Regulation, returns and systematic risk: the case of the UK privatised utilities

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Abstract

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Following the privatisation programme of public utilities implemented by the UK government in the 1980s and early 1990s, an interesting debate on the impact of regulation on the cost of equity capital has emerged. While the effects of regulatory announcements have been studied extensively in the USA, there is very little systematic evidence in the UK. This thesis partly redresses this imbalance by analysing the impact of regulatory announcements on the ex-post returns of equity capital and systematic risk of three utility industries in the UK, namely the electricity, telecommunications and water industries.

The main objective of this thesis is to test the impact of regulatory announcements that relate to competition, pricing and the quality of services on the return and risk of equity capital. By using an event-study type methodology, the thesis attempts to isolate the effects of regulation from technical and market uncertainties. The methodology normally used in this type of studies is extended to adjust for the well-documented problem in financial time series of volatility clustering and to allow for changes in the systematic risk through time.

Overall, the results in the empirical chapters reveal some important issues. While it is clear from the debate in the literature that the cost of capital influences the choice of regulatory parameters, this thesis provides evidence to support the view that regulation in turn alters the cost of equity capital by affecting the ex-post returns and systematic risk of both individual regulated companies and industries. Although the direction and size of these effects of regulation are not always easy to predict, there is evidence to suggest that they may depend crucially on the structure and competitive posture of the industry, as well as technological and market conditions and the parameters of the regulatory system.

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Declaration

The material contained in this thesis has not been previously submitted for a degree in this or any other university.

Statement of Copyright

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INTRODUCTION

During the 1980s the UK government pursued a massive programme of privatisation of publicly owned enterprises, in particular public utilities, which has been emulated throughout the world. Initially, the transfer of ownership did not alter the competitive posture of these industries and thus regulatory arrangements had to be set up to maintain, and in some cases improve, the quality of service, while protecting consumers against monopolistic exploitation.

Typically, the main regulatory emphasis in relation to public utilities has been on price regulation. In the UK, price regulation is implemented through the price-cap system, which allows the regulated utility to increase prices by something less than the increase in the general price level. A predetermined 'productivity factor', X, is subtracted from the price index, RPI, to determine the increase in rates that will be allowed without regulatory approval. If costs increase less than RPI-X, then the shareholders will benefit. Thus, the price-cap system, by de-coupling prices charged from profits earned, attempts to provide the cost reduction incentives that are absent from the rate-of-return regulation, traditionally used in the US. The RPI-X regulation involves a combination of judgements about asset values, appropriate rates of return on these assets and expected capital and operating expenditures. In this respect, one of the most controversial regulatory issues relates to the judgement on the level of risk associated with the regulated companies, which is essential in the determination of an acceptable and appropriate expected rate of return and cost of capital. The literature recognises that the cost of capital is likely to be endogenous to the regulatory process itself, since regulation is an on-going dynamic process that affects the characteristics of the investor's cash flows. However, the direction of this effect is ambiguous, both theoretically and empirically. Models of the determination of the cost of capital of regulated firms, hence, should include regulation explicitly.

Although the impact of regulation on share prices has been extensively studied in the context of the US rate-of-return regulation (Teets, 1992; and Binder, 1985a), the effects of regulation on the return of public utilities' stock in the UK is still an under-researched area (Sawkins, 1996; and Antoniou and Pescetto, 1997). In order to address this imbalance, this thesis analyses the impact of regulatory announcements on the returns and risk of equity capital for three of the UK utility industries, namely the electricity, telecommunications and water industries. The primary objective of this thesis is to test the impact of regulatory announcements that relate to competition, pricing and the quality of services on the return and risk of equity capital. However, unlike most previous studies (Sawkins, 1996) that use the methodology developed by Binder (1985b) and Karafiath (1988), this thesis extends that methodology to adjust for the well-documented problem in financial time series of volatility clustering and to allow for changes in the systematic risk through time. By using an event-study type methodology, the thesis attempts to isolate the effects of regulation from technical and market uncertainties. This investigation should shed light on whether regulatory announcements and decisions, such as the setting of pricing rules, may alter the risk perceived by the providers of capital, in particular equity capital. The regulators need to understand the nature of the effects that different types of regulation may have on the cost of equity capital of regulated companies, since adverse share price reactions to regulatory announcements may increase the cost of equity through their impact on the companies' systematic risk.

More specifically, this thesis contributes to the literature by:

- Extending the event study methodology to analyse the effects of regulatory announcements on the return and systematic risk of regulated utilities.
- Incorporating time variation in the estimation of systematic risk.
- Analysing the overall impact of each type of regulatory announcements on the return and systematic risk of privatised utilities.
- Recognising that regulatory announcements may have a different impact across the industry, since individual companies may face different problems and are subject to different price regulation rules, in the case of the water industry.
- Attempting to estimate the overall regulatory risk.
- Providing the first systematic investigation of the above issues for three UK privatised utilities with very diverse industry structures and potential for developing competition.

The remainder of this thesis is organised as follows. Chapter 1 reviews the main relevant issues in the economics of regulation, with a particular focus on the regulatory environment faced by the privatised utilities in the UK. This chapter defines regulation; critically reviews the objectives and outcomes of regulation and the two main systems of price regulation, namely the rate-of-return and the price-cap systems; analyses the specific regulatory system for the privatised utilities in the UK; and, finally, discusses the effects of regulation on the rate of return and the cost of capital of regulated firms.

Chapter 2 classifies unanticipated regulatory announcements by their expected main effect and tests their impact on the returns of equity capital of the Regional Electricity Companies (RECs) and the power generating companies in England and Wales, both at the level of individual companies and as equally-weighted portfolios of RECs and generators. Chapter 3 and chapter 4 use a similar classification of regulatory announcements to test their effect on the systematic risk of British Telecom (BT) and the water industry in England and Wales, respectively. From a methodological point of view, chapter 2 extends the methodology developed by Binder (1985b) and Karafiath (1988) to overcome the problem of serial correlation in the volatility of equity returns. In addition, the chapter also tests the informational content of individual announcements.

The methodology adopted in chapter 2 is an improvement over the methodology normally used in the literature for this type of investigation. Applied to the electricity industry, it allows for issues of competition and pricing, and their regulation, to be evaluated across the industry and provides evidence in relation to the impact of regulation on the return of equity capital. It also shows that regulatory announcements have an informational content and thus potential for altering the systematic risk. However, the methodology adopted in chapter 2 also suffers from a number of drawbacks. In particular, it is not possible to distinguish whether the observed impact on returns is due to changes in systematic risk or changes to the unsystematic component of returns. In addition, the parameters of the market model are assumed to remain constant through time. Therefore, chapter 3 and 4 build on the results of chapter 2 by utilising methodologies that overcome these problems. Specifically, chapter 3 allows for time variations in systematic risk and directly tests the impact of announcements on the estimated time-varying beta of BT. In chapter 4, an alternative methodology to allow for time-variation in systematic risk is adopted and an attempt is made to provide an overall estimate of regulatory risk for the water industry of England and Wales over the sample period.

In summary, as it will be further discussed in the concluding chapter, the thesis contributes to the empirical literature on the effects of regulation on the cost of capital of regulated firms at two main levels. Firstly, it analyses the effect of regulation on three industries with very different market structures and technology. Secondly, it tests different ways of extending the event study methodology to overcome some of the well-documented problems in the empirical literature.

Chapter 1

Regulation of Public Utilities: An Overview of the Issues

1.0 INTRODUCTION

The literature on the economics of regulation is vast and deals with many and diverse topics, ranging from the traditional economic problem of the exploitation of consumers by the monopolist, with the associated setting of 'fair' prices and output levels, to problems of a more 'political' nature, such as the objectives of the regulator. There is a wealth of both theoretical and empirical literature dealing with the whole spectrum of economic problems in relation to regulated industries and products. This initial chapter reviews some of the main issues in the literature, focusing throughout on the regulatory environment faced by the privatised utilities in the UK. In particular, Section 1.1 defines regulation and presents the main economic reasons for regulating an industry. Section 1.2 offers a critical review of the objectives and outcomes of regulation, including some of the main theoretical approaches. The two most widely adopted regulatory systems, namely the rate of return and the price cap regulation, are reviewed in Section 1.3, while Section 1.4 analyses the specific system of regulation applied to the privatised utilities in the UK, including its effects on firm's behaviour and competition. The chapter then proceeds to review and discuss in Section 1.5 the effects of regulation on the rate of return and the cost of equity capital of regulated companies. Section 1.6 concludes the chapter.

1.1 DEFINITION AND RATIONALE FOR ECONOMIC REGULATION

Government intervention in the private sector of developed economies in the form of regulation has been widespread for many decades. In the UK, with the privatisation of public utilities, regulation has increased recently, especially, but not exclusively, in terms of price regulation. However, finding a general definition of regulation is very difficult. For example, should government macroeconomic policy measures, such as fiscal or monetary measures, be considered regulatory instruments, alongside price control, exchange rate restrictions, or minimum wage legislation? The view taken here is that such an approach is far too general and that regulation cannot be seen as including all governmental activities. In this thesis regulation refers to statute law and the associated delegated legislation, which enables government departments and agencies to constrain the activities of firms and individuals in the private sector, within the framework of the policies pursued by the government (Peacock, 1984).

The economic rationale for regulating business can be found in the economy's failure, or perceived failure, to reach a competitive equilibrium. It is thus generally associated with market failure and in particular with the existence of natural monopolies, economic rents, insufficient or imperfect control of resources, externalities, asymmetric and costly information, imperfect bargaining and/or unequal bargaining power (Breyer, 1982). In these cases, orthodox economic theory suggests that the government has an important role to play in intervening in the private ownership of firms and property. State ownership is one extreme form of intervention in a continuum of governance structures that reflect the degree of government intervention in the economy. Regulation is just one of the forms of government intervention, which has acquired a prominent role in the post-privatisation era.

While the issue of privatisation has an accentuated political profile and can be simply justified in terms of an ideological preference for private rather than public ownership, economists have attempted to compare the consequences on resource allocation of the two forms of governance. Theoretical arguments in favour of privatisation tend to be based on the belief that, because of government failure and bureaucratic inefficiency, state ownership has greater harmful effects on a market economy than regulation, although it is well recognised that regulation has costs too. As some forty years ago Ronald Coase (1960) wrote in his seminal article referring to market failure: "All solutions have costs, and there is no reason to suppose that governmental regulation is called for simply because the problem is not handled well by the market or the firm." If the traditional case in favour of public ownership has rested with considerations of allocative efficiency (Rees, 1984), the case for private ownership traditionally rests on both the market incentives to improve technical or productive efficiency and the penalties imposed by the market for failing to do so. It is the interaction of product and capital market pressures that ensures efficiency gains from privatisation: competitive product markets penalise persistent under-performance, while competitive capital markets penalise managerial 'slack' (Kuehn, 1975; and Singh, 1975). In other words, inefficiencies in production are revealed by product markets and capital markets have a role in restoring efficiency[1]. In the presence of market failure, however, government

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[1] It should be stressed at this point, however, that the arguments in favour of privatisation tend to focus mainly on technical efficiency and often ignore allocative efficiency and aspects of economic distribution and stability (Jackson and Price, 1994, ch 1).

intervention, often in the form of regulation, is needed to restore some of the functions normally performed by competitive markets.

The argument for regulating natural monopolies is well known. Some industries cannot efficiently support more than one firm, due to large economies of scale. Under these conditions, production costs would increase if more than one firm were to supply the market. However, the producing monopolist, if unregulated, may cut down production in order to raise prices, up to the point where the higher prices no longer compensate for the lost revenue from lower production. Therefore, when economies of scale render competition 'wasteful', the regulator aims at setting a price near to the incremental cost, in order to induce the monopolist to expand output to a socially desirable level. In addition, the regulation of a natural monopoly can also be needed to prevent a resource transfer from consumers to investors, to prevent the concentration in the monopolist's hands of substantial political and social power, and finally to protect consumers from unjustified discrimination (Breyer, 1982).

An important role of regulators is indeed to monitor the distribution of rents and distinguish between economic rents that are due to an efficient use of resources and rents that are due to the exploitation of a monopolistic position, luck, or circumstances. The emphasis placed by the regulator in this case is on a fairer income distribution within society, and in particular between producers and consumers. Regulation should be designed to discourage the appropriation by the producer of increased economic rents that are due to the introduction of more efficient economic processes, or more efficient and effective management. The producer should be compelled to transfer at least part of these benefits onto the consumer.

One of the main problems encountered in the pricing of the product of some regulated firms is created by the existence of externalities in either production or consumption, i.e. discrepancies between the social and private costs and benefits. Even in markets without monopoly power, regulation may still be called for if the unregulated price of a good is not based on the true social cost of producing it. The difference between private price and social cost is known as spillover cost, or benefit, and is due to the presence of externalities. Spillover benefits, or the presence of positive externalities, are often associated with the public provision of services such as education and health, while economic regulation is more commonly used to attenuate the effects of spillover costs, or negative externalities. Once again, the argument for regulation is based on the principle of avoiding economic waste by rectifying economic inefficiencies. The textbook example is the instance of pollution, where regulation can be used to internalise the costs of pollution into the private choice of optimal output.

