chapter 4, where the individual main entrant firms start to fall around this period.

The breakdown in the normality assumption in the residuals, do not render a breakdown in the *gaussian* assumptions necessary for OLS estimators. The problem is particularly prevalent for small sample sizes ($n < 50$), hence the asymptotic properties imply normality. Another source of non-normality could be trended non-stationary regressors. Furthermore, non-normal residuals imply only the estimated intercept is biased. The bias is exactly equal to the mean of the error term, which in the present case is small. The coefficient estimates are unaffected. In the case of non-linear estimators, such as Non-linear Least Squares and Maximum Likelihood Estimators, there are those who warn against the normality assumption (see Bartels (1977)). Indeed, in non-linear estimations which are estimating more than one equation, different error terms generate the respective equations.
CHAPTER 6: NETWORK ACCESS REGULATION AND COMPETITION POLICY: AN ASSESSMENT OF THE “DIRECT-PLUS-OPPORTUNITY COST” REGIME AND POLICY OPTIONS

Section 1: Introduction

Section 2: Market Structure and Network Access Pricing

Section 3: Policy Simulations and Predictions: Options and Choices

Section 4: Conclusion
CHAPTER 6: AN ASSESSMENT & POLICY OPTIONS

Section 1: Introduction

In this chapter an empirical application of the "Direct-plus-Opportunity Cost" Regime (DOCR)\textsuperscript{1} in the contract gas market is undertaken. As discussed in Chapter 2, the DOCR was endorsed by Baumol et al (1997) as a legitimate extension of ECPR, and is an important attempt to provide a synthesis between ECPR and Ramsey Rule. Armstrong et al (1996) also provide a framework for applying it to public utilities.

Access charges based on DOCR are compared with the policy pursued by Ofgas where access prices are based on direct cost of provision, in particular a long-run marginal cost method, within an overall form of control determined by rate of return regulation. It is hoped that the empirical application undertaken here and the ensuing policy implications that are examined will extend the analysis. An examination is also made of the impact of access pricing on the competitive process and consequently the pricing behaviour of the contract gas market.

Section 2 attempts to establish the relationship between network access price and market concentration, prior to undertaking the empirical application in Section 3. Section 4 concentrates on the policy implications of applying the different access price regimes\textsuperscript{2}. The various policy choices and options are considered along with the applicability of the different access prices.

\textsuperscript{1} see Armstrong et al (1996)

\textsuperscript{2} Though this is done in the context of the contract gas market, they have some general implications and, therefore are examined in a more general context.
Section 2: Market Structure and Network Access Pricing:

2.1. Theoretical Framework

The theoretical framework illustrates the impact of entry cost such as access price on the market concentration. Earlier seminal works by Davies (1979) and Waterson (1984) maintain that the level of concentration depends on the number of firms in the market \( N_t \) and the inequalities in the market share of the firms in the industry \( I_t \):

\[
CR_t = f(N_t, I_t)
\]

(6.2.1)

where \( f_{N_t} < 0 \) and \( f_{I_t} > 0 \). An earlier seminal research by Mansfield (1962) suggests that the main cause of net entry into a particular market is the potential profits to be earned. More recent research maintains a similar line (see Geroski (1991) and (1995)). The number of firms in an industry basically changes with net entry, which in turn is dependent on expected rate of profits:

\[
CR_t = f\left(N_t, (\pi_t^e - ACC_t), I_t\right)
\]

(6.2.1')

where \( \pi_t^e = p_t^e - mc_t^e \) (less entry cost, such as network access price) and 

\( ACC_t \) denotes network access price. The level of entry cost, or network access price, affects potential profits the entrant can expect. The relationship between the market concentration and access price, is derived using the chain rule;

---

3 This is a general assumption or consideration because the access price regime can be higher than the direct cost of provision and an effective means of controlling entry by increasing cost per unit of output.

4 A similar position is taken when explaining trigger strategies in supergames theory (see Tirole (1989)). A recent work by McCloughan (1995) maintains that \( \Delta CR_t = f \) (Growth of firms, Entry, Exit) or (Growth of firms, Net Entry), if the reasons for entry and exit are the same. In the present case, it is assumed that the reason is expected profits.
Access price is deemed to have a positive effect on market concentration. The explanation here is that as access price, or entry costs, increase, the less profitable and smaller firms would exit the industry. Consequently, market concentration increases even though the overall industry output may decrease.

2.2. Empirical Results:

The theoretical framework above shows that network access prices have an impact on market concentration. The present sub-section empirically tests this relationship with respect to the contract gas market. The equation attempts to capture the dynamic response of market concentration to access price and therefore estimates dynamic elasticities\(^5\) as follows;

\[
CR_t = \beta_0 + \beta_1 CR_{t-1} + \beta_2 ACC_t + \beta_3 ACC_{t-1} + \epsilon_t \quad (6.2.3)
\]

where, \(ACC\) represents Transco's transportation charges. The estimates using \(OLS\) estimators are given in Table 6.1 below;

---

\(^5\) This is only a partial model of the determination of the concentration levels from equation (6.2.1). A dynamic specification such as equation (6.2.3) would eliminate any serial correlation problems when estimating. There are also very compelling theoretical justifications for estimating such a model, particularly when it is subsequently used for simulation purposes. A dynamic elasticity reveals how market concentration would change over time in response to a change in access price. Elasticity depends just as much on time and evolves with it. As Pindyck and Rubinfeld (1991) point out, one would expect the elasticity to grow monotonically and approach some asymptotic long-run value (calculated by equation (6.2.4)). It is also possible that the elasticity would oscillate while approaching the long-run value, as indicated in Table 6.1. Therefore, as Pindyck and Rubinfeld (1991) maintain, it is important to capture the dynamic response of elasticities for forecasting and simulation purposes.
CHAPTER 6: AN ASSESMENT & POLICY OPTIONS

Table 6.1: Linear Estimation of Industry Concentration

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>OLS Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_0$</td>
<td>-1.5419$^a$</td>
</tr>
<tr>
<td></td>
<td>(2.5044)</td>
</tr>
<tr>
<td>$\beta_1$</td>
<td>0.88922$^a$</td>
</tr>
<tr>
<td></td>
<td>(22.1912)</td>
</tr>
<tr>
<td>$\beta_2$</td>
<td>5.8347$^a$</td>
</tr>
<tr>
<td></td>
<td>(2.8336)</td>
</tr>
<tr>
<td>$\beta_3$</td>
<td>-5.0525$^a$</td>
</tr>
<tr>
<td></td>
<td>(2.6583)</td>
</tr>
</tbody>
</table>

No. of observations 49  Log-likelihood 133.0948
$R^2$ 0.95916  $\chi^2_{SC(1)}$ 0.077873
F-statistic 368.9245  $\chi^2_{H(1)}$ 0.33655
Std Error 0.10363  $\chi^2_{RESET(1)}$ 22.46$^a$
RSS 0.47253  DF -8.5907
Mean of Dep. Variable -1.2589
S.D. of Dep. Variable 0.51279

Notes: Figure in parentheses are (absolute) t-values.
a denotes significance at the 5% level for a 2-tailed-test and a $\chi^2$ distribution.
DF relates to test for non-stationarity in the regression residuals (Dickey-Fuller Test)
SC,H and RESET denotes test for serial correlation, heteroskedasticity and misspecification and/or non-linearity, which follows a $\chi^2$ distribution.

