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
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International Electricity Prices and Regulation

by

Carl Peter Wilkes

A Master's Thesis

Submitted in partial fulfilment of the requirements
for the award of


Master of Philosophy in Economics

of the

Loughborough University of Technology

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Abstract

International Electricity Pricing and Regulation

This thesis is a study of the international electricity industry and in particular its pricing and regulation. As an industry, electricity is characterised by its monopolistic tendencies and prominent government involvement.

Chapter 1 discusses the economic regulation of firms with particular reference to utilities. In the first instance there is a brief discussion of the history of regulation with its beginnings rooted in the Victorian era. The Chapter covers the different forms of regulation up to the present day and also discusses the possibility of the introduction of competition in former monopolistic markets. The regulatory problems of asymmetric information, political interference, regulatory capture and possible future regulatory reform in the UK are also covered here.

In the final Chapter (2) there is an econometric analysis of international electricity prices which provides an explanation of the variance in electricity prices between countries. The model built for this exercise utilises price data from eleven countries for various customer types along with other quantitative data for these countries over a four year period. The 'model' concludes that national regulation effects overcame the international effects on electricity prices and that the price of oil had no significant effect on the price differences experienced between the countries compared in the model.

Carl Wilkes

December 1998

Preface

In Chapter 1 of this thesis, price control is divided between that exercised directly by ministers (where an industry is owned by the state) or through an agreed pricing mechanism (economic regulation) which could include any aspect of the pricing mechanism's offered by economists since the days of the Victorian railways. However, price control is operated in all cases one way or another because of the natural monopoly that most electricity companies normally enjoy, particularly in their distributive capacity. Chapter 1 looks at the development of regulation and the choices open to regulators. It also deals with the other important economic aspects regarding regulation.

In Chapter 2 the effect of regulation on prices charged for electricity is examined in an international context. An econometric model is developed in order to analyse international electricity prices in relation to regulation and the other cost/price determinants. This model provides an explanation of the variance in electricity prices between various countries.

Chapter One

Economic Regulation

Chapter 1

Introduction

This Chapter delves in detail into the subject of economic regulation. To begin, this Chapter examines the history of economic regulation before looking at the economic fundamentals that face a would be architect of a regulatory regime.

This Chapter then goes on to look at the privatisation process in the UK since the early 1980's before moving on to discuss the possible economic arguments surrounding the introduction of competition as opposed to continuing to regulate a protected market. The different forms of competition that can be introduced are examined before this Chapter goes on to explain the different types of regulation that can be used should full competition prove impossible.

Finally, this Chapter considers some of the problems confronting regulators at the present moment, such as informational constraints, political interference and the case for regulatory reform in the United Kingdom.

History of Regulation

It is often overlooked in the present day period of privatisation that Britain, before nationalisation, had more than 100 years of economic regulation of natural monopoly. This 100 year period can be divided into two distinct time periods - the first being the period distinguished by Parliamentary regulation accompanied by increasing interference by the courts and the second in which the Regulatory Commission became the main instrument (post 1870s).

The Original Regulator

Towards the end of the 1870s railway regulation by Government was becoming increasingly legalistic and Parliament started to realise at this stage that somebody was needed to oversee the industry with a more permanent interest in railways than itself or the courts had. This realisation of its (the governments) shortcomings in controlling natural monopoly spawned the era of the regulatory commissions. One of the first targets for their control was the railways who were the biggest and most important commercial organisations of their day. As W.A. Robson (1960) in 'Nationalised Industry and Public Ownership' (1st edn. Allen and Unwin) writes;

"The Regulatory commission emerged in mid nineteenth century Britain as an instrument for regulating the railways in the public interest. It was Victorian capitalist democracy's notion of how to reconcile the public interest in a monopolist service of primary importance with the profit making incentive of joint stock enterprise. The idea quickly spread to the United States."

However, the regulation of railways and other natural monopolies was allowed to develop in a random ad-hoc manner either leading to huge unjustifiable profits or alternatively poor development of services because of lack of resources for investment (because of inaccurate calculations by regulators on the profitability of companies). Indeed, the financial stringency was so tight, that in many cases, companies were technically non viable and this inevitably led to poor, unreliable, low quality and unsafe services being offered to the public.

Because the failings of these commissions was so considerable, it is very possible that the forms of regulation adopted in Britain in the nineteenth century and first half of the twentieth century had consequences on economic efficiency which amounted to a substantial adverse effect on economic growth.

The collapse of this regulatory regime therefore paved the way for society's next attempt at regulation; this being regulation of industry through nationalisation as Foster (1992) states "thus did nationalisation follow the collapse of one kind of regulation and another kind of regulation the collapse of nationalisation."

Government Intervention in the Utility Industries in the 20th Century

The reasons for government intervention in electricity (as well as other energy industries) are varied, overlapping and take a number of forms; the IEA (1992) gives the following reasons. These are;

- a. Interventions arising from sectoral policies other than energy policy, for example, environmental, fiscal and transport policy have a significant impact on the energy sector;
- b. Interventions which arise from the fact that the production and use of electricity (energy) have special characteristics - in particular in some circumstances they are perceived as more dangerous than most other economic activities (e.g. nuclear generation) and are therefore subjected to special safety regulation;
- c. Interventions which may affect the economy as a whole - e.g. commercial law or general taxation;
- d. Interventions for reasons of energy policy, particularly the need to maintain energy security.
- e. Interventions specific to the energy sector but arising for other policy requirements, for example the bans on trade in energy which have been enforced against countries which have repressive regimes or are failing to comply with international law.
- f. The link between electricity production and foreign and defence policy i.e. the nuclear generation programme in most countries has military significance.

- g. To ensure indigenous resources are used where available and to control factors such as environmental effects of electricity production.
- h. The importance of social and regional impact of developments in the electricity industry.
- i. The need for secure and competitively priced electricity in order to promote an efficient and effective economy (including antitrust policy).

Government involvement will of course be affected by the type of ownership pertaining to the utility industries in each individual country. Government involvement in the 1990's can be classified according to the IEA in three general ways relating to ownership. These are;

1. Countries where the electricity industry are mainly in the private sector and subject to specific regulatory controls i.e. Germany, the United Kingdom and the United States.
2. An Electricity industry characterised by either joint ownership by the public and private sectors or arrangements for joint decision making which enable the government to direct general strategies or a combination of the two i.e. Australia, Belgium, Canada, Denmark, Japan, Netherlands and Sweden.
3. Countries where the electricity industry is dominated by major state owned industries i.e. France, Ireland, Italy, Portugal and Spain.

State intervention in the utilities industries is an international characteristic which is set to stay into the foreseeable future. Governments will be responsible for the type of regulations applied to their utility industries.

Nationalisation

Although the concept of nationalisation is widely believed to be a Socialist policy it is a matter of fact that during the inter war period many Liberals and Conservatives aligned themselves with the policy. The main objectives of public ownership in this era were social (due to the effects of recession) but the electorate at the time were also interested in the economic issues. For instance, it was agreed that in return for monopoly power no one should be refused service (therefore the obligation to provide universal service was part of the legal requirements of the new nationalised industries). This had considerable relevance at the time as for example a quarter of the population had no electricity in 1936 and the Chairman of the Central Electricity Board made reference to this situation ".. the very fact that yesterday something which was regarded as a marvel of science is today looked upon as a common place and indispensable service, throws upon us the responsibility not only of developing it to the fullest degree, but of developing it also at such a reasonable cost that the fullest possible use can be made of it" (Sir Archibald Page, CEB Chairman, Proceedings of the National Electrical Convention, 1935, p.20). A comprehensive account of this

period can be found in Hannah (1979) "Electricity before Nationalisation". The main economic reasoning was related to economies of scale and rationalisation. Indeed, it is generally agreed that in the electricity industry economies of scale were substantial and realised; however, for the railways, although economies of scale existed, these were never realised in any significant way. Because of the existing regulatory and legislative requirements, nationalisation seemed the only way to bring about the necessary reorganisation required in industries to achieve the required economies of scale; this being an objective which could not be achieved by existing private firms (e.g. Foster (1992) notes that before privatisation there were 369 municipal and 200 private electricity undertakings and 300 generating power stations operated by 130 separate generating authorities).

The main economies of scale to be found in electricity through nationalisation were the economic and technical advantages that effective co-ordination could bring and this co-ordination had eluded the Electricity Commissioners before nationalisation because they had not attempted to create an integrated market in electricity. As Foster (1992) states "because different areas had different peaks and troughs in demand for electricity, there were still substantial gains to be made by connecting generators and distributors by a grid network. Public ownership seemed the only way of managing such a system - the computers and computer based mathematics did not exist which would have made it possible for there to be a truly commercial electricity market buying and selling through the grid".

The beginning of the end for nationalised industries started with the theoretical attack of neo-classical economists in America on their regulated monopolies (ironically most of which were and still are privately owned). Their theories on the performance of monopolies began to receive acceptance in Britain especially with the Conservative Party (see Foster 1992).

Foster notes that this theoretical attack centred around the concept that the managers of monopoly firms would not always act in the public interest because of the interference of politicians (as well as civil servants) in these undertakings. Therefore, the setting of meaningful objectives and measures of performance was almost impossible and therefore, consequently, it was difficult to ensure any level of efficiency in these organisations. Indeed, at about the same time there was also plenty of evidence from researchers that publicly owned utilities were not as efficient as they could be (see for instance Pryke 1971, 1981 and 1987). Although it could be argued that this research on comparative efficiency was flawed, as it was not comparing like with like, (i.e. public undertakings with private companies whose objectives were in many cases different) the work of Kay (1987) and Bishop and Kay (1988) as well as Ashworth and Forsyth (1984) throws some light on this area. Overall, because of the lack of incentives to manage effectively, combined with poor ministerial judgement regarding nationalised companies, (which destroyed any attempt to improve performance with the aim of improving economic efficiency, both within the context of the efficient operation of these industries and in relation to their outputs feeding into other industries) even modest levels of efficiency were never achieved. This failure of the "nationalised" regulatory regime was in line with the failure of the regulatory regime that had gone before it (this being through Parliament and

Commission) in the sense that both failed to deliver meaningful and continual gains in economic efficiency and both were blamed for contributing to Britain's economic decline.

The main political motivation for the Conservative Party to adopt the markedly more right wing policies in the mid to late 1970's was probably due to the Conservatives industrial relations fiasco due to the public sector mineworkers (and their union the National Union of Mineworkers) in 1974. Before this period the Conservatives policies and objectives were in some respects indistinguishable from those of Labour. Swann 1988 comments "It could indeed be argued that the Heath government was not merely back on the consensus path, but had strayed into the kind of interventionist territory which was more likely to be occupied by the Labour Party". After the 1974 General Election defeat, one of the major economic influences on the Conservative Party was the Austrian school of Economics (the leading proponent of this school being the philosopher and economist Friedrich von Hayek), see D., Swann 1988 "The Retreat of the State" Ch.7. Another significant influence was that of the American economist Milton Friedman.

Underlying Theories of Regulation - Three Issues of Contention

These can be considered to be;

1. Public Choice and Public Interest Theories
2. Property Rights
3. Regulatory Distortions

We will consider each in turn;

1. Public Choice and Public Interest Theories

The thinking behind public choice relates mainly to Public Choice Theory and this is based on the idea of rent seeking behaviour first suggested by Tullock (1967) where rent is the abnormal or monopoly profit associated with setting price above average cost and marginal cost. Politicians often grant favours to companies in the form of economic regulations. The motives for this action are mezzanine, however, it may be that the firms concerned have used a great deal of effort in their attempt to make a case for regulation and these exertions may be sufficient to put forward a strong logical argument for the introduction of economic regulations such as limiting entry to the incumbents industry. Although this rent seeking behaviour by the incumbent may be enough on its own to ensure regulation occurs, there are very often other incentives for politicians to act in way which is not to the nation's economic benefit. These incentives may range from the securing of significant electoral support from the pressure groups concerned, the reinforcement of political ideals and perhaps the delivering of manifesto content and the expansion of their own departments duties

(therefore its size and budget), thus appearing to be seen to be doing something about a problem that the firm originally brought to the public's attention as part of their rent seeking action. These incumbents, being organised, have an advantage over disorganised groups such as consumers (see Moe 1980 and Noll 1983 for evidence of this). The most extreme form of this advantage is where only one interest is effectively organised and this usually results in Stigler's simple "capture" where the one organised group will tend to be a monopoly or cartel (Stigler 1971). This monopoly or cartel will adopt efficient monopoly pricing (e.g. perfect discrimination, optimal two part tariffs and Ramsey rules) only if regulatory conditions force them to do so.

The foregoing, therefore, suggests that the incumbents will waste resources in order to push there case for regulation, as regulation will, in most cases, be of benefit to them. However, once the incumbent has spent these resources they are lost to the economy because (according to Weyman Jones, T. 1994) the "prospective monopoly rents including the present value of the future rents will have been dissipated in the attempt to capture them. The dead-weight welfare loss to the economy is then the sum $H + T$ due to both price inefficiency and wasteful rent seeking behaviour, where":

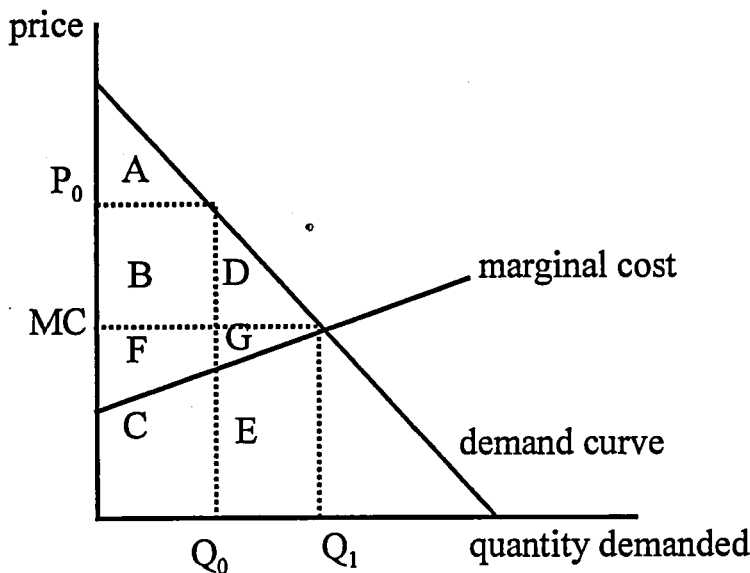
$$T = [\Delta p]q; \quad H = [\Delta p \Delta q]/2$$

"where T is the resource transfer which is equal to the price change multiplied by the new lower quantity sold",

"where H is the dead-weight welfare loss which is equal to half the product of the price change and the quantity change".

Buchanan-Tullock and Harberger costs of resource allocation distortion can be described as follows (according to Weyman Jones, T. 1998).

(These measures are illustrated in the following diagram.)



"The measures are interpreted as follows. Suppose that the firm is pricing at P_0 and selling Q_0 . This is not Pareto optimal i.e. not an efficient allocation of resources. The efficient allocation is that given by marginal cost pricing, $P = MC$ and Q_1 ."

"At P_0 ,

Consumer surplus = A

Producer surplus = B+F

Total cost = C"

"At $P = MC$,

Consumer surplus = A+B+D

Producer surplus = F+G (would be = 0 if MC curve was horizontal).

Total cost = C+E"

$\Delta W = \Delta \text{Consumer surplus} + \Delta(\text{total revenue} - \text{total cost})$

"Harberger cost is the dead-weight welfare loss ΔW , from non-marginal cost pricing.

$$\begin{aligned} \Delta W &= [A+B+D - A] && \dots\dots\dots \text{consumer surplus change} \\ &+ [(F+G+C+E)-(B+F+C)] && \dots\dots\dots \text{total revenue change} \\ &- (C+E-C) && \dots\dots\dots \text{total cost change} \\ &= D+G = \frac{1}{2} (P-MC)\Delta Q \\ &= \frac{1}{2} \Delta P \Delta Q \text{ where } \Delta P \text{ is the difference between price and marginal cost needed} \\ &\text{to establish efficiency in the allocation of resources"} \end{aligned}$$

"Now suppose we ask how the monopoly arose in the first place. The industry was pricing above marginal cost, and the monopolist earned B+F in profits. It could be argued that it would pay a firm to invest up to B+F in securing a monopoly position. Suppose it has done this. These resources have been spent in order to earn future profits of B+F. The sum B+F is the Tullock cost of monopoly. It is the amount (e.g. bribe or corrupt payment) spent in securing or maintaining the monopoly if this is the way that the monopoly position actually did arise. If the monopoly is removed, then these costs are not recovered, even though the Harberger cost is recovered."

"If this monopoly arose without prior investment, then only the Harberger costs are counted, but if the monopolist had to buy the franchise or otherwise incur costs of establishing the position, then the Tullock cost is counted as well. The Tullock cost is $B+F = \text{approximately } Q_0 \Delta P$." (G. Tullock 1967: 'The welfare costs of tariffs, monopoly and theft' Western Economic Journal, 5, June, pp 224-32).

"T + H are sometimes referred to as the Tullock and Harberger costs of monopoly after the economist associated with their analysis. The immediate policy implication is that the monopoly conferred by entry limiting regulation is a much more costly result than traditional economics recognises"

Public Choice theory also suggests that once regulations are established they will be almost impossible to remove and there will be a lack of interest in deregulation (see McCormick, Shughart and Tollison 1984). This disinterest arises because Tullock costs, once spent are sunk although the Harberger costs can be recovered if a

monopoly is deregulated. Therefore, pressure groups opposed to rent seeking producers will have little to gain from removing old regulations and will concentrate instead on stopping new regulations. As a result of this, it is likely that old regulations will still operate long after they produced the rents that were the original objectives of introducing regulation. This conclusion can only be changed when the regulated firms have to spend to maintain their regulatory privileges and it follows that deregulation is most likely in those industries where the incumbent finds it most expensive to maintain these old regulations.

All of this dissatisfaction with nationalised industries in general was a major factor in the undermining of the prevalent political conventions and the Keynesian economic philosophy which had dominated UK thinking since the 1930's. This disappointment with the performance of nationalised industries opened the gates to an alternative economic ideology i.e. that of monetarism as propounded by the Austrian School of Economists.

This alternative economic policy preferred the deregulation of nationalised monopolies by removing these state industries away from government ownership and control through the process of privatisation (although a new system of regulation was also installed at the same time).

In the USA, the Government was also in the process of deregulating monopoly, although in this case the emphasis was more on introducing competition rather than replacing an existing regulatory regime with another form of it.

Public Interest Theories assume that governments seek to maximise economic wealth. Vickers and Yarrow (1988) state "the usual approach is to assume that the objectives of government departments are defined by some form of social welfare function it is assumed that government departments seek to maximise a partial equilibrium measure of economic efficiency.... in reality, there are two public interest reasons why governments might want to attach differential weights to consumers' and producers' surpluses in their objectives...the first of these is distributional objectives" e.g. does the government want to favour one part of society more than another - Shareholders, Taxpayers, Customers etc. "The second reason why a government would not be indifferent to transfer payments to the firm is the cost of raising public funds" i.e. which makes giving subsidies economically inefficient and leads to distortions in economic decision making in other parts of the economy. "Given a welfare maximising government and assuming that the monitoring of management is equally effective under both types of ownership, that public ownership has advantages over the private alternative it provides government with the policy instruments to correct any deviations between social and private returns that arise from failures in goods and factor markets. The market failure argument can also be applied to the market for corporate control: government monitoring does not encounter the public good problems associated with dispersed shareholdings and avoids the transaction costs of share purchases".

The public interest theories of regulation take it as given that the purpose of regulation is the enhancement of economic welfare through improved efficiency in resource

allocation and that the appointed legal agencies pursue their economic maximisation objectives. However, there is another second alternative strand of thought which challenges these assumptions. This alternative philosophy is called the economic theory of regulation which is concerned with the determinants of supply and demand for regulatory activities. The main economic thinkers behind this theory were Stigler, Posner and Peltzman. The theory has looked closely at the income distribution consequences of regulatory processes and the incentives faced by the regulators themselves. The theories are intended to be non normative and seek to explain how particular forms of regulation emerge and change by assessing the gains and losses caused by alternative arrangements for the various stakeholders involved i.e. consumers, producers, suppliers and trade unions.

As Vickers and Yarrow (1988) point out "there is particular reason to be concerned about the potential influence of producer groups on regulations dealing with new entry into the industry. The effects on consumers of entry restrictions are less visible than the effects of price fixing and there is a public interest argument in favour of control of entry that could be used in self serving ways by producer groups. Simply stated, it is that natural monopoly implies that efficiency is improved by having the goods or services in question supplied by a single firm, and that entry prohibition is necessary to guarantee this outcome. A theoretical perspective on the possibility of collusion between regulator and the firm is provided by work on hierarchies i.e. principal - agent relationships consisting of several levels" (e.g. see Caillaud, B., R. Guesnerie, P. Rey and J. Tirole 1985).

If the members of the regulatory agency have interests that do not coincide with the public interest we could for example say that the government might wish to limit the amount of control that the regulator has over the firm. Whether this is in the public interest is another matter and the control voters exert over politicians and to what extent voters get what they want is examined later. For instance, it can be argued that the long term development of many nationalised industries in Britain did suffer from governmental interventions.

2. Property Rights

It is not unusual at the time of privatisation for there to be a debate about property rights. These usually centre around who actually owns the assets of the state owned firm. If the State decides to sell its stake in the company to private shareholders or to the company's existing managers and employees, the State is giving up the continual income that would have been generated in future years for a sum payable in the present. However, it should be remembered that the market price of an asset is simply based on the present value of the income stream to which it gives the owner. Therefore, so long as the asset is sold at its fair market price no-one should be worse off. However, there is evidence to suggest that the electricity utilities were sold at below their market price and this underlies the assertion that shareholders enjoyed a financial gain at the expense of taxpayers who did not invest in privatisation issues.

There is also the worry that the distribution of property rights at the time of privatisation will lead to the extinction of the firm in the future as the main claimants

on property rights are the firms shareholders, managers, employees, customers and creditors. Shareholders can come to expect very generous returns on their investments, especially in the early years after privatisation, when competition has not yet been fully established; similarly, remuneration packages for managers and workers can also have this effect, as can customer expectations of the levels of service that can be provided for the price they are paying partly due to increased media attention on the industry.

3. Regulatory Distortions

The main regulatory distortion here is the one identified where rate of return regulation is used (i.e. the work undertaken by Averch and Johnson). The crux of this work is embodied in what is commonly called the A-J effect (see Kahn (1971)). The A-J model examines a monopoly firm that produces output using the usual production methods which utilise two resources i.e. capital and labour. The firm is assumed to seek to maximise an objective, usually profits. A regulator imposes constraints on the firm's behaviour. It is usually assumed that the firm is constrained to earn some "fair" rate of return on its capital stock that is greater than its cost of capital, but less than the super normal levels that a monopoly could enjoy. The objective of the regulator is to keep the actual rates of return no higher than the allowed rate of return and the main result here is that the regulated firm will operate at greater than minimum cost. In particular, the regulated firm exhibits a pattern of capital labour ratios that is higher than a cost minimising producer would use i.e. there will be evidence of over investing in equipment, as the allowed rate of return encourages this "gold plating" in order to increase the capital base for regulatory purposes i.e. determining the firms income.

Other kinds of regulation such as Price Cap may also produce their own kind of distortions. Under 'Price Cap Regulation' the temptation for the company is to under invest in items which the regulator may not be monitoring in order to cut costs and increase profit, as the effect of price cap is to cut controllable costs but not profits. An example of where this happened was in the case of British Telecom (BT) who gradually ran down their call box services after privatisation as their cost cutting became over zealous. As the regulator at the time of privatisation, OFTEL had not stipulated certain quality standards in terms of customer services, the firm (BT), was tempted to make easy cost cuts by providing poorer service to its customers. Subsequent regulation has ensured that these customer service standards have been built in to the performance yardstick measurements used by the regulator and indeed in subsequent privatisation's these quality measures have been part of the regulatory control regime from the outset.

Reasoning for Privatisation

Putting aside any analysis of the possible benefits of improved efficiency and lower prices, made possible by the private ownership of utilities, and the effect this may

have on the economy as a whole for one moment, we will consider some of the other economic arguments put forward as the reasons for privatisation.

Many analysts of the privatisation process have noted that the process was used with increasing enthusiasm because of the effect that this had on reducing nationalised industries cash requirements. Privatisation was the easiest way of cutting public expenditure in order to reduce the Public Sector Borrowing Requirement and control the money supply. The popular economic argument that privatisation may lead these industries to be more efficient was not the major driver of the reasoning here for privatisation, especially as these arguments had yet to be proved beyond all reasonable doubt (and would take time to prove). Thus it could be said that at the time, the strength of the pure economic arguments for privatisation, on their own, were not enough to persuade the government to action the privatisation process.

However, privatisation's ability to cut the PSBR was a very attractive motivating factor, especially to the Treasury. At the time the Conservative Government had up to then been thwarted in its attempts to cut public expenditure (because of rising social security costs due to unemployment). For instance from 1978/9 public expenditure rose from 40.5% of GDP to 43.5% in 1982/3.