A further cause of market failure is the lack of sufficient information on both production and its output to support a well-functioning and competitive product market. Information has the distinct characteristics of being a commodity often expensive to produce and of quality difficult to monitor. However, once produced, information is often easy and cheap to disseminate, or, even worse, it may be very difficult to keep information private. If information has the public good characteristic of non-excludability, potential producers of information will be discouraged from producing it. And even if excludability were possible, it would not be easy for consumers to monitor the quality of information and thus the market for information may fail anyway. The proponents of regulation argue that regulation is needed to assist the producers of information and control the quality and type of information provided in order to protect the public. In particular, with the development of the economics of information in the early 1980s, the control of natural monopolies begun to be analysed as an asymmetric information problem, where the firm is better informed about technology and market than the regulator (Loeb and Magat, 1979; Baron and Myerson, 1982; and Sappington, 1982 and 1983). The focus of most of the theoretical literature on regulation under asymmetric information is the control of consumer prices. However, as Laffont and Tirole (1993) point out, "while this is an important dimension of regulation, many if not most regulatory schemes that have been tried also make use of observed accounting data such as costs or profits." (p xviii) A well known theoretical result of the literature that takes into account costs data, as well as price data, is that the rents of the regulated firm, gained because of its superior information set, can be reduced if the regulator bears part of the costs. This creates an incentive problem, since cost sharing reduces the regulated firm's motivation to reduce costs. The literature on this issue concentrates on the design of incentive schemes and their sensitivity to changes in market conditions under uncertainty[2].

The above theoretical arguments in favour of regulation have been supported by a significant body of empirical literature. Although empirical comparisons of state-owned and private firms raise many methodological concerns, including problems of benchmarking and selection bias, several studies have been conducted comparing the profitability and efficiency of state versus private ownership firms. There is a general

[2] For a review of the published work of Laffont and Tirole in this area, see Laffont and Tirole (1993).

agreement among the large majority of these studies that state-owned enterprises tend to be less profitable and efficient than privately owned firms (Borcherding, Pommerehne and Schneider, 1982; Boardman and Vining, 1989; Vining and Boardman, 1992; Ehrlich, Gallais-Hamonno, Liu and Lutter, 1994; Majumdar, 1996; and Dewenter and Malatesta, 2000). However, there is also some support that, at least in some cases, liberalisation without transfer of ownership can generate improvements in productive efficiency (Kay and Thompson, 1986) and thus factors other than ownership may also be relevant in determining firm's performance (Kole and Mulherin, 1997)[3]. Supported by this wealth of evidence, over the past two decades, governments world-wide have embarked on privatisation programmes that have reduced state ownership by about one-half (Gibbon, 2000). The phenomenon of privatisation has not been confined to Europe, though the pace of change in Eastern Europe and Britain in the 1980s and 1990s has been somewhat unique. It has been a world-wide phenomenon also involving many newly industrialised countries of Africa, South America and South-East Asia.

1.2 A CRITICAL VIEW OF REGULATION

The growth of regulation in many countries and industries during the recent decades has generated concern over the ability of the regulatory regimes to achieve their economic objectives and eliminate market inefficiencies. Regulation has been criticised on many accounts and authors have argued that, at least in some cases, too little is achieved in

[3] The evidence of non-superiority of private firms should also be noted (Millward, 1982).

terms of improved efficiency as compared to the high costs of regulating. Empirical evidence on the costs of regulation has been long available. For example, in the 1970s the annual direct costs of regulation in the USA were estimated to range between US$3 billion and US$6 billion (MacAvoy, 1979), while the annual indirect costs were estimated to range between US$60 billion and US$180 billion (Sommers, 1978). In the same decade, before the health, safety and environment regulation in the USA, the companies subsequently regulated grew faster before than after the regulation was imposed, as compared to other similar companies. After regulation, the regulated companies grew at an annual average rate of 0.4%, as compared to 2.1% for the unregulated companies. They also appear to charge relatively higher prices and produce relatively lower output (MacAvoy, 1978). Other critics emphasise the excessive delays in the decision process, which characterise the regulatory process. The examples here are many, from the ten years that it took for the US Food and Drug Administration in the 1970s to decide on the standards regarding the percentage of peanuts in peanut butter, to the seven years needed to set the requirements on car brakes standards (Breyer and Stewart, 1979). Accusations of unfairness and of lacking legitimacy have also been directed to regulation, on the grounds that most regulators are appointed, not elected (Freedman, 1975). Critics have questioned the procedures for controlling the great power of regulators and argued that regulators may be 'captured' by the industry and end up serving the interests of the industry, instead of the public (Stigler, 1971).

As regulation widened its scope in most industrialised countries, a new strand of literature emerged and shifted interest from market inefficiencies to bureaucratic inefficiencies. This literature emphasised the political nature of regulation and the tendency for regulators to pursue their own goals. If regulators are individuals accountable to the electorate, either directly or indirectly through the government, organised interest groups, such as regulated industries, may be in a better position to influence the regulator than consumer groups. This approach implies that regulators, instead of achieving efficiency gains and promoting the public interest, could be 'captured' by the industry and operate primarily for the industry's benefit. Some evidence for this hypothesis is again provided by the regulatory experience in the USA. Stigler (1962 and 1964) investigated the effect of regulation on both electricity prices and costs in securities markets. He found that electricity prices in regulated states were no different from prices in unregulated states; in addition, he found no evidence that the introduction of the Securities and Exchange Commission saved the purchasers of new issues any money, after costs were taken into account.

The complete capture of the regulatory agency by a pressure group is also likely to arise opposition from other groups that are adversely affected. In this case, a balance of interests will occur and the ensuing 'equilibrium' will crucially depend on the organisation costs faced by the opposing group (Peltzman, 1976). Furthermore, the capture of the regulator should not simply be seen in the context of total control of the industry over the regulator. There are more subtle forms of capture when the regulated parties manage to influence the regulator's views and activities, or manage to insure a mediocre performance, or non-performance, of the regulator. Posner (1974) argued that there is a life cycle for regulatory institutions. When a new regulatory environment is established, the participants are committed to correct market failures and inefficiencies and achieve the goals of the welfare economics approach to regulation. However, the regulated industry will gradually establish its influence over the regulator and increasingly affect regulatory decisions. Subsequent regulators are also likely to lack the enthusiasm and commitment of the original regulator.

In particular, Stigler (1971) argues that regulation is a good demanded by interest groups and supplied by regulators who maximise their political support. Peltzman (1976), building on Stigler's framework, shows that regulators redistribute surplus (wealth) since their political support is a function of producer and consumer welfare. In Peltzman's model, the regulator will never choose a corner solution, thereby maximising the wealth of only one group, unless the other group is politically powerless. Hence, the regulator will always dampen any shocks hitting profits in the industry. For example, the benefits of an increase in demand will not all go to the industry, but they will be shared with consumers.

According to Stigler's model, the politician's objective function is stated as follows:

$$M = M(W_1, W_2) \tag{1.1}$$

where W_i is the wealth of group i, for $i=1,2$; M_i is positive; and there are no inter-group dependencies, so that $M_{12}=0$. This objective function is then maximised subject to the following total wealth constraint:

$$V = W_1 + W_2 = V(W_1, W_2) \tag{1.2}$$

where $V_1 > 0$, but $V_{12} < 0$. That is, the total wealth to be distributed is limited.

Peltzman extended the above model to price-entry regulation and he derived implications for the price-profits outcome and the demand for new regulation. Under this framework, the political process is constraint through the setting of a maximum or minimum price, together with control entry. The majority generating function is given as follows:

$$M = M(p, \pi) \tag{1.3}$$

where p is the price of the regulated output; π is the wealth of the producers; $M_p < 0$; and $M_\pi > 0$. The relevant constraint here is given by cost and demand conditions, summarised by the following profit function:

$$\pi = f(p, c) \tag{1.4}$$

where c are production costs and are a function of the quantity of output. The formal problem for a successful regulator is to maximise the following Langrangian expression:

$$L = M(p, \pi) + \lambda(\pi - f(p, c)) \tag{1.5}$$

with respect to p, π and λ. This yields:

$$-\frac{M_p}{f_p} = M_\pi = -\lambda \tag{1.6}$$

Equation (1.6) implies that the marginal political product of an increase in profits by a pound, M_π, must equal the marginal political product of a price cut, $-M_p$,that costs a pound of profits, since f_p is the profit loss per a pound price reduction and must be greater than zero. A result of this formulation is that pure 'producer protection' can be rational only if there is no marginal consumer opposition to higher prices, and pure 'consumer protection' requires no marginal support for higher profits.

Some interesting implications for the pattern of regulatory choice can be derived from a more formal treatment of the interaction between productivity and growth and rational political choice. Consider a market already subject to regulation and in a political equilibrium. Then consider the effects on this equilibrium of a parametric shift, *dx*, in either the cost or demand function. To obtain the effect of the shift on the *p*-π configuration generated by regulation, we must solve:

$$[L_{ij}]\begin{bmatrix} dp/dx \\ d\pi/dx \\ d\lambda/dx \end{bmatrix} = -[L_{ix}] \qquad (1.7)$$

where *i, j* denotes *p*, π or λ. In the case of a cost shift, we obtain:

$$\frac{dp}{dx} = \frac{-\lambda f_{px} + f_x \cdot f_p \cdot M_{\pi\pi}}{-(M_{pp} - \lambda f_{pp}) - f_p^2 M_{\pi\pi}} \qquad (1.8)$$

The denominator of equation (1.8) is positive by a necessary condition for a maximum, so that the sign of the whole equation depends on the sign of the numerator, which also turns out to be positive. Thus, a shift in either demand or costs has an effect on price in the same direction. The most interesting insight provided by equation (1.8) is that a price change has two distinct components: a 'political' component and an 'economic' component. The first term in the numerator, λf_{px}, is essentially a 'substitution effect' similar to that faced by unregulated firms: under the assumption of profit maximisation, a higher marginal cost calls for a higher product price. The second term, $f_x f_p M_{\pi\pi}$, is a 'political wealth' effect: the disposable surplus has shrunk, and this forces the regulator to reduce his purchases of political support. The regulator will, in general, not force the entire adjustment onto one group. In particular, consumers will be called on to buffer some of the producer losses. The case of a shift in demand is more complex, because the demand function enters directly into the M function.

What emerges from the above is a number of working hypotheses about the nature of price and profit adjustments under regulation. Various possibilities can be stated. Firstly, regulation will tend to be more heavily weighted toward 'producer protection' in depressions and toward 'consumer protection' in expansions. Secondly, the tendency of regulators to change prices infrequently ought to be stronger when demand changes occur than when cost changes occur. This follows from the opposing wealth and substitution effects in the case of a shift in demand, but not in the case of a cost change. Here failure to change a price can be interpreted to mean that the opposing effects offset each other. Thirdly, studies that show regulation to be ineffective, such as Stigler and Friedland (1962) should be re-examined. Fourthly, it is very often difficult to distinguish between the political incentives from corresponding profit-maximising incentives. Finally, regulation should reduce conventional measures of owner risk. By buffering the firm against demand and costs changes, the variability of profits (and stock prices) should be lower than otherwise. To the extent that cost and demand changes are economy-wide, regulation should reduce systematic as well as diversifiable risk. Peltzman's main conclusion, thus, is that the rational regulator will seek a structure of costs and benefits that maximises political returns. This search for political advantage will in turn lead the regulator to suppress some economic forces that might otherwise affect the price structure. Therefore, it cannot be clear *a priori* what the effects of regulation are on either profits, prices or returns.

There are indeed serious theoretical grounds for doubting some of the basic rationale for regulation highlighted in the previous section. Firstly, there is the view that, if costless private bargaining were possible, the allocative problems created by monopoly power and externalities would be 'bargained away' in a well-functioning market. According to this view, private bargaining could induce the monopolist to produce the competitive output in exchange for an appropriate compensation to cover its loss of profits (Gravelle and Rees, 1992, p 516). In addition, bargaining could also induce the party who has legal control over the level of externality to internalise in its own decision making process the effects of the externality onto the other party (Coase, 1960). In reality, bargaining is not costless for a number of reasons, spanning from failure to agree on the division of the efficiency gains, to difficulties in communication and consensus gathering in externality situations with a large number of participants, where the free rider problem may also apply. Improving the allocation of property rights is likely to ameliorate bargaining, but it is unlikely to solve all bargaining problems.

The main theoretical arguments in support of regulatory caution are however to be found in the theory of the second best (Lipsey and Lancaster, 1956), price discrimination (Pigou, 1962), and the argument that the monopolist is faced with an elastic demand for its services. The theory of the second best formalises the inability to readily determine the level of prices needed to correct the inefficiencies resulting from the difference between monopolistic prices and true economic costs, because it is relative prices, and not absolute prices, that direct purchasing decisions. According to this theory, thus, a monopolist may indeed raise prices, but an equal degree of monopoly throughout the economy could lead relative prices to be roughly similar to those of competition. Although this is a very valid argument in theory, it is very difficult to apply in practice, given the consideration that needs to be given to the wider set of relative prices.

Finally, there is the argument of price discrimination, based on the view that the monopolist will not necessarily lower output if it can charge different customers two or more differential prices. In this case, the argument that regulation reduces economic waste weakens; however, distributional concerns arise as consumer surplus is transferred onto the producer. Although in most industries it may be difficult for a monopolist to apply price discrimination, in the case of many public utilities price discrimination is regularly used, given the difficulty of reselling the service received. In order to discriminate effectively, a monopolist must also be able to determine the demand elasticity of different customers over different price ranges and service characteristics. Indeed, the demand for the monopolist's product can be fairly elastic to price, as in the case for example of residential telephone services. In these cases, even in the absence of regulation, the monopolist needs to consider the effects on demand of a change in price. In addition, the threat of entry into the industry adds constraints onto the monopolist's price decision. Of course, it must be recognised that these arguments do not apply to situations in which entry barriers faced by new firms into a monopolistic industry are high and, as in the case of many utilities, demand is fairly inelastic to price.

In conclusion, governmental intervention is not costless and distorts the distribution of wealth and income. Whether intervention is economically justified or not must be determined on a case by case basis. It has often been argued that intervention is justified when the beneficiaries can more than compensate the losers out of their gains. In other words, if the benefit to the victims of pollution is larger than the additional costs imposed on the consumers of the output of the polluting firm, then intervention may be justified. However, this is a rather simplistic way of analysing this complex problem. Since this 'compensation' to losers is only hypothetical, the argument should become one of distribution, that is maximisation of welfare, not just net economic efficiency gain. It could be argued that an ideal regulatory solution should approximate a market solution where costless bargaining were feasible.