The estimates from Table 6.1 indicate that access price elasticity oscillates while approaching an asymptotic long-run value. Such a value can be calculated from the estimates as follows;

$$\eta_{LR} = \frac{\hat{\beta} + \hat{\alpha}}{1 - \hat{\beta}} = 7.09$$  \hspace{1cm} (6.2.4)

This confirms the implications of equation (6.2.2) that access price has a positive effect on the level of concentration and it is fairly elastic.
Section 3: An Empirical Application of “Direct-Plus-Opportunity Cost” Regime

Chapters 2 and 3 highlight that ECPR and DOCR accept the incumbent’s final goods price as given, with the approval of the regulator, and taking into account anti-competitive practises and the incumbent’s wider obligations or, conversely, optimality. Chapter 3, also highlighted Ofgas’s concern with the erosion of cross-subsidisation and increased “cherry-picking” as a result of the pursuit of pro-competitive polices. ECPR and DOCR are effective measures to eliminate “cherry-picking”.

Economides and White (1995 and 1997) and Economides (1998) theoretically examine market outcomes when access prices determined by ECPR are applied while pursuing pro-competitive policies. This section examines the market outcome by using an empirical application of DOCR.

Following Armstrong et al’s (1996) synthesis model (DOCR), outlined in Chapter 2, access price according to ECPR and Ramsey Rule are respectively determined as;

\[ a_1 = MC_1 + \sigma(P - MC_2) \quad (6.3.1) \]

\[ a_2 = MC_1 + \sigma(P - MC_2) + \theta \frac{2}{2_a} \quad (63.1') \]
where $MC_1$ and $MC_2$ denotes the marginal cost of providing network access and the incumbent’s marginal cost in the final goods market. $\sigma$ and $\lambda$ denotes displacement ratio and shadow price of budget constraint respectively, and $\theta = \frac{\lambda}{1-\lambda} \geq 0$. $\hat{z}$ refers to equilibrium demand for access. While $\frac{\partial z}{\partial a}$, where $a$ denotes the access price, and finally $P$ denotes incumbent’s final goods price. The additional term on the right hand side of equation (6.3.1) appears when the break-even budget constraint is binding, when Ramsey rule is applicable.

3.1. Stochastic Simulation of Competitive Process:

The present sub-section examines the impact of access charges determined by the Ramsey Rule and ECPR version of “direct-plus-opportunity cost” access price regime on market concentration and consequently the entrant’s pricing behaviour.

Transportation charges following Ramsey Rule and ECPR are formulated as follows:

$$\text{RAM} = MC_1 + \sigma(P_{BG} - MC_2) + \theta \frac{\hat{z}}{-\hat{z}_a} \quad (6.3.2)$$

and

$$\text{ECPR} = MC_1 + \sigma(P_{BG} - MC_2) \quad (6.3.2')$$

The $MC_i^6$ relate to the cost of providing transportation services and are based on figures published in a report by BG (TransCo); “Ten Year Statement” (1995). The displacement ratio ($\sigma$), in the present case, is deemed to be equal to one and
therefore, the Margin Rule version of the synthesis model is applicable. The gas provided in the firms contract sector is homogenous\(^7\) and there is no network bypass. The marginal cost \((MC_z)\) of BG for providing gas in the contract market comprises of the UK Continental Shelf (UKCS) beach head gas price\(^8\).

On the other hand, for the Ramsey rule the shadow price for the present case is arbitrarily set at 0.8. The equilibrium demand for network access \((\hat{z})\) is equated to the output of the main four non-BG shippers contract firm gas sector and \(\hat{z}_4\) is estimated at -92.6\(^9\). Subsequently, the entrant’s pricing behaviour, estimated in Chapter 5 (Table 5.1), is simulated in a reduced form incorporating the estimated concentration level (equation (6.2.3));

\[
PRAM = \hat{\alpha}_0 + \hat{\alpha}_1 PRAM_{t-1} + \hat{\alpha}_2 (\hat{\beta}_0 + \hat{\beta}_2 CR_{t-1} + \hat{\beta}_3 RAM_{t} + \hat{\beta}_4 RAM_{t-1} + \hat{\varepsilon}_{2,t})
\]
\[
\quad + \hat{\alpha}_3 MC_{R,t} + \hat{\alpha}_4 Dd_i + \hat{\varepsilon}_{1,t}
\] (6.3.3)

\[
PECPR = \hat{\alpha}_0 + \hat{\alpha}_1 PECPR_{t-1} + \hat{\alpha}_2 (\hat{\beta}_0 + \hat{\beta}_2 CR_{t-1} + \hat{\beta}_3 ECPR_{t} + \hat{\beta}_4 ECPR_{t-1} + \hat{\varepsilon}_{2,t})
\]
\[
\quad + \hat{\alpha}_3 MC_{E,t} + \hat{\alpha}_4 Dd_i + \hat{\varepsilon}_{1,t}
\] (6.3.3')

\(PRAM\) and \(PECPR\) denote the simulated entrant’s prices when access charges are determined by the Ramsey Rule and ECPR version of "direct-plus-opportunity cost"

\(^6\) The \(MC_i\) used refers to the network transportation cost between Bacton and Leeds, which is 0.9pence/therm.

\(^7\) The gas industry competes within the energy sector. Though products offered in similar segments in the energy sector, such as a similar industrial/commercial electricity market, can be treated as imperfect substitutes, different shippers in a particular segment of the gas industry are homogenous.

\(^8\) BG’s contract gas sector’s unit labour costs are neither published nor divulged. They, however, maintain they are only a small proportion of its marginal cost. The main and largest component of marginal cost is gas input. Firms may engage in long-term contracts to keep their prices down, and BG is no exception to this. However, for the purposes of policy simulation, BG is assumed to buy gas at a competitive rate according to UKCS beach head price rather than any long term contractual agreement they may engage. This may be a condition that the regulator may wish to impose when formulating access charges based on DOCR to ensure equity.

\(^9\) Appendix 6.1 gives the estimated coefficient of the network access price.
access price regime respectively. $RAM_t$ and $ECPR_t$ denotes the access price following equations (6.3.2) and (6.3.2'), while and $MC_{R/E}$ refers to the new marginal cost where the access charge element follows the Ramsey Rule and ECPR respectively.