This reasoning can be undermined by the fact that shifting profitable state owned firms into the public sector means there will be a temporary flow of funds into government coffers (i.e. from the privatisation sale) but these funds must be offset against the funds which would have come to the government as a result of these nationalised company's profitable operations. If the government sold the assets it held in nationalised industries at the correct market price, then no one would be worse off (e.g. taxpayers or the new shareholders) as the market price of an asset, as stated earlier, is simply the present value of the income stream which is received by the holder. However, there is evidence to suggest that most UK privatisation's have been under priced (i.e. witness the share price increases on flotation day). There may also be reason to believe that the government wanted to price these assets attractively in order to encourage wider share ownership, something they considered as an important policy objective which they were prepared to encourage (at the taxpayers expense). Another argument is whether the prospect of privatisation is the only way to improve management in nationalised industry and therefore whether this process has added to the valuation of the industry's worth.

A useful theoretical analysis of the factors that affect the public sector deficit are given by C.A.E. Goodhart ("Money, Information and Uncertainty" 1975, Macmillan Press, Ch.8 p.154). Goodhart uses the following to explain the public sector deficit:

$$PSD = OMO + NMD - MAT + ECF + \Delta H$$

Where

"PSD is the Public Sector Deficit after taking account of various financial transfers".

“OMO represents the outcome of the authorities' operations in marketable debt”.

“NMD is the outcome of transactions in non marketable debt”.

“MAT shows the required use of funds to pay off maturing debt”.

“ECF gives the total finance obtained from, or required for, accommodating external currency flows”.

“ ΔH represents the public sector's monetary liabilities, (high powered money).”

As Vickers and Yarrow (1988) have noted "the proceeds from the sale of state assets directly reduces the PSBR because they are treated as negative public expenditure. Unlike the sale of gilt's (i.e. Government Bonds) sales of shares in privatised companies (i.e. Government Equities) are deemed technically not to be borrowings, although in reality there is little difference between the two methods of Government finance. Privatisation therefore accorded well with the objective of reducing the PSBR so as to meet the targets the Government has set itself as part of its medium term financial strategy for anti inflationary monetary control".

There is also the worry that the flotation of large public utilities on the stock market can lead to fund deprivation for other private sector companies who wish to raise funds for often riskier but more important ventures in terms of national presence in these market sectors (i.e. investors will be tempted to switch funds away from risky ventures such as the new "cutting edge of technology" firms to the relatively safer pastures of the utilities). This does not mean that these firms will not be able to find financing on the market, only that as funds become scarcer because they are attracted to lower risk investments the remaining investment funds will demand relatively higher interest rates than they would have been if alternative investments in state enterprises had not been made available.

In a speech given in July 1981 by Sir Geoffrey Howe (then Chancellor of the Exchequer) the Governments feelings about nationalised industry were expressed vividly and critically. Foster 1992 states "he noted that private industry had responded to the recession by reducing its overall financial deficit whilst the nationalised industries had increased theirs, even though some of their prices had risen more than twice as much as the RPI. He blamed their immunity from market forces and effective government control”.

In addition, there were other pressing reasons why privatisation had become popular. One of the most significant reasons for the increasing popularity of privatisation in Britain was the increase in international trade between all countries. Some economists believe that Britain had allowed monopolies and cartels to develop within its business community to a greater extent than found in most other modern economies through such devices as barriers, quotas and transport costs (for instance

see Hannah, L. (1983) "The Rise of the Corporate Economy"). In Britain, exports have remained constant as a proportion of GDP throughout this century whilst imports, at the same time, increased to 25%. Those who produce traded goods in Britain, faced with increased overseas competition, became increasingly critical of state organisations, especially when these producers increased their costs when international trading conditions did not allow electricity consumers to pass on these costs to their customers. Privatisation and the introduction of competition was seen as a remedy for this situation.

An Alternative Political Explanation for Privatisation

There are many reasons why the privatisation process has been particularly successful for the Conservatives and this has led many observers to conclude that perhaps the denationalisation process had more to do with achieving political objectives than economic ones. For instance, privatisation has increased the number of people who own shares and there was evidence at the time indicating that share owning individuals were more likely to vote for the Conservative Party than any other political party, as were managers in the private sector compared to their public sector counterparts. Trade unionists are more likely to vote Labour and they are more numerous in the state industries. Civil servants are more likely to vote for Labour and the argument here therefore is that a reduction in the number of state firms will inexorably lead to a reduction in civil servants.

The aforementioned also has some synergy with the governments other policy objectives such as the reduction of trade union power and the extension of home ownership through the sale of council houses to their tenants.

Competition and Regulation

Most economists are in agreement that where competition can be introduced it should be, as it is a far more effective spur to efficiency and deterrent to customer exploitation than regulation. Open access to a market is the best regulator because it draws competitors into the market place to challenge incumbents and remove super level monopoly profits (as well as ensuring that competing firms are more responsive to their customers needs).

Foster (1992) notes that competition is also more likely to provide the best mechanism for revealing how much customers are really prepared to pay for a service (i.e. at different price versus quality thresholds). The pressure of competition ensures that firms almost always reveal more details about their true costs than can ever be realised even by the most sophisticated regulatory revelation mechanisms (see Vickers and Yarrow 1988). In addition, firms in the competitive environment have a greater incentive to keep their costs to a minimum, to constantly innovate and improve their products and methods of operation, otherwise rivals will gain a competitive advantage over them. Competition should also ensure that anti competitive practices do not

materialise. However, some would argue that in order to be effective, competition needs regulating.

Regulation on the other hand is riddled through with difficulties such as its ability to transport itself from economics to politics as well as being plain ineffective in some cases; suffering from its ability to be captured by the entities it is regulating to the more mundane explanations for ineffectiveness such as the possible incompetence of its staff and lack of necessary resources or its costs outweighing any benefits it may deliver. The success of the rent seeking activities of those regulated also need to be considered. R.G. Noll for example in his paper 'Economic Perspectives on the Politics of Regulation' 1989 comments on the effects rent seeking can have on the fairness of the regulatory process; ..."Regulation ...becomes a forum among them (i.e. organised interest groups) for creating and dividing rents....regulated businesses and their employees are likely participants in the formation and execution of regulatory policy and especially in decisions that directly and immediately affect them. All else equal, this implies an outcome that first creates monopoly rents, and then engages in rent sharing between management and labour of the benefits thereby attained. Although this is most easily detected in economic regulation where a disorganised group may face monopoly prices, similar outcomes can also arise in environmental, health and safety regulation in which standards can be written so as to reduce competition".

We will now consider the options policy makers have in respect of deciding upon whether competition or regulation will be the most effective and practicable (in terms of economic efficiency) for the control of companies and the reasons for these choices. The political reasons for perhaps not choosing the optimal arrangement will also be discussed.

Competition and Regulation - Why Both ?

Where natural monopoly does not exist and effective competition can be introduced, the need for economic regulation (in the sense of price control) is not great and indeed its costs will probably outweigh any benefits it could bring. It should also be remembered that regulation suffers from a number of failings and so the possibility that this might occur should also be borne in mind. Foster (1992) amongst others has noted that where natural monopoly does exist, regulation is necessary to prevent consumers from being exploited. The overall objectives of economic regulation therefore, are the promotion of competition and the control of monopoly and cartels thus leading to greater economic efficiency. Even when there is no natural monopoly, the regulator, in the interests of promoting competition and economic efficiency, may need intervene to stop cartels and other anti competitive practices. The regulator must also keep an eye open to prevent or mitigate practices like predation, trademark and patent abuse and unfair or unequal access by which dominant firms use their market power to penalise rival firms and this type of regulation is usually a government or high court duty which relates to all markets. This is the only type of economic regulation needed for those industries where competition is present or can be made to be present. However, arrangements of another kind are required where monitoring of

competition is difficult because of geographical differences (e.g. overhead or underground electricity networks, dictated by the land). When these circumstances arise, specialist regulators are required, as they will be better acquainted with the detail of the industry they oversee and therefore more able to ensure proper control than the general competition authorities could.

In the future, the need for specialist regulation may even spread to markets which are at present totally competitive. The globalisation of many companies combined with the fact that the constantly improving information and management systems that organisations have, enables the effective management of larger structures. Therefore, it could be argued that this might result in national economies losing international competitiveness in many industries, if they insist on more than one domestic firm providing for their home market. In order to allow one firm to supply the home market and therefore be a virtual monopoly where competition from overseas is weak, there needs to be a regulatory regime in place to ensure the dominant firm does not exploit its domestic customers or suppliers.

Choosing to Regulate or Introduce Competition

When deciding to regulate, policy makers first need to consider the other options available to them besides regulation for the reasons given earlier. However, as Vickers and Yarrow (1988) have pointed out, regulation and competition sometimes need to go hand in hand i.e. "an incumbent firm with market power usually has at its disposal a variety of instruments of strategic entry deterrence, and that incentives for predatory behaviour are likely to exist. Unless this sort of conduct (and threat of it) are checked by suitable policy measures, market "liberalisation" in the legal sense can be quite ineffective. It can be argued that the sanctions of ordinary competition policy are sufficient to strike down anti competitive behaviour of this kind but we disagree for several reasons. First, competition policy in the U.K. (and elsewhere) evolved at a time when dominant utility companies were in public ownership. The competition problems that may arise in these industries were therefore not envisaged when policy was made, and so there is little reason why it should be expected to cope with them. Secondly, it can be argued that U.K. competition policy has weaknesses generally (see for example Sharpe 1985). Certainly it has usually been less vigorous than U.S. antitrust policy. Thirdly, where the danger of particular anti competitive practices can be foreseen, it makes sense to legislate against them in advance, and to give the specialist regulatory agency the duty of monitoring and enforcing the policy. This also reduces uncertainty. Finally, the agency has greater knowledge and expertise regarding industry conditions than a generalist competition authority can have."

The most obvious option to regulation, besides of course the choice of no regulation, is the introduction of competition and this can be effected in a number of ways. This extension of competition raises a number of important issues relating to competition policy, for instance: (a) will the introduction of competition have a negative effect on the economies of scale of the industry (i.e. is it natural monopoly?) as introducing competition often means breaking up a monopoly; (b) the question of unnatural monopoly i.e. how to prevent it from occurring; (c) if it is economically efficient and

practically feasible to break up the monopoly, what kind of competition can be introduced? (d) if the monopoly cannot be broken up, is competition still possible? (e) should regulation be necessary - what kind of regulation should be utilised?

Natural Monopoly

Just because monopolies can be broken up into smaller units it does not follow that the resulting organisations will produce greater efficiency or that consumers will enjoy greater benefits (e.g. lower prices).

The basic definition of a natural monopoly (see Kahn 1971) is where a firm emerges as a single seller in a market because of cost or technological advantages contributing to lower average costs of production. Competition among firms in such an industry eventually results in one large firm supplying the entire market demand at lower cost than two or more smaller firms. A natural monopoly can produce the entire quantity demanded by buyers at any price at lower average cost than would be possible for each firm in the industry if more than one firm existed. There is no real doubt that some public utilities such as electricity distribution are "natural monopolies". The questions that then needs to be asked is what makes them natural monopolies and are they characterised by long run decreasing cost tendencies; or as Kahn (1971) puts it "an inherent tendency to decreasing unit costs over the entire extent of the market.....the principle source of this tendency is the necessity of making a large investment merely in order to be in a position to serve customers on demand....these tendencies are related to the fact that fixed or capacity costs bulk unusually large among total costs in most public utility industries. And it is these fixed costs that might be wastefully duplicated if two companies tried to serve the same markets.....*and even when unit costs are increasing*....monopoly is still present because one company can serve any given number of subscribers....at a lower cost than two".

Therefore, if natural monopoly is diagnosed it may be unwise to break up the monopoly in order to create competition as this will result in a less economically efficient outcome (in terms of higher costs to the industry, higher prices to customers and inefficient resource allocation for the economy as a whole) than retaining the monopoly would have been. The next question is whether to regulate the monopoly or not. However, should an unnatural monopoly be identified (i.e. where there is evidence to suggest that efficiency gains would result from one or more competitors entering the market place) the introduction of regulation may be a less attractive option compared to the various ways competition could be introduced. We will consider the various methods available to introduce competition later.

Unnatural monopolies can be identified by the fact that any increase in their size, brought about by organic growth, acquisition or merger, does not exhibit the declining unit costs which are the hallmarks of a natural monopoly.

Promoting Competition - Contestable Markets

The topic of deregulation has coincided with the theory of possible equilibrium outcomes in certain types of markets otherwise known as "perfectly contestable markets. E.E. Bailey in "Contestable Markets and the Theory of Industry Structure" Baumol, Panzar and Willig (1982) suggests that a "perfectly contestable market (PCM) is defined as one in which entry and exit are easy and costless, which may or may not be characterised by economies of scale or scope but which has no entry barriers. Potential entrants are assumed to face the same set of productive techniques and market demands as those available to incumbent firms and there are no legal restrictions on market entry or exit and no special costs must be borne by an entrant that do not fall on incumbents as well. Thus, potential entrants are undeterred by prospects of retaliatory price cuts by incumbents and instead are only discouraged when the existing market prices leave them no room for profitable entry".

"Consequently, a contestable market need not be populated by a great many firms; indeed, contestable markets may contain only a single monopoly enterprise or they may be comprised of duopolistic or oligopolistic firms. Willig (1979) proved that the absence of entry barriers can lead to the socially right amount of entry i.e. that for a feasible industry configuration to be sustainable it must minimise total industry cost for the production of the aggregate industry output".

The theory of perfectly contestable markets leads us to investigate the conditions under which markets will be perfectly contestable i.e. where second best welfare maximising prices are chosen voluntarily by the incumbent firm(s) (in order to deter new firms from entering the market place) and the socially "right" number of firms exist in each market. In particular three conditions have been identified by the above authors i.e. Bailey, Baumol, Panzar and Willig and these conditions are:

a. Free entry to the industry in the sense that potential entrants and the incumbents do not face different entry costs and there are no legal barriers to entry such as licenses or patent protection.

b. Costless exit from the industry - i.e. any firm in the market place can leave without additional costs to itself. Thus any fixed costs incurred should not be sunk or irreversible i.e. it can move the capital it has invested intact into another market or dispose of the assets in an efficient second hand market, which means that the amount paid for the assets does not exceed the economic depreciation on its capital.

A good example here is the difference in exit costs for potential entrants to electricity distribution as compared to operating a fleet of aircraft. As the costs to the economy and to the potential entrant of laying a new electricity distribution network to every potential customers home would be prohibitively high this market is unlikely to be very contestable. On the other hand, an entrant into the airline industry will find that the sunk costs here are much lower because the majority of the capital costs (i.e. the aircraft) are easily liquidated or transferable to another market i.e. aircraft can be moved to different locations cheaply in order to compete in other markets whereas distribution wiring, once installed, is difficult and costly to move.

c. The new entrant is able to offer supply, or sign a supply contract with the incumbent's customers before the incumbent can change its current price structure. The threat of this possible invasion into the incumbents market place should, according to PCM theory, be enough to make the incumbent price at average cost permanently rather than only temporarily.

Therefore, if conditions for contestability are satisfied, PCM theory suggests that regulation has nothing to offer even if the industry is a natural monopoly or naturally uncompetitive. Summarising the views expressed in Baumol (1984) and Elizabeth Bailey's OECD report (OECD 1985) we get the following conclusions:

- a. Contestable market theory should be used as a broad framework to analyse the consequences of deregulation.
- b. Governments should strive to promote policies that promote contests for markets.
- c. Impediments to entry and exit may be the primary source of interference with market efficiency (in the sense of promoting cost minimising structures).
- d. Regulatory policies tend to support cross subsidisation, encourage a high price and high service product, draw artificial boundaries that interfere with the scope of a firm's operations and fail to provide for firms to act efficiently.
- e. If the industries display the properties of contestability, deregulation should lead to a dramatic lessening of cross subsidies and the creation of a larger selection of products at different prices while providing enormous pressure to improve productivity.

Natural Monopoly - Should it be Regulated ?

One argument often made in the light of past regulatory failures and the evidence relating to the cost of regulating monopoly profit is that it might be more efficient to allow a monopoly to set its own prices if that avoided the costs involved in regulating monopoly profits. The cost of regulation is not insignificant, particularly in the USA, where the nature of their regulatory process has made regulation very costly. There is a possibility that regulation costs may rise in Britain if disputes get out of hand and the system declines into constant court actions. There is a substantial economic argument against the regulation of monopoly profits where there is free entry, effective fair trading arrangements and the possibility of product innovations and real competition. Higher returns to the incumbent will signal to potential competitors that there might be an incentive to overcome the barriers to natural monopoly (i.e. the absorbitant returns made by the monopoly may mean it is economically viable to provide an alternative e.g. own generation for electricity, gas cylinders for gas supply, road transport as an alternative to rail).

The economic justification for imposing some kind of regulatory regime on monopoly companies lies in the fact that all the evidence shows that where regulation has not

been applied to natural monopolies, there is a tendency for the incumbent to set prices higher than necessary whilst restricting output, thus enabling itself to earn super normal profits or be less efficient than need be. Therefore, in order to promote lower prices and more goods, the monopolist should be forced (through regulation) to set prices equal to short run marginal costs and increase production until price equals long run marginal cost.

However, the potential regulator must exercise caution when introducing regulation. Braeutigam (1989) states "When should a natural monopoly be regulated at all? In assessing the effects of regulation and later in comparing various options for public utility pricing, we need to employ a clear measure of the economic benefits to consumers and producers. While such measures do exist, they are often difficult to apply given the kinds of market data that are usually available. The work of Willig (1976) has suggested that the well-known measure of consumer and producer surplus is an adequate approximation in most circumstances".

Therefore, we can conclude that where natural monopoly exists it is prudent to enforce some kind of regulation. We will discuss what type of regulation may be the most economically efficient and what makes it so later. On the other hand, where unnatural monopoly exists, the policy decision will more probably be directed towards what kind of competition can be introduced (although the introduction of competition does not rule out regulation altogether i.e. the regulation of multiproduct firms in different markets some of which are fully competitive).

We will now turn our attention to the different types of competition that can be introduced where 100% natural monopoly does not exist. We will then look at the different types of regulatory regimes that can be used to control natural and unnatural monopolies (in cases where competition is not deemed appropriate).

Introducing Competition

As already stated, competition is preferable in most cases to regulation. However, there are situations where competition can be unproductive (i.e. where natural monopoly exists) and there are different ways to bring about competition, some of which may be more efficient than others, depending on the circumstances.

The arguments for preferring competition to promote efficiency are numerous. The forces that competition lets loose provide not only that firms reveal more facts about their costs than can be extracted by law or regulation, it also ensures that they reduce their costs to a minimum, otherwise they will lose their efficiency edge to a rival firm. In many cases, competition will ensure that the players in the market concerned will find it difficult to engage in anti-competitive practices. Competition also makes it more likely that the company will concentrate on innovating its products, processes and services. This will not only make it more unlikely that the company will be surpassed by its rivals, it will also mean that the consumer enjoys greater utility as these improvements will feed through to them in the form of, for example, lower prices, more diversity and higher quality/technically advanced goods.

We will now discuss the different forms that competition can take and how the regulator may go about introducing it where monopoly exists.

The Main Ways to Introduce Competition

The main methods are as follows;

1. Ensuring Free Entry
2. Intermodal Competition
3. Restructuring (Break Up) and use of Yardsticks
4. Interconnection
5. Franchise for the Market - Demsetz Competition

We will now discuss each type in turn.

1. Free Entry

There are many economists who are of the opinion that natural monopoly can be kept efficient simply by having the threat of a new company entering the market at the first sign of the incumbent operating below the most efficient level (thus offering the prospect that there is enough slack in the market for the new entrant to exploit the inefficiency of the incumbent and enter the market place and gain market share). However, at the same time as acknowledging this fact we must ask ourselves whether free entry is always desirable.

Is Free Entry Always Desirable?

As Kahn states in the Economics of Regulation Vol II 1971 "All economic regulation involves a limitation or suppression of competition, whether by control of entry or of price rivalry or both.....and in principle all such regulation has the avowed purpose, among others, of assuring a satisfactory quality of service". Adam Smith heralded the deregulation of his times by calling for the abolition of all legal monopolies in restraint of trade, whether granted or imposed by the Crown, by Parliament or the merchants of a borough. In recent years economists like William Baumol have reached a similar conclusion. The main weapon of free entry is that the incumbent (monopolist) will know that if they become demonstrably inefficient or set prices too high, another firm can enter and compete away market share and profits. However, Foster (1992) puts three main arguments against free entry, these being:

(a) Competition can be introduced too quickly - Where an industry is suffering from organisational shortcomings because of its past ownership and under investment, it

will probably be in no position to react quickly enough to changes in its business environment so that it will ultimately fail, whilst being unable to grasp the scale and extent of the economies available to it that a competent management and organisation would have been able to deliver. New entrants could, therefore, become the monopolist incumbents in a relatively short space of time. Allowing too many competitors into the market could also allow the experienced and relatively bigger incumbent to control the market, using its financial strength and comparatively superior economies of scale to capture the most profitable parts of the market whilst ensuring its rivals scrap over what is left, thus preventing these rivals from ever being able to grow big enough to mount a serious threat to its dominance. This is most likely when the initial entry investment is substantial and not readily saleable and therefore this was the reasoning used to justify Mercury Telecommunications being allowed as the only competitor to British Telecom initially. The experience in Britain to date, as regards the introduction of competition, is that competition is allowed to grow periodically. Announcements to this effect are usually made in advance by the relevant regulator in order to avoid shareholder hostility and possible early competitors from being disadvantaged.

Another issue here is asset specificity. This issue usually occurs when some kind of interconnection occurs e.g. where Mercury for example uses the British Telecom network to route its own calls (interconnection is discussed later). D.M. Kreps (1990) states...." a transaction has high levels of asset specificity if as the trade develops one side or the other or both becomes more tied to and in the 'power' of the other side. A simple example is a company that makes glass bottles locating a plant adjacent to a bottler" (with the intention of winning business through the efficiency gains made possible by locating next to one another). In this example 'asset specificity' is at work on both sides of the transaction. "There will also be cases in which asset specificity binds only or mainly on one side". An example of this is where one side in order to get the result they require must use more inputs than the other party in the transaction and therefore relatively more resources will be expended in the form of transaction costs to prevent this party from being exploited. "The second quality of a transactionis the extent of uncertainty in the transaction....and this goes hand in hand with bounded rationality. Indeed, uncertainty is the major complexity that gives rise to bounded rationality. Finally, there is the frequency of the transaction. This aspect of the transaction does not bear on the absolute magnitude of its costs, as with the previous two aspects, but rather on the relative costs of various means for dealing with the transaction". This usually means that transaction costs are relatively cheaper when they occur frequently as efficient governance structures can be constructed compared to when transactions are undertaken infrequently.

(b) Free entry can lead to wasteful and destructive competition because of the excessive investment of capital for the size of the market (thus causing duplications of assets). For competition to be of any use, market entry and exit must be as near costless as possible (i.e. capital costs are fixed but not sunk) as substantial sunk costs make the prospect of destructive competition more likely. In a two company situation (one being the incumbent, the other, the new entrant) the likely outcome where sunk costs are involved is that the two companies will try to compete with each other in a price war to try and dislodge one another from the market place. Prices may go down

to short run marginal costs (i.e. only variable costs are covered) or even lower. This contest will last until one party decides it can no longer take the drain on its cash resources and withdraws (or is made to withdraw by its backers) or goes bankrupt or the two parties agree to come to some agreement which may not be in the interests of the consumer. In any case, whoever wins or remains will be a lot worse off than if the contest hadn't occurred and may no longer be in a position to invest the sums required to maintain the efficiency and quality standards it had before the new entrants arrival. The winner may also be tempted to regain the losses it sustained in the battle by charging higher prices to its customers (if they cannot go elsewhere) and even if the two players survive, the probable anti competitive arrangement will almost certainly lead to higher prices for customers, as the two incumbents seek ways to recover their losses. In the event of one party losing, there is also the loss to society of the capital invested in the sunk investment (unless of course the winner can do something with this equipment). It would seem logical that the risks of entry may be so high that it would be very foolish for any possible competitor to try and enter the market place (let alone the considerable "cost of capital" that may be incurred because of the level of risk). Sappington and Stiglitz (1987) put this perceived foolishness down to lack of information and insufficient analysis of the facts or the deliberate misleading of shareholders by the instigators of these projects.

However, this possible risk, relating to new entrants failing needs careful political and economic judgement from the regulator if he is to see the introduction of competition succeed. Certainly he needs to ensure certain standards are maintained and that the new entrant at least succeeds long enough to promote real competition, but not at the cost of prices (and average costs) being higher and quality lower than they would have been had the monopoly remained intact.

(c) There are certain circumstances in which a natural monopoly may not be able to retain its maximum efficiency (the very factor that makes it a natural monopoly) if new entrants are allowed to enter the market. To remain viable, a natural monopoly must exhibit unit costs that fall as its output increases. A natural monopoly that does not exhibit these characteristics displays marginal costs rising over the whole of its output. There are many reasons why this might occur; Oliver Williamson (1983) puts the blame at the feet of factors he calls 'control loss diseconomies' (i.e. management competence is shown to be insufficient in its strategy, tactics and its ability to control the organisation).