1.3 SYSTEMS OF ECONOMIC REGULATION

Although the privatisation of public utilities has reduced the extent to which prices are politically determined in an explicit way, the political hold on the pricing decision of the regulated private enterprises has not been eliminated. In a mythical world of full information, governments could monitor regulated private firms perfectly and force the management to apply the desired model of price determination. However, in reality, governments are not fully informed and thus, typically, they can only induce managers to comply with the regulator's aims through a system of price regulation.

As seen in the previous section, the government's objectives in regulating the price of public utility services can be grouped under two main general aims, the first leading to a normative theory of price regulation and the second providing the basis for a positive theory of price regulation (Bös, 1994). Firstly, governments *ought* to maximise society's welfare. Models based on this assumption provide a benchmark for the critical evaluation of the effectiveness of regulation in correcting market failure. Empirically, regulatory systems can then be evaluated against this benchmark (Quoilin, 1976; and NEDO, 1976). This normative aim of welfare maximisation encompasses the five ex-ante objectives firstly suggested by Stephen Littlechild (1983) for the regulatory framework of the privatisation of British Telecom, namely: (i) prevent abuse of monopolistic power, while enabling the industry to benefit from economies of scale and thus allowing monopolistic production; (ii) promote competition; (iii) encourage efficiency and innovation; (iv) lower implementation cost; and (v) maximise sales proceeds and consequently enhance the privatised company's commercial prospects.

Secondly, through price regulation, governments will also try to fulfil other political and bureaucratic objectives, such as win votes and maximise output. There is no economic justification for this set of objectives, however they are real and need to be considered when analysing regulatory decisions that have actually been taken. There is little doubt that it is not in anyone's interest that privatisation programmes be unpopular, both with the management of the regulated firm and with the public at large. This may cause governments to compromise when designing the regulatory regime. In a way, the government, as well as the regulatory agency, can be 'captured'. Instances of regulatory capture and their consequences have been extensively discussed in the literature and need to be considered when modelling regulatory systems (Posner, 1971; Stigler, 1971; and Peltzman, 1976).

In addition to the above objectives, models of price regulation also need to take into account the constraints faced by the regulator and the regulated firms, such as market characteristics, production technology, profits and managerial objectives. Many of the regulated privatised firms sell products and services that have some characteristics of public goods and/or externalities. Nevertheless, they are usually sold in a market with a demand elastic to price, where there may be some type of segmentation and where they may compete with other products, either within the industry or from potential entrants. Regulated firms are also constrained by the conditions of their input markets and by the state of production technology. Whether price regulation embodies the correct incentives for firms to operate on the production possibility frontier and to maximise profits has been debated extensively in the literature, both in theory and in practice. It is a wide-spread well-supported view that, if the rate-of-return is fixed by the regulator, there is no incentive for the regulated firm to increase its productivity. This is why, in the case of the UK privatised utilities, the regulator does not control the rate of return directly, but he controls the increase in price[4]. However, this price regulation system still does not solve the incentive problem of the rate-of-return regulation completely, since the 'appropriate' level of returns for the regulated company plays an important role in informing the setting and revision of the price control rules[5], as it is discussed later in this chapter. Finally, when assuming asymmetry of information, there is the problem of ensuring that the management

[4] For a detailed discussion of the price-cap regulation used in the UK, see Beesley and Littlechild (1989).

[5] See Oftel's Consultative Document on "The Regulation of BT's Prices", January 1992, pp 12 and 13.

fully participates to the implementation of the regulatory framework and does not instead follow different goals. Incentive-compatible contracts are used in these cases to bridle the management into the rules set by the regulator. In conclusion, a regulatory system is the outcome of a bargaining process between government, regulator and industry under a set of market and technological constraints.

1.3.1 The Rate of Return Regulation

There are two main regulatory regimes that have been extensively applied in practice: the rate-of-return regulation and the price-cap regulation[6]. The rate-of-return regulation restricts the regulated company to a maximum level of profits defined as a proportion of its capital. The firm is then free to choose output level and price, although the regulator has oversight control of inputs and can disallow costs for nonessential inputs. The intuition behind this system of regulation is that regulation requires the imposition of a fixed constraint on the performance of a regulated firm/industry. However, the environment in which regulated firms operate changes all the time and thus the regulator, or the government, would have to change the regulatory constraints accordingly. Such a process may be tedious and lead to regulatory lags and waste of time and other resources by the firm's management. Thus, it seems to be a more economical and flexible procedure for the government/regulator to link the regulatory constraint to the rate of return on investment,

[6] For a more detailed discussion and further references on the differences between rate-of-return and price-cap regulation, see Braeutigam and Panzar (1993).

defined as follows[7]:

$$\text{Rate of Return} = \frac{\text{Gross Revenue} - \text{Labour Costs} - \text{Depreciation} - \text{Taxes}}{\text{Capital Acquisition Costs} - \text{Cumulated Depreciation}}$$

A 'fair' rate of return on investment is earned if gross revenue minus operating expenses is sufficient to compensate the firm for its investment in physical assets.

For simplicity, we assume that depreciation is zero, and exclude taxation. Thus, the rate base is reduced to the capital acquisition costs, $r_A k$, where r_A are the acquisition costs of resources tied up in plant and equipment and k the quantity of capital. The acquisition costs, r_A, differ from the opportunity costs of capital, r. If the firm borrows capital, r is equal to the borrowing interest costs; if the firm uses own capital, r is the return that the firm could earn by lending capital. Factor prices, r_A, r and w, the cost of labour, l, are exogenously given. Capital is defined in such a way that the acquisition price, r_A, is equal to unity. The rate of return, ρ, is thus given by:

$$\rho = \frac{\sum_{i=1}^{n} p_i x_i - wl}{-k} \tag{1.9}$$

where x_i and p_i are the quantity and price of output i respectively, for $i=1,\ldots,n$.

Using the above notation, the profit of a firm, on the basis of the opportunity costs of capital instead of the acquisition costs, can be written as follows:

[7] This definition follows Averch-Johnson (1962), p 1054.

$$\Pi = \sum_{i=1}^{n} p_i x_i - rk - wl \tag{1.10}$$

From (1.9) and (1.10) we can re-write the profit formula as follows:

$$\Pi = (\rho - r)(-k) \tag{1.11}$$

Equation (1.11) shows how the rate of return on investment relates to the profit of the firm and provides a benchmark for the regulator. Thus, any rate-of-return constraint becomes a profit constraint and can be used according to the objectives of the regulated firm (Baily and Malone, 1970). The regulator could use (1.11) to prevent a profit maximising firm from earning excess profits by setting the rate-of-return such that the profits are below the unconstrained profit-maximising level. Thus, the relevant constraint becomes

$$\Pi \leq (\rho - r)(-k) \tag{1.12}$$

It is clear from the above equations that a rate-of-return regulation may distort both the capital-labour input ratio and output prices. Therefore, it cannot be known a priori whether $(\rho - r)$ is positive or negative.

To implement the rate-of-return system, the regulator first selects a base year for which he calculates the sum of operating costs, depreciation, taxes and a 'reasonable' profit, determined on the basis of a 'reasonable' rate of return. This calculated total is the firm's revenue requirement. Prices will then be set by the regulator so that the firm's gross revenue equals its revenue requirement. In order to determine the 'reasonable', or 'fair', rate of return, three methods are most commonly employed: the dividend growth model, the capital asset pricing model and, sometimes, simply a historical comparison of rates of return in similar firms, or industries[8].

It has been argued that this system of regulation, which was traditionally used for many years in the USA, can prevent monopoly abuse and achieve allocative efficiency if the allowed rate of return is set very close to the cost of borrowing (Train, 1994). Indeed, the rate-of-return regulatory system worked reasonably well in the USA, until several significant changes occurred in the 1970s and 1980s, such as a sharp increase in the rate of inflation and in the rate and extent of technological change and competition. This led to a failure of the regulatory system to provide adequate capital recovery, incentives for internal efficiency, flexible price structure and the system became excessively expensive to implement. It became widely recognised that the rate-of-return system tended to provide perverse incentives and thus encourage an inefficient use of resources. Theoretically it has been argued that tying profits to capital encourages over-use of capital (Averch and Johnson, 1962). In addition, the definition of the costs of the industry used in calculating profits can be controversial, for example in determining which capital expenditures are allowable, and cumbersome, since it involves detailed examination of costs. Finally, since any increase in profitability is regulated away and thus redistributed from the company to the consumer, there is no incentive to improve efficiency and innovate, nor to increase

[8] The setting of a 'fair' rate-of-return will be discussed in more details in the final section of this chapter.

output. Empirical evidence has indeed supported the view that rate-of-return regulation leads to inefficiencies (Courville, 1974; Spann, 1974; and Peterson, 1975).

1.3.2 Price Cap Regulation

Direct control of prices avoids a number of problems besetting the rate-of-return system and it is thought to provide incentives towards efficiency improvements (Crew and Kleindorfer, 1992). The price regulation experienced in the British system of regulation for public utilities generally ensures that a weighted average of price increases in any one year does not exceed the percentage increase in the Retail Price Index, RPI, less a factor X. The X factor can vary from time to time, but it is fixed between price reviews. The number of years between price reviews, the regulatory lag, is also fixed. Once the price control has been set for a significant period of time, the regulated firm can behave like under market discipline and decrease costs to increase profits. In other words, the fact that prices are capped, rather than profits, gives the firm an incentive to improve productive efficiency and innovate, since the regulated firms is allowed to keep any gains from cost reduction between price reviews. Thus, there is a strong profit incentive. However, just like in a market situation, if there is not enough competition, product quality may fall and an inappropriate output mix may result if regulation leads to a distorted structure of relative prices. In addition, if regulators set initial caps too low, then the incentives to invest will be reduced by the anticipated low return on capital. An undoubted advantage, however, of this type of direct control of prices is that it is easier and cheaper to implement and monitor than the traditional rate-of-return regulation experienced in the USA.

Given these benefits, it is not surprising that a price-cap system of regulation was introduced for the privatisation of British Telecom and other industries in the UK. The price-cap system is based on four fundamental characteristics (Acton and Vogelsang, 1989)[9]:

(i) The regulator sets a maximum price, called the price cap, and the firm can then retain whatever profits it can make by selling its output at that price. In the setting of the price cap, the regulator considers cost, demand and profit conditions of the firm.

(ii) In the case of multi-product firms, the regulator may define an aggregate cap for a basket of related goods or services, which takes the form of a weighted average of prices or a price index. The regulated firm can then alter the prices of individual products, as long as the index, or weighted average, does not exceed the aggregate cap.

(iii) The price cap may be linked to a factor exogenous to the firm, which varies over time, such as a price index.

(iv) At predetermined intervals of several years, the price cap is reviewed and changed if cost, demand and profit conditions of the regulated firm have changed over the regulation period.

If the index m denotes monopolistically supplied goods, a profit maximising firm faces a constraint $p_m \leq p_m^*$, where the price ceilings, p_m^*, are set by the regulator and the firm can choose any set of prices p_m up to the price ceiling. The flexibility of the regulated firm can be greatly enhanced if a joint price ceiling is defined for a basket of services supplied by

[9] More details on the specific UK system of price-cap regulation will be provided in the next section of this chapter.

the firm, rather than price limits on individual products. The best-known example of such a joint ceiling is the British RPI-X regulation: an average price of some bundle of the firm's products must not exceed the retail price index minus an exogenously fixed constant X. Under this regulation, a profit maximising firm is prevented from exploiting the consumers by the constraint:

$$P \leq RPI - X$$

where P is a price index of the monopolistically supplied outputs of the firm. P is usually assumed to be a sub-index of the retail price index and X the sum of weighted output revenue increases minus a sum of weighted input cost increases. The choice of X will reflect different objectives by the regulators. In general, a regulator with 'political' objectives will determine X as exogenous to the regulated firm. On the other hand, if X is endogenous to the firm then the regulator has 'productivity-related' objectives.

As Train (1994) points out, a fixed price cap will induce the firm to choose the cost-minimising input mix and invest in cost saving technologies. This is because the firm is allowed to retain any cost reduction achieved and thus it will drive towards efficiency. Of course, during the regulatory period of fixed price cap, the firm can retain all efficiency gains, without sharing them with consumers, as it would have happened in the case of a rate-of-return system. However, when the regulatory period comes to an end, the regulator will revise the price cap in the light of any efficiency gains and changed market and technological conditions during the period. This periodic review allows the consumers to participate in the efficiency gains occurred during the regulatory period. The problem with this system is that, although there is a window of time when the firm can exploit efficiency gains, eventually these gains will be regulated away and thus, like in the rate-of-return regulation, there is a possibility of strategic behaviour by the firm, which could prevent the achievement of cost reductions (Vogelsang and Finsinger, 1979). Depending on the length of the regulatory lag and the price review arrangements, the distinction between rate-of-return and price cap regulation could blur.

Nevertheless, given that costs and demand conditions change over time, it is in everybody's interest, including the firm, that the price cap changes over time too. The question is how and when these changes should take place. Some changes are usually predetermined by the price formula. For example, the price cap may be tied to a price index to reflect changes in input prices. Thus, if there is a general increase in prices, the price cap will raise in line with it and the firm is protected from cost changes that are beyond its control. This exogenously determined price cap adjustment does not affect the cost-minimising behaviour of the regulated firm, which still benefits from any endogenously determined efficiency gain. However, when the price cap adjustment is due for a periodical review, the analysis of the firm's behaviour becomes rather more complex and strategic games between the regulator and the regulated firm cannot be ruled out. In particular, it is possible that the firm will 'waste' resources, especially as the end of the review period approaches, to induce the regulator to set a higher price cap. If the review periods are very short, price-cap regulation can become equivalent to rate-of-return regulation.