**FIGURE 6.1: SIMULATED AND ACTUAL PRICES**

![Graph](image)

Figure 6.1 depicts both the actual and simulated prices, where PNBG and PBG are the actual prices of the entrants shippers (non-BG) and BG. An important issue discussed in Chapters 4 and 5 is that the entrants pricing behaviour was distinct from BG over the relevant period. The former adhered to the prevailing market structure and conditions. However, the simulated prices indicate that the entrants’ pricing behaviour would closely follow the incumbent’s when access charges according to DOCR are applicable.

The difference between the actual and simulated prices of the entrants are twofold. The first difference is the marginal cost element, where the entrants’ marginal cost increases as a result of the new access charges based on DOCR. Secondly, the new higher access regime affects market conditions which, in turn, has
an impact on the final goods prices. As seen in Section 2, a higher access charge increases market concentration which leads to higher final goods prices.

In addition, in the case of Ramsey Rule access charges, the break-even constraint is binding. Therefore, PRAM and PECPR diverges, when BG experience significant losses in its market shares, and the entrant is obliged to increase its contribution in the form of access charges, to maintain the incumbent’s break-even constraint. The results are consistent with the theoretical exposition of Economides and White (1995) where they maintain that prices increase to monopolistic levels, or the maximum allowed under regulation.

Section 4: Policy Implications and Analysis: Options and Choices

Armstrong et al (1996) made two important points in their conclusion. First and foremost, the nature of competition in the final goods market is affected by access pricing. Secondly, though these issues were not developed in their paper, they maintain that effective competition may ease the process of regulation. Nevertheless, they felt that “direct-plus-opportunity cost” regime in its modified form, taking into account bypass and non-homogenous products, has to be the basis of access pricing regulation.

Vickers (1997), however, was more ambivalent and suggested that access price based on long-run marginal cost (LRMC) may be more appropriate in utilities and sectors that have pursued pro-competitive policies. It is hoped that the empirical
application undertaken here, comparing access price regimes based on LRMC and DOCR, will illuminate the issues and subsequently the policy options. The analysis in Sections 2 and 3 clearly indicate that the nature of access price regime does affect the nature of competition in the final goods market. This section considers the policy implications in a general context; when a particular access price regime is applicable and in which scenario.

The regulator promoting pro-competitive policies may wish to encourage contestable outcomes, especially as the original ECPR model is based on the theory of contestability. Also, in the contract gas market, the regulator introduced a public pricing policy. The net welfare gains, as a result of applying DOCR compared with LRMC, is also examined. The policy implications are investigated, bearing in mind the efficiency, or optimality, versus equity arguments outlined in Chapters 2 and 3. The latter is particularly important if the incumbent retains considerable Universal Services Obligations (USOs) and the cross-subsidisation that it implies.

4.1. Access Price Regimes and Perfectly Contestable Markets:

Before engaging in discussions relating to contestable outcomes, the issue of the types of cost need to be cleared. Chapter 2 outlines some of the relevant cost but the use of various costs in the various models is confusing and, indeed, at times contradictory. While explaining ECPR, Baumol and Sidak (1994) used AIC which is consistent with contestability. While Armstrong et al (1994 and 1996) when putting forward DOCR use MC as they intentionally move away from using contestability as a
basis of their analysis. In contrast, Vickers (1997), in outlining his version of DOCR, uses AIC.

Nevertheless, the relationship between Average Incremental Cost (AIC), MC and LRMC needs to be established thereby making the following analysis clearer, hence this is not a trivial issue. As argued in Chapter 2, MC and AIC differ substantially if the increment is large. This is consistent if sunk costs are involved, as is the case with the gas transmission network.

The question of difference between LRMC and AIC is less clear. During the consultation process in 1992 and 1993 relating to transportation charges, BG argued that the AIC is the nearest practical approximation to LRMC. Ofgas, while agreeing on the practical aspect, had other reservations (Ofgas Nov 1992);

"The AIC approach is pragmatic, based as it is on existing investment plans and demands projections. This pragmatic basis has the weakness, however, that the types - load factors and geographical locations - of demands increments currently expected and planned for, may, on average, be very different from any particular new incremental load brought by a gas shipper."

Consequently, Ofgas deemed the LRMC/EE option more appropriate for the gas market. In general, however, AIC can be assumed to be equal to LRMC.

The possibility of contestable outcomes in the final goods market was first introduced in Chapter 3, in the context of the contract gas market. In Chapter 3, the compatibility of a public pricing policy and the pursuit of a pro-competitive policy to achieve contestable outcomes, was examined. This sub-section examines the role of
access prices based on LRMC and DORC when pursuing pro-competitive policies to achieve contestable outcomes.

Baumol et al (1982) introduced the concept of contestable markets as a counter to the notion that under increasing returns to scale, or subadditivity, where only a finite number of firms are viable and make positive (supranormal) profits. They argue that potential competition and the threat of entry may serve to discipline established firms. There are two groups of firms; \( m \) "incumbents" and \( n - m \geq 0 \) "potential entrants". The industry configuration is feasible if market clears;

\[
\sum_{i=1}^{m} q_i = D(p) \quad (6.4.1)
\]

and firms make;

\[
\pi \geq 0 \text{ and } pq_i \geq C(q_i) \quad (6.4.2)
\]

An important criteria of contestable markets is "sustainability". An industry configuration is sustainable if no entrant can make a profit taking the incumbent's price as given. There does not exist a price where the entrant can price;

\[
p^e \leq p \quad (6.4.3)
\]

and make non-zero profits, and an output;

\[
q^e \leq D(p^e) \text{ such that } p^e q^e \geq C(q^e) \quad (6.4.4)
\]

A perfectly contestable market is one in which any equilibrium industry configuration must be sustainable. This is illustrated as follows;

Total cost is depicted as follows;
\[ C(q) = f + cq \]  
(6.4.5)

let profits be;

\[ \pi^m = \max_q \{ [p(q) - c]q \} \]  
(6.4.6)

where \( \pi^m \) is gross of the fixed cost. Assuming that a monopoly is viable: \( \pi^m > f \).

There exists only one incumbent in the industry, charging price; \( p^c \) and supplying output; \( q^c \), while other firms kept out. The contestable price-output pair;

\[ \{p^c, q^c\} \]  
(6.4.7)

is obtained from the intersection of the average cost and demand;

\[ (p^c - c)D(p^c) = f \]  
(6.4.8)

A firm that charges a price less than \( p^c \) loses money because price is below average cost. Conversely, a price above \( p^c \) is not sustainable, as an entrant can undercut this price and still make a positive profit. The contestable theory predicts the ensuing conclusions;

i. there is a unique operating firm/s in the industry (technological efficiency),

ii. firms make zero profit, and

iii. average cost pricing prevails.

Furthermore, Baumol et al (1982) show that if a sustainable allocation does exist, it satisfies the following conditions;

i. industry cost minimisation holds,

ii. firms make zero profits,

iii. the price of a product exceeds its marginal productions costs, and
iv. Ramsey prices and outputs are sustainable. Therefore, cross-subsidisation issues do not come into consideration.