In addition, the entry of a new participant can lead to an economic domino effect. For instance, the new entrant enters one part of the natural monopoly's market by lowering prices for one product or one geographical area. As a result of this competition, the monopoly firms average unit costs increase as the same fixed costs must be recovered from a lower level of sales. This leads to possibilities for other competitors to enter other parts of the monopolists market and reduce prices there, leading to even lower sales and increasing average costs. These invasions will mean that over time, the monopoly will be gradually dismantled. This will be economically inefficient if, eventually, average costs are higher than when just the one firm served the market (which of course means higher prices for customers). Therefore, the economic argument should be for the monopoly to be protected from free entry.

However, the attack on the monopoly (i.e. domino invasion) cannot happen if, according to Foster (1992) a "natural monopoly has declining average costs and the freedom to discriminate in its pricing"...since the monopoly... "can protect itself by lowering its prices sufficiently in that part of its market where it meets competition". As it is not economically efficient to prevent price discrimination what stops incumbent monopolies from doing this? Foster notes the case of British Telecom in the 1980's, where political forces kept prices (and hence profits) in the long distance and international call sector artificially high whilst local calls were kept low (local calls being subsidised by the more profitable long distance calls). Free entry means that a competitor could cream off the high profit market by offering lower prices than BT's whilst leaving the unprofitable local market to BT. If BT had pricing freedom it would have rebalanced its charges to prevent Domino invasion. However, BT was restricted from discriminating in this way, by the regulator and politicians who feared the political backlash from residential customers, whose local call charges would have risen suddenly. Because of its social obligations, BT is vulnerable to domino invasion, which could lead to economic inefficiency in the market.

In this situation the regulator has to decide whether to opt for allowing cross subsidisation or the promotion of competition. However, it should be remembered, as Foster (1992) notes, that ever since the 1840's politicians have interfered with regulation on purely political grounds by insisting on imposing social obligations on regulators and these strictures make it very difficult for regulators to formulate regimes that ensure maximum economic efficiency. It is difficult to see how a regulator can move away from this position, as it is unlikely that politicians would even allow a long transitional period to ensure that cross subsidisation was eliminated.

The technical innovation in many industries has meant that a large number of barriers to entry have been overcome but the issue of free entry is important in this context. For instance, in telecommunications, copper wire is being challenged by mobile phone networks, microwave transmission and fibre optics and in electricity, wind generation and gas fired generation stations are challenging coal and oil. Foster notes "to leave such developments in the hands of a monopolist would ensure that the rate of innovation would be slow" (thus reducing consumers opportunities to benefit from the cost reductions and the new services that these cutting edge technologies make possible).

Overall, it could be said that although a case can be argued for restricting entry in order not to jeopardise economic efficiency, an example where this argument would be deemed relevant are only normally to be found in the text books. Restricting freedom of entry, even when used as a method to ensure long term competition, should, as a rule, only be used sparingly. Where restrictions on entry do exist, this is usually due to political intolerance towards efficient pricing systems and where restrictions do not exist, politically determined pricing systems will eventually be eliminated and this may lead to further interference from politicians (and customer complaints) as demonstrated after the privatisation of British Gas and British Telecom. If the regulator feels it is his duty to prevent moves towards inefficient pricing he may opt for alternative methods beside entry restriction to achieve this.

Barriers to Free Entry

Although the introduction of competition, in theory, is the perfect solution where markets are contestable, it is probable that new entrants will face a number of barriers that will restrict their entry. Apart from the obvious defence of incumbents such as predatory pricing, excess capacity and the blocking of access to the networks there are other problems to be overcome. The existence of brand names is one problem and coupled with the incumbents probable superior financial strength, this will certainly mean that the new entrant will be faced with intense promotion of the incumbents products through advertising. Thus by advertising (so long as this is successful) the incumbent will raise the entry price to the industry i.e. the new entrant will not only have to make large investments in production and labour but also in marketing and sales, a task made even more expensive where the incumbent has established brand name goods. In addition, legal barriers to competition may exist such as Patents.

2. Intermodal Competition

This usually cannot be introduced by the regulator as it often exists already e.g. Gas versus Electricity for domestic heating. Braeutigam (1989) comments "competition can be introduced.....through Chamberlinian monopolistic competition (see Chamberlain 1962). For example, in the transportation sector of the economy monopolistic competition among various modes of transport is often referred to as 'intermodal competition'. This term is employed to describe the rivalry between railroads, motor carriers, pipelines and water carriers all of whom compete for freight traffic. If intermodal competition is strong enough, it might be cited as a basis for deregulation even if one or more of the modes of transport appears to have the structure of a natural monopoly. Consider a simple example of freight transportation between two points. Suppose that a railroad and a competitive motor carrier industry can provide the required point to point service, and suppose the railroad has the cost structure of a natural monopoly. If the intermodal competition between the railroad and the motor carriers is strong enough to prevent the railroad from earning super-normal profits, then the unregulated market outcome may be very nearly second best in the absence of regulation".

A good real life example of intermodal competition is the deregulation of the motor carrier industry in the USA since 1980. This deregulation has led to declining rates for motor carriers and this has added further to the intermodal competition faced by the railways. In the UK, the planned synchronisation of the Gas and Electricity market liberalisation timetables (i.e. 1998) is an example of the regulators need to ensure a level playing field, wherever possible, for intermodal competition.

3. Restructuring

Although breaking up a monopoly may not lead to increases in efficiency (although this is a point of some contention) restructuring the industry usually means breaking the large monopoly into a number of smaller entities. These smaller natural

monopolies will have less scope to cross subsidise or undertake predation than its larger predecessor.

In the case of regulated oligopolists, it has been argued that the break up of two existing firms into say five or more separate companies, would reduce their ability to control their market place and thus lead to lower prices for customers. This scenario has been backed up by Game Theory simulations which suggest lower prices are achieved when there are five or more competitive firms in a market as opposed to two. However, when considering breaking up companies the regulator must bear in mind what the 'minimum efficient scale' of operation is. The regulators decision regarding the two firms referred to earlier would have to be tempered by the consideration that if they were broken into five separate companies, would they still be big enough to retain their minimum efficient scale of operation and would this affect their chances of competing successfully on the international stage.

Break up can also have another spin off advantage for the regulator. The advantage for the regulator is the fact that each of the new companies he has created will be reporting data about their performance (which is comparable, as each of the new companies will be serving roughly the same type of markets with the same product). The regulator can use this information to make comparisons about the relative performance of each firm. Littlechild (1986) has suggested that it may be possible to build this 'yardstick' into the price formula by requiring that the costs which a firm is able to recover are based not on its own costs but on those of an average or above average firm and therefore this data would be of particular use to the regulator, especially when revising the price formula. Complications in making comparisons will arise however if all the units compared and measured as a result of the break up are not identical. For instance, within electricity board areas or British Telecom districts the grouping of customers are not identical e.g. in terms of numbers served, geographical and demographic spread, consumption per head, income levels, growth rates, industrial mix, investment patterns, temperature and climate. These differences will have a significant effect on unit costs and other measures of efficiency.

The devising of efficiency indicators is extremely difficult especially across a number of companies serving different market areas (i.e. geographic). It is very common to find many business operations and public bodies who have not developed sufficient indicators to track even their own performance over time. Schleifer (1985) and Vickers and Yarrow (1988) deal with the issues of performance measurement and the use of yardsticks. Schleifer (1985) examines a model of yardstick competition. Vickers and Yarrow state "in the basic version of the model there are n identical risk neutral firms operating in a certain environment. Each faces demand curve $Q(P)$ in its market (the n markets are separate). A firm spending z on cost reducing effort achieves unit cost level $c(z)$, with $c(0) = c_0$."

"The lump sum transfer to the firm (if any) is denoted by T . Profit is therefore given by Schleifer as;"

$$\pi = [P - c(z)]Q(P) - z + T$$

"If the social welfare objective is the sum of consumer and producer surplus (and so this is not affected by considerations of distribution or the cost of raising public funds) then the optimum subject to the non negative profit constraint has,"

$$P^* = c(z^*),$$

$$-c'(z^*)Q(P^*) = 1$$

$$Z^* = T^*$$

"In sum, price equals unit (and hence marginal) cost, efforts to reduce unit costs occur up to the point where their marginal cost (=1) equals marginal benefit (= $-c'Q$, i.e. degree of cost reduction times volume of output) and the cost of effort is reimbursed by the lump sum transfer."

"However, this first best outcome cannot be achieved if the regulator does not know the function $c(z)$, which describes the scope for cost reduction. Schleifer supposes that each firm is run by managers who like profits π but dislike effort z . In particular it is supposed that their preference ordering is lexicographic with profits preferred over leisure. This is the minimal extent to which some weight can be given to leisure in manager's preferences. The key to efficiency is to break the dependence of the price for firm i upon its cost level". "Let....

$$\bar{c}_i = \sum_{j \neq i} c_j / (n-1)$$

and

$$\bar{z}_i = \sum_{j \neq i} z_j / (n-1)$$

"...be the average cost and effort levels of firms other than i . These provide yardsticks against which to compare i 's performance. Schleifer 1985 shows that the following regulatory mechanism for all firms i induces first best behaviour:"

$$P_i = \bar{c}_i$$

and

$$T_i = \bar{z}_i$$

"The profit of firm i is then

$$\pi_i = [\bar{c}_i - c(z_i)]Q(\bar{c}_i) - z_i + \bar{z}_i$$

and the first order condition is therefore"

$$-c'(z_i)Q(\bar{c}_i) - 1 = 0$$

"There is a symmetric Nash equilibrium in which all firms choose $c_i = c^*$ in which case $P^* = c^*$ and $T^* = z^*$ and Shleifer shows that there exists no asymmetric Nash equilibrium. Therefore the equilibrium that sustains the first best outcome is unique. This result in fact holds with pricing rules considerably more general than $P_i = \bar{c}_i$. A related result holds even when lump sum transfers are impossible. Yardstick competition can then induce the second best outcome, i.e. the social optimum subject to $T = 0$."

"The main shortcoming of the version of this model is that it assumes that firms operate in the same environments with exactly the same constraints. However, in real life this is unrealistic as companies do not operate in exactly the same environments especially where they are regionally based. Shleifer used regression analysis based on observable characteristics to screen out at least part of the heterogeneity between firms that occurs in practice."

Reduced form regulation works well if it takes into account all the variations between firms and is truly accurate. Where it fails to capture the full extent of the differences, reduced form regulation does not provide perfect incentives and it causes undesirable noise to be brought into the analysis. Using reduced form regulation also has the disadvantage of encouraging endless arguments about the appropriate way to conduct the regression analysis (e.g. which variables to include).

If the regulated firms concerned collude in order to frustrate competition via regulation i.e. if firms deliberately used less than maximum effort (to an equal extent) inefficiency would persist.

The use of econometric studies can also be used for making comparisons although it is unlikely that a regulator would rely on them entirely for setting and revising a price (or rate of return) formulae, as the results of such studies are qualified because of doubts over the quality of the data. The UK Audit Commission uses such studies for comparing the performance of local authorities and, although it is not their regulator, the commission is effective because it uses the media to distribute and therefore force its recommendations.

In theory it may also be possible to enforce the establishment of a system of accounting which would ensure that comparisons would be a lot easier and more accurate for the regulator. Something along these lines has been attempted in the USA, in which particular items are, or should be, recorded in the same way, although even this system is not accurate enough to be used for detailed statistical analysis.

4. Interconnection

Where there is a sustainable natural network type monopoly, interconnection is one of the best ways to introduce competition. Thus interconnection usually entails other companies being able to use the monopolists distribution network for a charge usually known as the "Use of System Charge". One of the earliest (in modern times) and

most successful examples of interconnection was the use of British Telecom's telecommunications network by Mercury.

Joskow and Schmalensee (1983) have commented on the problems and advantages that have been highlighted in the United States from the issue of interconnection. The difficulties in the USA stem primarily from the contractual nature of the relationships between the players in the market place there, as opposed to the command type system operating in the UK between the National Grid, the respective generators and the regional distribution companies.

One of the economic advantages of using interconnection, according to Foster (1992) is that the system can be operated with greater technical efficiency (particularly true for electricity systems). It also enables other firms other than the monopolist to deliver products to users and this usually results in lower prices and greater product innovation than would have resulted had interconnection not occurred. The regulator, however, must be wary of the problems that can be created by interconnection. The possible loss of quality is one such problem (i.e. the operators disturb the technical integrity of the monopolists service by using poor equipment or offering poor standard goods and services). Another problem is that the contractual disputes between the parties reach such a point that the costs involved in challenging legal rulings outweighs any economic advantages that were originally obtained. The provision of adequate capacity (at all times) for possible parties wishing to use the system is another problem.

One of the main regulatory offences that can come from interconnection is inefficient interconnection. This offence arises when one party to the interconnection agreement has and uses his superior knowledge and bargaining power to gain advantage in the use of the system. The knowledge needed to understand these contracts is likely to necessitate stringent regulation to prevent offences such as this occurring.

Prices charged for use of system should encourage economic efficiency. Long run marginal cost, including whatever profit rate is required to maintain the network, is an accepted basis for price setting. However, although LRMC may be easy to estimate when there is one operator using the system under easily forecastable future demands, the position is made more complicated when there are a number of third parties wishing to use the system, all with their own ideas on how demand can be stimulated.

In "Toward Competition in Local Telephony" (W. Baumol and G.Sidak, MIT Press and the American Enterprise Institute, 1994) the authors argue that regulators should tear up their traditional rules and use marginal pricing (although the issue here is how to redefine the marginal cost to the network owner of providing access). This consists of more than just the cost of the use of the system as the network is nearly always in the market for the final product and will therefore lose revenues to any newcomer. The prices that regulators usually let the network owner charge for final products also makes a contribution to the networks fixed costs. When the network owner loses market share to the new entrants, the network owner also loses this contribution, which can be called the opportunity cost (which should be included in the access price

to the system). This approach has been named "Efficient Component Pricing" (ECP) and enables the regulator to achieve four important economic aims. First, it enables

the correct price signals to be sent to possible new entrants about whether it will be viable for them to enter the market. Second, it ensures the network costs are properly covered. Third, it means that utilities should worry less about entrants 'cream skimming' customers located in the lucrative bits of the network (e.g. city centres) and the effect this has on the network owner being able to meet its obligations to customers in the less lucrative areas of the network. Fourth, it should mean that there is no need to separate the network from the supply of final products, as the right access prices should mean that incumbents have no incentive to keep rivals out.

ECP has already been used in practice by the American railways and California's telephone regulators'.

One criticism is that because ECP requires new entrants to reimburse utilities for lost revenues it will only encourage monopoly. Baumol and Sidak argue that this is not the case as the final product price should mimic the outcome in a contestable market where there is no barriers to entry. ECP will not ensure against high prices because the regulator is slack, but no other regime will either.

Defining the opportunity cost is another problem. If the market has a fixed number of customers, with the result that all of the new entrant's sales are from the incumbent utility, it is fairly easy. But if the entrant's product differs from, or is cheaper than the incumbents, the market will expand. Working out what the monopolist has foregone is then much trickier. As with most other forms of regulatory mechanism's the regulator is not perfectly informed.

5. Franchise for the Market (Demsetz Competition)

Franchising is an alternative to taxing monopoly rent (and this will be looked at in more detail in our section on types of regulation). This could be said to be competition for the market rather than competition within the market. Demsetz (1968) ("Why regulate utilities" *Journal of Law and Economics*) pointed out that in many cases where there is a risk of losing economies of scale, it is not always sensible to have competition within the market. In theory, franchising is an efficient way of taxing the profits of any monopoly enterprise, since it allows prices to remain at levels determined by supply and demand and therefore to be efficient, potential franchisees have to compete at certain predetermined time intervals, thus reducing long term profitability to competitive levels. The franchising scenario is therefore a means of regulating prices and as such this method of introducing competition can be said to be a way of regulating prices, as the process has to be repeated (and supervised) at predetermined intervals.

For franchising to work effectively in these circumstances, two conditions need to be satisfied. First, inputs must be available to all firms in an open market (at competitive

prices). Second, the cost of collusion among bidding rivals must be prohibitively high, so that competitive bidding is in fact the outcome of the franchise procedure.

The companies may own the means of delivering the service or product if they win the bid or they could merely provide the expertise and personnel to operate equipment or facilities owned by a third party (e.g. the government) and this would necessarily be the case in network industries such as Gas and Electricity.

Demsetz competition, in theory, leads to average cost pricing since all excess profits are bid away. If bidding competition is fierce enough, the price awarded to the winning firm would only be sufficient for it to break even (including normal profit).

One problem arising from this method of organising competition is the risk that the winning franchisee will also provide the lowest quality service. Here the regulator must, as part of the franchising system, devise quality standards that stipulate quality levels that have to be adhered to. Setting the quality standards required, and indeed determining them in the first place is very difficult. Future changes in the market place, which are not foreseeable at the time the contract was written, but which may necessitate re negotiation in the original contract at a later stage, add further complications and costs. Re-negotiation of the franchising contract, enforcing compliance or re-opening the bidding process are all options open to the regulator when changes in the market place occur, but none of these options is without financial consequences.

The problem of the winners curse also needs to be considered i.e. will the winning bid be so low that the winning company will be forced out of business or forced to cut back on quality in order to survive.

Another problem to be encountered with franchising is that the firm with the existing franchise possesses an advantage over other bidders because they have superior information as to what the true costs of the operation really are. In addition, if the franchised business has substantial assets, the valuation, replacement or transfer of these assets from a losing to a winning franchisee poses considerable accounting/financial problems. Williamson (1976) also suggests that franchising has a tendency to degenerate into rate of return regulation.

Finally, this kind of competition can also face problems when the enterprise concerned provides more than one service to the customers it serves. As Braeutigam (1989) states ..." in the single product case the winner might be chosen on the basis of the tariff that the franchisee would charge to customers....however this selection criterion does not naturally generalise to the case of multiple products....this may lead to a number of different bids which are undominated. Demsetz competition offers no obvious basis for choice among a number of undominated prices, even though some of these may be quite inefficient relative to others".

Types of Regulation

Although the regulator can introduce competition he may be faced with a situation where competition can only be introduced slowly, or because of reasons of natural monopoly the introduction of competition would be counter productive i.e. the incumbent in the market place, if left unregulated, would exploit its customers even though competition might exist (e.g. there may be a tendency for two big players in the market to collude) or finally, competition cannot be introduced, because of political reasons. In these situations, the need for regulation (usually of an economic kind) is obvious. The choice of regulatory regime the regulator decides upon will usually be influenced by the numerous economic theories that make up the bulk of the work on regulation theory.

This section now looks at the main regulatory theories (and mechanisms) that can be used by the regulator to induce the firms he regulates to produce and price their outputs (i.e. goods and services) in the most efficient and equitable manner. In this section we will also examine some regulatory theories which have been used in practice (i.e. Rate of Return and Price Cap).

Before going on to discuss the different types of regulatory regimes we will briefly discuss the concept of "First and Second" best pricing (see Train 1991) as this will be illuminating to the discussions on regimes. First best prices occur where a firm selling products such as electricity sell this product at marginal cost. However, firm's have to sell the products at above marginal cost in most circumstances, as marginal cost is below the firms average cost. If a firm sells goods at marginal cost, the firm would lose money on each unit sold. In theory, companies could be subsidised for this loss and therefore continue to achieve first best prices by selling to customers at marginal cost. In the absence of subsidy, prices have to be raised to average cost where the firm is allowed to cover its costs but earn only zero economic profits. This is the "second best" outcome as the consumer surplus is higher here than under any other scenario apart from the first best outcome. Subsidies are usually undesirable, as the money needed to fund these subsidies usually has to be raised through taxes, which of course have to be raised somehow and of course will distort incomes or prices elsewhere in the economy. Theoretically, in a multi product situation, there is room for some price differentials, which will allow the firm or regulator to charge first best prices to consumers for some of the firms products (at prices unsustainable in a single product situation). Finally, effective mechanisms to ensure truth telling about a firms costs are an essential part of regulatory regimes, otherwise it will be impossible for the regulator to know what is marginal cost and where first/second best prices are being achieved. It is generally agreed that pure "competition" is the best truth revealing mechanism and therefore, where firms produce in a truly competitive market place, it can be said that the majority of their products will be sold at second best prices.

We will now discuss the types of regulatory schemes and mechanisms open to the regulator. The regulatory options are as follows:

1. Rate of Return

2. Price Cap regimes
3. Surplus Subsidy Schemes
4. Return on Sales, Output or Cost regimes
5. Sliding Scale (Profit Sharing) arrangements

Some of the mechanisms that enhance optimality are:

1. Ramsey Prices (in addition using the V-F mechanism to induce Ramsey prices)
2. Time of Use Prices
3. Multipart Tariffs
4. Self Selecting Tariffs

Regulatory Options

1. Rate of Return Regulation

In the United States the most prevalent form of economic regulation is the Rate of Return regulation employed to regulate most of the country's utilities. The "test of fairness" here is that the firms revenue should yield no more than a fair return on its capital. The tradition of putting a control on a monopoly's returns goes back a long way in the United States and, as in Britain, maximum rates of return were often written into statutes and charters, the figure of 10% often being used as the acceptable rate of return.

The judgement of what constitutes a fair rate of return was something much argued about. In the United States, Foster (1992) notes that the Supreme Court discussed this issue in great detail in *Smyth vs. Ames* (1898), a case which influenced US regulatory policy for half a century. Unfortunately, this case led the US regulatory authorities into many future difficulties, as the court, in its conclusion to this case, made an incoherent list of inconcise statements and observations on how capital value should be ascertained and what items should be allowed in the valuation. This judgement, therefore, had the effect that many lawyers and their advisers were kept in lucrative employment arguing over how the total present value of a monopoly firm should be calculated, whenever a regulatory dispute flared up. Inevitably, these arguments were usually won by the company rather than the regulator, as the company usually had better information and the benefit of practical experience at its disposal and the courts were usually reluctant to rule against firms where the matters in dispute were of a technical/commercial/economics nature. The effect of the *Smyth vs. Ames* case affected American regulatory policy until 1944 when the Supreme court in *Federal Power Commission vs. Hope Natural Gas* reversed the earlier decision in the "Ames" case. However, the decision in the *Hope Natural Gas* case did not do anything to remove the uncertainty surrounding rate of return regulation in the United States, as it did nothing to address the problems surrounding the issues relating to the calculation

of the rate base. The main arguments remained i.e. cost of capital, the evaluation of the effect of risk and forecasting the future rate of inflation.

In the period between the Hope and Ames cases, the American regulatory system has fluctuated between three views of what constitutes a fair and reasonable rate of return. To sum this up we can paraphrase Foster (1992) ... "first was that the property right of the shareholder is defined by the market or net present value of the business, on which it then should earn a return not too different from that which could be earned as a return from a business of similar risk. The second view stresses the historic value of the actual investment, that is, the rate of return not should be based on whatever rises or falls have occurred to the value of the investment subsequently. The third of these views is of a managerial nature, in that it puts forward the idea that the organisation must have a sufficiently high return to raise whatever capital it needs to maintain its operations. These three views, unfortunately do not agree or compliment one another and therefore do not lead to the same result, thus leaving a great deal of scope for regulated firms to argue about the merits or otherwise of their particular circumstances. This situation favoured the regulated because, as they had more resources, it was in their favour to make the court hearing last as long as possible in order to wring out concessions from the regulator".

More recently the discussion about rate of return regulation has centred around the incentive that it gives the regulated organisations management to behave in an optimal economic manner. As Averch, Johnson* and Wellisz** amongst others have pointed out, (* H. Averch and L.L. Johnson "Behaviour of the Firm under Regulatory Constraint" American Economic Review, December 1962; ** S.H. Wellisz "Regulation of Natural Gas Pipeline Companies: An Economic Analysis" Journal of Political Economics February 1963) this combination of circumstances may induce companies to make investments where the social benefits fall short of their social costs, because as Kahn (1988) observes;

1. Such investments will expand the rate base on which the companies are entitled to a rate of return in excess of the cost of capital.
2. Where net revenues directly generated by such incremental investments fall short of yielding the allowed rate of return they can recoup the revenue deficiencies by raising their rates in markets in which they have hitherto been prevented from pricing at profit maximising levels. These considerations could induce them (1) to adopt an excessively capital intensive technology and (2) to take on additional business, if necessary, at unremunerative rates.

The effect of the "A - J - W" effect might be reflected in (as noted by Kahn and others);

1. The resistance of many public utility companies to full peak - responsibility pricing, which would tend to hold down the expansion of demand at the peak and the consequent justification for capacity.
2. A willingness to maintain a large amount of standby capacity, in excess of peak requirements.

3. Some considerable resistance by electric utility companies to the thorough ongoing regional planning of investment that represents the most highly integrated form of power pooling (which would reduce the need to invest in generating capacity).
4. A resistance to the introduction of capital saving technology.
5. A reluctance to lease facilities from others.
6. A tendency for public utility companies to adhere to excessively high (because excessively costly) standards of reliability and uninterruptedness of service, with correspondingly high and costly specifications for the equipment they employ.
7. An incentive to bargain less hard than they otherwise would in purchasing equipment from outside suppliers.
8. A tendency to reach out for additional business, inside or outside the sphere of their franchised public utility operations, if need be at rates below incremental costs in order that the company can increase its rate base.