Price-cap regulation has also been adopted in the USA, initially for AT&T. However, in the USA the price cap system adopted provides for bands of acceptable rates of return, which can override the price caps when the rate of return falls outside the acceptable boundaries[10]. This modified price cap system has all the disadvantages of the high transaction costs of the traditional rate of return regime and, in the case of very high returns, the system reverts to the rate-of-return regulation. This is why Thompson (1987 and 1991) argues for a loose upper band and a tight lower band and adds that this would minimise both cost of capital and revenue requirements.

1.4 PUBLIC UTILITIES REGULATION IN THE UK

1.4.1 The Legislative Background

In addition to the characteristics outlined above, there are also legal and administrative differences between the ways in which the UK and US governments approach the issue of regulation. In the UK, regulation is administrative-based and the relevant Act and licence, to which the regulated firm is subjected and which spell out the obligations, powers and responsibilities of both regulator and regulated firm, ensure enforcement. In addition, during the period investigated by this thesis, regulatory decisions were also subject to appeal to the Monopolies and Mergers Commission and to judicial review. In the US, instead, the courts are heavily involved in setting the regulatory policy and the principles of regulation are set out in legislation and subject to appeal to the courts. This court-based approach has been mainly adopted to deal with the problem of the

[10] Some of the changes to the original price cap scheme in the USA have been justified on the basis of different technology and market conditions, as well as ensuring continuation in the regulatory function, i.e. continuation in the 'administered contract' (Goldberg, 1976).

regulated industry establishing its influence over the regulatory decision. However, this system has created another problem: organised special interest groups and big regulated companies often have more and better resources available, such as more financial resources, better lawyers, scientists, information, than consumer groups. Thus this court system may eventually go against the interests of the groups that it is designed to protect. This is why, in the UK, the role of courts has been minimised (Carey et al., 1994).

From a legal prospective, UK Government's regulation is in the form of primary legislation and is imposed by Act of Parliament, which may be either Public or Private[11]. Acts of Parliament may legislate and impose regulations directly, or empower others to regulate. Because of the concentration of primary legislation within Parliament, many Acts merely set out the broad policy of the law and the vehicle for detailed regulation is subordinate or delegated legislation. The most common among several forms of delegated legislation is the statutory instrument, which since 1946 has exercised subordinate legislative powers either by an Order in Council, or at the instance of a Minister of the Crown. Another form of subordinate legislation is the by-law, issued by a local authority or a statutory undertaking. In contrast to primary legislation, delegated legislation is subject to judicial review. The usual form of UK regulation is considerable primary legislation, accompanied by detailed and extensive regulation by subordinate legislation, effected by central or local government, or public

[11] Public Acts may be General, if they affect the entire UK, or Local, if they refer to a localised matter. Private Acts relate to affairs of individual persons and corporations. To become an Act, a Bill requires a simple majority vote by both the House of Commons and the House of Lords. However, the Lords cannot reject a Bill passed by the Commons and certified by the Speaker to be a 'money Bill', and can only delay a Public Bill for a maximum period of one year.

corporations, and devolution of administration from central government to local government and to public corporations (Peacock, 1984).

In addition, the UK industry may be subject to European Union (EU) legislation. EU laws are binding for all member states, firms and individuals and, in the case of conflict between EU laws and national laws, the former prevails. There are four main EU institutions involved in the legislative process: the European Council, which consists of one minister for each member state; the European Commission, whose members are appointed for four-year terms by agreement of the governments of the member states; the European Parliament; and the European Court of Justice, which consists of one judge from each member state. Secondary legislation is issued by the European Council and the Commission, and may take several forms. It may be in the form of: (i) regulations, which apply in their entirety to all member states and are directly applicable, i.e. they do not need implementation by means of national legislation; (ii) directives, which are binding but allow choice of implementation's methods by the national authorities; (iii) decisions, which are rulings applicable and binding to individual cases; and (iv) recommendations, or opinions, which are not binding.

1.4.2 RPI-X Regulation

The history of public utilities regulation in the UK is much shorter than its USA counterpart. Most of today's regulatory agencies and procedures were established during the 1980s, as part of the programme of subsequent conservative governments to privatise the major public utilities. Telecommunications were the first to be privatised, soon followed by airports, gas, electricity and water[12]. The original privatisation Acts were subsequently augmented by the Competition and Services Act of 1992, under which regulators are compelled to promote and secure competition, while maintaining appropriate quality standards, and the Competition Act of 1998, which facilitates the sharing of networks and the use of a common carriage. European Union competition law comes to strengthen UK legislation. The statutory duties of UK regulators include protecting the interests of consumers with respect to prices and quality of services, the interests of producers by ensuring that they are able to finance the provision of these services, employees and third parties where environmental concerns may arise.

As already mentioned, the main instrument of regulation in the UK is the price-cap system, first proposed by Littlechild (1983) and implemented to the regulation of the newly privatised British Telecom. It has become known as RPI-X regulation and it is based on a system of price control, according to which the increase in the weighted average price of a basket of services must not be greater than the increase in the Retail Price Index

[12] Telecommunications Act, 1982; Airports Act, 1986; Gas Act, 1986; Electricity Act, 1989; Water Act, 1989; and Water Industry Act 1991.

(RPI) reduced by an agreed percentage, known as the X factor. This X factor is supposed to reflect the expected productivity gains and ensures that the benefits from productivity gains are passed on to the consumer. In particular, when setting the price cap, regulators assess the expected efficiency levels over the period in which a specific price cap will apply. These expected efficiency levels are then used to forecast cost trends and thus the likely rate of return at different service prices. The chosen price cap will be the one that allows the company to earn a 'fair' rate of return over the period before the next review, usually four to five years. Of course, the RPI-X constraint is only one of many conditions imposed by the regulated company's licence, initially set by the government as part of the privatisation process. But unlike other conditions, the magnitude of the X factor has limited duration, being periodically reviewed by the regulator as part of the continuing regulatory process.

There is no formal conditions imposed on the review process, i.e. there is no formal constraint on the magnitude of X in subsequent review periods. However, the regulator is limited by a number of circumstances. Firstly, the other conditions in the licence need to be taken into account. These conditions can be changed, but only with the agreement of the licensee. In case of disagreement, during the period of investigation of this thesis, the regulator could refer the case to the Monopolies and Mergers Commission, but it was a cumbersome and unpopular procedure and the regulator might have feared failure in securing the MMC support. Secondly, since different levels of X determine how profits are split between the consumers and the shareholders of the regulated company, the expectations of these two interest groups must also be considered. Many of these expectations are formed at the time of privatisation and thus the regulator may not have had any control on their formation. Finally, financial markets have better information on the company's performance at the time of the review of factor X than at the time of privatisation. When X is reviewed, the company's shares have usually been traded for a number of years and financial indicators such as the β coefficient, the dividend yield, the price-earning ratio are known. Therefore, investors will react to any regulatory change and discount in share prices the expected effects on the company's performance. The regulator cannot ignore the financial market reaction. In conclusion, there are certainly more constraints on the regulator's actions at the time of the review, than on the government when setting X for the first time.

The advantages of the price cap system over a rate-of-return regulation have been highlighted earlier. Here, it is worth mentioning some specifically important aspects for the UK privatised utilities. As discussed above, in the case of companies with monopoly power, such as regulated utilities, economic theory predicts that there is a tendency to inefficiency and rate-of-return regulation tends to exhacerbate this tendency[13]. On the contrary, price-cap regulation is expected to encourage improvements in efficiency because, once the RPI-X formula has been set, it is not expected to change for a stated number of years and the company can retain any profits generated over this period, even if these profits are higher than expected. In other words, the regulated company can shares in any social gains from efficiency with increased profits, at least for a number of years. However, if a price cap is chosen incorrectly, inefficiencies can still result. In particular, if the price is set well above average costs, a dead-weight loss occurs relative to the second best solution; if price is set below average cost, the company may not be able to survive.

[13] The first formal analysis of the potential inefficiencies caused by a rate-of-return regulation appeared in Averch and Johnson (1962). Braeutigam and Panzar (1989) discuss inefficiencies caused by profit-based regulation in both competitive and non-competitive markets.

In the case of a multi-product company, such as BT, this problem is augmented by having to choose a price-cap index and the weights in the index[14]. Furthermore, as mentioned earlier, whether or not rate-of-return and price-cap regulations have different effects on efficiency depends crucially from the time period over which fixed price controls operate. If price rules were to be revised very often, there would be no real difference between the two types of regulation. However, if a price-cap is fixed for relatively long periods, then the incentives to increase productivity are believed to be greater under price than profit regulation[15]. While in the rate-of-return regulation the firm recovers its costs ex-post, the price-cap is fixed on an ex-ante estimate of the regulated firm's efficiency gains. As long as the regulated firm can keep the rate of increase of prices charged to customers in line with the RPI-X formula, its earned rate of return should be of no interest to the regulator. That is, by untying the setting of prices charged from profits earned during each regulatory period, there should be an incentive for cost reductions, since any cost reduction not accounted for in the setting of the price-cap will benefit shareholders through an increase in profits.

The so-called 'productivity factor', X, is the key element in this incentive mechanism, since it is subtracted from the retail price index to determine the increase in rates that will be allowed without regulatory approval. If cost reductions exceed the productivity factor, then profits will increase without an increase in real prices charged to customers. In a way, the productivity factor determines the rule for sharing cost reductions between

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[14]For issues related to multiproduct firms facing price-cap regulation, see Sappington and Sibley (1992) and Armstrong and Vickers (1991).

[15]Although from a public-policy perspective price-cap regulation is today widely preferred, from an economic theory point of view whether or not price-cap regulation is more welfare enhancing than rate-of-return regulation remains an open question (Braeutigam and Panzar, 1993).

customers and shareholders. Thus, factor X reflects more than the mere return on capital, because it is set as part of the negotiations of the whole regulatory framework, including for example the coverage of the regulated basket of services, non-commercial obligations and restrictions on competition. It is interesting to note that, unlike their US colleagues, UK regulators do not have an obligation to disclose the exact basis for the setting of X[16]: as long as their actions are deemed legitimate in terms of the Act, the decisions of regulators are not questioned. This implies that in the UK system there is greater scope for bargaining and X is only one of the variables on which this bargaining occurs. The additional bargaining power of the regulator in the price cap system is a main distinguishing feature and efficiency gains from regulation will be greater the more effectively the regulator is able to use this power (Vickers and Yarrow, 1988).

The aggregate weighted RPI-X formula also allows the regulated multi-product company greater flexibility to adjust the structure of prices within the basket of services, while placing no constraint on prices outside the basket. This characteristic was thought to be particularly desirable for British Telecom for which lack of accurate knowledge of costs and demand conditions meant that 'optimal prices' for individual services could not be immediately determined at the time of privatisation (Beesley and Littlechild, 1989). The consequence of initial prices being out of line with costs was attenuated by British Telecom's ability to determine their price structure across services in and outside the regulated basket.

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[16] The exact details of the calculation of X are not in the public domain, but for some information on the calculation procedure see Beesley and Littlechild (1989), MMC (1990), CAA (1991), Cave (1991) and Ofwat (1991).

The UK price-cap system is however also open to criticisms. Hillman and Breautigam (1990), for example, argue that, since the choice of productivity factor determines the share of cost reductions to be passed on to the consumer, its choice is a political one, and also one that can affect the ability to realise the maximum cost reductions. It is certainly acknowledged that the determination of the correct productivity factor is very difficult and full of uncertainties (Kiss, 1991; and Kwoka, 1991), since it should not be merely based on past data, but reflect future trends in productivity. Past regulatory experience confirms this difficulty: for example, the factor for British Telecom was changed from 3% to 4.5% after only three years of implementation of the regulatory system. Some of the literature suggests that the factor should be adjusted frequently in order to accomplish a fair sharing of productivity gains (Hillman and Breautigam, 1990) and the criteria for revising X should be clear to avoid higher cost of capital and encourage investment. The problem is that, with frequent readjustments of the productivity factor based on cost reductions, the price-cap system becomes very similar to the rate-of-return system and thus looses its efficiency incentive. However, the consequences of leaving the cap at an undesirable level for a long time period could be quite damaging. Thompson (1992) demonstrated that there is a single value of the productivity factor that is consistent with firm value maximisation and revenue growth minimisation. If a higher value than this is chosen, it may induce perverse behaviour on the part of the firm. Greater flexibility to set the structure of prices can also be seen as a disadvantage, since it allows cross-subsidisation, which leads to allocative inefficiency and can be used anti-competitively. Finally, it has been argued that placing emphasis on the level of prices may lead to a lower quality of services (Vickers and Yarrow, 1988).

An important consideration for UK regulators is the theoretical view that, while rate-of-return regulation can be applied equally well to all industry structures, price cap regulation can be successful only when applied to monopolistic industries. That is, price cap regulation should be limited to those industries where competition is absent (Spulber, 1989; and Price, 1994), otherwise a firm could combine predatory pricing in the competitive sector with consumer's exploitation in the monopolistic sector, while adhering to the aggregate price cap. This is potentially a problem in the case of British Telecom since its basket of regulated services includes competitive as well as monopoly services. In practice, economic regulation in the UK is in many cases more complex than a simple RPI-X formula. British Telecom, for example, has more specific constraints regarding the rate of increase of residential line rentals and private circuits. The regulator also puts informal pressure on licensees: OFTEL, for example, indicated in the past that the re-balancing of trunk and local calls had gone far enough and that further action by British Telecom would be followed by explicit controls via a modification in the licence agreement. Given that the Competition and Services Act (1992) states that regulators are compelled to promote and secure competition, it could be concluded that UK regulators have an obligation to protect the consumer only temporarily, while encouraging competition to develop. One way of doing so would be to subject sections of the market that differ by degree of competition to different price caps, without discouraging potential entrants with too heavy restrictions. Certainly the basket needs to be reconsidered and, if necessary, redefined to reflect market conditions. In reality, UK regulators have not been overly concerned with relative price re-balancing. This is another major difference between the UK and the US systems: while in the USA regulated companies have to justify any proposed price changes, in the UK regulated companies can rebalance the relative prices of their services. The burden of proof to show that the re-balancing should not occur is on the regulator. Whether this flexibility is desirable or not depends on the balance between the need for prices to reflect fast changing technological and market conditions and the opportunity for anti-competitive behaviour.