Chapter 3 suggests that a network in vertically integrated industries such as the gas industry, can be regarded as a “shared sunk cost”. The entrants entry and use of the network is regulated. Though the incumbent could use it to manipulate final goods market outcomes, the incumbent’s actions are not binding. Therefore, access price on the basis of LRMC enables the vertically integrated incumbent to recoup the cost of network investment from the interconnecting entrants and, subsequently, contestable outcomes are possible in the final goods market, which is examined here;

An incumbent’s price in the final goods market is as follows;

\[ p = p_I = LRMC_N + AIC_I \]  \hspace{1cm} (6.4.9)

where \( p \) denotes industry price, while \( LRMC_N = AIC_N \) and \( AIC_I \) denotes the long-run marginal cost and average incremental cost of network provision and the incumbent’s average incremental costs for the provision of final goods market. The entrants’ price taking the incumbent’s price as given is;

\[ p_I = p_E = LRMC_N + AIC_E + \delta_E \]  \hspace{1cm} (6.4.10)

where \( \delta_E \) denotes the entrant’s profit. Therefore, the industry price is sustainable if and only if;

\[ \delta_E = 0 \text{ and } AIC_E = AIC_I \]  \hspace{1cm} (6.4.11)

If, on the other hand, the access price determined by DOCR is applied, the incumbent’s price is;
$p = p_i = LRMC_N + AIC_j + \delta_i$  \hspace{1cm} (6.4.12)  

where $\delta_i$ denotes the incumbent’s profit and the entrant’s price is;

$$p_i = p_E = (LRMC_N + \delta_i') + AIC_E + \delta_E$$ \hspace{1cm} (6.4.13)  

where $(LRMC_N + \delta_i')$ denotes the access price the entrant pays, and $\delta_i' \leq \delta_i$.

Though, $\delta_i > 0$ violates the theory of perfect contestability, one could suggest that the industry price is sustainable if;

$$\delta_E = 0, \delta_i = \delta_i' \text{ and } AIC_E = AIC_i$$ \hspace{1cm} (6.4.14)  

Conversely, the entrant’s market could be perfectly contestable ($\delta_E = 0$) under DOCR Margin Rule. Therefore, equating equation (6.4.12) and (6.4.13), suggests that;

$$AIC_E = AIC_i$$ \hspace{1cm}  (6.4.15)  

and may choose to enter the industry. The inconsistency here is that while the entrant is earning zero profits, despite being as efficient as the incumbent, the incumbent earns positive profits. A justification for this, possibly the only justification, is the need for the incumbent to maintain cross-subsidised services.

This is further illuminated when the matter of “subadditivity” is considered.

For a simple single product scenario, a cost function $C(q)$ is said to be subadditive at $q$ if, for all outputs $q_1, q_2, ..., q_n$, we have;

---

10 If the general DOCR model is applicable then; $AIC_E \geq AIC_i$ by the amount $\delta_i - \delta_i' \geq 0$.
\[ C(q_i) > C(\sum_{i=1}^{n} q_i) \]  \hspace{1cm} (6.4.16)

If the subadditivity condition is satisfied, the industry is said to be a natural monopoly. If the DOCR access price is in operation, the subadditivity condition is still maintained even if;

\[ AIC_E = AIC_i \]  \hspace{1cm} (6.4.17)

and thereby maintaining a false natural monopoly status in the final goods for the incumbent. This emphasises the point that the application of DOCR is only justifiable on the grounds that the incumbent has to maintain cross-subsidised services with the approval of the regulator.

As discussed in Chapter 3, public pricing policy is consistent with ensuring perfectly contestable outcomes in the final goods market. Access price determined by LRMC is consistent with this goal. In the contract gas market, as seen in Chapter 4, the incumbent chooses to pursue an inter-temporal pricing strategy. Much of this is explained by the nature of post-entry competition in the contract gas market, where the entrant operated as an upstream firm. As suggested in Chapter 4, a possible reason why Ofgas did not seek to eradicate such behaviour on the part of BG was that BG still maintained cross-subsidies.

Therefore, access prices determined by DOCR could at best attain "pseudo-perfectly contestable outcomes", where only the entrants' behaviour is consistent with perfectly contestable outcomes. While, on the other hand, LRMC access charges are consistent with attaining perfectly contestable outcomes, which also implies that it is
consistent with Ramsey-optimal outcomes in the final goods market\textsuperscript{11}. Access price based on a LRMC method may not be consistent with second best principles but is consistent with the existence of a network which is a "shared sunk cost". However, the former which accepts the incumbent's final goods price, regardless of it being distortionary, is consistent with attaining equity rather than perfect contestability.

4.2. Cross-Subsidisation and Welfare Gains:

Network access price regimes clearly affect the competition process and prices in the final goods market. Nevertheless, examining the impact on welfare gains from using DOCR to LRMC may be academic and slightly superfluous. If the former is used to reduce cherry-picking and maintain cross-subsidisation, as seen in Chapter 2, the regulator's objective of maximising total welfare becomes a secondary issue, in particular with relation to consumer surplus gains.

On the other hand, there may be a case for examining its impact on producer surplus gains. The margin-rule version of DOCR, or ECPR, seeks to attain some productive efficiency. Indeed, Section 2 indicates how access price has a positive effect on market concentration. Therefore, any increase in access price implies that the less efficient firms exit the industry and more efficient firms increase their market share. Inevitably this has an impact on gains in producer surplus. This basically involves the interaction between the industry's demand elasticity and the relative production efficiency of the entrants. A formal analysis is undertaken here;

\textsuperscript{11} Baumol et al (1977) argues that Ramsey prices and outputs are sustainable.
CHAPTER 6: ASSESSMENT & POLICY OPTIONS

The analysis is based on the simple Cournot duopoly game\(^{12}\) and the assumptions are as follows;

1. inverse demand for the service which is linear;
   \[
P_j = a - bQ_j \tag{6.4.18}
   \]
   expressing the relationship between industry price \((P_j)\) and quantity \((Q_j)\).

2. quantity is the sum of the incumbent’s \((Q_i)\) and entrants’ \((Q_e)\) production, and the price at which they sell jointly.

3. the marginal cost of the incumbent and entrant for their respective output in the final goods market are;
   \[c \text{ and } c + \kappa \tag{6.4.19}\]
   where \(c\) includes network input cost as part of final goods production, \(\kappa\) denotes the relative marginal cost difference between the entrants and incumbent.