Foster (1992) notes that utility rate case hearings are therefore dominated by such factors as whether the utility has overstated replacement costs (i.e. why were they higher than original cost?) the appropriate depreciation rates and appropriate cost interpretation when assets are acquired from another firm. In fact these proceedings can be so exhaustive that it has been claimed that the regulatory initiatives of the 1930's in the United States were necessarily so meticulous and documented that they formed the foundations of the modern accountancy profession (see McCraw, T.K.(ed.) (1981) "Regulation in Perspective" and "Prophets of Regulation" (1984) both Harvard University Press).

In recent years, the most difficult problem for rate of return regulators has been how to deal with multi product firms where certain goods (i.e. electricity units on one tariff) are priced at competitive levels and others are priced either well above or below a reasonable level. In addition, there will be a tendency to over capitalise the core monopoly. The argument then follows that the natural monopoly will have higher capital to labour ratios than normal firms (i.e. gold plating) or at the very least the accusation is that they have not maximised their capital/labour input ratios. However, some writers believe there is no real evidence to suggest over investment due to rate of return regulation (e.g. Vickers, J. and Yarrow, G. (1985) "Privatisation and the Natural Monopolies" Public Policy Centre). Also, under rate of return regulation the firm will be induced to move as much cost as possible into its regulated business in order to justify increases to its regulated prices (thereby meeting the rate of return proscribed). In response, regulators have to devise various constraints relating to cost apportionment in order to stop obvious exploitation, although these rules have tended to create their own conundrums. For instance, where a firm has set up separate companies to supply its monopoly part with inputs, it will be tempted to over charge for these goods.

The one thing that is certain is that the interpretation of accounting rules and the inconsistency of approach and application has led, in the United States, to endless court cases between the regulated and the regulators. To this extent, the whole U.S. experience can be rightly described as a descent into legalism.

Foster (1992) notes that the result of a century of U.S. style rate of return regulation has been the formulation of the classical regulation concept, which depends on calculating the cost of providing the output and then allowing a justifiable return, so that a price for the output can be arrived at. The investigation and calculations involved to arrive at this juncture have proved to be the biggest stumbling block for rate of return practitioners. Regulatory commissions have understood the concept of a reasonable rate of return with price, quality and entry being the main factors for their attention. The decision in the Hope Natural Gas case led to the courts allowing regulatory commissions a great deal of room to exercise their judgement as to what constituted anti competitive monopolistic behaviour. Therefore, provided that a commission goes through a full set of hearings during which evidence is produced and tested and its own findings can be regarded as consistent with its responsibilities and recent case history, its decisions are unlikely to be challenged successfully in the courts. However, reaching this point, where all the provisos are in place, can be difficult, time consuming and expensive. This use of discretion has enabled regulatory agencies, where they have chosen, to take action to blunt any of the rate of return regimes tendencies to allow distortions that Averch and Johnson and others said would follow from this type of regulation. More recently, this discretion has allowed some regulators to follow their beliefs e.g. that the industries they regulate should reflect marginal cost. Where marginal costs are falling below average costs, which is a defining characteristic of strong monopoly, this forces those regulators to allow price discrimination, so long as the relevant legal statues enable such discrimination. With weak monopolies, on the other hand i.e. where marginal costs are above average costs, efficient pricing ceilings will be needed to limit the return to what is deemed acceptable. However, this is just one standpoint amongst many, some regulators use their discretion to regulate in a more traditional classical mould, while others concentrate on the political and social aspects of regulation.

Rate of Return Regulation in Operation

According to Train 1992 "under Rate of Return (ROR) regulation the firm is allowed to earn a 'fair' return on its investment in capital, but it is not allowed to earn profits in excess of this fair rate of return. The firm can freely choose its levels of inputs, its output levels, and its price as long as the chosen levels do not result in profits in excess of the fair return. The rate of return on capital is defined as";

"Revenues minus costs for non capital inputs, divided by the level of capital investment."

ie $ROR = (PQ - wL)/K$

where P = price
Q = quantity

w = wage rate
 L = non capital input
 K = capital

"This rate must be no greater than the fair rate of return, called f, that the regulator has previously announced. Therefore, the firm can choose any K,L,Q, and P as long as "

$$f \geq (PQ - wL)/K$$

"The economic profits or what economists call the excess profits are the difference between the firm's revenues and its costs for all inputs including capital;"

$$\pi = PQ - wL - rK \quad \text{where } r = \text{cost of capital}$$

"The maximum return the regulated firm is allowed to earn can be expressed in terms of economic profit i.e."

$$f - r \geq ((PQ - wL)/K) - r;$$

$$f - r \geq (PQ - wL - rK)/K;$$

$$f - r \geq \pi/K;$$

$$\pi \leq (f - r)K.$$

"Therefore, the maximum economic profit the firm is allowed to earn is $(f - r)K$."

"If, for example, the fair rate of return is 10% and the cost of capital is 8% the firm is allowed to earn no more than 2% of its invested capital."

"e.g. If £100m is invested, it will be allowed to earn no more than £2m in profits" (Train 1991).

The apparent unfairness of the rate of return regulation when used for different types of business, is displayed by the example given in Kahn 1988 where a typical utility is compared with a typical bus company; this is shown below:

	TYPICAL UTILITY \$	TYPICAL BUS COMPANY \$
Annual Income	10,000,000	10,000,000
Net Investment	25,000,000	4,000,000
Operating expenses	8,500,000	9,760,000
Return (6% of investment)	1,500,000	240,000

2. Price Cap Regulation

Price Cap regulation could be considered as one of the great innovations of the regulatory world over the last 10 years. Where the regulator uses Price Cap regulation, the price cap imposed restricts the permitted change in the average charge for a bundle of services to movements in a general price index (typically the Retail Price Index). In their simplest form, price caps are expressed in terms of an RPI-X constraint on charges, where the X factor reflects expected efficiency gains and investment requirements. A cost pass-through factor may also be added to allow significant cost items, which are outside the control of management, to be passed through directly to consumers in final prices. During the privatisation period of electricity in the UK, the price cap took the form of a revenue yield control. This is considered to be a forward looking approach which controls increases in the average revenue per unit of output, for example the average price per kilowatt hour of electricity distributed. Such an approach usually requires forecasts to be made of the volume of expected future sales and increases in inflation. This means that a correction factor is required to adjust tariffs in subsequent years for any forecasting errors.

Worked Example of Revenue Yield Price Control

A good example of how Price Cap control works in practice is given by the Centre for the Study of Regulated Industry's Electricity charges review for 1993/4 Chapter 2.

This is as follows;

Assumptions:

- Three component formula which includes;
 - average revenue per unit for Service A
 - average revenue per unit for Service B
 - average revenue per unit for Service C
- Mix of units between services A, B, and C remains constant;
- Change in RPI from Year 1 to Year 2 = 3%

4. $X = 0\%$

Table: Revenue Yield Control (CRI)

1	2	3	4	5	6	7	8	9	10
Regulated Activity	Price Year 1	Quantity Year 1	Total Revenue Year 1 (2x3)	Revenue Yield per Unit Year 1 (4/3)	Price Year 2	Quantity Year 2	Total Revenue Year 2 (6x7)	Revenue Yield per Unit Year 2 (8/7)	Increase in Revenue Yield per Unit Year 1-2 ((9/5)-1)x100
Service A	10.00	25,000	250,000	10.00	10.75	25,000	268,750	10.75	7.50
Service B	20.00	15,000	300,000	20.00	20.35	15,000	305,250	20.35	1.75
Service C	30.00	10,000	300,000	30.00	30.15	10,000	301,500	30.15	.50
Total Average	-	50,000	850,000	17.00	-	50,000	875,000	17.51	3.00%

Allowable increase, $RPI-X = 3\%$

Actual Increase, per Column 10 = 3%

The CRI example states... "the table above shows the increase in the average revenue yield per unit (i.e. revenue divided by the number of units sold) for three services, A, B and C from year 1 to year 2. In this example the increase is constrained to an RPI-X limit of 3%. For simplicity, a constant mix of units between the three service categories is assumed in addition to no forecasting errors in order to avoid the complication of a correction factor. The revenue yield per unit in Year 1 is shown in column 4. For the services individually, the revenue yield per unit is simply the price or tariff for that service. The average revenue yield for all units (i.e. Services A, B and C combined) in year 1 is £17.00. In Year 2, increases in the prices for services A, B and C are 7.5%, 1.75% and 0.5% respectively. These price increases result in an average revenue yield for all units in Year 2 of £17.51 (column 9). The individual increases in average revenue per unit are 7.5% for Service A, 1.75% for Service B and 0.5% for Service C, which result in an increase in the average revenue yield per unit for all units of 3%. This is equal to the RPI-X constraint of 3%".

"The price control is intended to reflect certain aspects of a competitive market, principally giving a business an incentive to operate efficiently and ensuring over time that its customers obtain the benefits of greater efficiencies. If for a period of time (say five years) the average level of prices charged to customers is capped, thus limiting the company's revenue during that time, there is a greater incentive for the business to make efficiency gains and reduce costs than if those profits are removed by regulation as they occur. Indeed, the control may be set such that efficiency gains are required of the business to maintain its profitability. To ensure that the benefits of efficiency gains are passed onto customers over time, periodic reviews of the price cap are undertaken. This exercise in a sense emulates the workings of a competitive market where company's, in order to maintain profitability, have to make efficiency

gains similar to their competitors, or if their gains outstrip everyone else, they can expect to see this advantage competed away over time".

"Difficulties arise with an RPI-X control however when a company is able to obtain higher rates of return than anticipated, not because of efficiency savings but because of shortcomings in the regulator's estimates of returns achievable under the price cap set, either as a result of estimation problems, unforeseen events or errors of judgement".

"However, it is important, that the period between price cap reviews is sufficient to enable the business to enjoy the benefits that its increased efficiency savings make possible".

It can be seen therefore, that from a possible range of prices, the firm will choose the most profitable price combination, as it is allowed to retain all the profit it makes. Although there is a ceiling capping prices, the overall surplus should at least stay at the same level as before. However, the more efficient output mix should ensure that consumer surplus increases.

The regulator will usually specify that a review of the price will be conducted periodically (Acton, J. and I. Vogelsang in their introduction to the 'Symposium on Price Cap Regulation', *Rand Journal of Economics*, 1989, Vol.20, No.3, pp.369-372, make this an important aspect of price cap regulation).

Finally, to paraphrase Train (1991) "when the price cap is altered in view of the firm's profits rather than just on exogenous factors, the situation and the reaction of the firm and its subsequent behaviour will be far more complex. For instance, in these circumstances the firm may be induced to use strategic behaviour e.g. the firm may be induced to waste so as to convince the regulator to allow a higher price cap. There are a number of possible scenarios which can be imagined, where the firm will be induced to waste. For instance, where a company is currently regulated under a rate of return regime and is aware that a price cap may be used instead, the firm may be induced to waste under the ROR regulation, as the firm is allowed to recover its costs under this regime, and at the same time this will help the firm obtain a higher cap when price cap regulation is imposed. When the price cap is introduced, the firm's profits will increase as there will be less incentive to waste and the firm's output will be priced artificially high (as the price cap will be set higher than is necessary). Another problem occurs if the regulator when undertaking his periodical review (say every 3 years) pays more attention to the latest years profit forecast rather than the first two years. Here, there is a danger (if the firm knows which year the regulator is more interested in) that the firm will waste in the third year if it believes that subsequently the more leniently reset price cap will enable them to make more profit in the following three years, to offset the loss in real terms due to the wastage incurred in the year before the review".

There is also a danger that if the review is conducted in the same manner and with the same frequency as under Rate of Return Regulation, these two forms of regulation risk becoming almost identical and therefore the inefficiencies experienced under Rate

of Return regulation will not be eliminated by the introduction of a Price Cap regime. The longer the period between reviews the more likely the firm will cost minimise and

not indulge in strategic behaviour to waste resources. There is, however, a question of trust here i.e. does the firm trust the regulator to stick to the review periods and the formula he has promised at the outset (e.g. the second electricity distribution re-review of 1995 is relevant here) because if it does not, it will almost certainly engage in strategic behaviour.

Price Cap - Resetting the Value of X

At the time of privatisation, the initial level of X is set by the government as part of the privatisation process. The regulator, usually after an agreed period, has to reset X. According to Beesley and Littlechild ("The Regulation of Privatised Monopolies in the United Kingdom", M.E. Beesley and S.C. Littlechild, *Rand Journal of Economics* Vol.20, No.3, Autumn 1989) this difference between the initial setting of X compared to the resetting process has three important implications. They argue "first, the initial level of X is set as part of a whole package of measures, whose parameters affect the costs, revenues, and risks of the regulated company. Some of these parameters pertain to the design of price control itself, including the duration of the price constraint, its scope in terms of goods and services included, what costs (if any) are allowed to be passed through into prices, and whether the constraint is calculated on the basis of historical or expected performance. All these parameters are embodied in license conditions. Other parameters pertain to the wider regulatory framework, including what other non commercial obligations or constraints are put on the company, what steps are taken to encourage or restrict competition, what policies are adopted towards suppliers and so on. Both sets of parameters are fixed by the government, more or less simultaneously, in full acknowledgement of the interactions and trade offs between them. They are gradually firmed up and made more precise in the run up to privatisation, culminating in the determination of certain key parameters, including X, prior to the publication of the prospectus a few weeks before privatisation. (The striking price of the shares is determined later in this last period and will be heavily influenced by the anticipated changes in the stock market level to the flotation date.)"

"In contrast, the resetting of X takes place in a context where these parameters have already been determined. Admittedly, they could be changed, and in practice some have been, but to make substantial and unexpected changes would have potentially adverse affects on the company's cost of capital and hence on prices to customers. Moreover, insofar as any proposed changes pertain to the company's license, if the company does not agree to the changes, the regulator may not wish to run the risk of an unsuccessful appeal to the MMC. There are thus fewer degrees of freedom in resetting X."

"Second, the initial level of X is set by the government as owner of the company, whereas X is reset by a regulator who does not own the shares. The government as owner can choose, if it wishes, to take lower proceeds in return for, say lower prices to customers. The regulator does not have that extra degree of freedom: any shift in

favour of one interest group (such as customers) will be at the expense of another group (such as shareholders). The regulator is constrained by the expectations of shareholders and customers, which were established at privatisation, and his discretion is limited to whatever range is deemed acceptable (or can be so presented)".

"The third difference between setting and resetting X, which reinforces the previous two, relates to the effect on the company's share price. In both cases the level of X will influence the share price via its effect on expected net revenue streams, so the stock market in fact decides the yield to shareholders. At the time that X is initially set, however, this effect has to be conjectured. It is not known with any certainty how potential investors will evaluate the company put before them. Nor is there any market valuation of the previous or alternative arrangements with which to compare it. After privatisation, however, the views of investors are clearly reflected in the company's traded share price, with its accompanying dividend yield, price earnings ratio, relative risk factor β , etc. A change in the stock market's evaluation of the company, following any action by the regulator, in particular his revision of X can be immediately observed in the change in the share price. If the market regards the regulator's decision as favourable to the company (i.e. more favourable than expected) its share price is marked up and its cost of capital falls; the opposite happens if the decision is regarded unfavourably. The regulator cannot ignore this consideration in his decisions, and it reinforces the greater constraints on resetting X than on setting it initially".

Price Cap and Rate of Return Regulation both have some common features with one another i.e. they both accept the need to secure an adequate return for the company's shareholders in order to induce them to continue to finance the business, without conceding unnecessarily high prices at the expense of customers. However there are some differences which Beesley and Littlechild believe give Price Cap a number of advantages over Rate of Return regulation (ROR) in respect of encouraging and promoting efficiency. These are as follows:

- a. Price Cap regulation uses exogenously determined risk periods between appraisals of prices, whereas for ROR this period is determined endogenously.
 - b. Price Cap regulation is more forward looking than rate of ROR as ROR tends to be based on historic costs and demands, with future changes being catered for by forecast inflation adjustments and extrapolation of historic trends. Price caps on the other hand, embody forecasts of what productivity improvements can be achieved and what future demands will be and is set on the basis of predicted future cash flows.
3. When resetting X there are more degrees of freedom for the regulator than exist under ROR regulation i.e. in the resetting of X. ROR regulation does allow some room for manoeuvre (e.g. on the basis of asset valuation, the definition of the rate base, treatment of work in progress etc.) but it would seem difficult to change these decisions repeatedly. In resetting X (taking into account the initial value which would have considered factors such as coverage, duration and form of the price constraints - the extent of non commercial obligations - the restrictions on competition and the

permissible rate of adjustment from inherited pricing policies) the regulator, although constrained by his degrees of freedom, can modify any aspect of this framework.

4. In setting X, the U.K. regulator has more discretion and less need to reveal the basis of his decisions than his U.S. counterpart. However, this is perhaps more to do with the different legal procedures and what is expected of public authorities in the two countries. The basis for legal challenge in the U.K. is reduced compared to that in the U.S. This has led to calls from the Chairmen of regulated companies for the setting up of a Regulatory Commission in order to avoid the cult of the personality developing and to ensure that regulatory decisions are more consistent, transparent and predictable, a topic which has been fashionable recently in the UK. It may also mean of course that challenging a regulators decision is made more straight forward.

The overall effect of these four differences is that there is greater scope for bargaining in Price Cap regulation than in ROR of return regulation. The level of X can reflect negotiations with the company and could be said to be one of several bargaining chips in a political process.

However, it could also be said that the UK system of regulation straddles the fence between ROR and PC regulation. This position is discussed in Helm (1994). The main argument here is that the fixed periods that are the hallmark of the PC system only run their course because the regulator foregoes the opportunity to intervene, although in practice intervention has occurred. The types of intervention (sometimes called regulatory chiselling) are listed by Helm as:

- a. Interim Price Reductions - These fall mainly into two categories; either voluntary (under threat of MMC referral) or through the 'interim determination mechanism' which is used to provide 'within review period' flexibility.
- b. Quality of service enhancements without compensating price increases - again by voluntary and compulsory means. These increases in quality cost the utility, thus reducing their returns.
- c. Increased investment without compensating price increases - these can be made part of the utilities Licence conditions (i.e. the British Gas transportation and storage price cap is in effect conditional on the delivery of appropriate systems to ensure the operation of a competitive market in gas supply). Another variant is energy efficiency investments to meet environmental targets.
- d. Market Share Reduction - enforced access to the incumbents markets by competitors can reduce revenues. Very often the agreed introduction of competition is undertaken at a more rapid pace than the Utility had originally agreed with the regulator.

3. Surplus Subsidy Schemes

Most regulatory mechanisms only enable the second best consumer surplus outcome to be achieved. However, if the regulator has the ability to subsidise the firm, theoretically the first best outcome is possible. The main drawback to these schemes in practice are the stringent informational requirements to enable the regulator to allocate subsidies fairly and efficiently. The work of Loeb and Magat 1979, Sappington and Sibley 1988, and Finsinger and Vogelsang 1985 is relevant here. Each of these economists has produced variations on the 'subsidy' mechanism that tries to overcome the inherent informational constraints of operating subsidy mechanisms in the real world.

4. Return on Sales, Output or Cost

Even if we do not entirely believe that the Averch-Johnson model is 100% correct in its prediction of how a firm operating under rate of return regulation will behave (i.e. the firm will not be induced to use the optimal mix of inputs and outputs) we can use the model to try to identify other mechanisms that do induce optimality. The alternative mechanisms we will now discuss are:

- a. Return on Output Regulation (ROO)
- b. Return on Sales Regulation (ROS)
- c. Return on Cost Regulation (ROC)

a. Return on Output Regulation

Here the firm is allowed to earn a stipulated amount of profit on each unit of output it sells. The firm chooses its inputs, output level and price as long as its profits do not exceed the allowed amount per unit of output, this being the "fair" return per unit decided upon by the regulator (usually stated in terms of say £'s of profit per unit of output e.g. for every penny of profit made on one Kilowatt hour of electricity sold, the company could retain one fifth of a penny).

Train 1991 shows the profit constraint to be expressed as

$$\pi \leq kQ$$

"Where k is the allowed profit per unit of output and Q is the quantity of output."

For the profit constraint, "the maximum allowed profit, at any input combination is k times the maximum output that can be produced with the inputs. The constraint surface therefore takes the same shape as the production function, rescaled by k".

"Because profit per unit is constant on the constraint curve, absolute profits increase as output increases". To paraphrase Train we can say that the firm therefore chooses the greatest output that its constraints allow it. If the firm attempts to go beyond this point (i.e. exiting its constraint curve) the firm would be allowed to earn more profits

but would not be able to. Because of these characteristics, firms regulated by Return on Output display the following results;

- a. They utilise the most efficient input combination for its level of production.
- b. They produce greater output than if there were no regulation in place.
- c. If the regulator reduces profit, the regulated firm increases its sales.
- d. The firm does not waste as it produces as much sales as efficiently as possible (allocative efficiency).

The ability of Rate of Output regulation to move the firm close to the optimum input and output levels compares well with the situation under ROR regulation. With Rate of Return Regulation, the firm cannot be motivated to enter the inelastic area of demand. In addition, Rate of Return cajoles the firm to operate with an inefficient input mix.

However, Train notes a problem with Return on Output regulation arises if the firm can influence its demand curve e.g. through advertising. If the company uses demand stimulating devices, Return on Output regulation establishes an incentive to indulge in these demand stimulating activities. On the other hand, if the firm has the ability to reduce its demand, Return on Output regulation gives it a motive not to do so even if production cutbacks are necessary e.g. conservation reasons. Under Return on Output regulation, the firm has no incentive to introduce measures that would motivate its consumers to lower their requirements, even if these reductions were efficient for the Economy as a whole.

b. Return on Sales Regulation

Train 1991 states that the "revenues generated by a firm are called its turnover or volume of sales. If sales are easier to observe than its quantity of output, the regulator will want to use sales as the basis for determining allowed profit. Return on Sales (ROS) regulation means the firm can choose its outputs and inputs under the constraint so long as its profits do not exceed a portion of its revenues".

$$\pi \leq kPQ$$

"Where k is the allowed proportion of revenues that can be retained as profit".

"If marginal revenue is positive over the relevant output levels, then allowed profit grows with the amount of output, because revenues increase. Consequently, the analysis of ROS regulation, when marginal revenue is positive, is nearly the same as that for Return on Output Regulation. The conclusions are identical i.e. if marginal revenue is positive over the relevant output range, ROS regulation induces the firm to increase output, not waste and to choose the efficient input mix for its level of output".

"Furthermore, output increases as the allowed proportion of revenues that can be retained as profit decreases. Therefore, it follows that the firm can be enticed by lowering the allowed proportion toward (but not to) zero, to produce arbitrarily close to the second best output level, using cost-minimising inputs".

"Should marginal revenue be negative, then allowable profit drops when output rises, because revenue decreases. Therefore, 'Return on Sales' regulation is different from Return on Output regulation, if the optimal output level is in the inelastic portion of demand, because under Return on Output regulation, the firm will not reach into the inelastic area (where marginal revenue is negative), because doing this would decrease its allowed profit".

The difference between this form of regulation as compared to 'Return on Output' regulation, is shown in the table below after the section on 'Return on Cost' Regulation.

c. Return on Cost Regulation

The profit the firm is allowed to retain can be based on the costs of the firm. Return on Cost regulation imposes a restriction on the firm as follows: Train shows the constraint as;

$$\pi \leq k(wL + rK)$$

"where k is the proportion of costs the firm is authorised to keep as profit"

"This type of regulation is like allowing the firm to mark up price over average costs by the proportion k:"

$$\pi \leq k(wL + rK)$$

$$PQ - (wL + rK) \leq k(wL + rK)$$

$$PQ \leq (1+k)(wL + rK)$$

$$P \leq (1 + k) AC$$

where AC is average cost

"If marginal revenue is consistently positive, the implications of this form of regulation are very different than if the optimal output falls in the inelastic portion of demand". Therefore, (according to Train 1991) the following can be said to be true for Return on Cost Regulation.

a. "An organisation operating under Return on Cost Regulation and facing positive marginal revenue produces on the expansion path, using the most efficient input allocation for its level of output".

b. "Under Return on Cost Regulation, if the firm is facing positive marginal revenue, it will produce more output than the unregulated firm".

c. "The firm facing positive marginal revenue does not waste inputs under Return on Cost regulation".

d. "If the allowed amount 'k' costs to be retained as profit is lowered toward (but not to) zero, then any firm will increase output, by using inputs efficiently under Return on Cost regulation (when experiencing positive marginal revenue)".

To paraphrase Train 1991, it should be noted that the firm does not increase its costs through wasting inputs even when it is allowed to increase its profits by engaging in waste. However, this is dependant on marginal revenue being positive. If the firm purchases non-productive inputs (i.e. waste), then its allowed profit increases but its real profit decreases (because costs increase but revenues do not). Alternatively, if the firm uses the same amount of money to purchase inputs and uses them productively, allowed profit rises by the same amount, but feasible profit either rises or drops by less (because revenues increase, at least partially offsetting the cost of the extra inputs).

Return on Cost regulation enables the firm to increase costs, but as long as marginal revenue is positive, the firm earns greater profit by increasing output as much as possible along with costs.

Train goes on to state "if marginal revenue becomes negative within the relevant range of output, then the cost based incentive does not translate into a quantity based incentive. If marginal revenue is negative, the firm loses revenue by selling extra output. As a result, the firm is able to earn greater profits by selling less even without reducing inputs - its allowed profit does not change and its profit increases. On the other hand, the firm can increase its allowed profit by purchasing inputs (whether productive or not) and yet its feasible profit decreases less when inputs are purchased without expanding output than when using the inputs to produce more."