While price regulation of the telecommunications and water industries is based on the tariff basket described above, price regulation of the electricity and gas industry is based on a revenue yield approach. According to this price-cap system, price changes must be such that the forecasted average revenue per unit of output in the next year does not increase by more than RPI-X. To implement this system, the regulated companies themselves provide an estimate of output and the formula contains an additional correction factor to recoup any deviation between prediction and outcome. Although the comparison between this two price cap systems is still open to controversies and their effectiveness depends on other aspects of privatisation, it has been argued that in general the revenue yield approach allows more strategic behaviour by the company (Cheong, 1989). It also decreases the company's risk by smoothing out the average unitary revenue and giving it more control over total revenue, since the company provides the forecasts. Finally, since the price formula is more complex and based on company's estimates, this system is also less transparent.

1.4.3 RPI-X Regulation and the Promotion of Competition

While the promotion of competition was not traditionally a relevant issue in the US rate-of-return regulation[17], the protection of potential entrants from anti-competitive pricing policies of incumbent firms was important in the regulation of UK privatised utilities from the very beginning. Indeed, as mentioned earlier, an important aim of the UK privatisation programme is to develop competition in industries that have traditionally been state monopolies, while maintaining appropriate quality standards. The extent to which this is possible varies from industry to industry, depending on the technical and market conditions of the various UK privatised utilities. The very limited scope for developing competition in the water and airport services industries is reflected by the small place that competition plays in the Airports and Water Acts. On the contrary, in the telecommunications, electricity and gas industries the regulator has a role to play in the licensing of entrants and in developing the right conditions to encourage competition for the market (Vickers and Yarrow, 1988; and Spulber, 1989).

Regulation can influence the competitive posture of an industry by affecting its structure and conduct. Structural regulation includes measures aimed at breaking up monopolies, controlling merger activity and the scope of business and removing legal barriers to entry. On the other hand, conduct regulation relates to competition policy measures, such as pricing behaviour and other forms of dominant behaviour. Price regulation thus

[17] On the contrary, it has been argued that one of the main purposes of US regulation traditionally was to protect incumbent firms against potential competitors (Stigler, 1971; and Jarrell, 1978).

has a role to play in determining the conduct of the industry. In particular, when a weighted average price cap is applied to a basket of commodities, the regulator needs to focus his attention on: (i) the structure of relative prices charged by the regulated multi-product firm; and (ii) the use of pricing strategies, such as price discrimination, non-linear pricing, predatory pricing, cross-subsidisation and network access pricing (Laffont and Tirole, 1993, ch 3; and Armstrong, Cowan and Vickers, 1994). When searching for an optimal pricing structure, the aim of promoting social welfare can conflict with the aim of promoting competition. In particular, when the regulated firm has an informational advantage over the regulator, the firm is in a better position to decide on a welfare maximising structure of prices; however, it is unlikely to do so, since the firm's aim is different from the regulator's aim. These conflicts lead towards a situation in which the firm has discretion over the pricing structure, but the regulator imposes restrictions on the exercise of this discretion (Vickers, 1997).

Any restriction on pricing behaviour must be based on some kind of benchmark. The definition of a benchmark is a very difficult task in the presence of given technological conditions and conflicting objectives. While the efficient allocation of resources calls for price to equal marginal cost, in the presence of economies of scale this rule leads to a price below average cost and thus creates the additional problem of cost recovery. In any case, distributional and political concerns complicate this simple rule. If the regulator is perfectly informed and has the ability to make lump-sum transfers, a solution to this problem is for the regulated multi-product firm to charge a price equal to marginal cost for each product and for the regulator to make transfers to the firm to cover the cost differential. If such transfers are not possible, then optimal regulation would call for Ramsey pricing. The benchmark of Ramsey pricing is the theoretical answer to many of the problems outlined above (Ramsey, 1927). Ramsey prices are based on the price/cost mark-up on products, $(p_i - mc_i) / p_i$, for each product i, where p is the unitary price, mc the marginal cost and $(p\text{-}mc)$ the 'tax' charge on each product. An optimal set of Ramsey prices does not usually imply equal mark-ups on all products; that is, $mc_i{=}mc_j$ does not imply $p_i{=}p_j$. Therefore, Ramsey pricing generally entails a form of price discrimination. Although a brief definition of such a complex concept inevitably leads to over-simplification, it could be said that, if a set of optimal Ramsey prices applies, a small proportional change in the 'tax' on products, $(p\text{-}mc)$, would cause the same proportional change in the compensated demand for each product. In other words, small increases in taxes, ignoring income effects, lead to equi-proportionate reductions in quantities (Mirrless, 1976). Furthermore, the Ramsey principle can also apply to non-linear pricing, such as two-part tariffs (Wilson, 1993), and can be adapted to accommodate distributional concerns (Hancock and Waddams Price, 1995).

In practice, however, Ramsey pricing is rarely implemented and the pricing of services often fails to reflect costs. For example, the charge for being connected to the telephone network in the UK does not depend on where the user is located, although the cost of providing the service is higher in a rural than in an urban area. Similarly, although the consumption of gas and electricity is higher, and also less elastic, in winter than in summer, charges do not vary across seasons. The charge for sending a letter does not vary with the distance it travels, or with the remoteness of the destination. This departure from efficient pricing may be explained by a number of reasons. First, the implementation of Ramsey prices is a very complex matter, to the extent that, as reported in Laffont and Tirole (1993, pp 200-202), Ramsey pricing was not even attempted by Boiteux, one of the pioneers of this theory, when he was in charge of Électricité de France. To apply Ramsey prices, the regulator needs to know accurately consumer demand as well as the firm's cost functions. It then needs to price discriminate according to geographical locations, calendar factors, sections of the market, and so on. Second, efficiency is not the only concern, but political objectives of fairness and acceptability are also important. Thus, for example, the regulator does not want to be seen as penalising people leaving in rural areas. Third, Ramsey pricing is not always compatible with the objective of promoting competition. If the competitive structure takes the form of a dominant firm and price-taking followers, in theory Ramsey pricing can be extended to accommodate this competitive model (Vickers, 1997). In practice, however, the competitive structure is often more complex and any pricing system imposed by the regulator will be sub-optimal, due to firms' monopoly on information.

However, the theory of Ramsey pricing stresses the importance of information in the setting of prices. Thus, it emphasises how difficult the job of the regulator is, being simultaneously the promoter of competition and less informed than the regulated firm. Because of superior information, in most cases, it would be desirable to leave some pricing discretion to the regulated firm, so that decentralised information can be incorporated into the decision making process. However, there is always the risk that freedom will be abused in an anti-competitive manner. Thus, the crucial question becomes how to constrain pricing discretion so that competition can be allowed to develop. One proposed answer to this question is to impose a single global price cap on the firm's product range (Laffont and Tirole, 1996). This would impose a cap over an index of the firm's prices, but leave the firm free to choose the pricing structure within that index. If this price constraint is linear and the weights are set correctly, this global price cap is compatible with Ramsey pricing. It can, however, give raise to cross-subsidisation among products and predatory pricing behaviour.

It has been suggested that the imposition of floors and ceilings on the prices of individual products, as well as set of products, may solve the problem of cross-subsidisation (Baumol and Sidak, 1994, chs 5 and 6; and Baumol 1996). The theoretical literature describes incremental cost floors and stand-alone cost ceilings on prices of the type that would normally ensue in a contestable market situation, since their calculation does not need information on demand conditions and are thus simpler to derive. Even simpler is the derivation of bans on price discrimination, which merely impose cross-restrictions on prices. The issue here is to avoid price discrimination by the profit maximising firm. Whereas, as described above, price discrimination is desirable in the context of an optimal pricing policy by the regulator, the effects on welfare of a price discriminating regulated monopoly are ambiguous (Armstrong, Cowan and Vickers, 1994, section 3.3.2; and Varian, 1989). In general, in most cases of monopoly, it is certainly not desirable, unless it causes output to raise, although under certain conditions it may open up new markets, for example for consumers prepared to pay high prices. In the case of regulated monopolies, price discrimination is desirable in the case of linear price caps with fixed weights proportional to demand, but undesirable in the case of average revenue regulation. However, under the constraint that consumers should continue to be able to buy at the uniform price, price discrimination may have benefits. For example, discounts to certain types of consumers may be offered as on optional scheme, without affecting the price faced by other consumers.

The tension between the promotion of competition and an optimal pricing structure has been particularly acute in the context of network access pricing in industries where rivals have to buy key inputs from dominant firms, such as access to cable or pipe networks. Even when the ownership of these networks is separate from competitive activities, such as in electricity lines and railway tracks, the pricing of access to the network is a complex issue. When a vertically integrated dominant firm is providing the network, it is very difficult to strike the correct balance between allowing access on reasonable terms and setting a price that discourages inefficient operators. There are two main theoretical approaches to these problem: the efficient component pricing rule (Baumol and Sidak, 1994, ch 7) and the Ramsey pricing based rule (Laffont and Tirole, 1994 and 1996). The efficient component pricing rule says that the access price should reflect the direct plus the indirect costs of access, where the direct cost is simply the incremental cost of access and the indirect cost is the opportunity cost, in the form of lost profits, of supplying the network to rival firms. The alternative proposed by Laffont and Tirole is that the access price should be equal to the incremental cost of access plus a Ramsey term, which takes into account cross-price elasticity as well as own-price elasticity of demand. Although this latter approach is more general, since it takes into account fixed cost recovery as well as product differentiation, it is also more difficult to implement, given the required information on demand functions[18]. In the case of access leading to the supply of several products, the above analysis of Ramsey

[18] For a synthesis and critical comparison of these two approaches, see Armstrong, Doyle and Vickers (1996).

pricing would suggest that different access tariffs should be charged for different uses, according to the demand elasticities of the relevant products (Armstrong, Doyle and Vickers, 1996). This result is also supported by the efficient component pricing rule, according to which access used to supply a product that complements existing products should be cheaper than access used to supply a substitute product, since the opportunity cost of the latter is higher. In addition, if the regulator wishes to provide incentives to innovation, access sought to supply new innovative products should be even cheaper.

The importance of incentives in the regulatory process is particularly emphasised by the literature that addresses the consequences of the existence of informational asymmetries between regulator and regulated firms. If the regulator is not as well informed as the firm about industry conditions, even under 'optimal' regulation firms will be able to gain undesirable excess rents from their monopoly on information. To weaken individual firm's informational monopoly, the regulatory system should provide incentives towards competitive behaviour between firms located in different regions. This type of regulation-induced competition is known as yardstick competition and can be implemented by making the rewards to one firm dependent on its performance in relation to that of other firms in the industry (Laffont and Tirole, 1993, section 1.7). For example, the regional structure of the electricity and water industries in England and Wales is suitable to yardstick competition between firms in different regional areas. Theoretically, models of yardstick competition are part of the literature that formalises the treatment of situations where a principal needs to monitor several agents and does so by using comparative methods of performance (Holmstrom, 1982; Nalebuff and Stiglitz, 1983; and Mookherjee, 1984). It has been shown that yardstick competition can be used by the regulator to obtain the first-best level of welfare, since firms can compete away the informational asymmetry completely (Demski and Sappington, 1984; and Shleifer, 1985).

1.5 PRICE REGULATION, RATE OF RETURN AND COST OF CAPITAL

In the previous sections, the main focus of analysis was on the workings and failures of product markets and how their efficiencies and inefficiencies could justify a mixture of privatisation and regulation. However, as mentioned earlier, it is the interaction of product and capital market pressures that ensures efficiency gains from privatisation. Competitive pressure in product markets can lead to efficiency gains by penalising persistent under-performance, though managers are often left with some discretion. Overspending, overstaffing and some degree of managerial 'slack' do not necessarily result in higher output prices, but they can be hidden by lowering profits. Product markets cannot observe and thus penalise this kind of managerial behaviour, which does not directly harm customers but cuts into shareholder's returns. On the contrary, efficient capital markets will detect managerial 'slack' by exposing managers to clear 'market' rules. How well capital markets monitor managers is a matter of intense debate in the literature and can depend on the form of governance, such as concentrate versus diffuse ownership (Stiglitz, 1985). In principle, the government, as a single agency, has more power to monitor managers than disperse share ownership; however, managers in state enterprises often work towards badly defined objectives. On the contrary, it is argued that in a privatised firm managerial discretion is constrained by the threat of take-over. If capital markets receive the information that the firm is under-performing, this information will be embodied into its share price and the firm will became a target for a take-over, which is most likely to result in the replacement of the existing management team. While the theoretical argument is convincing, the empirical evidence on the effectiveness of the market for corporate control to discipline managerial discretionary behaviour is somewhat inconclusive, with a plethora of studies finding no evidence of improved performance after a take-over (Singh, 1971 and 1975; Meeks, 1977; Firth, 1979 and 1980; Grossman and Hart, 1982; and Hughes, 1989), and others challenging this finding (Halpern, 1973; Mandelker, 1974; and Asquith, 1983).

In addition to being an instrument of managerial control, capital markets set the price of funding on the bases of the regulated firm's performance and risk. The accurate ex-ante determination by the regulator of a 'fair' rate of return for regulated firms is obviously very important in the case of the rate-of-return regulation. However, even in the context of the RPI-X regulation, rate of return considerations are implicit in the setting and re-setting of factor X (Littlechild, 1986), since allocative efficiency requires that the cost of capital be equal to the rate of return and the regulator must ensure that regulated firms are financially viable. In effect, if the price rules were to be revised very often, there would be little real difference between rate-of-return and price-cap regulation. At privatisation, the regulator needs to anticipate capital market expectations and forecast the cost of capital that the regulated firm will face to set the parameters for price regulation[19]. Once privatised, the regulated firm faces capital markets to raise funds for its operations and the regulator must consider the effects of any subsequent regulatory decision on the firm's cost of capital. It has been long recognised that the cost of capital may well be endogenous to the regulatory process itself (Marshall, Yawitz and Greenberg, 1981) and that any model of determination of the cost of capital of a regulated firm should include regulation explicitly. The pioneering work of Brennan and Schwartz (1982), who analyse the dynamic effects of regulation on firm value and risk, shows that it is not accurate to determine the risk, and thus the cost of capital, of a regulated firm, without incorporating a model of regulatory action.