   \(\kappa\) comprises of the relative inefficiency of the entrant firms \((\tau)\) and any access charges above that is determined by LRMC \((\alpha)\);
   \[
   \kappa = (\tau + \alpha) \tag{6.4.20}
   \]
   \(\tau\) lies between \(-\infty\) and \(+\infty\), as the access charges decrease, less efficient firms enter. Indeed, the application of ECPR and the Margin-Rule version of DOCR imply that the entrant should be at least as efficient as the incumbent. It is assumed, for simplicity, that under a LRMC access price regime, the entrants’ marginal cost is on average equal to the incumbent’s\(^{13}\). On the other hand, under DOCR, \(\kappa\) could be both negative or positive. Basically, it depends on whether the entrants’ relative

\(^{12}\) The analysis could just as easily be done in a Bertrand competition context. Here, the Cournot game theme is continued and as seen in Section 2, a change in access charges affects marginal cost and market concentration which affects final prices.

\(^{13}\) Both more and less efficient firms than the incumbent enter. However, it is assumed that on average the entrants’ relative inefficiency, or the average representative entrant’s relative inefficiency; \(\kappa = 0\), particularly as \(\tau = 0\) under LRMC access price. This enables a simplified Cournot duopoly analysis.
inefficiency ($\tau$) outweighs the additional access charge they face ($\alpha$).

Furthermore, it is also assumed, for simplification, that in the final goods market marginal cost and average cost are constant and equal.

Analysis of the conditions that enable net social benefit gain is set in the context of a simple Cournot duopoly model, where the entrants' behaviour is represented by a typical entrant firm. The incumbent's and entrant's profits for their respective output in the final goods market are as follows;

$$\pi_i = [a - b(Q_i + Q_E)] \cdot Q_i - cQ_i \quad (6.4.21)$$

and

$$\pi_E = [a - b(Q_i + Q_E)] \cdot Q_E - (c + \kappa)Q_E \quad (6.4.21')$$

As mentioned before when LRMC access price is applicable, $\alpha = 0$. In order to examine the net social benefit "gains", the equilibrium Cournot-Nash game outcomes under both LRMC and DOCR access price regimes, need to be established;

i. **LRMC Access Charges: Cournot-Nash Equilibrium Outcomes:**

The equilibrium of the Cournot game is\(^1\)

$$Q_i = (a - c) / (3b), \quad Q_E = (a - c) / (3b),$$

$$Q_J = Q_i + Q_E = 2(a - c) / (3b), \quad (6.4.22)$$

$$P_J = -a + 2c / 3$$

ii. **DOCR Access Charges: Cournot-Nash Equilibrium Outcomes:**

The equilibrium of the Cournot game subsequently becomes;

$$Q_i^1 = (a - c + \kappa) / (3b), \quad Q_E^1 = (a - c - 2\kappa) / (3b),$$

\(^{14}\) This is derived via their respective reaction functions and setting $\kappa = 0$. 

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\[ Q_j^1 = Q_j^1 + Q_E^1 = [2(a - c) - \kappa] / (3b), \quad (6.4.23) \]

\[ P_j^1 = -a + 2c / 3 \]

Given that the firms face a downward sloping linear demand curve, the consumer surplus gains are\textsuperscript{15};

\[ \frac{1}{2} (\Delta Q)(\Delta P) = \frac{1}{2} (Q_j^1 - Q_j)(P_j^1 - P_j) < 0 \quad (6.4.24) \]

As mentioned earlier, it may be more relevant to look at the impact on the producer’s surplus, which is where the focus will be. Producer’s surplus gains are derived as follows;

\[ \Delta \pi = \Delta TR - \Delta TC - \text{productive inefficiency} \quad (6.4.25) \]

\[ \Delta TR - \Delta TC = (P_j^1 Q_j^1 - P_j Q_j) - (Q_j^1 - Q_j)(c) \quad (6.4.26) \]

\[ = \kappa (-a + 3c - \kappa) / (9b) \]

The productive “inefficiency” attributable to the entrant’s output is;

\[ \kappa Q_E^1 = \kappa (a - c - 2\kappa) / (3b) \quad (6.4.26) \]

The productive “inefficiency” is subtracted from equation (6.4.26), and the net producers’ surplus “gains” are;

\[ (\kappa)(-4a + 6c + 5\kappa) / (9b) \quad (6.4.27) \]

The expression is positive if, and only if, both bracketed terms are positive or negative. Therefore;

\[ (\kappa)(-4a + 6c + 5\kappa) > 0 \quad (6.4.28) \]

\textsuperscript{15} Consumer surplus and producer surplus are examined separately, bearing in mind the policy-maker may not give equal weights to both these components when they maximise total welfare as discussed in Chapter 2.
\( \kappa \) is;

\[
\kappa > \frac{4a - 6c}{5} \quad (6.4.29)
\]

or, equivalently;

\[
\kappa < \kappa^* = \frac{4a - 6c}{5} \quad (6.4.29')
\]

where \( \kappa^* \) is the critical level or minimum level of "productive inefficiency" for the net producer surplus gains are non-zero. The critical value can be derived in terms of industry demand elasticity at the Cournot equilibrium (when DOCR access regime is in use);

\[
e = \frac{(AQ / AP) / (Q'_j / P'_j)}{a + 2c + \kappa} = \frac{-a + 2c + \kappa}{2a - 2c - \kappa} \quad (6.4.30)
\]

If normalised by setting \( c=1 \), subsequently it can be solved for \( a \) in terms of \( e \) and \( \kappa \);

\[
a = \frac{-2e + e\kappa + 2 + \kappa}{(-2e - 1)} \quad (6.4.31)
\]

and this result can then be used to solve for \( \kappa^* \) in terms of elasticity \( e \);

\[
\kappa^* = \left[ -\frac{8(-2e - 1)(e - 1) - 6}{-4(-2e - 1)(e - 1)} \right] \quad (6.4.32)
\]

The above expression suggests that as demand is more elastic, the more efficient the entrant firm has to be in relation to the access price charge determined by DOCR, that is the absolute value of entrants' productive inefficiency is;

\[
\tau > \alpha
\]

For example, if \( e = 2 \) then \( \kappa^* = -1.7 \) and if \( e = 3 \) then \( \kappa^* = -2 \).
Positive net producers’ surplus is only attained if the average relative efficiency of the entrants are greater than the “opportunity cost” element of the access charge. Though it is a necessary condition, it is not a sufficient condition. The magnitude of the difference for positive gains depend on the elasticity of demand faced by the firms\textsuperscript{16}. In the case of the Margin Rule version of DOCR, which is applicable in the contract gas market, the relative entrants’ efficiency level has to be higher than the profit rate of BG.

Section 5: Conclusion

This chapter has shown that access price regimes affect the outcomes that may evolve in a competitive market, a view consistently held by regulatory theorists. It affects the competitive process in the final goods market, the market concentration and prices. Therefore, access price regimes play a crucial role in determining competition policies.

The unfettered pursuit of pro-competitive policies reduce any distortions such as cross-subsidisation. Access charges based on LRMC methodology is consistent with the perfectly contestable outcomes in the final goods market. Nevertheless, while pursuing pro-competitive policies, policy makers may wish to retain some equity and incumbent’s universal service obligations, even if it is only transitory and part of a wider competitive policy.