"The firm will only increase output beyond its unregulated level to the point that marginal revenue is zero. If allowed profit exceeds feasible profit at this point, the firm purchases wasteful inputs thus increasing allowed profit while decreasing feasible profit as little as possible. If the firm used these additional inputs to produce extra output, its real profit would decline even more. However, if the firm purchases additional capital but does not produce greater output, its profits would decline by less (i.e. by not selling more output, the firm's revenues do not shrink at the same rate)."

"Summing up, if optimal output is in the inelastic portion of demand, then ROC regulation can be used to motivate the firm to expand output and use cost-efficient inputs only to where marginal revenue is zero. Any attempt to force the firm to expand output further (i.e. by reducing the allowed profits) simply motivates the firm to waste".

A numerical analysis giving a comparison of outcomes from similar inputs for ROS, ROO and ROC schemes is now given.

Table of Comparisons between Return on Output, Sales and Cost Types of Regulation Under Given Assumptions

Return On Output

Scenario	Demand	Price	Sales	MC	FC	TC	AP kWh	TP	RP
1	200	10	2000	8	200	1800	1	200	200
2	300	9.5	2850	6	200	2000	1	850	300
3	100	20	2000	8	200	1000	1	1000	100
4	300	10	3000	8	200	2600	1	400	300

Where:

Scenario 1 = Control scenario

Scenario 2 = Increased demand due to price decrease, driven by achievable reductions in MC i.e. 8 down to 6.

Scenario 3 = Reduced demand caused by increase price where costs remain the same.

Scenario 4 = Increased demand due to increased penetration of electrical goods in households - price and costs remain unchanged.

And where MC = Marginal Cost, FC = Fixed Cost, TC = Total Cost (MC + FC), AP kWh = Allowed Profit Per kWh, TP = Total Profit, RP = Retained Profit. All figures given in pence except demand which is given in kWh.

RP is calculated as 1p per kWh sold under any scenario unless TP is less than this figure.

Conclusion under ROO^o - Profit can only increase if prices are reduced or demand increases. Increasing price reduces profit.

Return On Sales

Scenario	Demand	Price	Sales	MC	FC	TC	A%R	TP	RP
1	200	10	2000	8	200	1800	10%	200	200
2	300	9.5	2850	6	200	2000	10%	850	285

3	100	20	2000	8	200	1000	10%	1000	200
4	300	10	3000	8	200	2600	10%	400	300

Scenarios as before except where A%R = Allowed % of sales to be retained.

RP is calculated as 10% of Sales under any scenario unless TP is less than this figure.

Conclusion under ROS - Profit can only increase if prices are reduced or demand increases. Increasing price reduces profit. Natural increases in demand result in higher profits than where increases in demand are induced by price cuts. Under Scenario 3 retained profits are higher than under ROO as RP is a function of £ turnover rather than just kWh sales.

Return on Cost

Scenario	Demand	Price	Sales	MC	FC	TC	%C	TP	RP
1	200	10	2000	8	200	1800	11.1%	200	200
2	300	9.5	2850	6	200	2000	11.1%	850	222
3	100	20	2000	8	200	1000	11.1%	1000	111
4	300	10	3000	8	200	2600	11.1%	400	289

Scenarios as before except where %C = Allowed % of Costs to be retained i.e. for Scenario 1 to achieve 200 TP, %C is set at 11.1%. RP is calculated as 11.1% of TC under any scenario unless TP is less than this figure.

Conclusion under ROC - Profit is less under Scenario's 2&4 than under either ROO or ROS, however under Scenario 3, ROC results in a superior RP than ROO although these outcomes are produced under contrived cost levels. In real life, for instance, when facing Scenario 4, a company regulated under ROC would be motivated to increase costs, which would of course have an effect on demand.

Similarly, firms operating under ROO and ROS would be induced to stimulate demand through advertising. ROO participants would also be inclined to increase demand through price reductions, especially if the regulations stipulated that where RP was greater than TP the regulator would subsidise the difference.

5. Sliding Scale Schemes

Recent criticisms of the RPI-X price cap regime operating in the UK have surfaced because of the high level of profits made by the utility companies and this has led to a

search for alternative regulatory regimes. One such alternative is the sliding scale arrangements used in the UK and the US from the mid 1800's until the Second World War. Burns, Turvey and Weyman Jones (1995) point out, under 'Sliding Scale

Regulation' (SCR), a strong incentive should still exist for the firm to maximise profits even though these profits will have to be shared with customers as well as its shareholders. Indeed, although the present price cap regime provides ample incentives to increase efficiency it could also be said to lead to instability for the company e.g. in that profits will be higher than the normal in good times (thus causing adverse publicity and political pressure) but lower when circumstances worsen (thus the financial viability of the company could be in jeopardy).

Therefore, it can be said that SCR is more flexible than price cap because there is a mechanism for both customers and shareholders to share in the good times as well as the bad (the size of profits and losses will be less under SCR than under Price Cap Regulation). Another advantage of SCR is that the regime avoids the drawbacks of using forecast or lagged RPI because it operates when all relevant information is known.

Sliding Scale Options

Burns, Turvey and Weyman Jones (1995) put forward three main forms of Sliding Scale Regulation (SCR). These are;

1. Dividend Sliding Scale
2. Price Related Profits Levy
3. Rate of Return Sliding Scale

Each of these are now described in turn

1. Dividend Sliding Scale - Under this option, end of year dividend payments can only increase (decrease) beyond a certain level if prices throughout the year have been lower (higher) than a standard price.

Burns, Turvey and Weyman Jones (1995) show the constraint to be

$$\begin{aligned} & \bullet \quad [\text{Actual yield} - \text{standard yield}] \\ & \qquad \qquad \qquad \text{must be less or equal to} \\ & [(\text{standard price} - \text{actual price}) / \text{standard price}] \text{ multiplied by the profit sharing} \\ & \qquad \qquad \qquad \text{parameter} \end{aligned}$$

Therefore if the profit sharing parameter is 50%, this constraint simply says that if the firm keeps its prices 10% below the standard price, and if the standard dividend is 5%, then the firm is permitted to pay out a dividend of 10%. Profit sharing only takes place after dividends exceed a stipulated level.

2. **Price Related Profits Levy** - This is similar to dividend sliding scale, except the firm's profits, rather than dividends, is conditional on its pricing behaviour. As in the dividend sliding scale case, the firm can choose to pay the levy as a one off rebate at the end of the financial year or it could avoid paying the levy by lowering prices below the standard price throughout the year.

3. **Rate of Return Sliding Scale** - Here deviations from a target rate of return can only be justified by prices which differ from the standard price.

Much of the recent debate about Sliding Scale/Profit Sharing mechanisms has come from the UK. The SCR method of regulation has been suggested as a replacement for the existing RPI-X price capping arrangements which are currently used to regulate the utilities. Much of the debate has centred on the fact that SCR is a more equitable method of regulating public utilities as it enables excess surpluses (i.e. returns above a 'normal' level) to be returned to customers more quickly than at present under PC arrangements. This is of course politically attractive, as price cuts or refunds are more immediate and the reporting of excess utility profits will be short-lived and, where reported, they will be accompanied by good news for customers.

However, critics of SCR have pointed out that although surpluses may be given back to customers more quickly, this will reduce incentives on the company's concerned to be efficient as possible i.e. in the long term companies are incentivised more to be efficient under price cap arrangements than under SCR, as this type of regulation could be called price cap regulation with annual regulatory reviews. Therefore, customers will eventually be better off under a price cap regime (e.g. prices will be lower) than under SCR because of the better incentives that PC provides utility managers to increase efficiency.

Much of the analysis of SCR schemes therefore has focused on the amount of risk to be shared under SCR arrangements (e.g. how much is to be shared with customers). For instance, Schmalensee (1989) numerically analysed how risks could be shared between a firm and its customers under incentive regulation arrangements (profit sharing) to optimise the effectiveness of the regime (which can be defined as either direct customer benefits or overall aggregate economic efficiency). Haring and Rohlfs (1994) analysed the effect on incentives due to the length of time between regulatory reviews.

Cave (1995) analysed the experience of US telecoms regulation in terms of its use of PC and SCR (and hybrids) to see whether there was a clear winner. The evidence suggests to date that neither SCR or PC regimes can be assumed to be superior in terms of promoting economic efficiency.

Mechanisms to Achieve Optimality

There are a number of mechanisms that can be used by a Utility Regulator to induce economic optimality: Some of these are;

1. Ramsey Prices
2. Time of Use Prices (TOUP)
3. TOUP with Riordans Mechanism - (first best price mechanism)
4. Multipart Tariffs - Access / Usage Tariffs and Block Rate Tariffs.
5. Surplus Subsidy Mechanisms (mechanisms to induce first best prices)
6. Pareto Dominating Block Rate Tariffs
7. Self Selecting Tariffs
8. Self Selecting Tariffs with Sibleys Mechanism.

For our purposes we will look at 1, 4, and 7 in more depth.

Achieving Optimality - Ramsey Prices

In the field of theoretical economics Ramsey Prices are regarded as an effective mechanism in reaching optimality (i.e. efficient resource allocation). The work of Frank Ramsey and in particular his 1927 contribution to the optimal theory of taxation ("A contribution to the Theory of Taxation" Economic Journal, Vol.37, No.1) has made a considerable impact on the world of regulatory economics. Ramsey developed a method for determining the tax rates for various goods that would provide the government with sufficient revenue while reducing consumer surplus as little as possible. Baumol and Bradford (1970) noted that optimal taxation rules are directly applicable for determining second best prices for multiproduct natural monopolies and it is usual therefore to refer to these second best prices as Ramsey prices.

As Train (1991) puts it;

"Of all possible price combinations for a multiproduct firm, Ramsey prices provide the greatest total surplus while allowing the firm to break even. At the Ramsey price, profits are zero, and"

1. "the output of each good is reduced by the same proportion relative to the outputs that would be produced when prices are at marginal cost; and"
2. "the amount by which price exceeds marginal cost, expressed as a percentage of price, is greater for goods with less elastic demand".

N.B. "Statement 'one' only "applies exactly only when demand is linear, otherwise output is reduced by approximately the same amount for each good".

The second statement, called the 'inverse elasticity rule', "applies with both linear and non-linear demand. The two statements are equivalent, but are simply described in different terms. That is, if prices are raised inversely to elasticity, outputs will be reduced by the same proportion for all goods and vice versa".

RAMSEY PRICE EXAMPLE
Price Combinations that result in Zero Profit

		DEMAND	DEMAND	REVENUE	REVENUE	TOTAL	PROFIT	CONSUMER	CONSUMER	
		IN	IN	IN	IN	COST		SURPLUS	SURPLUS	TOTAL
		MARKET 1	MARKET 1	MARKET 1	MARKET 2	19800+		IN	IN	CONSUMER
P1	P2	Q1	Q2	P1Q1	P2Q2	20Q1+20Q2		MARKET 1	MARKET 2	SURPLUS
20.00	25.44	4,000	3,640	80,000	92,600	172,600	0	60,000	26,499	86,499
21.00	23.98	3,867	4,005	81,200	96,040	177,240	0	56,067	32,080	88,147
22.00	22.88	3,733	4,280	82,130	97,930	180,060	0	52,267	36,637	88,904
23.00	22.00	3,600	4,500	82,800	99,000	181,800	0	48,600	40,500	89,100
24.00	21.27	3,467	4,683	83,200	99,600	182,800	0	45,067	43,852	88,919
26.25	20.00	3,167	5,000	83,140	100,000	183,140	0	37,605	50,000	87,605

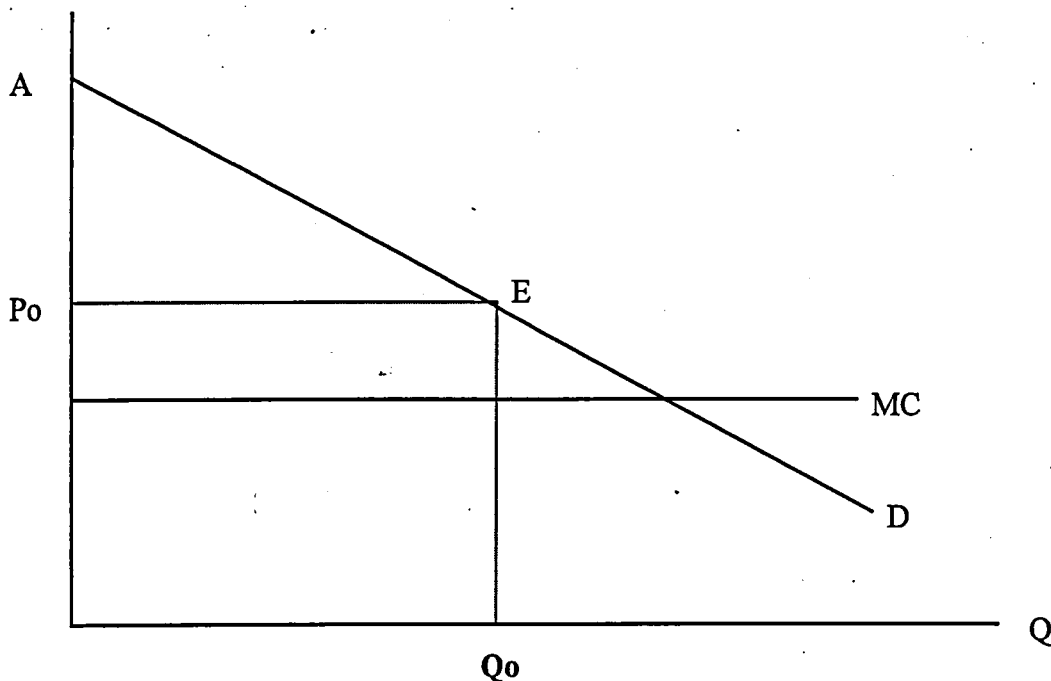
Extract from K.E. Train "Optimal Regulation" 1991 MIT Press

Train notes there are many price combinations that will result in zero profit. The question for the regulator is which price combination produces the best economic surplus. Ramsey prices should produce the "best" price combination, this being the one that results in the smallest loss of consumer surplus. As all price combinations that result in zero profit provide the same producer's surplus; the price combination that reduces total surplus the least and also reduces consumer surplus the least is the best price combination. "Ramsey and others, have derived formulae for calculating the prices that result in the smallest surplus loss when prices must be raised above marginal cost in order for the firm to remain solvent" (Train 1991).

In the Ramsey Price Example above we have two goods in two markets. Demand in the two markets is, $P1 = 50 - .0075Q1$ and $P2 = 40 - .004Q2$. The firm has incurred start up costs of £19,800 and marginal costs of £20 for each unit of either good produced. Its cost function is $TC = £19,800 + 20Q1 + 20Q2$ as shown in the example table.

"If the firm priced at marginal cost it would sell 4000 units in market 1 and 5000 in market 2". As its revenues would only cover its variable costs it would incur a loss of £19,800". In a real life situation the firm would have to raise the price on one or either of the two goods to a price that would ensure that both variable and fixed costs were recovered. An infinite number of price combinations could be chosen by the firm to achieve this goal and some of these are shown in the table above. However, although the firm will find any combination that achieves its goal, consumers enjoy a greater surplus at certain price combinations and lower surplus at other price/demand levels (i.e. consumers are better off where the surplus is calculated to be at its highest). To calculate which price mix results in greatest surplus we use the Ramsay method to obtain a measure of consumer surplus.

Ramsey Consumer Surplus in a Market



(Graph extracted from Train 1991)

For P1 A = 50 and Po = 20. Qo = 4000 (50-20=30 therefore 30/4000 = .0075)

For P2 A = 40 and Po = 25.44. Qo = 3640 (40-25.44 = 14.56 therefore 14.56/3640 = .004).

"Consumer surplus in a market is the area under the demand curve and above price as shown above in the area covered by A, Po and E. For linear demand this area can be calculated fairly easily. It is the area of triangle whose width is the quantity sold (Qo) and whose height is the difference between the price and the y-intercept of the demand curve (A - Po). Because the area of a triangle is one half the width times the height, consumer surplus in this figure is $(1/2) Q_o(A-P_o)$. Applying these ideas to the two markets in our example we find that consumer surplus is £86,499 when P1 = 20.00 and P2 = 25.44, which is one of the price combinations that result in zero profit. Consumer surplus for each other price combination, that provides zero profit, is given in the last column of the table above" (Train 1991).

Example Proof: Where P1 = 20 and P2 = 25.44

P1 surplus $1/2 \times 4000(50-20) = £60,000$

P2 surplus $1/2 \times 3640(40-25.44) = £26,499$. Total Surplus $£60,000 + £26,499 = £86,499$.

Consumer surplus is optimised when $P_1 = 23$ and $P_2 = 22$ (i.e. £89,100). These prices can be said to be second best prices because, of all the price combinations possible, they provide zero profit with the greatest consumer surplus i.e. of all the possible ways of raising prices to allow the firm to break even, the price changes that keep the ratio of outputs unchanged (that is keeps this ratio at its first best level) are the changes that result in the least loss to consumers and hence are second best. This fact provides a mechanism for calculating second best prices. Train 1991 describes the procedure as follows; "first commence with marginal cost prices and determine the ratio of outputs at these prices. Raise prices a little in each market in such a way that this output ratio is unchanged, that is, that output in each market is reduced by the same proportion. With these slightly higher prices, the firm will have somewhat smaller losses. Raise prices again, still keeping the output ratio constant, and the firm will incur even smaller losses. Continue raising prices in this way until the firm breaks even and these are the second best prices".

Using Ramsey pricing means that prices are raised on outputs with less elastic prices. As the "elasticity of demand is a measure of price responsiveness in a market it can be defined as the percentage change in output that results from a per cent change in price" Train 1991. The elasticity is calculated as:

$$\varepsilon = (\Delta Q / Q) / (\Delta P / P)$$

In the Ramsey Price example table shown earlier and according to Train, at the second best prices "the elasticity of demand in market one is -0.85 (calculated as $(1/0.0075)(23/3,600)$) whilst the elasticity of demand in market two is -1.2 (calculated as $(1/0.004)(22/4,500)$ ". Examination of the examples shows that "the price is higher in the market with lower elasticity i.e. the price in market one is higher than in market two (23 to 22) and the elasticity of demand is lower (-0.85 compared to -1.2 , where 'lower' means smaller in magnitude, representing less price response).....this characteristic of second-best prices is often called the inverse elasticity rule". This is an important fact for a company to remember, as more funds can be obtained with less disruption in consumer's consumption patterns (i.e. less reduction in output) by raising price in the market with inelastic demand than in the market with elastic demand.

Train (1991) states that the general rule is, that where there are no cross-elasticity's, at the second best prices, we find the following;

$$((P_1 - MC_1)/P_1) \cdot \varepsilon_1 = ((P_2 - MC_2)/P_2) \cdot \varepsilon_2 \quad \text{where } \varepsilon \text{ is the elasticity of demand,}$$

the term $P_1 - MC_1$ is the amount by which price in market one exceeds marginal cost for that good.

Dividing $P_1 - MC_1$ by P_1 gives the amount by which price exceeds marginal cost expressed as a proportion of price. The equation states that, at second best prices, if the percentage by which price exceeds marginal cost in each market is multiplied by the elasticity of demand in that market, the resulting product is the same for all markets.

In the example given in Train we arrive at the following;

Market One - elasticity is .85, price 23 and MC = 20

Price - MC = 3 therefore $3/23 = 13\%$ of the price

Therefore: $-0.85 \times 0.13 = -.11$

Using the same for Market 2 we also get a figure of $-.11$

Ramsey Prices and the Issue of Equity

Train 1991 states that "Ramsey prices are those that provide the greatest total consumer surplus while allowing the provider to break even.... the distribution of this surplus among consumers is not considered. If total surplus is as high as possible, then there is, theoretically at least, some way that this surplus can be redistributed such that all people are better off than at any other price combination" (and therefore, if this is the case, the issue of equity is resolved). However, this scenario is usually not possible and the regulator will need to consider the issues of fairness when redistributing the surplus. If Ramsey prices were to be introduced unfettered, it is more than likely in many instances that "lower income consumers would subsidise higher income households", as the inverse elasticity rule means that prices are increased proportionately more above marginal cost on goods with lower elasticities. As poor consumers often have less choice than richer consumers, this implies that the goods poorer consumers have to buy (i.e. often all disposable income is spent on necessities such as food, housing, transport, clothing and energy) would be increased whilst goods where higher incomes meant that more choice could be exercised, would be raised less. An example here could be transport systems where poor consumers are forced to use public transport whereas more affluent consumers can choose to travel by car or taxi.

In energy, this could mean that necessary supply prices were increased where alternatives could not be found by consumers. Healthcare is another example where consumers would continue to spend on this service, even if prices were raised substantially. The Ramsey rule implies that prices be raised more on these goods than on goods with more elastic demands. The regulator has to consider whether this is equitable in the circumstances. Therefore, we can conclude that although Ramsey prices may achieve the greatest surplus, this does not mean they are the best if judged by other social criteria that the regulator might consider relevant.

Achieving Optimality - Multipart Tariffs

A tariff can be considered as a schedule of prices to a customer which contains a number of billing components. Multipart tariffs are sets of prices with several billing components and they can have important implications for customers and the utilities concerned. According to Train (1991) if the regulator can encourage the use of a specially designed multipart tariff it will be possible to ensure a monopolist operates

closer to the first best outcome than would have been attained with a single rate tariff. Under certain circumstances, it is even possible to achieve the first best outcome. There are two main types of multi part tariffs.

a. Access/Usage Tariff - is made up of a fixed charge that does not relate to the level of consumption (called the standing charge or access charge) and a 'per-unit' price for consumption e.g. kWh (called the consumption component or usage fee).

In the UK, electricity tariffs are designed with a standing charge and a consumption component i.e. the quarterly standing 'fixed' charge is the access fee and the unit price per kWh consumption is the usage fee. The standing charge is the "access charge" because this payment buys access to the electricity distribution network. In a way, the standing charge is payment for the right of the customer to connect his appliances to the electricity distribution network whilst the unit charge is for actual consumption of electricity delivered over the system.

b. Block Rates Tariffs - these are rates where the price for each unit of electricity changes when the consumption of electricity reaches certain predetermined levels. Many electricity tariffs are charged in this way. Block rate tariffs can be designed to have declining or inverted price levels i.e. the price for additional units decrease or increase as consumption increases.

As the customer is facing different price levels at different usage levels, a definition of average and marginal prices is necessary. The average price per unit of consumption (kWh) is the overall cost paid (standing charge plus unit charges) by the customer divided by the total consumption in the period. Marginal Cost per unit is the cost of units used over the period divided by the total number of units used kWh.

Block rate tariffs and access/ usage tariffs can be combined in one tariff package. For example, the usage charge under an access/usage tariff can consist of block rates e.g. a electricity company may charge a fixed quarterly fee and then allow a certain number units to be charged at one rate and then steadily increase unit rates in stepped bands of consumption (i.e. if it wished to deter high usage of the system).

The difference between access/usage fee and block rate tariffs with two blocks is important; e.g. in the case of an electricity service, a person might choose to have the service (i.e. subscribe for access) and yet not use any electricity because they only want to use the electricity company's power as fail-safe for their on site generation. They value this service and do not wish to be disconnected and be without power for a lengthy period in the event of a fault on their own system (and they also do not want to incur the high costs of reconnection).

Achieving Optimality - Self Selecting Tariffs

It is customary nowadays for utilities to offer their customers a choice of tariffs. Where customers have this choice, the tariffs are called "optional" or "self selecting". Self selecting tariffs are now common place, not only because they give customers a

choice, but also it is often easier to obtain regulatory clearance to offer a new tariff in addition to existing tariffs. Also, any conundrums relating to the increase in surplus to some customers, against the decrease to others, when deciding whether the new tariff provides any economic improvement, are made redundant.

Train 1991 argues that "not all self selecting tariff offerings allow for Pareto dominance or even increase surplus. Indeed, if not appropriately designed, the introduction of a new self selecting tariff can reduce surplus. The successful design of a self selecting tariff requires information on the demand of customers (which the regulator generally does not possess)". To overcome this problem Sibley ("Asymmetric Information, Incentives and Price Cap Regulation", (1989) *Rand Journal of Economics*, Vol.20, No.3) has proposed a regulatory mechanism that will induce a firm (under certain circumstances) to design and offer self selecting tariffs that increase surplus. To be effective, however, Train outlines the following conditions which need to be met to allow the mechanism to operate effectively:

a. "Demand for access to the service is assumed to be fixed independent of price".

b. "All customers have the same demand or the firm knows the demand of each individual customer is able to offer a separate tariff to each customer".