The above considerations make the empirical observation of the rate of return and the cost of capital even more complex than it may appear at first sight. Firstly, standard models of cost-of-capital determination, from simple discount-cash-flow models to the more complex Capital Asset Pricing Model, do not include regulation explicitly. Although the Arbitrage Pricing Theory has the potential for including regulation as one of the factors, it would be difficult to subsume the complex and dynamic process of regulation in a single factor. Secondly, it is the firm's regulated business only that is of interest to the regulator, not the firm as a whole. However, the cost of capital of the firm's regulated business only cannot be observed directly, since any market data refers to the firm in its entirety, and it can only be inferred from financial data. Finally, stock market data are useful in determining the firm's cost of equity capital, but the regulator must consider the aggregate cost of capital coming from whatever source. These three considerations make the use of observed measures of systematic risk, such as the beta

[19] For an analysis of the initial setting of X and K factors in price-cap regulation, see Armstrong, Cowan and Vickers (1994), section 6.3.

coefficient, somewhat inaccurate in assessing the cost of capital of regulated firms (Meyers, 1972; and Breen and Lerner, 1972).

In the context of the rate-of-return regulation, the determination of a 'fair' level of rates of return is usually based on revenue requirements, defined as total expenses plus a fair rate of return on invested capital. The fair rate of return on invested capital can in turn be defined as:

Fair Rate of Return × Rate Base = (Embedded Cost of Debt × Book Value of Debt) + (Fair Rate of Return on Equity × Book Value of Equity)

All components of the above formula can be measured, apart from the rate of return on equity. It is therefore fundamentally important for regulators to determine the 'fair' rate of return required by equity markets. This is problematic even in the absence of regulation, since there is no general agreement in the theory of finance as to the most appropriate model to use for the determination of the ex-ante required rate of return on equity. In addition, in the case of regulated firms, the evaluation of a required market rate of return is further complicated by the regulatory process, since the regulator's allowed rate of return is closely, and circularly, related to the required market rate of return (Dubin and Navarro, 1982). Under price-cap regulation, the regulator does not explicitly set an allowed rate of return. However, as said, the setting of regulatory parameters is based on the regulator's view as to the present and future profitability of the firm in relation to investor's expectations. Since in the rate of return regulation the determination of the allowed rate of return is based on the regulator's view of the rate required by investors, in both regulatory systems the regulator considers investor's expectations in setting regulatory rules. However, once set, the allowed rate of return is likely to influence investors' expectations, and thus affect the determination of the future market 'fair' rate of return on equity. In other words, there is circularity in the determination, by the market and by the regulator, of the rate of return.

In addition to the above, the process of regulation can affect the cost of capital by affecting the perceived risk of the firm through several effects. By altering the effects of market changes on the industry, it can alter future cash flows, and thus it can alter profitability and risk. Traditionally, the literature has identified two main opposite effects of regulation on the firm's cash flows. Firstly, during inflationary periods, regulation has a tendency to slow down the price adjustment and thus regulated firms are likely to show a reduced level of financial performance and increased risk (Joskow and MacAvoy, 1975; Spann, 1976; and Keran, 1976). Secondly, a regulatory regime tends to buffer the effects of changes in external economic conditions and thus it is likely to reduce firm's risk (Peltzman, 1976; and Shaffer, 1984). Whichever the direction of the effect of regulation on firm's risk, there is little doubt that, as shown by Brennan and Schwartz (1982), regulation is a dynamic on-going process that affects the characteristics of cash flows to investors. In particular, Binder and Norton (1999) have shown that regulation can affect the systematic risk of a firm by altering: (i) the covariability of the returns on equity of the regulated firm with the market; (ii) firm's or industry's specific factors; and (iii) the buffering effects of regulation[20].

[20] Binder and Norton's model will be discussed more extensively in Chapter 3.

Under an efficient-markets/rational-expectations hypothesis, investors base their evaluation of a company on all available relevant information; that is, information which affects future cash flows. To illustrate the effects of regulation on the share price of the regulated firm, we can express the price of a share in company i at time t, P_{it}, as equal to the discounted value of the future cash flows:

$$P_{it} = \sum_{k=1}^{\infty} \frac{CF_{i,t+k}}{(1+r_i)^k} \tag{1.13}$$

where $CF_{i,t+k}$ is the cash flow that, at time t, investors are expecting a share in company i to generate at time $t+k$, and r_i is the discount rate, equal to the opportunity cost of the cash flow, given its perceived level of risk.

A regulatory change may affect expression (1.13) in two ways: by changing future cash flows and/or by changing the perceived risk of company i. Assuming that both cash flows and risk change, the difference between the pre- and post-regulation share price is equal to:

$$(P_{it}^{*} - P_{it}) = \sum_{k=1}^{\infty} \left(\frac{CF_{i,t+k}^{*}}{(1+r_i^{*})^k} - \frac{CF_{i,t+k}}{(1+r_i)^k} \right) \tag{1.14}$$

where P^*_{it}, $CF^*_{i,t+k}$ and r^*_i are the price, the expected cash flow and the opportunity cost of the cash flow after the regulatory change, respectively. The size and direction of the potential effects of regulation on share prices described in equation (1.14) above cannot be determined a priori. They are empirical questions that will be investigated in the remaining chapters of this thesis.

1.6 CONCLUSIONS

The review of the main issues in the economics of regulation conducted in this chapter highlights the importance of empirically investigating the consequences of regulatory action for the regulated firm. From a theoretical point of view, the traditional approach to regulation assumes that regulators have only one objective and are fully informed, while firms produce a single good, maximise profits and are equally well informed. More recently, however, the literature has incorporated into the theoretical models of regulation many of the imperfection of real life, such as, to mention just a few, the case of multiple objectives, multi-product firms and potential prices cross-subsidisation, rationed markets, price discrimination and asymmetric information (Bös, 1994). Similarly, the practice of the regulation of economic activity has changed dramatically in the last century, transforming the relationship between government and business, as well as their role in the economic progress. It is fair to say that: "*The economics of regulation would be a relatively simple matter if regulators were omniscent, benevolent, and able to precommit future policy, but in practice there are problems arising from asymmetric information, policy credibility, and the danger of 'capture'*" (Armstrong, Cowan and Vickers, 1994, p 6-7).

This uncertainty about the form that regulation should take and its effects on regulated firms permeates all aspects of the literature, including the relationship between regulation and the cost of capital. Section 1.5 above, in particular, shows that, irrespective of the regulatory system, there is a two-way feedback effect between the regulator's decisions and the cost of capital. In the rate of return regulation, this occurs through the setting of the allowed rate of return; in the case of price cap regulation, it is embedded in the setting of the X factor. The theory however is inconclusive about the direction of the effects of regulation, with arguments supporting both increasing and decreasing returns and risk. Thus, the issue remains largely empirical. The remaining chapters of this thesis contribute to the investigation of this relationship between regulation, rate of return and systematic risk.

Chapter 2

The Effects of Regulatory Announcements on the Return and Conditional Volatility of the Equity Capital of the Power Generators and the RECs

2.0 INTRODUCTION

Following the privatisation of public utilities by the UK Government and the introduction of regulatory bodies to control their activities, there was anecdotal evidence to suggest that such regulation had an impact on the utilities' cost of equity capital. While in the USA there was a body of empirical literature quantifying the effects of regulation on the return of public utilities' stock, these aspects had not as yet been investigated in any rigorous way in the UK. However, the results of such investigation would obviously be of great interest to regulatory bodies and firms in regulated industries, as well as to consumers and investors.

Existing studies on the impact of unanticipated regulatory announcements on share prices relate mainly to the US rate-of-return regulation. These studies tend to consider infrequent or one-off regulatory events and the main aim of the analysis is to quantify the regulatory effects over some time period, usually several days (Teets, 1992) or a month (Binder, 1985a). The present chapter analyses instead the impact of unanticipated regulatory announcements on the cost of equity capital of the Regional Electricity Companies (RECs) and the power generating companies in England and Wales, which are subject to price-cap regulation administered by Offer, a regulatory agency. This is achieved by studying the impact of regulatory announcements on the return on equity of these regulated companies. In this type of studies, the literature usually applies the methodology of Karafiath (1988) and Binder (1985b) and uses an extended market model, with dummy variables that capture the effects of announcements on and around the announcement date. In this chapter, this methodology is extended to capture the heterosckedasticity of financial time series. Announcements are classified into three groups: announcements which affect the industry's competitive posture, its pricing policy and its supply of services. Each of these three groups is further split into two groups, depending on whether the announcements are expected to increase or decrease competition, price and service supply, respectively. The effects of announcements are tested on an equally weighted portfolio of generators and of RECs, as well as on the individual RECs. Finally, the informational content of individual regulatory announcements is also investigated.

The remainder of this chapter is organised as follows. Section 2.1 outlines the privatisation and regulatory framework of the electricity industry of England and Wales in the light of the main economic characteristics of electricity generation and supply. Section 2.2 analyses the event study methodology adopted in this chapter to investigate the effects of regulatory announcements on the returns and conditional volatility of returns of the equity capital of both the Regional Electricity Companies and the electricity generating companies of England and Wales. This section also contains the formulation of the hypotheses tested for groups of regulatory announcements and individual announcements. The data and the selection process for the announcements is described in Section 2.3. The empirical results for both group and individual announcements are presented in Section 2.4, while the conclusions are in Section 2.5.

2.1 PRIVITISATION AND REGULATION OF THE ELECTRICITY INDUSTRY OF ENGLAND AND WALES

There are four main stages of production in the supply of electricity: generation, transmission, distribution and supply to final customers. With respect to generation, there is a choice of energy inputs, but all involve some environmental costs; that is, there are considerable spillover effects in the generation of electricity. Furthermore, electricity generation is capital intensive and most investment costs are sunk. Essentially, electricity is a product that is, in the main, non-storable, with fluctuating difficult-to-predict demand and constrained supply. Demand fluctuates by time of the day and time of the year and heavily depends on weather conditions. Supply is constrained in the short-run by the capacity limit of power stations and can be affected by unpredictable outages. In spite of these difficulties, demand and supply must be matched continuously throughout the system and total capacity needs to exceed expected demand by a safe margin to allow for uncertainties. Thus, at any one time, some power stations may not be producing electricity, but nevertheless supplying a valuable electricity call option. Evidence on electricity generation indicates that, depending on the energy input used, there are increasing returns at relatively low levels of production, but mainly constant returns otherwise[21].

The transportation of electricity is costly and the rate of power loss is an increasing function, approximately quadratic, of the net power flow along transmission lines. Thus, the choice of geographical location and size of plants in relation to local demand is important for the overall efficiency of the system and generation is closely related to transmission. Transmission too is capital intensive and has sunk costs. In addition, transmission has the characteristics of a natural monopoly, since duplication of lines would normally be inefficient and a system-wide network desirable. There is no physical trade between one supplier and one user. A number of generators supply power at different nodes in the system and a greater number of users withdraw power at other nodes.

[21] For example, the minimum efficiency scale for fossil fuel generation is estimated to be

Equilibrium between demand and supply must be continuously maintained by co-ordinating very closely generation and transmission. This is why these two activities have typically been vertically integrated and it has been argued in the empirical literature that economies of scope between them could be large enough to give them joint natural monopoly cost conditions, even if generation per se is not a natural monopoly (Kaserman and Mayo, 1991; and Kerkvliet, 1991). Thus, in separating generation and transmission, there could be a trade-off between the gains of greater competition in generation and the losses of economies of scope between generation and transmission. In general, the optimal price at any one node depends not only on the marginal cost of generating electricity, but also on the effects across the system of incremental supply and/or demand at that node, and in particular the effects on the system's losses and transmission constraint[22].

Like transmission, distribution is also characterised by capital intensity, sunk costs and natural monopoly cost conditions within any given area. Traditionally, the supply of electricity to retail customers has been carried out by the same companies providing the distribution, with the exception of large industrial customers who could be supplied directly by the transmission company. However, although a replication of wires would obviously be inefficient, there is no reason why a number of suppliers could not compete in retailing, using a common distribution network.

The structure of the electricity industry in England and Wales before privatisation was established by the Electricity Act of 1957. According to this Act, it consisted of the Central Electricity Generating Board (CEGB), responsible for generation and bulk

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around 400 megawatts capacity (Joskow and Schmalensee, 1983).

[22] On the theory of the spatial pricing of electricity, see Bohn, Caramanis and Schweppe, 1984; and Hogan, 1992.

transmission of electricity and in control of most of the industry's investment, and twelve Area Boards, which distributed and supplied electricity from the CEGB's bulk supply points within their designated areas. In addition, the Electricity Council had policy-making functions and comprised of three representatives of the CEGB, the chairmen of the Area Boards and six independent members appointed by the Minister[23].

As a state owned industry, the electricity industry experienced similar problems to the ones faced by other British nationalised utilities, mainly due to lack of competition in both product and capital markets, and the political nature of the decision-making process. In particular, the industry's monopoly in the product market mainly translated in a lack of choice for consumers. The absence of a market for corporate control meant that there were no incentives to improve efficiency, since there was no takeover threat, with the ultimate 'owners' of the business being members of the public without property rights over their 'ownership'. Priority was often given to political objectives over commercial and public service objectives; for example, in the 1970s the industry was asked to keep prices low in an attempt to contain the general level of consumer price inflation by a Labour Government, and in the 1980s it was asked to increase prices by a Conservative Government in order to reduce public borrowing. In addition, the electricity industry was used to support the nationalised British coal industry by putting pressure on the industry to produce a higher proportion of electricity by burning coal than it would have freely chosen (Robinson and Marshall, 1985; and Robinson, 1985).