\textsuperscript{16} The more elastic the demand, the greater the entrants’ relative efficiency has to be in relation to the “opportunity cost” element.
Indeed, in the preceding chapters, it was shown how competition in the gas industry is introduced in stages; initially in the contract gas market, subsequently in the tariff market and eventually in the entire domestic market. In particular, Ofgas was concerned about the inevitable "cherry picking" and erosion of cross-subsidisation.

Nevertheless, as argued by Economides and White (1995 and 1998) if unfettered pro-competitive policies are pursued, potential positive welfare gains are lost when access prices are based on ECPR. The empirical application in this chapter, indicates that the use of access prices based on the Margin Rule version of DOCR, increases the market concentration and average industry prices. Therefore welfare gains, particularly, net positive producers' surplus, are only attained under very stringent conditions: relative efficiency of the entrants and elasticity of demand.
APPENDIX 6.1: ESTIMATED COEFFICIENT OF ACCESS DEMAND WITH RESPECT TO ACCESS PRICE (\( \hat{z}_a \))

As discussed in Chapter 2, the equilibrium demand for access following Armstrong, Doyle and Vickers (1996) is:

\[
\hat{z}(P_I, a)
\]

that is, it is a function of the incumbent’s price \( (P_I) \) and access price \( (a) \). Hence the estimated equilibrium demand for access in the contract gas market is:

\[
\hat{z} = 2267.1 - 4.0383 \cdot (5.1863) - 92.6105 \cdot (-1.4444) - 92.6105 \cdot (-4.7104) \cdot ACC\ (A6.1.1)
\]

\( \hat{z} \) refers to the demand for network access which is equal to output in the case for the contract gas market. The coefficient of network access prices \( (ACC) \) is negative and significant. Therefore, \( \hat{z}_a \) is approximately 92.6.
CHAPTER 7: CONCLUSION: CONCLUDING REMARKS AND POSSIBLE FUTURE DIRECTIONS
CHAPTER 7: CONCLUSION

INTRODUCTION:

In this, the concluding chapter, a brief summary of the competitive process in the contract gas market is given. Some general conclusions relating to access price regulation and competition policy are considered. This is done in the context of the contract gas market and the investigations undertaken in the preceding chapters. Possible future work and directions regarding regulation theory and policies are also considered.

MAIN ISSUES AND CONSIDERATIONS:

The role and importance of access price regimes in determining competition policy cannot be understated. Regulators and regulatory theorists have increasingly placed importance on access pricing when trying to promote competition and also ensuring that their objectives in the final goods market are met. This is the crux of the matter; the shape and form of competition that has to be determined, not just in a particular sector but in the industry as a whole.

These objectives, as shown in Chapter 2, can be conflicting. For example, trying to ensure optimality, or second best outcomes, in the final goods market and access input, while removing distortionary practices. On the other hand, equitable distribution, ensuring equal prices and services for all customers regardless of demand or cost considerations is also important. Whatever the objectives the regulator wishes
to pursue, access price regimes remains an important policy instrument in determining
the competitive process.

1. Strategic Behaviour and Competitive Process in the Contract Gas Market:

   Chapters 3 and 4 investigate the impact regulatory policies have on the
   competitive process in the contract gas market. This was done in the context of the
   strategic advantage of BG and the entrants, non-BG shippers. The former, as the
   incumbent and as a vertically integrated firm, potentially has pre-entry advantage,
   while the latter have post-entry advantages, as the main entrant firms operate as
   upstream firms in the contract gas market.

   Ofgas, together with the MMC and OFT, sought to reduce BG’s pre-entry
   advantage. Initially, they focused on the final goods market, subsequently, they
   concentrated on network access, or transportation charges. Chapters 3 and 4 indicate
   that BG reacted to Ofgas’s policies in the contract gas market by invoking its strategic
   advantage.

   In the final goods market, BG practised an inter-temporal pricing strategy.
   With regards to network access regulation, BG took advantage of the Rate of Return
   regulation, manipulating access charges to suit their own final price structure while
   increasing access charges, or the Averch-Johnson effect. In addition, the crucial
   strategic practice of large capacity pre-commitment, or the Stackelberg-Dixit model,
   by BG is considered.
Both the models have different impacts; the Averch-Johnson model manipulates and increases access charges, within an overall cap, by large capitalisation. The Stackelberg-Dixit effect, on the other hand, sought to manipulate post-entry outcomes through large capacity pre-commitment as it lowered the incumbent’s marginal cost. Both models work in tandem, the former effect enables the cost of excess capital, which was an inevitable outcome of the Stackelberg-Dixit model, to be kept down.

More importantly, both the Stackelberg-Dixit effect and inter-temporal pricing strategy complement each other closely. When BG reverts to a pricing policy consistent with the market conditions, keeping its marginal cost low would be useful. Subsequently, BG is able to maintain its price-cost margin, or the Lerner index, relatively high;

$$\frac{p_{BG} - mc_{BG}}{p_{BG}}$$

In particular, as seen in Chapters 4 and 5, when the competitive process evolves without any regulatory restrictions, the market is characterised by oligopolistic competition with a high concentration ratio.

2. *Regulation of Incumbent’s Final Goods Market Pricing Policy:*

As discussed in Chapter 2, Newbery (1997) argued vehemently that final goods market regulation is essentially inefficient, and efficient outcomes are best achieved by introducing effective competition. The inability of Ofgas’s policies such as public pricing policies to curb BG from invoking its pre-entry advantage indicates this clearly.
Nevertheless, regulators, while pursuing pro-competitive policies, have chosen to maintain regulatory control of the incumbent’s final goods pricing policy. Broadly speaking, the purpose of any regulation relating to the incumbent’s final goods is twofold: first and foremost, to ensure that predatory or anti-competitive practises are eliminated, secondly, to ensure efficient outcomes. Efficient outcomes relate to allocative and productive efficiency. The first purpose is particularly important at the transitory stage, when competition is being introduced. The second purpose, according to Newbery, is best achieved via competition rather than formal regulation.

The next issue is the form of regulation the incumbent’s final goods market pricing behaviour should take. It could take the form of formal regulation, such as RPI-X and/or Rate of Return regulation, or a public pricing policy. The latter, though less formal than the former, could be implemented just as vociferously, as practised by Ofgas and proposed by Baumol et al (1997). The incumbent’s pricing schedules are published and changes to them are subject to approval by the regulator, and the incumbent’s prices should reflect its cost or, indeed, cross-subsidisation. Both of these forms of regulation are just as effective in attaining these two purposes while incorporating the regulator’s wider objectives.