"It was shown that in many circumstances surplus can be improved and Pareto dominance achieved through the judicious use of multipart tariffs and this can be extended to the case of self selecting tariffs which can be said to be the same as multipart tariffs without selection. Self selecting tariffs possess a unique feature that is important in itself and facilitates the analysis of surplus. Specifically, the introduction of a new self selecting tariff in addition to existing tariffs can only benefit customers" i.e. if customers are offered a new tariff without changing the original ones "then no customer is made worse off by this addition and some customers might be made better off". However, although no customer loses out the firm might lose some surplus (e.g. profits may decrease). To paraphrase Train (1991),..... for instance, where time of use (TOU) rates were offered only customers standing to gain from them would choose to switch to them. However, if these customers were non price responsive i.e. the new tariff did not induce a change in consumption behaviour, these customers would only be making savings because the company had priced the tariff in a way that meant that these customers did not have to do anything (other than to change tariff) to save money. Therefore, the company would lose revenue but its costs would stay the same (as off peak production compared to peak production would not have altered). However, if customers were price responsive and therefore a significant amount of consumption shifted into off peak periods (thus saving the company money) then the company would increase profits.

It should be remembered however, that in the real world, where a new tariff is introduced and this leads to a loss for the company concerned, it might be necessary for the firm to change the original tariffs i.e. by raising the rates, which would of course mean that those customers not changing to the new tariff would be worse off.

Tariff Comparisons - Affect on Average Unit Price due to Load Factor Levels and Time Pattern Consumption

In the real world of tariffs, it is usual to find a number of tariff types on offer to customers. However nearly all tariffs will offer some discount for customers prepared to use electricity in off peak periods e.g. at night when generation costs are lower (because only efficient baseload plant is required to meet demand) and this also gives customers an incentive to switch load from peak periods, thus lowering the demand on distribution systems, which of course will mean, that on average, system reinforcement costs will be lower than if all customers chose not to use any electricity in off peak periods.

For larger customers, most tariffs will have some maximum demand charging and peak rate charging, both elements designed to give customers incentives to use electricity outside the main peak times, which tend to be winter weekday afternoons.

Normally, in the UK, a system of self selecting tariffs operate, where a number of tariff choices are given, thus avoiding the need to force customers to use certain types of tariffs. Customers, should therefore, make cost comparisons, before choosing a tariff, based on the past and forecast future levels of electricity consumption and usage patterns.

The tariff selections offered and the difference in price these different terms could have on a particular customer are explained and demonstrated below.

Description of Price Regimes used to Create Different Price Combinations

For the purpose of this explanation we are using 7 different price regimes, which are explained below. First, however, we will give an explanation of the components used in the price regimes.

Components of the Price Regimes

i. Fixed Rate

Also called the Standing Charge. Often used for recouping fixed costs such as metering and connection costs. These costs are not volume related.

ii. Availability Charge

Used to reflect the costs incurred for making available a certain amount of network capacity for a customer whether it is used or not. Usually applied to larger industrial customers charging regimes.

iii. Maximum Demand Charges

Sometimes referred to as MD or 'Max Demand' charges. These are used to recoup the costs of providing maximum capacity in periods of peak demand (i.e. weekday afternoons in the winter months). Again, usually applied to larger industrial customers charging regimes for peak periods only or where used as an 'availability charge' this might be a monthly charge for all 12 months .

iv. kWh Rate

Sometimes called the 'unit' cost. This element recovers the cost of electricity purchased and other volume related charges (e.g. transmission costs and working capital charges).

The 7 Price Regimes (a description of the regimes)

a. Single Rate Tariff

kWh rate 1 (p) 7.00 All days, all hours

Fixed £30.00 The fixed charge levied regardless of consumption
(p) = pence sterling

b. Two Rate Tariff

kWh rate 1 (p) 8.00 All hours except those being used for rate 2

kWh rate 2 (p) 2.00 Night Rate operating from Midnight to 7 am

Fixed £ 40.00

c. Simple Single Block Rate

Fixed £ 30.00

kWh rate 1 (p) 10.00 first 4000 units per annum

kWh rate 2 (p) 7.00 >4000 All other units after first 4000 kWh

d. Block Rate with additional Off Peak Night Rate

kWh rate 1 (p) 11.00 First 4000 units per annum other than those recorded on rate 3
 kWh rate 2 (p) 8.00 >4000 units other than those recorded on rate 3
 kWh rate 3 (p) 2.00 Night Rate operating from Midnight to 7 am
 Fixed £ 48.00

e. 2 rate Night / Day Tariff with Maximum Demand

kWh rate 1 p 5.00 Day time units
 kWh rate 2 p 3.00 Night Rate operating from Midnight to 7 am
 MD rate 1 £1.50 Peak MD recorded in November and February
 MD rate 2 £2.50 Peak MD recorded in December and January
 MD rate 3 £6.00 Max Demand Availability Charge based on the highest recorded monthly demand reading in a rolling 12 month period.
 Fixed £200.00

f. 4 Rate Time of Day and Seasonal Tariff

kWh rate 1 p 13.00
 kWh rate 2 p 8.00
 kWh rate 3 p 5.00
 kWh rate 4 p 3.00
 MD rate 1 £ 1.50 Max Demand Availability Charge based on the highest recorded monthly demand reading in a rolling 12 month period.
 Fixed £250.00

Rates 1 – 4 cover the following periods

- December and January Weekdays 0700hours to Midnight
- November and February Weekdays 0700hours to Midnight
- All other periods other than those above and the night period
- Night = Midnight to 0700 hours

g. 6 Rate Seasonal Tariff

kWh rate 1 (p) 32.00
 kWh rate 2 (p) 16.00
 kWh rate 3 (p) 6.00
 kWh rate 4 (p) 5.00

kWh rate 5 (p) 5.50
 kWh rate 6 (p) 2.50
 Md rate 1 (p) 0.90 (availability charge)
 Fixed £800.00

Rates 1 – 6 cover the following periods

- December and January Weekdays 1600 – 2000 hours
- November and February Weekdays 1600 – 2000 hours
- December and January Weekdays 0700- 1600 then 2000 hours to Midnight
- November and February Weekdays 0700- 1600 then 2000 hours to Midnight
- All other periods other than those above and the night period
- Night = Midnight to 0700 hours

For the purposes of the comparisons given later the tariff regimes will be referred to by their tariff code i.e. 'Single Rate Tariff' = a, 'Two Rate Tariff' = b, etc

For example in the cost comparison tables below for a 'Single Rate Tariff' we will show:

Tariff Code	Charges Per Annum £	Pence per unit
a.	Charges £ 14030	Cost/unit : 7.02

i.e. Tariff Code relates to the codes given above i.e. 'a' = the Single Rate Tariff and total charges were £14,030 per annum and the average pence per unit was 7.02, this figure being derived by using a consumption level of 200,000 units (kWh) over the period of a calendar year.

Specification of Consumption and Demand Levels Used to Achieve Load Factor Levels

In order to obtain the 'Schedule of Price Regime Rates and Outturn Price and Average Pence per Unit to Consumer Outcomes' we need to construct some theoretical usage patterns to enable the calculation of average pence per unit costs to demonstrate the effect of varying load factors on unit price and price regime chosen. Load factor is calculated as:

$$\text{Load Factor \%} = (\text{Annual Consumption kWh} / (\text{Peak MD} \times 8760 \text{ hours})) \times 100$$

Load factor will be mainly affected in our examples by adjustment to Maximum Demand (MD).

For the purpose of this analysis we will use 9 different load factor scenarios which will be applied to the 7 price regimes outlined above. For each scenario, we will consider two outturns, the first based on 24% of total usage being dependant on night use and the second with night usage at 50%. These 9 load factor scenarios are as

follows i.e. 5%, 15%, 25%, 35%, 45%, 55%, 65%, 75%, & 85%. These are described in more detail below.

1. 5% Load Factor

Customer Characteristics

Annual kWh :	200000	% kWh Night :	24	NOV MD :	30
MD	450	% kWh Weekdays :	90	DEC MD :	20
Nov Feb%Units:	1.88	**%PT	5	JAN MD :	20
Dec Jan%Units:	1.95	%LF :	5.07%	FEB MD :	15

* %PT = %Kwh usage at Peak Times = kWh used on Winter Weekday afternoons

Tariff Code	Charges £		Pence per unit (24%Night)	50% Night
a.	Charges £	14030	Cost/unit : 7.02	n/a
b.	Charges £	13160	Cost/unit : 6.58	5.02
c.	Charges £	14150	Cost/unit : 7.08	n/a
d.	Charges £	13288	Cost/unit : 6.64	5.08
e.	Charges £	17693	Cost/unit : 8.85	8.33
f.	Charges £	17681	Cost/unit : 8.84	8.27
g.	Charges £	15269	Cost/unit : 7.63	6.85

Please note that 'a' and 'c' will remain the same for all load factor and night usage combinations as these tariffs do not contain components that are sensitive to these factors. However, 'b' and 'd' change by night usage but not by load factor, whereas 'e', 'f' and 'g' change with both load factor and % night usage.

'n/a' is denoted for options 'a' and 'c' because there will be no change from 24% to 50% night usage for these tariff options, as they are single rate (all day) terms.

2. 15% Load Factor

Annual Kwhs :	200000	% kWh Night :	24	NOV MD :	30
MD	150	% kWh Weekdays :	90	DEC MD :	20
Nov Feb%Units:	1.88	**%PT	5	JAN MD :	20
Dec Jan%Units:	1.95	%LF :	15.22%	FEB MD :	15

* %PT = %Kwh usage at Peak Times = kWh used on Winter Weekday afternoons

Tariff Code	Charges £		Pence per unit (24%Night)	50% Night
a.	Charges £	14030	Cost/unit : 7.02	n/a
b.	Charges £	13160	Cost/unit : 6.58	5.02
c.	Charges £	14150	Cost/unit : 7.08	n/a

d.	Charges £	13288	Cost/unit :	6.64	5.08
e.	Charges £	12293	Cost/unit :	6.15	5.63
f.	Charges £	12281	Cost/unit :	6.14	5.57
g.	Charges £	12029	Cost/unit :	6.01	5.23

3. 25% Load Factor

Annual Kwhs :	200000	% Kwh Night :	24	NOV MD :	30
MD 90		% Kwh Weekdays :	90	DEC MD :	20
Nov Feb%Units:	1.88	*%PT	5	JAN MD :	20
Dec Jan%Units:	1.95	%LF :	25.37%	FEB MD :	15

* %PT = %Kwh usage at Peak Times = kWh used on Winter Weekday afternoons

Tariff Code	Charges £		Pence per unit (24%Night)	50% Night	
a.	Charges £	14030	Cost/unit :	7.02	n/a
b.	Charges £	13160	Cost/unit :	6.58	5.02
c.	Charges £	14150	Cost/unit :	7.08	n/a
d.	Charges £	13288	Cost/unit :	6.64	5.08
e.	Charges £	11213	Cost/unit :	5.61	5.09
f.	Charges £	11201	Cost/unit :	5.60	5.03
g.	Charges £	11381	Cost/unit :	5.69	4.90

4. 35% Load Factor

Annual Kwhs :	200000	% kWh Night :	24	NOV MD :	30
MD 65		% kWh Weekdays :	90	DEC MD :	20
Nov Feb%Units:	1.88	*%PT	5	JAN MD :	20
Dec Jan%Units:	1.95	%LF :	35.12%	FEB MD :	15

* %PT = %Kwh usage at Peak Times = kWh used on Winter Weekday afternoons

Tariff Code	Charges £		Pence per unit (24%Night)	50% Night	
a.	Charges £	14030	Cost/unit :	7.02	n/a
b.	Charges £	13160	Cost/unit :	6.58	5.02
c.	Charges £	14150	Cost/unit :	7.08	n/a
d.	Charges £	13288	Cost/unit :	6.64	5.08
e.	Charges £	10763	Cost/unit :	5.38	4.86
f.	Charges £	10751	Cost/unit :	5.38	4.81
g.	Charges £	11111	Cost/unit :	5.56	4.77

5. 45% Load Factor

Annual Kwhs : 200000 % kWh Night : 24 NOV MD : 30
 MD 50 % kWh Weekdays : 90 DEC MD : 20
 Nov Feb%Units: 1.88 *%PT 5 JAN MD : 20
 Dec Jan%Units: 1.95 %LF : 45.66% FEB MD : 15
 * %PT = %Kwh usage at Peak Times = kWh used on Winter Weekday afternoons

Tariff Code	Charges £	Pence per unit (24%Night)		50% Night
a.	Charges £	14030	Cost/unit : 7.02	n/a
b.	Charges £	13160	Cost/unit : 6.58	5.02
c.	Charges £	14150	Cost/unit : 7.08	n/a
d.	Charges £	13288	Cost/unit : 6.64	5.08
e.	Charges £	10493	Cost/unit : 5.25	4.73
f.	Charges £	10481	Cost/unit : 5.24	4.67
g.	Charges £	10949	Cost/unit : 5.47	4.69

6. 55% Load Factor

Annual Kwhs : 200000 % kWh Night : 24 NOV MD : 30
 MD 41 % kWh Weekdays : 90 DEC MD : 20
 Nov Feb%Units: 1.88 *%PT 5 JAN MD : 20
 Dec Jan%Units: 1.95 %LF : 55.69% FEB MD : 15
 * %PT = %Kwh usage at Peak Times = kWh used on Winter Weekday afternoons

Tariff Code	Charges £	Pence per unit (24%Night)		50% Night
a.	Charges £	14030	Cost/unit : 7.02	n/a
b.	Charges £	13160	Cost/unit : 6.58	5.02
c.	Charges £	14150	Cost/unit : 7.08	n/a
d.	Charges £	13288	Cost/unit : 6.64	5.08
e.	Charges £	10331	Cost/unit : 5.17	4.65
f.	Charges £	10319	Cost/unit : 5.16	4.59
g.	Charges £	10852	Cost/unit : 5.43	4.64

7. 65% Load Factor

Annual Kwhs : 200000 % kWh Night : 24 NOV MD : 30
 MD 35 % kWh Weekdays : 90 DEC MD : 20
 Nov Feb%Units: 1.88 *%PT 5 JAN MD : 20
 Dec Jan%Units: 1.95 %LF : 65.23% FEB MD : 15
 * %PT = %Kwh usage at Peak Times = kWh used on Winter Weekday afternoons

Tariff Code	Charges £		Pence per unit (24%Night)	50% Night
a.	Charges £	14030	Cost/unit : 7.02	n/a
b.	Charges £	13160	Cost/unit : 6.58	5.02
c.	Charges £	14150	Cost/unit : 7.08	n/a
d.	Charges £	13288	Cost/unit : 6.64	5.08
e.	Charges £	10223	Cost/unit : 5.11	4.59
f.	Charges £	10211	Cost/unit : 5.11	4.54
g.	Charges £	10787	Cost/unit : 5.39	4.61

8. 75% Load Factor

Annual Kwhs :	200000	% kWh Night :	24	NOV MD :	30
MD 30		% kWh Weekdays :	90	DEC MD :	20
Nov Feb%Units:	1.88	*%PT 5		JAN MD :	20
Dec Jan%Units:	1.95	%LF : 76.10%		FEB MD :	15

* %PT = %Kwh usage at Peak Times = kWh used on Winter Weekday afternoons

Tariff Code	Charges £		Pence per unit (24%Night)	50% Night
a.	Charges £	14030	Cost/unit : 7.02	n/a
b.	Charges £	13160	Cost/unit : 6.58	5.02
c.	Charges £	14150	Cost/unit : 7.08	n/a
d.	Charges £	13288	Cost/unit : 6.64	5.08
e.	Charges £	10133	Cost/unit : 5.07	4.55
f.	Charges £	10121	Cost/unit : 5.06	4.49
g.	Charges £	10733	Cost/unit : 5.37	4.58

9. 85% Load Factor

Annual Kwhs :	200000	% kWh Night :	24	NOV MD :	30
MD 27		% kWh Weekdays :	90	DEC MD :	20
Nov Feb%Units:	1.88	*%PT 5		JAN MD :	20
Dec Jan%Units:	1.95	%LF : 84.56%		FEB MD :	15

* %PT = %Kwh usage at Peak Times = kWh used on Winter Weekday afternoons

Tariff Code	Charges £		Pence per unit (24%Night)	50% Night
a.	Charges £	14030	Cost/unit : 7.02	n/a
b.	Charges £	13160	Cost/unit : 6.58	5.02
c.	Charges £	14150	Cost/unit : 7.08	n/a

d.	Charges £	13288	Cost/unit :	6.64	5.08
e.	Charges £	10079	Cost/unit :	5.04	4.52
f.	Charges £	10067	Cost/unit :	5.03	4.46
g.	Charges £	10701	Cost/unit :	5.35	4.56

Although the information for the comparisons is based around a contrived theoretical customer consumption pattern (in real life a customer choosing a tariff would make an effort to utilise the low cost periods of the tariff) it is useful to demonstrate how customers usage patterns and choice of tariff can affect final price paid. If customers fail to appreciate these differences, they will risk paying more for their energy than they need to (although most energy supply companies do offer advice on tariff choice).

For example, as demonstrated by the tables, tariff 'b' with 50% night consumption at low load factors is the cheapest choice, however at higher load factors, all the MD type tariffs are cheaper than 'b'. This is due to the fact that the main unit price for MD type tariffs is cheaper than the 2 rate 'day/night' type tariff and therefore, at high load factors, this unit cost advantage outweighs the cost of the additional MD related charges.

Rationality of Customer Choice of Tariffs

When considering the increase in surplus that different tariffs bring we usually assume that the customer chooses the tariff that will provide them with the lowest average price. However, empirical research shows that customers do not always choose this option (for example see Kling and van der Ploeg 1989 "Estimating Local Telephone Call Elasticities with a Stochastic Model of Class of Service and Usage Choice" - MIT) i.e. a significant number of customers chose tariffs that did not provide the lowest bill for their actual level of consumption. In Great Britain, where Time of Use terms have been offered by electricity companies, many customers have not switched to these tariffs, even where they would have made savings by choosing these new tariffs.

If customers do not choose the cheapest tariff because they are miscalculating (or not calculating at all) then one of the biggest advantages of self selecting tariffs is lost; conversely, if they mistakenly choose the new tariff and they are worse off they have reduced their surplus. Pareto dominance relies on the belief that by making a new tariff option, in addition to the existing tariff choices, this will not adversely affect any customer. If customers make mistakes however, 'Pareto' dominance is severely weakened.

However, customers may not be choosing the right tariff for other reasons. These reasons may include the issue of risk (i.e. the customer does not know his exact future consumption pattern and so he may choose a single rate tariff over multi rate terms, as in all likelihood he may not use enough of the cheap rate to make it worth his while to

switch to the multi rate tariff). Another reason is the potential cost saving i.e. if it is small it may not be worth searching for another tariff. This ties in with the effort of optimisation - the inconvenience of using extra effort to find a better tariff and continually check that it is more cost efficient to be on that tariff may be considered too much effort, and therefore, customers will not bother searching for alternative tariffs.

Asymmetric Information and Regulation

One of the main problems all regulators experience is the lack of information available to them to help them regulate. After all, if the regulator had complete information about the firms costs and industry conditions he could simply design the most economically efficient plan and instruct the firm to follow it. However, the firm obviously knows more about itself and the industry than the regulator and may use this knowledge to gain an advantage over the regulator. Therefore, the regulator has to resort to using techniques which will help him reveal true costs and demands (including unobservable effort) and these are known commonly as "truth revealing mechanisms". Most of these models are rarely used in practice and therefore we will only refer to these briefly.

Baron and Myerson (see Baron and Myerson 1982 "Regulating a Monopolist with Unknown Costs") devised a model that allowed the regulator to discover a company's true cost (i.e. where the company knows their true costs but is not willing to disclose them).

An excellent in depth analysis of regulating with asymmetric information is given in Caillaud, Guesnerie, Rey and Tirole (1985) "The Normative Economics of Government Intervention in Production in the Light of Incentive Theory"

Regulation and Politics

The political causes of regulatory policy became an important issue in the 1970's with the publication of Stigler's highly influential paper (Stigler, G.J. (1971) "The Theory of Economic Regulation", *Bell Journal of Economic and Management Science*, 2:3-21) which led subsequently to his award of the Nobel Prize. This area of study was motivated by the problems associated with market failures, governments' attempts to rectify these failures through regulation and whether these attempts to overcome market failure were more efficient than doing nothing. Therefore, the market failure rationale has three separate components - first a positive theory of conditions under which a market produces an inefficient outcome, second a normative theory that government ought to undertake actions to improve the efficiency of poorly performing markets and finally a positive theory that expects government to overcome significant market failures through regulation.

The introduction and extension of regulation has been defended by its proponents on the basis of supposed market failures (for instance see Breyer, G.S. 1981). The three main types of market failures that have been used to justify regulation have been (1)

natural monopoly, (2) imperfect information and (3) the presence of external effects and public goods. Two other rationales have also been used, these being scarcity rent and destructive competition.

An important concept here is that of the public interest theory that government should adopt regulatory strategies that cope with market failures. However, economic literature contains a number of alternatives for coping with market failure other than regulation such as competitive bidding for franchises as advocated by Demsetz or the use of taxes and subsidies. In addition, some market failures can be overcome simply by redefining property rights and creating markets in them (i.e. for instance, Spitzer, M.L., 1987). However, the positive theory of public interest regulation states that the regulatory policies which are adopted will be the most effective remedy for a market failure.

Surprisingly, many people believe that regulation can make matters worse. Noll (1989) states "many scholars in law, philosophy, political science, and psychology reject welfare economics as having interesting normative content and microeconomic theory as a relevant scientific approach to studying political behaviour".

Noll and others have noted that the tenants of the economic theory of policy making, (which includes regulation), is also reliant on the concepts of cost of trading and the problems associated with asymmetric information and agent management. Regulators depend on a myriad of agency partners involving multiple principals and agents i.e. elected political officials act as agents for their constituents, regulatory agencies act as agents for these political officials etc. Elected politicians decisions are enforced through various means including legislation, enabling orders, appointing agency leaders and the control of finance. Governments normally delegate policy control, budgets and responsibility for formulating legislation to committees and full time officials. As the complexity of the agency relationships may cause inertia, the scope and interpretation of the instructions of elected Politicians depends heavily on (according to Noll 1989) several important factors, these being;

- a. The extent to which principals and agents have conflicts of interest.
- b. The costs and accuracy of methods for principles to monitor the performance of agents.
- c. The power of the principles' enforcement mechanisms for redirecting the incentives of the agent.

Therefore, policy drift can occur i.e. what politicians promised the electorate would happen may not be achieved, either partly or in total. Drift can occur for instance where agents own policy preferences go unnoticed and unchecked because monitoring may be too expensive or the need for it had not been anticipated.

Another set of problems we have not yet identified are those that the voter faces in checking and influencing the actions of its Politicians. Most members of the electorate are powerless as individuals, as a single vote is unimportant and cannot

convey the intensity of the individual voters wishes. In addition, voters cannot air their views on each issue; they therefore have to reject or accept the whole manifesto being offered. In addition, voters have to be prepared to make large efforts for few benefits in trying to undertake in-depth analysis of its politicians preferences and therefore it is not surprising that voters are poorly informed about policies and choose only to vote on a few major issues which affect them. A further difficulty stems from the problem of assigning responsibility for the performance of the public sector (see for instance Fiorina, M.P. (1981). Assigning responsibility for a change can be difficult as elected officials, the courts and the administration all play a role in shaping policy and ensuring its introduction.

Noll (1989) and Moe (1980) have both commented on how organised pressure groups help counteract the problem of insignificant influence and informational complexity in electoral systems. To paraphrase their arguments, persons joining the group pay to monitor the performance of politicians and government departments and as the group represents a significant number of votes, they may be able to influence policy. Key politicians may also be given funding and therefore, these group members are more likely to have influence with politicians than unidentified voters. However, it must be remembered that the decentralised nature of Political Parties and the Civil Service found in most democracies acts as a antidote against the possible excessive influence which could be exercised by organised pressure groups. However, as pressure groups differ in their ability to organise and fund themselves, there is a key public interest implication for policy, in that the better organised pressure groups are likely to be successful promoters of their views with policy makers because the time, effort and costs of attacking them will be too exhausting. In addition, unorganised voters will be unlikely to know of the policy decisions that are detrimental to them and from the pure perspective of economic policy, this favouring of the most organised group may mean that policy departs from the most efficient economic outcome. When a policy is reached where pressure groups have obtained what they wanted from policy makers, the surplus gained, which is sometimes called monopoly rents, will be shared amongst the members of the pressure group. Pressure groups are also formed to capture rents because a market failure has fallen heavily on members of the group in the past and therefore this failure has provided the impetus to form the group to recapture the surplus belonging to the them.

Indeed, over a period of time, the monopoly rents effectively stolen from unrepresented voters will eventually lead to these unrepresented voters taking an interest in regulation. Externally imposed reform will eventually arise because of the impact on unrepresented voters, who having paid the cost of this biased regulation, are forced to take effective political action. In addition, some represented groups who are party to rent sharing will perceive that their share of the rents from regulation have shrunken sufficiently to show that their net returns from the system as a whole are negative, which will lead to renewed efforts from them to capture new sources of rent or recapture old ones.

The effects of rent sharing display themselves in higher charges than necessary to consumers, barriers to entry, lack of innovation and less than efficient production. An example of this is illustrated in the number of firms operating in transportation before

and after deregulation (see Bailey, E.E., Graham, D.R. and Kaplan D.P. (1985) "Deregulating the Airlines" Cambridge: MIT Press).

Therefore, the overall picture is one that suggests that organised interests do succeed usually at the cost of economic efficiency by capturing regulators until those who are made worse off organise themselves to do something about it.