[23] For a history of the British electricity industry up to the late 60s, see Kelf-Cohen (1969), Ch 4, and for the later period including privatisation, see Thomas (1997).

Figure 2.1

Chronology of the Privatisation of the Electricity Industry

May 1987	The Conservative Party manifesto specifies the commitment to privatise the electricity industry
Feb 1988	Publication of the White Papers entitled 'Privatising Electricity' and 'Privatisation of the Scottish Electricity Industry'
May 1988	The Public Utility Transfer and Water Charges Act empowers electricity boards and the Electricity Council to transfer property
Dec 1988	Second reading of the Electricity Bill in the House of Common
Apr 1989	Second reading of the Electricity Bill in the House of Lords
Jul 1989	The Electricity Act 1989 is enacted
Sep 1989	Appointment of the Director General of Electricity Supply
Nov 1989	Nuclear generation is withdrawn from the privatisation programme and Nuclear Electric and Scottish Nuclear are created
Mar 1990	The assets of the Central Electricity Generating Board and Area Boards are transferred to successor companies and the Licences come into effect
Dec 1990	The twelve Regional Electricity Companies and National Grid are sold
Mar 1991	National Power and PowerGen (60% of shares) are sold
Jun 1991	Scottish Power and Scottish Hydro-Electric are sold

The commitment to privatise the electricity supply was made in the 1987 Conservative Party election manifesto and was based on the usual claim that the process of privatisation would result in an increase in efficiency and consumer welfare. It was in many ways the most difficult privatisation attempted. The asset value of the British electricity industry at privatisation was estimated to be about four time as large as the total asset base of all the industries privatised in the first two Thatcher terms (Holmes, Chesshire and Thomas, 1987). In addition, this was a complex industry with a number of firms operating at different stages of production, very different from the previous experiences of the privatisation of the telecommunications and gas industries. There was no clear agenda for the electricity privatisation in the 1987 manifesto and no vision of the final desired structure of the industry. There was a commitment to promote nuclear power generation without any suggestion as to the safety of this in a privatised industry.

The actual privatisation of the electricity industry was legislated in 1989. Figure 2.1 describes the chronology of this privatisation. The structure of the newly privatised electricity industry in England and Wales involved the separation of generation from transmission[24]. The privatisation scheme of the electricity industry adopted by the then Government involved privatising the twelve Area Boards as twelve Regional Electricity Companies (RECs), without any restructuring. The CEGB on the other hand was split both 'horizontally' and 'vertically' before it was privatised. The generation assets were passed to three new companies: National Power, PowerGen, and Nuclear Electric. The first two received all the CEGB's fossil-fuel stations and were privatised, while the last one received all the nuclear power stations and remained within the public sector. Initially the percentage share of generating capacity for the three companies was as follows: National Power (52%), PowerGen (33%) and Nuclear Electric (15%). The transmission assets of the CEGB were transferred to a forth new company, the National Grid Company (NGC). Thus, the vertical separation of generation and transmission that characterised the state-owned industry was replaced by vertical integration of transmission and distribution. The NGC became responsible for many of the co-ordinating activities of the CEGB.

The RECs were required to keep separate accounts for their distribution and supply business. Thus, distribution and supply were separated in an accounting sense, but not in terms of either ownership or control. RECs must, however, make their distribution systems available to other suppliers on equivalent regulated terms to those upon which they provide services to their own supply business. Thus, the RECs have become monopolies in distribution, but not in supply.

[24] For details on the structure of the industry at privatisation, see HMSO (1988).

The 1989 Electricity Act set out the regulatory framework of the electricity supply industry, which among other things established the post of a Director General of Electricity Supply (DGES) and a new Office of Electricity Regulation (OFFER). Under this framework, to operate in the industry a firm requires one or more of four types of licence: generation, transmission, public electricity supply and second-tier supply. The general duties of the DGES, and also of the Secretary of State for Energy, are to: (i) secure that all reasonable demands for electricity are satisfied; (ii) secure that all licence-holders are able to finance and perform their licensed activities; and (iii) promote competition in generation and supply of electricity. In addition to the above, the DGES is also responsible for monitoring compliance with license conditions, including price controls, and ensuring enforcement.

Apart from the above structural changes made at the time of privatisation, the privatised electricity market differs from the nationalised industry in three fundamental respects:

(i) entry is now permitted to both the generation and supply business whereas previously it was prohibited by the state;

(ii) the electricity companies have private shareholders, instead of being owned by government;

(iii) regulation is by an independent body with a duty to promote competition, instead of being conducted mainly behind closed doors, with unclear rules, by politicians, civil servants and industry managers.

The general approach to regulation of the industry can be summarised as comprising of two main objectives. First, price-cap regulation is intended to prevent abuse or market power in the naturally monopolistic parts of the industry, namely transmission and distribution. Second, other regulatory aspects are designed to promote competition in the other parts of the industry, namely, generation and supply. Under this regime, the revenues of the distribution businesses of the RECs and most of the revenues of the National Grid are subject to an RPI-X price cap. As from 31 March 1998, the monopoly franchises have shrunk with more competition being introduced in electricity supply. To encourage more competition, initially certain restrictions were imposed on the retail competition. Specifically, in the period up to 1998, caps were imposed on the shares of the various regional retail markets that could be captured by the two major generating companies, National Power and PowerGen.

Unlike distribution and retail supply, the regulation for generation and wholesale supply of electricity is not of the price-cap variety. Instead, it takes the form of the imposition of obligations on companies wishing to participate in the wholesale market. The mechanism for this is the Pooling and Settlements Agreement, to which all the main players must belong. The pooling agreement requires the generators to submit day-ahead bids to supply power to the system from each of their sets, and on the basis of this and its information on demand, NGC seeks to dispatch generating sets so as to minimise total supply costs. The offer price of the marginal generating set operating in any half-hour is called the system marginal price. Under the pooling agreement, generators supplying power to the system are paid a price per unit equal to the system marginal price plus a 'capacity' element. This, in turn, is intended to remunerate capacity held for system-security reasons. Certain procedures have been imposed by regulation in estimating the capacity element of the price. Following privatisation the behaviour of wholesale (pool) prices has been the subject of much public attention. Post-privatisation pool prices have shown substantial volatility. As a result of concerns about pool pricing, the Director General reviewed pool pricing in 1991. The review concluded that the generators where manipulating prices to some extent and recommended changes in some of the procedures set out in the Pooling Agreement.

The introduction of competition has been the distinctive feature of the privatisation of electricity. An effective competitive market in generation has been a fundamental aim of electricity privatisation from the beginning. While the market is not yet fully competitive, competition in generation has increased over the years. For example, at the time of privatisation, National Power and PowerGen together had 78% of the output and capacity in England and Wales. Their output share in 1995 was below 60%, with new entry continuing to take place. However, their share of total capacity has fallen only half as fast, to 69%. Shares of capacity are also important in assessing competition. While originally ownership of NGC by the RECs was allowed for transitional purposes, subsequently the RECs have been encouraged to sell their entire holdings in the NGC. This was intended to encourage competition between the NGC and the RECs (for example, in metering and settlements and provision of connections) and in effect led to total separation of transmission from generation and supply, something very central to the electricity privatisation. The separation of REC's distribution networks from their activities in generation and supply and other business was promoted and encouraged. In order to allow competition to develop in the supply of electricity, the captive market of the RECs has been gradually reduced up to April 1998, since when most consumers can choose their supplier.

There can be little doubt that competitive pressures and RPI-X price caps have reduced operating costs significantly. However, prices in all stages of the electricity chain have not fallen as much as costs. While some aspects of pricing have fallen, this decrease was mainly due to a decline in primary fuel prices; only some of the price reduction was due to the actions taken by the Director General.

2.2 REGULATORY EFFECTS, METHODOLOGY AND HYPOTHESIS FORMULATION

As discussed in the previous chapter, the aims of governments when regulating private industries and the intended effects of such regulation are well known and widely discussed in both the academic (e.g., Stigler, 1971; Posner, 1974; Peltzman, 1976; Kahn, 1988) and popular press. However, the direction of the actual effects of regulation on the value of regulated firms, and thus their cost of capital, is unclear and depends on specific regulatory policies and how they allocate risk between the parties involved. As discussed in the previous chapter, Peltzman (1976) identifies economic as well as political influences in the regulatory process and examines how regulatory action will be affected by the desire to ensure that its effects are distributed among consumers and producers, rather than directed towards only one group. This analysis shows that ultimately regulators will tend to maximise political returns, suppressing some economic considerations. The final outcome of the regulatory process and its effect on either profits, prices, or returns will thus be uncertain. In the absence of precise theoretical predictions, the impact of regulation remains an empirical question.

Given the complexity of establishing the regulator's objectives, when conducting an empirical investigation, assumptions regarding the main aim of regulation need to be formulated. Predictions on specific effects can then be made under each of these assumptions, although in reality they need not be mutually exclusive. Throughout this thesis, three competing, but not mutually exclusive, assumptions on the regulator's objectives are considered. According to the first assumption, regulation is seen as protecting the consumer from monopoly power and externalities, and thus it should cause a reallocation of returns from shareholders to consumers. Under this first assumption of consumer protection, regulation would be expected to have a negative effect on the value of the regulated company, increase its level of risk as perceived by investors and thus increase its cost of equity capital.

According to the second assumption, regulation may assist incumbent firms to maintain their monopoly power. For example, the regulator by keeping prices low may be seen as effectively creating barriers to new entrants. This producer-protection assumption, also known as regulatory capture, implies that such regulation has a positive effect on share prices and the associated perceived risk and thus decreases the cost of equity capital. Under the third assumption, regulators are seen as optimising their own utility at the expense of both consumers and producers and regulatory announcements are then not dictated by economic and social needs but by the need of the regulator to be seen as useful and active. No predictions on the effect of regulation on share prices can be made in this case.

Irrespective as to which of the above hypothesis underlies the actions of the regulators, it is generally accepted that regulation has an impact on the rate of return on equity of public utilities, as explained in more detail in the previous chapter, section 1.5. Two ways in which the regulatory process can affect the rate of return are by : i) setting pricing rules that affect the profit level and its sensitivity to variations in revenue and cost; and ii) altering the risk faced by the providers of equity and debt finance. The direction of these effects on equity prices is however unclear and will depend on specific regulatory policies and how they allocate risk between consumers and shareholders. It is important to the regulators to understand the nature of the effects that different types of regulation can have on the return on equity, since this in turn has obvious implications for the cost of capital of regulated companies. Adverse price reactions to regulatory announcements are likely to increase the cost of equity capital. While the cost of debt is usually linked to current interest rates, and there is evidence that 'blue chip' company debt typically earned, in the period investigated in this thesis, a rate of return between one-half and one per cent higher of that of government debts, the return on equity changes with investors' expectations and can be rather volatile for an actively traded security.

As also analysed in section 1.5, the cost of equity capital is a very important variable for regulators because it determines the appropriate level of the rate of return (see Dubin and Navaro,1982). Although in the UK the regulator does not control the rate of return directly, an appropriate level of return for the regulated company is considered when price control rules are revised (see Braeutigam and Panzar, 1993). The chosen price cap is the one that allows the company to earn a 'fair' market rate of return on equity, based on investors' expectations. In an efficient capital market, rational investors react to news expected to alter the risk/returns relationship of a company's equity capital. Therefore, regulatory announcements perceived by investors to affect future cash flows and/or risk lead to changes in the required rate of return on equity capital and thus share prices.

2.2.1 Event Study Methodology

A regulation process can be described as a chain of events. Whenever these events have informational content, they will be expected to have an impact on financial markets. The empirical investigations of this impact can be grouped under the name of event studies. Up to the 1980s, event studies had traditionally used anticipated accounting data, especially earnings, to test the impact of announcements on share prices (Beaver, 1968; and Ball and Brown, 1968). In these studies, events are certain and often the informational content of announcements is widely forecast. However, forecasts may be inaccurate, especially earnings forecasts, and thus price reactions may still occur following announcements.

The use of financial data to measure the effects of regulation is relatively recent (Schwert, 1981; and Dowdell, Govindaraj and Jain, 1992). It is a well accepted view, acknowledged even by the regulators, that stock price data lead to more powerful tests than accounting data for at least four reasons:

(i) stock price data are more accurate than accounting data;

(ii) they provide a greater number of observations;

(iii) they relate to future earnings, while accounting data relate only to current earnings and thus the regulation must be effective before accounting data are used for testing; and

(iv) in well-specified market models, the market-wide movements are discounted to isolate the effects of individual regulatory announcements on the returns of a specific company.

The empirical model used in event studies, in its general form, is stated as follows:

$$r_t = x_t B + e_t \qquad (2.1)$$

where, r_t is the return of the security in period *t*; x_t is a vector of independent variables not related to the event of interest, such as the return earned on an index portfolio in period *t;* B is a vector of parameters, such as the security beta, measuring the co-movement between the security return and the independent variables; and e_t is a zero-mean disturbance with different variance in event and non-event periods.

Equation (2.1) is the return generating process for the non-event time period. Returns are typically assumed to follow a stationary stochastic process. The return generating process shifts following an event when market participants revise their value of the security. Thus, the return generating process in event periods becomes:

$$r_t = x_t B + F\Gamma + e_t \qquad (2.2)$$

where, F is a row vector of regulatory announcements thought to influence the impact of the event on the return process; and Γ is a vector of parameters measuring the influence of F on the impact of the event.