In the theoretical literature there is some confusion regarding the usage of the term “deregulation”. Consistency and clarity with regards to these issues is not a trivial point, as it makes clear what is the appropriate regulatory regime and in which scenario. Vickers (1995) uses the term “deregulation” to describe sectors that are open to competition, while the incumbent is still formally regulated. In Vickers (1997) the
term “partial deregulation” refers to scenarios where some or all of the incumbent’s retail prices are “deregulated” or not subject to formal regulation. When sectors are open to competition, according to Vickers (1997), the policy-maker is pursuing “liberalisation policies” in regulated industries.

In general, “deregulation”, “pro-competitive” and “liberalisation policies” are synonymous and interchangeable, and refer to sectors or industries where competition has been introduced. Regulation of incumbent’s retail prices are an imperfect substitute to increasing competition in order to achieve efficient outcomes. The regulation of incumbent’s final goods prices is important if the policy-maker’s wishes to attain objectives other than economic efficiency as well and/or prevent anti-competitive policies. In most cases, as discussed in the previous chapter, both these issues are transitory.

In the case of the contract gas market, the public pricing policy was introduced to eliminate anti-competitive practices, though they expressed concern about the elimination of cross-subsidises. Ofgas’s general policy, concurring with Newbery (1997), maintains that only through increased competition is efficiency ensured, and their policies were directed towards this end.

3. Perfectly Contestable Market and Cross-Subsidisation/Wider Obligations:

The most important consideration for ECPR, or the Margin-Rule version of DOCR, is to ensure productive efficiency. Baumol and Sidak (1994) first discussed this issue and it was reiterated in Baumol et al (1997). Furthermore, it enables
contestable outcomes in the final goods market, but only amongst the entrants as the incumbent is able to retain positive profits².

Given that the network is treated as a "shared sunk cost", where entrants have equal access and any network capacity pre-commitment by the vertically integrated incumbent is not binding, access prices determined by LRMC regime are consistent with an efficient way of achieving perfectly contestable markets for the entire final goods market. The question is whether access price regime based on LRMC methodology is consistent with the Ramsey Rule? In Chapter 6, the possibility of attaining perfectly contestable outcomes and, consequently Ramsey-optimal prices, in the final market outcomes using LRMC determined access prices is discussed. The Ramsey Rule and Global Price Cap methodology, on the other hand, treat input prices and final prices equally. Discussions in chapter 3, raise the issue regarding networks being as a sunk cost with a multi-period dimension. Consequently, a LRMC methodology taking into account this multi-period dimension, as done by Ofgas when determining formal "third-party carriage", may be more appropriate³.

A contrary objective, that violates contestable and Ramsey-optimal prices, is to allow the incumbent to be able to maintain Universal Service Obligations and the cross-subsidisation that this implies. This could also be transitory. Pro-competitive policies are usually introduced in stages. Firstly, in the profitable sectors, in the case

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¹ Vickers (1995) suggests that this is a particularly important issue in vertically integrated industries.
² DOCR model which incorporates the "displacement ratio" means that the incumbent could receive less than the full profits it earns in the final goods market. However, it still enables it to maintain positive profits for its participation in the final goods market.
³ Access charges based on Global Price Cap may be higher than that determined by LRMC methodology. The issue, however, is the appropriateness of it as a methodology.
of the gas industry this is the contract gas market, and subsequently in the less profitable sector such as the domestic sector.

As seen in Chapter 3, Ofgas was concerned with the erosion of cross-subsidisation when competition is introduced. This is a possible explanation of why BG was allowed to practise inter-temporal price discrimination while Ofgas tried to eliminate first degree price discrimination and maintained that the contract gas market had a "low swing factor" (Ofgas (1987)). Quite clearly Baumol and Sidak (1994), Baumol et al (1997) and Armstrong et al (1996), accepted the incumbent's final goods price, which was set with the approval of the regulator, incorporating its wider objectives. The Privy Council judgement of 1994 strongly concurred with this position. It may be appropriate at this stage to point out that when Baumol et al (1997) put forward a case for public pricing policy, as an additional regulatory measure to complement access prices determined by DOCR, they suggested that the incumbent's final goods price corresponds to "stand alone cost". 4.

4. Efficiency of ECPR and DOCR:

Economides and White (1995 and 1998) and Economides (1997) vociferously argued that access price based on direct plus opportunity cost produces inefficient outcomes in competitive markets. They suggest that increased competition, allowing entrants that are less efficient than the incumbent to enter, could attain positive net welfare gains.

4 Baumol et al (1997) suggest that the incumbent's prices should be "high enough that if entry cost were zero it would still be profitable for entry by an efficient rival producer". The question is does this imply that the DOCR and ECPR access price regime collapses to AIC or LRMC, and final market outcomes are consistent with perfectly contestable markets? More importantly, judging from Vickers (1997) and
In Chapter 6 it was argued that, when access charges are determined by DOCR, net consumer surplus gains may be less important. Nevertheless, net producer surplus gains may still be an important consideration, particularly as ECPR or the Margin-Rule version of DOCR aims to achieve productive efficiency. Higher access charges also make an industry more concentrated. Nevertheless, positive producer surplus gains are only achieved when the entrants’ “relative productive efficiency” is higher than the amount of the access charge that is greater than direct cost of provision. This again depends on the elasticity of demand. The more elastic it is, the higher the entrants’ relative productive efficiency needs to be. This implies that in the case of ECPR or Margin Rule version of DOCR, the entrant’s relative productive efficiency needs to be higher than the incumbent’s profit rate in the final goods market, and this varies with the level of demand elasticities.

4. “Shared Sunk Cost” and Non-optimal Use of Network:

In a vertically integrated industry, the network can be viewed as a “shared sunk cost”. Even though the incumbent owns the network, it is obliged to give competing entrants access, and consequently pre-committed capacity levels are not binding. Nevertheless, the incumbent could manipulate post-entry outcomes using its pre-entry advantage which affects post-entry outcomes. It could endeavour to keep its marginal cost down.

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Baumol et al (1997), are theoretical models moving towards an access pricing regime consistent with direct cost of provision, such as LRMC method? A position pursued by policy-makers like Ofgas.
SPECIAL NOTE

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CHAPTER 7: CONCLUSION

FUTURE DIRECTIONS AND WORK


Ofgas is actively engaged in pursuing pro-competitive policies in the contract gas market and, subsequently, the tariff and domestic market. Ofgas, as highlighted in Chapter 3, believes that what would evolve in these sectors are competitive markets with competitive outcomes. Ofgas focused initially on the final goods market when introducing competition in the contract gas market, subsequently they focused on network access regulation. The dictum expressed by Newbery (1997) that liberalisation induces efficient outcomes and improvements and that regulation is essentially inefficient, is not new, and has widespread support amongst regulators and regulatory theorists alike.

The easing out, or withdrawal, of the regulator’s role may, however, be premature. Possibly the direction and focus of regulation needs to be reconsidered. There is no disagreement that the regulator plays an important role in determining and implementing the appropriate access price regime. Regardless, regulation in the final goods market is still important. Naturally, the regulator plays a pivotal role in the transitory phase of introducing competition. The issue is whether there is a case for a sustained final goods regulation beyond the transitory.