Avoiding Regulatory Capture

As discussed above, we have seen that regulators can be captured and induced to follow less than optimal economic policies, not only by the industry's they regulate but also by other interest groups and by the officials who have been appointed by politicians to administer them. Foster (1992) outlines a number of ways that regulatory capture can be avoided or at least checked and these are as follows:

1. "Experience suggests that it requires an independent regulator who retains substantial discretion to interpret and decide regulatory offences".
2. "The adoption of elaborate, court-like procedures, and a right of appeal to the courts on merits and the interpretation of the law, are likely to favour the regulated industry".
3. "The adoption of procedures by a regulator which protect natural justice without leading to over elaborate and costly proceedings is likely to check regulatory capture. Such natural justice may be protected by a right of appeal to a court".
4. "If there are to be appeals on merits and interpretation of the law they should be preferably to a similar regulatory body with similar discretion and procedures".
5. "The more firms within an industry a regulator regulates the less likely he is to be captured by any of them, except where there is one dominant or they are able to make common cause against him because their interests are complementary".
6. "The more influence on a regulator that is given to interested parties other than the regulated the more likely it is that he will strike a balance between those interests and those of the regulated industry, preventing or checking capture by any party".
7. "As important as any other is the consideration that ministerial and other political influences must be constrained as far as possible to roles that do not allow them to have opportunities to impose uncompensated burdens on regulated industries with a significant effect on their efficiency".
8. "The interest that most needs to be built up is that of the consumer. One needs an apparatus to reflect the consumer's economic interest intelligently, since consumers tend to be apathetic. But one should not make them dominant, as that could lead to regulatory failure".

Another aspect of the situation to consider when looking at the extent to which regulation can induce economic efficiency and serve the public interest, is the monopoly power the regulator has because he has no competition, in the sense that the regulator has no direct competition for his role of regulator (see for instance Alessi, L. de (1975) "An Economic Analysis of Government Ownership and Regulation" Public Choice, vol.19, pp.1-42). Just as all other monopolies would maximise their monopoly position, so will the regulator. Therefore, some economists have argued that competition should be brought into regulation i.e. all parties concerned (e.g. customers, the firm, the government, other interested and affected parties) would choose a regulator (from a selection) that would give them the greatest surplus. However, the formal procedure for this type of selection could be complicated if not unworkable. In the United States many companies have more than one regulator, being differentiated by geography, procedures and process which has led to competition between the regulators concerned. However, it has been argued that this multi regulator arrangement has been responsible for poor regulatory decisions (see for instance Wenders, J.T., 1987). It could be argued that the law courts provide a form of competition because, in a way, lawyers and the courts compete in their understanding of the law and regulatory decisions and these hearings may result in further changes to the law and regulatory principles. However, giving legal precision to economic cases, as demonstrated on the railways in the last century, can lead to economic and commercial nonsense.

Foster (1992) notes a different kind of competition arises where a regulatory Commission sits with a number of commissioners as its members, who then take decisions collectively. These commissioners will have differing views of what the public interest is i.e. some in line with customer groups and others favouring the regulated industry. The UK regulatory model prefers single to commission type regulation. In the United States most commissions over the past 30 years have seen a scenario develop where the Chairman's view tends to be final and decisive.

Using a single regulator has the advantage that they are able to make more consistent decisions, which could be said to be in line with the philosophy that the more a situation requires the use of discretion, the more it requires a single person to weigh it up e.g. see Solo, R.A. (1980). However, in order to curb any excess there needs to be some appeals procedure i.e. so that justice and fairness can be clearly demonstrated (the appeal should be to another body specialising in economic regulation such as the Monopolies and Mergers Commission).

Competition can also be induced by limiting the term of appointment of each regulator, any extension of the term being given by an elected official (although performance here will be judged by politicians not always on purely economic terms). Replacing one regulator with another will also risk a certain loss of consistency from the regulatory process.

The Case for Regulatory Reform in the UK

The case for reforming the UK system has been strengthened recently, partly because of the perceived excessive returns for utilities and in addition for other reasons, one of which is the lack of transparency that the present system has and the problems this causes for those companies (and other stakeholders) who are being regulated.

Helm (1994) puts forward five arguments for reform in the UK system of regulation. These can be summarised as:

1. **Regulatory Arbitrage (Substitution)** - This deals with the effects that can occur where regulators decisions for two different industries (e.g. Gas and Electric) which are interrelated are inconsistent. As Helm (1994) states "the potential and actual exercise of discretion over each of the main determinants of price caps (OPEX, CAPEX, asset valuation and cost of capital) and over the promotion of competition, creates uncertainty about regulatory decision making. This, in turn, has created a major activity among utilities, consultants and financial analysts in modelling and attempting to predict how each individual DG will exercise his or her discretion. The uncertainty encourages speculation and consequently affects the pricing of utility shares in equity markets. The resultant volatility may raise the cost of capital. A process of regulatory capital market substitution takes place, as investors switch between utilities, betting on the conduct of the regulators".

In addition, 'product market distortions' can occur. At present each regulator acts independently when deciding on issues of price level and structure. Where inconsistencies occur, this may lead to three forms of distortion. These are described by Helm as;

- a. Inaccurate pricing leading to under or over investment.
- b. Differential pricing between networks leading to substitution between utilities.
- c. Location distortions as suppliers locational requirements are sensitive to transmission pricing (e.g. Gas fired generation in the north but demand in the south). That is, building generating plant near to where its output will be used can reduce transmission system usage and therefore transmission costs and prices.

2. **Capture** - there is evidence that UK regulators have been captured by utility shareholders i.e. that the returns made by shareholders in UK utilities far outweigh those in other countries, particularly where rate of return regulation is in operation. There is also evidence to suggest that fuel price reductions have not been passed through to customers in Britain as much as in mainland Europe (Stern 1994).

3. **Administration Costs** - As the tools and skills required to regulate one utility is nearly always identical to another (e.g. calculating cost of capital, asset valuations, OPEX and CAPEX for price setting can be done using a common set of tools) a degree of merger between regulatory offices could lead to cost savings. It should also be remembered that the main costs of regulatory administration fall on the utilities as they have to create specialist units to track and predict the behaviour of their regulator.

4. Investment, Sunk Costs and Regulatory Hold-up. Regulation has now replaced the role of public expenditure appraisal in controlling investment. For utilities the major problem in investing is that the investment is usually long term and sunk and this is out of step with periodic regulatory reviews of 3-5 years which means that returns on investment cannot always be guaranteed (at least in the planned timescale). This uncertainty for investors means that capital is rationed or the cost of capital is increased. In the private sector this problem has been overcome by vertical integration (e.g. industries with upstream sunk costs (oil refining) have integrated downstream to ensure final markets (petrol retail stations). However, regulation is an obstacle to this arrangement and therefore utilities have replaced vertical integration with long term contracts (e.g. 10-15 year contracts for Independent Power Projects (IPP's) with RECs). The key question is, therefore, whether the regulatory system can facilitate the emergence of long term contracts with customers. This is unlikely under the present system as long term contracts prevent entry. The result is likely to lead to significant distortions in investment decision making.

5. Political Instability. As utilities costs comprise 20% of the bottom 20% of households spending and comprise a significant proportion of GDP, they will always remain under public scrutiny. As investment in utility firms is long term and sunk in the majority of cases, a degree of political stability is important. However, as elections are periodic (every 4 to 5 years) and regulators are appointed by their political masters, there is a risk that a change of government could alter the regulatory rules (and the regulator) with all the associated consequences this could have on issues such as pricing, introduction of competition and energy efficiency. This political uncertainty can increase utilities costs of capital and affect their investment decisions.

The recent spate of take-overs in the electricity sector also caused concern amongst regulators. The apparent attractiveness of the Regional Electricity Distributors to foreign utilities and UK water companies has raised concerns about the effectiveness of regulation to control and regulate multi utility concerns, especially where foreign ownership is involved. These take-overs have led to calls for separate listings for these companies, both to part them from their parent companies and in addition, their supply (potentially competitive) and distribution businesses (usually a natural monopoly).

Chapter Two

Electricity Industry
International Price Determinants

Chapter 2

Introduction

In this Chapter there is an econometric analysis of international electricity prices which will give an explanation of the variance in electricity prices between countries. The model built for this exercise utilises price data from eleven countries along with other quantitative information for these countries using a four year period which means that a panel data regression was used. The model attempts to analyse electricity prices in terms of a non traded good, using the work by Falvey and Gemmell (1991) regarding the explanation of service price differences in various countries as the starting point for much of the analysis.

As this Chapter also relies on econometric analysis, there is a discussion relating to Econometric modelling and, in particular, as a panel data regression is used, there is an explanation of 'Pooled Cross Section Time Series' modelling.

Much of the analysis in this Chapter is dependant upon the use of Purchasing Power Parities (PPPs) to convert international cost, price and economic data into a single currency; therefore this Chapter starts off with an explanation of PPPs and why they are used.

An Explanation of Purchasing Power Parities (PPP's)

According to Begg, Fischer and Dornbusch (1984) the "definition of long run equilibrium requires that the economy is both in internal balance (full employment) and external balance (zero net exports and current account balance). Import demand depends on domestic output and on the real exchange rate. Export demand depends on foreign output and on the real exchange rate. Hence, when both the domestic economy and the rest of the world are at internal balance or potential output there is only one real exchange rate compatible with external balance at the same time. At any higher real exchange rate, the domestic economy will be less competitive. Imports will be higher and exports lower and the country concerned will have a current account deficit. Conversely, at any lower real exchange rate, the domestic economy will have a current account surplus. Only one real exchange rate is compatible with internal and external balance at the same time".

"Our theory of floating exchange rates in the long run can be summarised very simply. When exchange rates float freely, there is no official intervention in the foreign exchange market and no net monetary transfer between countries since the balance of payments is always zero. Just as in a closed economy, the domestic money supply is determined by the quantity of high powered money issued by the government and by the extent to which the domestic banking system creates domestic bank deposits against this monetary base. In the long run the domestic money supply will determine the domestic price level just as in a closed economy....in the long run the nominal

exchange rate must adjust to achieve the unique real exchange rate required for external and internal balance in long run equilibrium”.

According to Eurostat, the calculation of purchasing power parities became necessary once it was realised that international comparisons of gross domestic product (GDP) based on conversion into a common currency using exchange rates did not provide a reliable indication of the volume of goods and services intended for a particular final use. For many years it was assumed that exchange rates could be relied upon, at least during periods of relative stability between the currencies, as a good alternative to purchasing power parity rates, but this assumption was wrong and this realisation that comparison exercises using exchange rates could be flawed, meant that PPP's are now an important means of achieving a level playing field in international economic comparative studies. Therefore, they have been utilised for the statistical comparisons used in this thesis as we are dealing with international data.

The exchange rate does not necessarily reflect the real purchasing power of a currency on the national territory as it is determined mainly on the one hand by the demand for and supply of foreign currency needed to pay for the goods and services traded between countries and, on the other hand, by factors such as capital flows, speculation and the political and economic situation in the country. Consequently, a comparison of data converted by means of exchange rates can be subject to considerable complexities and distortions i.e. varying from country to country and sector to sector.

Eurostat notes that to calculate the parities, it is necessary to refer to the flow of products, the values of which are broken down into a price and a volume component. In national accounts, two types of products can be distinguished;

- a. Final products.
- b. Intermediate products, those which are re-used in the production process to produce final products.

Only the prices of final products are taken into account in calculating the parities and their sum gives the gross domestic product. The price level of this flow can be regarded as an indicator of the general level of prices in a given country. However, comparisons between countries can also be made for price levels of specific flows. Obviously, the specific parity rates differ according to the flow and are not identical to the overall rate because the existing price structures in countries are not always exactly the same.

The work programme of the Statistical Office of the European Communities (Eurostat) in the field of purchasing power parities, is part of the International Comparison Project (ICP) being carried out by the United Nations at world level. Every five years (i.e. base or reference years) the estimates of parities and real values are made on the basis of wide ranging surveys at a very detailed level, while for the intervening years the estimation procedure is much less complex and at a more aggregated level.

Utilisation of PPP's

The interest generated by comparisons of the purchasing power of GDP in real terms (as explained by PPP's) has grown steadily, according to Eurostat, since they were introduced. The main users are the international institutions and organisations, particularly the various UN bodies, the OECD and the institutions of the European Communities, which can use these data for political and economic purposes. However, over the last 10 - 15 years the circle of users has widened considerably to such areas as the business world, universities, government departments and private individuals.

The use of the parity alongside the exchange rate for conversion purposes has come up against a number of problems since its creation because it is a relatively new statistical instrument.

In general, it can be said that PPP's are being used in fields where it was previously the custom to make comparisons between countries, using data converted into, for instance ECU's, by means of exchange rates. The first application of parities is in national accounts and in particular, comparisons of GDP. However, it should be borne in mind that there are some reservations to using PPP's in analysis work, as they do not always reveal the reality of the situation. For instance, energy price comparisons in PPP's do not reveal the impact on businesses of price differentials in energy (especially if that business has international competitors) i.e. the business pays for energy in real currency terms which are immediate and not in PPP's terms, which are long term.

Use of the parities, especially outside the field of national accounts, raises the problem of which rate should be used. Should it be the overall GDP rate or, depending on the type of value to be converted, specific rates which existed for the 260 or so basic headings of GDP, or in certain cases, specific rates that are not obtained as part of the normal calculation of parities, but would have to be specially devised according to the requisite data sets individual requirements. It should also be noted that specific parities are costly, difficult and time consuming to calculate and their use is not as popular as the overall GDP parity.

The overall parity has a number of advantages such as being easy to interpret, it also eliminates the effect of differences in the general level of prices and, above all, avoids the need to produce large numbers of specific parity rates. Therefore, in the study presented in this submission, we will be using the overall parity rates as published for each individual country.

Tradable and Non Tradable Goods

When comparing the prices of commodities and services it is sometimes useful to distinguish between traded and non traded goods. Services, such as expenditure on personnel (i.e. government employees), public transport and communication, public entertainment and energy (e.g. electricity) plus construction constitute non traded

goods; all others are placed in the traded classification (see Kravis, I.B., Heston, A., and Summers, R. (1978) "International Comparisons of Real Product and Purchasing Power", John Hopkins University Press for the World Bank). According to Kravis, Heston and Summers the definition of 'tradables' and 'non tradables' derives from the distinction that can be made between commodities and services "services are defined as including categories in which expenditures are on goods that cannot be stored. These include categories in which personal services are being engaged (for example, domestic services, teachers and government employees), repairs of various kinds (footwear, auto), rents, public transport and communication, public entertainment, restaurants and hotels. All other categories of GDP are regarded as commodities. The distinction between the services/commodities and tradable and nontradable classification lies in the treatment of construction. Tradables consist of all commodities except construction; non tradables consist of all services plus construction".

Therefore, as electricity constitutes expenditure on goods that cannot be stored it can be regarded as a nontradable good.

An often expressed generalisation holds that the expenditures on services tend to rise as per capita incomes increase. Kravis, Heston and Summers in "The Share of Services in Economic Growth" (1982) noted that services are much cheaper in the relative price structure of a typical poor country than in a rich country. This was explained by them as follows:

"As a first approximation it may be assumed for purposes of explaining the model that the prices of traded goods, mainly commodities are the same in different countries. With similar prices for traded goods in all countries, wages in the industries producing traded goods will differ from country to country according to differences in productivity - a standard conclusion of Ricardian trade theory. In each country the wage level established in the traded goods industries will determine wages in the industries producing non traded goods, mainly services. Because international productivity differences are smaller for such industries, the low wages established in poor countries in the low productivity traded goods industries will apply also to the service and other nontraded goods industries. The consequences will be low prices in low income countries for services and other non traded goods."

This explanation is also to be found in Balassa (1964), Samuelson (1964) and Harrod (1933).

International Electricity Price Differences - Use of Econometrics

The Basis of the Experiment

The model built for this part of the analysis utilises the work of Falvey and Gemmill (1991) regarding the differences in the price of non traded goods in various countries. As discussed earlier, electricity can be regarded as a non traded good. The model (The International Utilities Econometric Price Model - IUEPM) uses a framework

inspired by Falvey and Gemmell to analyse the significance of a number of factors on the price of electricity in order to obtain an explanation of the international differences in the price of this commodity.

The basis of the experiment was to see whether international electricity price differences were due to reasons relating to international effects on energy inputs (e.g. the price of oil) or whether the price paid by consumers was more reliant on indigenous regulation effects. An example of the differences in electricity prices between the countries in the model is given below using 'domestic' customer prices in 1985 as an illustration. Prices have been converted using Purchasing Power Parities.

Country	1985 PPP kWh
Belgium	17.12
Denmark	9.79
France	12.43
Germany	13.36
Ireland	13.71
Italy	22.47
Portugal	20.54
Spain	16.44
UK	12.07
USA	12.81
Japan	15.07

The Data Sample for the IUEPM

The data sample used was over four separate time periods (i.e. 1981, 1982, 1983 and 1985).

For each time period we used price data for 4 different types of customer and these were:

- i. Domestic Customers - Consumption 3300 kWh per annum
- ii. 100kW Maximum Demand - 20% Load Factor Customers
- iii. 500kW Maximum Demand - 60% Load Factor Customers
- iv. 2500kW Maximum Demand - 20% Load Factor Customers

The four year period (i.e. 1981, 1982, 1983, and 1985) was chosen because there were no data gaps for this period. It was also chosen because there were no significant intra period regulation changes in the countries concerned (e.g. the subsequent change from public to private ownership in the UK electricity supply industry). The countries used for the sample, eleven in total, were Belgium, Denmark, France, Germany, Ireland,

Italy, Portugal, Spain, UK, USA and Japan. The completed model shall be referred to as the International Utilities Econometric Price Model (IUEPM).

The regression process in the model was undertaken using the 'Shazam' econometric modelling software.

As previous published work on the price of traded and non traded goods (e.g. Falvey and Gemmell's paper published in 1991 regarding 'Explaining Service Price Differences in International Comparisons') forms the basis of the methodology used to build the IUEPM, it is appropriate that this work is now discussed along with other relevant references.

Some Recent Analysis on the Factor Productivity Explanation of International Differences in Service Prices

As mentioned above, some relevant work in relation to econometric modelling concerning international differences in prices can be found in the literature regarding international factor endowment and productivity differences (which deals with the effect these factors have on the price of traded and non traded goods). As electricity can be regarded as a non traded good, this literature is particularly relevant.

As mentioned earlier a contribution to this field of analysis comes from Falvey and Gemmell (Falvey R.E. and Gemmell, N. (1991) "Explaining Service Price Differences in International Comparisons", *American Economic Review*, 81, 1295-309)

The above paper sets out to build upon previous models which were devised to try and explain the determinants of international differences in the prices of services relative to tradable commodities. Falvey and Gemmell's model identifies the effects of differences in factor endowments, population, trade balance and trade impediments to explain the differences in service prices (i.e. non traded goods) found in the countries investigated.

The work of Kravis, Heston and Summers (KHS 1982) has shown that there are quantifiable differences between countries in terms of services relative to commodities. In addition, these differences have been shown to be positively correlated with differences in per capita real incomes.

Much of the work of KHS is influenced by Harrod (1933) who was of the opinion that the price of nontraded services (e.g. transport and domestic services) relative to traded commodities could be expected to be higher in countries with higher per capita incomes. The Kravis, Heston, Summers and Harrod explanations are based on the effect that differences in factor productivities (or technologies) have on service prices across countries. The crux of this "Factor Productivity Hypothesis" (FPH) is that countries with a low factor productivity overall (low real income per capita) will, in relation to traded goods, be relatively more productive in services and therefore have lower service prices. Bhagwati (1984) provided the first multifactor model to explain price differences in terms of factor productivity differences. Bhagwati also

demonstrated that factor endowment differences can also be used to explain observed service price differences. Later research and papers such as Falvey and Gemmell (1991) have focused on the factor endowment explanation partly because of the absence of data on sectoral total factor productivity differences across countries.

Using duality models of trade and national income accounts, the Falvey Gemmell model (as set out in their 1991 paper) derives a reduced form equation for the difference between a country's service prices (non traded goods prices) and those of a base country. This difference is expressed as Δp_s , and therefore the Falvey Gemmell model has the approximate form:

$$\Delta p_s = f(\Delta v, \Delta b, \Delta p_t, \Delta y)$$

where:

Δv = the difference in factor endowments relative to the base country.

Δb = the difference in the balance of trade deficit to the base country.

Δp_t = the difference in the price of non traded goods relative to the base country.

Δy = difference in per capita income compared to the base country.

The explanation for the role of these variables can be given briefly as follows.

Δv reflects the role of endowments in raising relative real income and therefore the demand for non traded goods.

Δb explains the role of the real trade deficit in raising the demand for non traded goods.

Δp_t will also increase real demand for non traded goods in the country experiencing the relative rise in the price of its traded goods.

Δy reflects the difference in real per capita income, long believed to be a cause of differences in non traded goods prices.

Later work by Falvey and Gemmell (1993) further confirmed the FPH hypothesis of Harrod (1933), KHS (1982), Kravis and Lipsey (1983) and Bhagwati (1984) i.e. that is average differences in sectoral factor productivity across countries appear to be positively correlated with differences in real incomes per capita and that the relative magnitudes of sectoral TFP differences in tradables versus services appear to be consistent with that required to produce a positive correlation between real income per capita and service prices.

The question the FG model now asks is whether the estimated productivity terms used in the FG model have any significance in relation to how much they explain service

price differences. The FG model uses data generated from regression residuals to estimate the effects of sectoral TFP differences. This use of regression residuals by the FG model builds on the results from the 1993 Falvey and Gemmell paper, which in turn draws on the work relating to 'rational expectations' in the 1970's e.g. by Sargent (1976) and Barro (1977) and the econometric issues involved with the use of these residuals which is explored in Pagan (1984) and suggests, that any explanation of international differences in the price of services is enhanced, if both factor endowment differences and total factor productivity differences are recognised, even if TFP differences appear to affect prices less than factor endowment differences. However, for the purposes of our model (i.e. the IUEPM) due to data restrictions, we have concentrated on factor endowment differences.

The conclusion of the FG paper is that the observed positive correlation between service prices and real incomes per capita across countries can be partly explained in terms of differences in sectoral factor productivities across countries. Therefore, the Factor Productivity Hypothesis (FPH) can be regarded as a complementary factor to the endowment explanation rather than an alternative. When combined with endowment factors the model provides a good explanation for international differences in service prices and the positive correlation between service prices and real incomes per capita.

Overall the FG model did concur with the FPH hypothesis i.e. that is average sectoral factor productivity differences did meet the appropriate FPH conditions in that the results of the model showed that sectoral productivity differences are positively correlated to real incomes per capita and service TFP differences do appear to be smaller than tradable differences. The model also detected some evidence to support the supposition that countries with higher productivity will exhibit higher service prices. However, for the purposes of the IUEPM, we are interested in the endowment factor explanation and their effect on price rather than the effects due to factor productivity differences.

Utilising the Work of Heston, Falvey and Gemmell et al to Construct the IUEPM

We can assume, for the purposes of constructing a framework for the IUEPM, that comparable 'traded goods' will be roughly equal in price in different countries, when corrected by purchasing power parity exchange rates. However, we can expect 'non traded' goods to show a difference in price i.e. that

$$\left[\frac{P_{NT}}{P_T} \right]_i : \left[\frac{P_{NT}}{P_T} \right]_j$$

can be used as a measure of the real exchange rates for two economies i and j. It can be said, therefore, that the Falvey Gemmell model is a widely known hypothesis for the explanation of non traded goods prices. Therefore,

$$\frac{P_{NT}}{P_T}$$

will vary positively with the country's GDP per capita.

The object of the analysis in this section is to take the work of Falvey and Gemmell and extend it to international electricity prices by treating electricity prices as non traded goods. However, in addition to the Falvey Gemmell effects, the IUEPM uses other factors that may explain differences in electricity prices and by implication raises the possibility that ownership and regulation factors may also be significant in relation to electricity prices.

Use of the 'Generalised Linear Regression Model'

Classic regression modelling uses rather restrictive assumptions concerning the way regression disturbance behaves. This prevents a three dimensional econometric analysis of a data set. For our modelling purposes in the IUEPM, we are interested in data observations relating to eleven different countries, over four time periods utilising data for each of these years relating to each countries electricity prices e.g. net thermal generating capacity, balance of trade etc (these will be specified more fully later) and this requires a more three dimensional approach.

Therefore, in this instance, for the IUEPM regression analysis we needed to use an alternative model. In 'Elements of Econometrics' (Kmenta, J., Macmillan 1971) Kmenta describes such a model i.e. the Generalised Linear Regression Model (GLRM) which he states 'an interesting application of this model is (to) observations on a number of cross-sectional units over time' 'the classical normal linear regression model is characterised by a number of assumptions concerning the stochastic disturbance in the regression equation including homoskedasticity and nonautocorrelation'. Kmenta describes the disturbance term ε_i in

$$Y_i = \beta_1 + \beta_2 X_{i2} + \beta_3 X_{i3} + \dots + \beta_K X_{iK} + \varepsilon_i$$

this is supposed to satisfy the following requirements:

$$E(\varepsilon_i^2) = \sigma^2 \text{ for all } i$$

$$E(\varepsilon_i \varepsilon_j) = 0 \text{ for all } i \neq j$$

These assumptions in the matrix notation can be described by

$$E(\varepsilon \varepsilon') = \sigma^2 I_n$$

where

$$\epsilon = \begin{pmatrix} \epsilon_1 \\ \epsilon_2 \\ \cdot \\ \cdot \\ \cdot \\ \epsilon_n \end{pmatrix}$$

and I_n is an identity matrix of order $(n \times n)$. Therefore, if we do not make these two assumptions (homoskedasticity and autocorrelation), whilst retaining all the other assumptions of the classical normal linear regression model, we have the 'generalised linear regression model'.