Regulators when pursuing pro-competitive policies in deregulated sectors, focus on achieving allocative and productive efficiency in the final goods market.
In addition, any access price regime which is higher than direct cost of provision may exacerbate the situation. It affects the entrant’s marginal cost and, consequently, its reaction function. It was also argued that the Averch-Johnson effect works in tandem with the pre-capacity commitment model. It enables the incumbent to charge higher access charges. Indeed, any access charge higher than the direct cost of provision keeps the incumbent’s network relative cost down, particularly as there is likely to be excess capacity, which gives it greater incentive to pre-commit higher levels of sunk cost capacity,

It was also highlighted that excess capacity is an important byproduct of this form of strategic game. This implies that sub-utilisation of natural monopoly network and/or the encouraging of non-optimal bypass. This was clearly an issue with BG Transco, prompting Ofgas to take severe actions to curb any under utilisation of resources. Basically, in a vertically integrated industry or a “shared sunk cost” situation, it is the responsibility of the regulator to ensure that the network is not under utilised or sub-optimally used when strategic behaviour is invoked. Furthermore, access charge regimes higher than the direct cost of provision, could provide the incentive for such behaviour.
Discussions in Economides and White (1995) suggest that both these objectives may not be compatible. The "excess entry" literature suggests that an increased number of firms may not be efficient (see Mankiw and Whinston (1986) and Suzumura and Kiyono (1987)).

Chapter 5 suggested that the contract gas market evolved as a monopolistic competition with high concentration ratios. The strategic behaviour, modelled and estimated, gave insights into the games played in deregulated sectors. The present subsection puts forward an argument for retaining regulation in the final goods market to achieve more efficient outcomes. However, the focus could be on the market structure, or industry concentration, rather than the final goods prices. Chapters 3 and 4 show that in the contract gas market, given the various strategic advantages and the nature of the industry, an oligopolistic market with relatively high levels of concentration emerges as a result of pro-competitive policies. The situation may not be very different in other sectors of the gas market or, indeed, other industries.

The analysis in Chapter 5 suggests that modelling and analysing strategic behaviour is never straightforward. Varying theoretical models do not necessarily suggest consistent outcomes. Indeed, there is no reason to suggest that all oligopoly industries behave consistently. What is crucial, however, is the role of information and uncertainty, even in the original Stigler (1964) explanations. Given the impact of uncertainty and the incentive to behave competitively, that is to behave negatively or "countercyclically" to industry demand, there would appear to be a trade-off; trying to create conditions that give incentives to firms to behave competitively, while not having a highly concentrated industry.
This is clearly illustrated by the simulated average prices in Figure 5.1 in Chapter 5. It indicates that average industrial prices are the lowest when industry concentration is held at the "critical concentration ratio" level. In such a situation, the critical concentration ratio may be deemed an "optimal market structure". Regulating around this target provides the benefits of "competitive" behaviour and low average industry prices.

The impact on net welfare gains is examined here. When regulators operate a restricted pro-competitive policy and regulate at "optimal market structure" as opposed to pursuing an unrestricted pro-competitive policy, where the industry concentration level evolves unhindered;

$$\Delta W = \Delta CS + \Delta PS$$

where $W$, $CS$ and $PS$ denotes total welfare, consumer surplus and producer surplus respectively. Given a downward sloping demand curve, net consumer surplus is as follows, $\Delta CS$ ;

$$\frac{1}{2} (\Delta Q)(\Delta P) = \left[ \frac{1}{2} (Q_R - Q_{UR})(P_{UR} - P_R) \right] > 0 \quad (7.1)$$

where $P_R$ and $P_{UR}$ represent the respective prices as a result of restricted and unrestricted pro-competitive policies being implemented. While $Q_R$ and $Q_{UR}$ represent the corresponding. Positive net consumer surplus can be attained by implementing a restricted pro-competitive policy. Furthermore, greater allocative efficiency is also achieved.
Net producers’ surplus are derived as follows, $\Delta PS$:

$$\Delta \pi = \Delta TR - \Delta TC - \text{productive inefficiency}_R$$ (7.2)

where $\text{productive inefficiency}_R$ denotes the relative production efficiency as a result of regulators practising restricted pro-competitive policy. As discussed in Chapter 6, this lies between $-\infty$ and $+\infty$ and increases with greater numbers, or lower concentration levels, as a result of ease of entry, and as average productive efficiency decreases. As before, net producers’ surplus gains are dependent on the industry demand elasticity and “relative productive inefficiency”, as defined in the previous chapter, gains:

$$\Delta PS = f(\eta, \tau)$$ (7.4’)

where $f_\eta > 0$ and $f_\tau < 0$. Whether net producers’ surplus gains results from restricted pro-competitive policy is attainable is less certain. For the same reasons, total welfare gains are also less certain. Nevertheless, from the discussions in Chapter 2, regulators may wish to allocate a higher weight to positive consumer surplus gains. Pursuing a restrictive pro-competitive policy may still be optimal regardless of overall welfare gains. The regulator balances between setting CR at a sufficiently high level to create conditions for competitive behaviour and not letting it grow too high so that it will engage in collusive practises and price raises. This issue needs further research and investigation.

2. Access Price Regulation:

Chapter 6 argues a case for LRMC as a yardstick for network access prices, as opposed to “Direct-Plus-Opportunity Cost”. A regulator pursuing restrictive pro-
competitive policies, as suggested in the previous section, could still use LRMC as the access price benchmark.

As seen in Chapter 6, access price can affect the competitive process and is an important policy instrument for final market outcomes. One possible method is to use a dynamic feedback system, with LRMC as the benchmark. Though this is fairly onerous on the regulator, and can be informationally demanding, it could not be any more than that required by DOCR or Global Price Cap. Some of the relevant issues are discussed in Easaw and Gu (1998) and require further research.

3. Regulating Information and Search Cost:

Much of the above discussion relates to informational problems and costs. It is anticipated that by creating a particular market structure, informational gaps and costs are minimised, establishing conditions for competitive outcomes. It has also been noticed that enabling more co-ordination, more collusive outcomes are also possible.

A related issue is search cost. Search costs arise from informational gaps. The experience of the contract gas industry gives interesting insights into how competition may evolve in other markets such as the tariff market and, in particular, the domestic market. Most, if not all, the main competitors in the contract gas market have entered or intend to enter the liberalised domestic markets.

Contractual agreements may be prevalent. It may not be worth the while of competing firms to supply consumers unless they could engage consumers for a period of time. The terms and conditions may vary from that of the contract market.
Nevertheless, consumers in the domestic market, like their counterparts in the contract gas market, have to engage in some market search which incurs costs and market inefficiencies. Policy-makers and regulators must create conditions that facilitate competitive outcomes. They must find a balance between the inefficiency of final goods market regulation and the inefficiency of incurring undue search cost.
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