The full description of this model given by Kmenta is:

$$Y_i = \beta_1 + \beta_2 X_{i2} + \beta_3 X_{i3} + \dots + \beta_k X_{ik} + \epsilon_i$$

"The joint distribution of $\epsilon_1, \epsilon_2, \dots, \epsilon_n$ is multivariate normal",

$$E(\epsilon_i) = 0 \quad i = 1, 2, \dots, n.$$

$$E(\epsilon_i \epsilon_j) = \sigma_{ij} \quad i, j = 1, 2, \dots, n$$

"Each of the explanatory variables is nonstochastic and such that for any sample size",

$$\frac{i}{n} \sum_{i=1}^n (X_{ik} - \bar{X}_k)^2$$

"is a finite number different from zero for every $k = 2, 3, \dots, K$ ".

"It should also be remembered that the number of observations exceeds the number of explanatory variables ($n > k$) and that no linear relation exists between any of the explanatory variables".

Kmenta notes that the model is 'generalised' because it includes other models as special cases. The classical normal linear regression model is one such special case in which Ω is a diagonal matrix with σ^2 in place of each of the diagonal elements.

According to Kmenta another special case is the heteroskedastic model "here Ω is again diagonal, but the diagonal elements are not necessarily all the same. For the model in which the disturbances follow a first order autoregressive scheme, the matrix Ω becomes"

$$\Omega = \sigma^2 \begin{bmatrix} 1 & \rho & \rho^2 & \dots & \rho^{n-1} \\ \rho & 1 & \rho & \dots & \rho^{n-2} \\ \cdot & \cdot & \cdot & & \cdot \\ \cdot & \cdot & \cdot & & \cdot \\ \cdot & \cdot & \cdot & & \cdot \\ \rho^{n-1} & \rho^{n-2} & \rho^{n-3} & \dots & 1 \end{bmatrix}$$

“Assuming that the variances and covariance's of the disturbance (i.e. the elements of the Ω matrix are known) we can attempt to estimate the parameters of the generalised linear regression model. Since the OLS estimators of the regression coefficients are obtained by minimising”

$$\sum_{i=1}^n (Y_i - \beta_1 - \beta_2 X_{i2} - \dots - \beta_K X_{iK})^2$$

“they are exactly the same as the least squares estimators of the classical normal linear regression model; that is”

$$\beta = (X'X)^{-1}(X'Y)$$

Note that

$$E(\beta) = E(X'X)^{-1} X'[X\beta + \epsilon] = \beta + E(X'X)^{-1}(X'\epsilon) = \beta$$

and

$$p \lim \hat{\beta} = \beta + p \lim \left[\frac{1}{n} X'X \right]^{-1} \left[\frac{1}{n} X' \epsilon \right] = \beta.$$

This demonstrates that the ordinary least squares estimators of β of the generalised linear regression model are unbiased and consistent.

Pooled Cross Section Time Series Analysis

Our International Electricity Prices model combines pooled cross section and time series observations. The behaviour of the disturbances over the cross-sectional units is likely to differ from the behaviour of the disturbance of a given cross sectional unit over time i.e. the relationship between the disturbances of two countries at some specific time may differ from the relationship between the disturbances of a specific country in two specific time periods.

Therefore, various kinds of prior specifications with respect to the disturbances will lead to various kinds of restrictions on Ω . Kmenta (1971) states that the regression equation for this type of equation can be shown as;

$$Y_{it} = X_{it,1} + \beta X_{it,2} + \dots + \beta_k X_{it,k} + \varepsilon_{it} \quad (i = 1, 2, \dots, N; t = 1, 2, \dots, T)$$

The above shows that sample data are represented by observations on N cross-section units over T time periods. Altogether we have $n = N \times T$ observations. It is anticipated, that the regression disturbance and explanatory variables will satisfy the assumptions of the generalised linear regression model. In the majority of cases we will have $X_{it,1} = 1$ for all i and t .

(Where i = countries & t = time periods)

According to Kmenta (1971) it is usual to combine the assumptions that are usually made when we deal with cross sectional or time series observations (e.g. with cross sectional observations it is frequently assumed that the regression disturbances are mutually independent but heteroskedastic, however, with time series data it is usually assumed that disturbances are autoregressive, although not usually heteroskedastic). Therefore, it is usual when dealing with pooled cross section time series data to adopt a cross sectionally heteroskedastic and time wise autoregressive model. The characteristics of this model according to Kmenta are;

$E(\varepsilon_{it}^2) = \sigma_i^2$	heteroskedasticity
$E(\varepsilon_{it} \varepsilon_{jt}) = 0 \quad (i \neq j)$	cross sectional independence
$\varepsilon_{it} = \rho_1 \varepsilon_{it-1} + u_{it}$	autoregression

where

$$u_{it} \sim N(0, \sigma_{ui}^2)$$

$$\varepsilon_{it} \sim N\left(0, \frac{\sigma_{ui}^2}{1 - \rho_1^2}\right)$$

and

$$E(\varepsilon_{it-1} u_{jt}) = 0 \text{ for all } i, j$$

Therefore, for the purposes of our model we had to assume that the autocorrelation coefficient was the same for all countries in order to make the estimation method feasible.

Structure of Model and Source Data Used

As already discussed, the data sample used for construction of the International Utilities Econometric Price Model (IUEPM) was over four separate annual time periods. The four year period (i.e. 1981, 1982, 1983, and 1985) was chosen because there were no data gaps for this period (originally the model had included data on the following variables for an 11 year period, 1981-1992, but this period had suffered from data gaps for the eleven countries mentioned below). The four year period was also chosen because there were no significant intra period regulation changes in the countries concerned (e.g. the change from public to private ownership in the UK electricity supply industry). The countries used for the sample, eleven in total, were Belgium, Denmark, France, Germany, Ireland, Italy, Portugal, Spain, UK, USA and Japan.

The model was populated by data obtained from the sources listed below.

Sources of Data Used in the International Utilities Econometric Price Model

1. Price Data

Price data (in local currency price per kWh) was collected in the first instance from the International Electricity Prices annual published by the Electricity Association Services Limited (formerly known as the Electricity Council). The comparisons compiled by the Electricity Association are based upon the replies to a questionnaire sent to electricity supply authorities and national electricity organisations. For domestic customers, the prices include all taxes (recoverable and non recoverable). For non domestic customers, the prices include only non recoverable taxes. A consumption level of 3300 kilowatt hours per annum for domestic customers was used for comparison purposes. For non domestic comparisons, 3 types of customers price data was used i.e. prices for consumers with demands and load factors as follows; 100kW maximum demand (MD) consumer with a 20% load factor, a 500kW MD consumer with a 60% load factor and 2500kW MD consumer with a 20% load factor.

No load management, interruptibility or similar discounts have been included in the prices, because of the variety of such schemes, the problems of obtaining confidential information about them and the difficulties encountered when trying to make meaningful comparisons when using them (even with full knowledge of the details of these schemes). Above the 2500kW level of demand, special commercial relationships are more common and these make it very difficult to find a basis for comparison. In addition, some of these customers are in industries which may receive assistance in support of national economic or strategic aims.

The prices are determined on a like for like basis. Where more than one tariff is available to new customers the lowest tariff is used. The analysis is based on United Kingdom consumption patterns which have been consistently applied throughout.

Prices were then converted into Power Purchasing Parity terms using PPP rates as given in Eurostatistics: Theme 1, Series B and extrapolated to other countries using PPP's from OECD Main Economic Indicators.

2. Population of Country

These figures are based on mid year estimates as shown in the United Nations Monthly Bulletin of Statistics. This figure is a measure of the size of the country in terms of electricity using inhabitants and could be used along with the surface area of the country (i.e. see 'Surface Area of Country' below) as a guide to population density. Population density is an important statistic for network industries as it gives an indication to the amount of investment per capita required to service the population.

3. Surface Area of Country

As given in the United Nations Statistical Yearbook. The surface area figure gives an indication to the approximate size of the country's distribution network.

4. Gross Domestic Product Per Capita

GDP per capita was derived from data shown in the OECD Main Economic Indicators. This figure has been converted into Purchasing Power Parity terms and acts as a measure of the economic prosperity of the country concerned.

5. Net Electricity Production (GWh)

Figures for each country as published by the International Energy Agency publication 'Energy Statistics of OECD Countries (1994)' which contains the necessary data for the relevant years i.e. 1981, 1982, 1983 and 1985.

6. Type of Plant used for Electricity Generation - Percentage of Net Electricity Production

As given in the Electricity Association's International Electricity Prices annual publication for the years specified e.g. the percentage used of the following types of plant for generation purposes i.e.

- a. Conventional Thermal
- b. Hydro and Pumped Storage
- c. Nuclear
- d. Other (e.g. Solar & Wind)

7. Transmission and Distribution Losses as a Percentage of Sales

Calculated from information contained in the Electricity Association's International Electricity Prices annual publication.

8. Gross Hourly Earnings of Male Workers in Manufacturing Industry

Calculated from information contained in the Electricity Association's International Electricity Prices annual publication. Information on these levels is given in local currencies and this is converted into a PPP value using the method outlined for price data for electricity prices given above.

9. Trade Balance

Derived from the 'Balance of Payments - Trade Balance' section of the International Financial Statistics Yearbook Vol. XLVI, 1993 which is given in US Dollars and then subsequently converted into a PPP level.

10. Price of Oil

Either Crude Oil Spot Price of Brent or Arab Light or Oil Product Gasoline Price for North West Europe, as supplied by the International Energy Agency in their publication IEA Statistics (Energy Prices and Taxes) 4th Quarter 1993 (OECD Paris). Prices are quoted in U.S Dollars bbl/FOB as these are not a country specific variable.

Choice of Variables

The variables listed above have been chosen partly because they are available for all countries in a similar format and partly because for the analysis we intend to undertake these variables should, hopefully, represent reliable explanatory variables of the price of a non traded good such as electricity.

Finally, it was decided after much analysis that the IUEPM model would utilise the following combination of variables as shown in 1,2,4,5,6, 9 and 10 above (3,7 and 8 were omitted).

The regression equation formulated for the IUEPM is;

$$DPS = f(DV, EDNPS, PTDBPS, PT, CONSTANT)$$

where;

(i). Where D is the difference relative to the base country. (DPS is the difference relative to the base country of the price of the non traded good i.e. electricity).

(ii). 'DV' is the percentage of Thermal Generating Capacity of Total Generating Capacity of the country multiplied by the Net Electricity Production of the Country. This variable proxies the factor endowment variable in Falvey Gemmell.
 $C\%TGC \times CNEP$

(iii). 'EDNPS' is the national income per head of the country concerned (ie. the non base country's e.g. France, Germany etc) multiplied by the difference in population to the base country i.e. the United States of America.
 $(CGNP/CPOP) \times (BPOP-CPOP)$ expressed in Falvey Gemmell as $(e*dN/Ps)$

(iv). 'PTDBPS' price of the traded good (in this case oil) divided by the price of the non traded good (in this case the purchasing power parity per kilowatt hour price of electricity for each of the non base countries) multiplied by the difference in the balance of trade to the base country (i.e. USA).
 $(OIL/CPPP\text{KWH}) \times (BBOT-CBOT)$ expressed in Falvey Gemmell as $(Pt/Ps)*db$

(v). 'PT' is the price of the traded good and in this model this is the price of oil (either Crude Oil Spot Price of Brent or Arab Light or Oil Product Gasoline Price for North West Europe as supplied by the International Energy Agency in their publication IEA Statistics (Energy Prices and Taxes) 4th Quarter 1993 (OECD Paris) prices quoted in U.S Dollars bbl/FOB. This variable represents the effect of an important, internationally determined factor price in setting the price of the non traded good. A statistically significant result for this variable will suggest that non traded electricity prices in different countries are driven by international factor prices. A non significant result (failure to reject the null) will suggest that internal factors, such as the nature of the regulatory regime, are more important for determining the price of non traded electricity.

(vi). 'CONSTANT'

NB: Where 'C' is used at the beginning, as in 'CGNP', this relates to the GNP level of the country concerned. Where 'B' is used, this relates to the base country i.e. the USA and therefore BPOP means the base country's population.

The results of the model will be evaluated, in addition to normal econometric analysis tests, with reference to each countries regulatory regime for the period. These are set out in the table below.

Country	Ownership Type 1981-85	Regulatory Method 1981-85
Belgium	Private	Implicit Rate of Return
Denmark	Municipal and Private	Implicit Rate of Return
France	Public	Nationalised Industry guidelines
Germany	Municipal and Private	Implicit Rate of Return

Ireland	Public	Nationalised Industry guidelines
Italy	Public	Nationalised Industry guidelines
Portugal	Public	Nationalised Industry guidelines
Spain	Public and Private	Explicit Rate of Return
UK	Public	Nationalised Industry guidelines
USA	Private	Explicit Rate of Return
Japan	Private	Implicit Rate of Return

Where;

- a. 'Implicit rate of Return' means that the underlying economic principles guiding policy makers will relate to this form of economic control although decision making will not be seen to be made entirely on these principles as other political considerations will also be taken into account.
- b. Nationalised Industry Guidelines' encompasses all considerations (i.e. social, political, economic).
- c. 'Explicit Rate of Return' - the regulatory body sets its price control guidelines based on 'rate of return' economic principles which are laid out in an explicit contractual relationship with the companies.

Results of the Analysis Using the Generalised Linear Regression Model

As outlined earlier, the IUEPM looked at various data for eleven countries over four different time periods (i.e. 1981, 1982, 1983 and 1985) for four different types of customer, these being;

- i. Domestic Customers - Consumption 3300 kWh per annum
- ii. 100kW Maximum Demand - 20% Load Factor Customers
- iii. 500kW Maximum Demand - 60% Load Factor Customers
- iv. 2500kW Maximum Demand - 20% Load Factor Customers

We now consider the output from the IUEPM for each of these in turn.

i. Domestic Customers - Consumption 3300 kWh per annum

R Square = 57.35%

F test = 11.766 (analysis of variance from mean)

F crit = 2.65 (at 4 numerator and 35 denominator degrees of freedom)

T - statistic

at t 0.05 (10% significance) t crit = 1.690

at t 0.025 (5% significance) t crit = 2.031

Name	Coefficient	Error	35DF	Positive/Negative Significance
DV	0.12053E-05	0.6128E-06	1.967	positive*
EDNPS	0.14452E-04	0.4057E-05	3.562	positive
PTDBPS	-0.29875E-04	0.4904E-05	-6.092	negative
PT	-0.46601E-01	0.5065E-01	-0.9201	not significant
CONSTANT	13.593	2.601	5.227	

* At 10% level only.

ii. 100kW Maximum Demand - 20% Load Factor Customers

R Square = 24.55%

F test = 2.848 (analysis of variance from mean)

F crit = 2.65 (at 4 numerator and 35 denominator degrees of freedom)

T - statistic

at t 0.05 (10% significance) t crit = 1.690

at t 0.025 (5% significance) t crit = 2.031

Name	Coefficient	Error	35DF	Positive/Negative Significance
DV	0.32617E-06	0.5323E-06	0.6128	not significant
EDNPS	0.10220E-04	0.3675E-05	2.781	positive
PTDBPS	-0.12489E-04	0.3295E-05	-3.790	negative
PT	-0.10200	0.4627E-01	-2.205	negative
CONSTANT	9.5164	2.129	4.470	

iii. 500kW Maximum Demand - 60% Load Factor Customers

R Square = 60.52%

F test = 11.879 (analysis of variance from mean)

F crit = 2.65 (at 4 numerator and 35 denominator degrees of freedom)

T - statistic

at t 0.05 (10% significance) t crit = 1.690

at t 0.025 (5% significance) t crit = 2.031

Name	Coefficient	Error	35DF	Positive/Negative Significance
DV	0.50789E-06	0.3682E-06	1.379	not significant
EDNPS	0.79949E-05	0.1708E-05	4.680	positive
PTDBPS	-0.35163E	0.1612E-05	-2.181	negative
PT	-0.889964E-01	0.3446E-01	-2.582	negative
CONSTANT	7.9057	1.605	4.926	

iv. 2500kW Maximum Demand - 20% Load Factor Customers

R Square = 40.08%

F test = 5.853 (analysis of variance from mean)

F crit = 2.65 (at 4 numerator and 35 denominator degrees of freedom)

T - statistic

at t 0.05 (10% significance) t crit = 1.690

at t 0.025 (5% significance) t crit = 2.031

Name	Coefficient	Error	35DF	Positive/Negative Significance
DV	0.49709E-06	0.5643E-06	0.8810	not significant
EDNPS	0.11457E-04	0.3201E-05	3.579	positive
PTDBPS	-0.10152E-04	0.3185E-05	-3.188	negative
PT	0.39803E-01	0.4544E-01	0.8759	not significant
CONSTANT	4.2908	2.097	2.046	

Conclusion on the Results of the IUEPM

In general, the model fits the data relatively well. The Goodness of Fit (F) test is passed in all cases and each regression contains statistically significant explanatory variables on the basis of the efficient estimators with the t statistics adjusted for panel heteroskedasticity and first order autoregression i.e. each current disturbance is equal to a portion of the preceding disturbance plus a random effect represented by U_t .

In the period used, the model demonstrates that national regulation effects overcame international effects on electricity prices i.e. PT was either negative or not significant..

The model concludes that the bigger the negative figure for PTDBPS the higher the price of electricity because the PTDBPS will be greater as the trade deficit for a country gets larger. This is in line with Falvey and Gemmell (1991) which states "an increase in the real trade deficit raises real income per capita by the corresponding increase in real capita expenditure".

Falvey and Gemmell (1991) conclude that "an increase in population, *ceteris paribus*, reduces real income per capita by the average reduction in expenditures necessary to provide these additional people with the nonnumeraire country's per capita real expenditure".

Our model shows that as a country's population gets larger the EDNPS figure in the model gets smaller (i.e. as a small population will cause a bigger difference when compared to the population of the USA thus causing an increase in EDNPS) and this therefore demonstrates that as a country's population gets bigger the price of our non traded good denoted as DPS (i.e. electricity) decreases as EDNPS has a positive correlation to DPS.

The model also showed that the percentage of thermal generating capacity owned by the country concerned had no significant effect on the price of electricity.

Other Factors Not Considered by the IUEPM

Although the analysis represents one view of evaluating the determinants electricity prices there are also a number of other reasons for price differences which could be brought into the argument. Some of these factors are:

1. Technology Constraints
2. Indigenous Resources
3. Energy Mix
4. Price Elasticities of Demand

1. Technology Constraints

The use of certain types of plant could be restricted because of government energy policy, resource shortages e.g. spare parts, trade embargoes and shortage of skilled staff. Poor fuel input (i.e. use of low quality fuels) could also hinder the efficiency of plant.

2. Indigenous Resources

Certain countries have an abundance of natural sources of energy. This indigenous advantage may not just be large quantities of cheap coal and oil, it could be an abundance of water above sea level e.g. Hydro generation is responsible for some of the worlds cheapest electricity and countries that possess this in abundance will usually display lower electricity prices than countries using more conventional forms of generation.

3. Energy Mix

This can be considered from two aspects - mix of generating stations to produce electricity and secondly the mix the country concerned uses to meet its overall fuel needs i.e. between electricity, gas and solid fuel.

Generating station usage will depend on past planning decisions, government restrictions, finance, available technology, grid types and fuel availability. An efficiency maximising mix may not always be achieved, which will then result in higher prices than normal.

Overall fuel mix will depend on the factors above plus any taxes that the government may impose on different fuels. Again, achieving an efficiency enhancing fuel mix will be difficult and the degree of success achieved will have an effect on all fuel prices to customers (as different fuel types do not operate independently from one another).

4. Price Elasticities of Demand

Demand for fuel use may vary from country to country. When comparing electricity prices between different countries, it may be that variances in prices could be due to alternative fuels, different tax structures and access arrangements between the countries. All the factors above i.e. Technology Constraints, Indigenous Resources and Energy Mix could all be said to be factors affecting price elasticities of demand. In addition, customers in certain countries may be more price sensitive to electricity prices than in others (e.g. in cold countries electricity prices may be less price elastic and this could result in higher prices).

Final Comments

In the period used the model demonstrates that national regulation effects overcame international effects on electricity prices. There was heavy regulation in this period. Therefore, we can conclude that the price of the traded good (oil) had no significant effect on the price differences in electricity prices charged in different countries and this was demonstrated by the statistical output produced by the model regarding this factor (PT) in the analysis above .

We see that the PT variable is either negative or not significant in explaining differences in electricity prices between countries. The underlying alternative hypothesis is that national regulatory factors are significant for determining electricity price differences. In some cases, these actually counteract the effect of oil prices. This is particularly the case for domestic customers with low maximum demand levels. In nearly all cases, the prevailing regulatory regime at the time was some form of rate of return regulation or public ownership. These regulatory regimes appear to have insulated smaller domestic customers from the full effect of oil price changes. Large industrial customers also appeared to be insulated from these changes, although this 'insulation' may have come from market power, in terms of these customers ability to negotiate good prices (i.e. larger customers are usually enjoy a competitive electricity market), rather than from any kind of regulation.

We have also noted the other factors not considered by the IUEPM which could have affected the price differences observed.

Concluding Comments

We have seen that government involvement in utilities is significant and universal in the sense that no nations government is so completely confident of market forces that they allow them, unhindered, to ensure that the countries energy requirements are provided. Indeed, in most cases, government intervention goes much further than this. The usual type of government intervention comes from measures to control fuel diversity and security issues. In addition, environmental and conservation concerns are attracting increasing political attention and intervention. Social policy issues such as public safety, the disposal of hazardous materials and employee safety are some of the other areas which most governments feel compelled to get involved in.

Another concern for governments are the activities of foreign administrations in relation to the treatment of their own energy industry (i.e. what policies are developing overseas) as well as the activities of foreign owned energy subsidiaries operating in the home market place and the potential influence they may have on the national utility infrastructure (i.e. in other words, what are home based foreign companies doing). An associated issue here is the extent of any subsidies being paid by national governments to their utility sector and whether this has as any impact on the input price to manufacturing industries which may be competing internationally i.e. the subsidy could be considered as an aid to the manufacturer to enable cheaper production, which could lead to manufacturers in other countries being unfairly disadvantaged. Another major concern which many countries have is the level of foreign ownership of their electricity industry. Even in the UK, where the government has proven fairly receptive to foreign investment, the proposed take-over in 1996 of National Power, the United Kingdoms biggest electricity generator, by an American utility was ruled out by the Secretary of State for Trade and Industry.

In Chapter 1 the underlying economics of regulation are examined. It can be argued that economists are still trying to find the ideal system of regulation; indeed some of the most popular new systems are those that have been tried before in the last century i.e. Sliding Scale/Profit Sharing.

One of the most significant changes in regulation in the past decade has been through privatisation of the electricity industry in the UK and the subsequent introduction of competition or, where this was not possible, the use of price cap regulation (the drivers of this process being the UK business establishment who were concerned about the loss of international competitiveness in the 1970s, partly because of the inefficiency of utility providers). The apparent success of the 'price cap' system, in controlling prices, has influenced regulators in the USA to begin to replace their cost of service arrangements with price cap regulation as well as utilising profit sharing sliding scale arrangements. The notion of introducing competition into parts of the utilities sector, where an unnatural monopoly previously existed, has also taken hold in the USA and other countries because of the apparent success of the UK experiment with this part of the privatisation process.

Critics of the UK system of regulation claim that other countries have cherry picked the best parts of our system without the drawbacks induced by the political dogma

that insists that the doctrine has to be pure to its roots (i.e. certain UK politicians devotion to the Austrian School of economics). It is ironic that the UK privatisation process has been the catalyst for privatisation world wide when there is so much pressure to reform the system at home. Some of the main criticisms of the regulatory process at present is that the system is too fragmented (i.e. separate Gas and Electricity regulators), there is an indefensible reliance on individual discretion and a lack of due procedure and transparency in the regulatory process.

Chapter 2 concludes that regulation can overcome international movements in commodity prices especially where domestic customers are concerned. This conclusion was reached by using an econometric model to analyse international electricity prices. The conclusion reached by the model may not be surprising if we consider the elector - political - agent model discussed in Chapter 1 i.e. domestic customers are the electorate who confer power on politicians who use their agents (e.g. regulators) to carry out their policies. It would be interesting to see whether in the period after 1985 (the last year our econometric model in chapter 2 examines), if the more recent changes in regulatory arrangements (perhaps forced through by non domestic pressure groups concerned at the price paid for their electricity) have meant any shift in favour away from domestic customers, in other words, have business customers had proportionately better price reductions under the new regulatory arrangements compared to domestic users? Another interesting issue that the introduction of new regulatory arrangements raises is whether the changes made can be considered to be Pareto dominating and how near prices achieved under these new regimes reflect 'first best' price outcomes compared to those obtained under previous arrangements.

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