The above model (2.2) is typically estimated for securities having common characteristics, for example subject to the same regulatory regime. Hypotheses to be tested are usually centred on Γ. Announcements in F are set to unity during the event period and zero otherwise, and Γ measures the impact of the event. In estimating and drawing inferences on Γ, a number of issues need particular attention[25]. Firstly, the return interval is typically one day, since events occurring in a specific day are expected to have an immediate effect on asset prices in an efficient market. Ideally, it would be desirable to have intra-daily data and analyse the effect at the exact time when the announcement is made. However, this data frequency is only suitable for short event periods and the precise time in the day of announcement is in many cases not known. A researcher needs to be aware that the choice of data frequency affects the parameter estimates. The second issue relates to the choice of event window. Although the informational impact of the announcement is expected to be instantaneous, it is a widespread practice to test for the impact in a window around the announcement date (Ball and Brown, 1968). This is done because, although the date of the announcement is normally known, the informational content of the announcement may have been anticipated by the market, or there may be a delayed reaction to it. The accurate determination of the event date is of fundamental importance. This may be particularly difficult when an event comprises of a number of unfolding announcements and when there is potential for information leeks. In some cases, several announcements may fall in the same day, or within a few days. In these cases, a trade-off needs to be struck between focusing on the most important announcements and loosing some information,

[25] For a more extensive review of this issue and event studies in general, see Thompson (1995).

and including more announcements but be unable to infer the true nature of market reaction.

Another issue to be considered is the possibility that an announcement may not only shift the level of share prices, but also affect the risk. The change in risk could be permanent or transitory and the literature discusses both. Permanent changes can be identified by comparing the measure of risk before and after the event. For example, studies have been conducted to identify shifts in risk around mergers (Mandelker, 1974; and Dodd and Ruback, 1977) and share repurchases (Dann, Masulis and Mayers, 1991; Hertzel and Jain, 1991; and Bartov, 1991). Transitory risk changes during the event window have been documented by Kalay and Loewenstein (1985) for dividend announcements and Brown, Harlow and Tinic (1988) for major corporate events. Finally, the effects of an event may need to be analysed across a group of firms, for example an industry. A popular recent approach to this problem is to combine firms into a portfolio and examine the impact of the event on portfolio returns (Sefcik and Thompson, 1986).

2.2.2 Methodology and Hypothesis Formulation

In regulatory event studies that use stock price data, the event date is generally unanticipated and it is characterised by an unpredictable information set. Binder (1985b) uses regulatory announcements from the *Wall Street Journal* and finds that there is little US industry share price reaction to each event. Schumann (1988) finds that regulations of New York takeover bids causes negative effects on shareholder wealth and Teets (1992) shows that the regulation of US electrical utilities causes the average share price response to unexpected earnings announcements to be less than for non regulated companies. This means that such regulatory announcements are likely to cause security prices to change (Schwert, 1981).

In this thesis, in order to model the market reaction to unanticipated regulatory announcements, the market model is extended to incorporate dummy variables. Such model measures the reaction to each announcement investigated after discounting general market movements. This methodology has been first developed by Binder (1985a and 1985b) and Karafiath (1988), who tested the effects of statutory regulation in the USA. Later, Ederington and Lee (1993) use the same model to examine the impact of economic announcements on market volatility. This latter study dispenses with any exogenous market variable and simply estimates a dummy variable regression.

Traditionally, the event study methodology involves a two-stage estimation procedure. In the first stage, the market model is estimated for the period before the event. In the second stage, returns are forecasted using the pre-event estimated parameters to calculate abnormal return (or forecast errors) and their respective t-statistics. Since the publication of the pioneering studies by Ball and Brown (1968) and Fama et al. (1969), this procedure has been used extensively, especially in corporate finance, to measure, for example, the price effects of financing decisions or the wealth effects of mergers. This methodology is based on the assumption that the residuals are independent and identically distributed. The assumption of independence of residuals means that, when analysing aggregate abnormal returns, it is assumed that the abnormal returns on individual securities are uncorrelated. Thus, the variance of the aggregated sample cumulative abnormal returns can be calculated assuming that the covariances are zero. This is normally a reasonable assumption if the event windows relating to the individual securities do not overlap in time. However, if some of the event windows do overlap, in other words if there is a problem of clustering, the covariances between abnormal returns may well be different from zero[26]. Equally, the assumption that residuals are identically distributed is problematic if, as Binder (1985b) indicates, the abnormal returns and/or the residual variance are expected to differ across firms[27].

In this thesis, each event tested is a regulatory announcement expected to affect most of the firms in the industry. In other words, each event takes place at the same time for all firms in the industry and thus the assumption of residual independence is likely to be violated. One way to overcome this problem is to analyse abnormal returns without aggregation, where the null hypothesis that the event has no impact is tested by using security-by-security data. This can be performed by using a multivariate regression model, that is by simultaneously estimating a market model for each firm, augmented by including a dummy variable taking the value of one during the event period and zero otherwise. In this way, the dummy variable's coefficient measures the abnormal return during the event period[28].

More specifically, the extended market model for each company *i* is formulated as follows:

$$R_{it} = \alpha_i + \beta_i \, R_{mt} + \sum_{j=1}^{n} \gamma_{ij} \, D_{jt} + \varepsilon_{it} \qquad (2.3)$$

[26] See Bernard (1987) for a treatment of the problems relating to clustering.
[27] See also Fama (1976), pp 129-39.
[28] Karafiath (1988) shows the equivalence of the two-stage procedure and the extended market model.

where, R_t is the continuously compounded return on equity capital at time t, defined to be the natural logarithm of its gross return; R_{mt} is the continuously compounded return on the market index; D_{jt} is an announcement dummy variable that equals one on the day(s) of announcement j and zero otherwise; α, β and γ_j are coefficients to be estimated; and ε_t is the error term. The above model measures the impact of an event by quantifying the abnormal returns caused by the event. The parameters γ_j measure the abnormal performance during the announcement period; that is, they measure the deviation of a company's actual return during the announcement period from the expected normal return predicted by the market model.

This methodology not only allows the abnormal returns, as measured by γ_j, to differ across firms, but it also allows the residuals and their variances to differ across firms. In addition, the contemporaneous covariances of residuals are not assumed to be zero, although the noncontemporaneous covariances are assumed to be zero. In other words, the multivariate regression model expressed in equation (2.3) already incorporates heteroscedasticity and contemporaneous dependence of residuals across equations.

An additional advantage of the multivariate regression model methodology is the existence of robust statistical tests to test joint-hypotheses. Binder (1985b) identifies two main joint-hypotheses of interest in event studies:

(i) All the abnormal returns for all announcements and all firms equal zero:

$$H_1: \gamma_{ij} = 0 \quad \forall\, i, j$$

(ii) The abnormal returns for a specific announcement equal zero for all firms:

$$H_2: \gamma_{ij} = 0 \;\; \forall\, i$$

There are a number of statistics that can test these joint hypotheses, such as the likelihood ratio test, but the distribution of these statistics is only known asymptotically and Binder (1985b) shows that they tend to be biased when a limited number of observations are sampled. The Wald statistic is also widely used, but Laitinen (1978) finds that it tends to be biased against the null hypothesis in small samples. This problem can be overcome by using an F-distributed statistic developed by Rao (1973), which has been shown to be accurate with as little as 60 observations[29].

Although the testing of the joint hypotheses discussed above is of great interest in some investigations, this thesis aims at conducting a more disaggregated analysis of the impact of different types of regulatory announcements and also of the effects on individual firms in the industry. This should provide useful insights to policy makers about the effects of implementing their regulatory policy. When the impact of group announcements is tested in section 2.4.1, an equally-weighted portfolio of stocks of the electricity companies is created and the estimation sample includes four years of daily returns. In this case the size of the sample is large enough to accept that the asymptotic significance test used are robust. When individual announcements are regressed against individual companies, the estimation period is broken down to individual years, given the complexity of estimating the adopted GARCH methodology. In this case, the relatively small number of observations makes the significance of the asymptotic test

[29] For a critical comparison between statistics available to test joint hypotheses in the multivariate regression model, see Binder (1985b).

weaker. However, looking at individual announcements firm by firm does provide greater insight into the aggregate effect of the group announcement results, as discussed later in this chapter.

It is commonly accepted that the volatility of asset returns tends to be serially correlated. In other words, large return changes tend to be followed by even lager return changes in either direction. To capture this serial correlation in volatility, Engle (1982) proposed the class of Autoregressive Conditional Heteroskedasticity (ARCH) models. Bollerslev (1986) extended the ARCH model to a Generalised ARCH (GARCH) with the following conditional variance function:

$$h_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{q} \beta_i h_{t-i} \qquad (2.4)$$

where $\alpha_i \epsilon^2_{t-i}$ is a moving average component and $\beta_i h_{t-i}$ is an autoregresssive component.

To capture the serial correlation in the volatility of return in the extended market model in equation (2.3) the following model is, thus, estimated:

$$\begin{aligned} R_{it} &= a_i + \beta_i R_{mt} + \sum_{j=1}^{n} \gamma_j D_j + \varepsilon_{it} \\ h_{it} &= \alpha_0 + \alpha_1 \varepsilon_{i,t-1}^2 + \alpha_2 h_{i,t-1} \end{aligned} \qquad (2.5)$$

where R_{it} is the return on equity capital of company *i* at time *t*. The above model (2.5) is the extended market model with the conditional variance modelled as a GARCH (1,1) process[30].

2.2.2.1 Hypothesis Formulation for Groups of Announcements

The model at (2.5) is used to investigate the impact of regulatory announcements on the return on the equity capital of the privatised electricity industry in England and Wales, at the level of both distribution and generation. Regulatory announcements are grouped by their expected impact on competition, prices and quality of service in the electricity industry. In addition, they are also grouped according to whether they relate to generation or distribution. Thus, the following groups of announcements are considered[31]:

- *Distribution Price Negative (DPN)*: announcements relating to distribution and expected to have a negative impact on electricity retail prices.
- *Distribution Price Positive (DPP)*: announcements relating to distribution and expected not to have a negative impact on electricity retail prices.
- *Distribution Competition Positive (DCP)*: announcements relating to distribution and expected to increase competition in electricity distribution and supply to final customers.

[30] The finance literature has demonstrated that the GARCH (1,1) specification is the most appropriate for a wide variety of markets (Bollerslev, Chou and Kroner, 1992).
[31] Initially, announcements expected to have a negative impact on competition (*DCN*) and quality of service (*DSN*) in distribution and announcements expected not to have a negative impact on price in generation (*GPP*) were also considered. However, once the list of announcements was cleaned of clashes with other events, no announcements belonging to these groups were left.

- *Distribution Service Positive (DSP)*: announcements relating to distribution and expected to improve the quality of service in electricity supply.
- *Generation Price Negative (GPN)*: announcements relating to generation and expected to have a negative impact on electricity wholesale (pool) prices.
- *Generation Competition Negative (GCN)*: announcements relating to distribution and expected not to increase competition in electricity generation.
- *Generation Competition Positive (GCP)*: announcements relating to distribution and expected to increase competition in electricity generation.

The effects of these announcement groups are estimated for both the RECs and the generators. The investigation is carried out on equally-weighted portfolios of RECs and generators, as well as on individual RECs. With respect to their effects on the portfolio of RECs, the following hypotheses are tested:

(i) Announcements expected to lead to a fall in the retail price of electricity supply (DPN) are also expected to decrease profits and thus have a negative impact on the return on equity. In terms of model 2.5:

$$H_0 : \gamma_1 = 0$$

$$H_1 : \gamma_1 < 0$$

(ii) Announcements expected not to lead to a fall in the retail price of electricity supply (DPP) are also expected to have potential for an increase in profits, since the regulated firm has more discretion on price setting, and thus have a positive impact on the return on equity:

$$H_0 : \gamma_2 = 0$$

$$H_1 : \gamma_2 > 0$$

(iii) Announcements expected to increase competition in electricity distribution and supply to final customers (DCP) are also expected to lead to a decline in profits and thus have a negative impact on the return on equity:

$$H_0 : \gamma_2 = 0$$

$$H_1 : \gamma_2 < 0$$

(iv) Announcements expected to improve the quality of service in electricity distribution (DSP) are also expected to lead to a decline in profits and thus have a negative impact on the return on equity:

$$H_0 : \gamma_2 = 0$$

$$H_1 : \gamma_2 < 0$$

(v) Announcements expected to lead to a fall in the electricity wholesale (pool) price (GPN) are expected to increase the profits of the RECs and thus have a positive impact on their return on equity:

$$H_0 : \gamma_1 = 0$$

$$H_1 : \gamma_1 > 0$$

(vi) Announcements expected not to lead to an increase in competition in electricity generation (GCN) are also expected to have the potential for a decline in the profits of the RECs as their suppliers keep their monopoly power, and thus have a negative impact on their return on equity:

$$H_0 : \gamma_3 = 0$$

$$H_1 : \gamma_3 < 0$$

(vii) Announcements expected to increase competition in electricity generation (GCP) are also expected to lead to a increase in the RECs' profits and thus have a positive impact on their return on equity:

$$H_0 : \gamma_2 = 0$$

$H_1 : \gamma_2 > 0$

With respect to the effects of the above groups of announcements on generators' rate of return on equity, the assumption made in formulating some of the following hypotheses is that whatever affects price and competition in distribution could eventually affect the electricity generating companies for two main reasons. Firstly, it will affect the wholesale demand of electricity. Secondly, the divide between generation and distribution is expected to become weaker with time, with generators being increasingly allowed to supply electricity direct to customers and large customers allowed to generate their own electricity. Thus, the following hypothesis are formulated:

(i) Announcements expected to lead to a fall in the retail price of electricity supply (DPN) are also expected to have a potential for decreasing the profits of the generators and thus may have a negative impact on the generators' return on equity. In terms of model 2.5:

$H_0 : \gamma_1 = 0$

$H_1 : \gamma_1 < 0$

(ii) Announcements expected not to lead to a fall in the retail price of electricity supply (DPP) are also expected to have potential for increasing generators' profits and thus have a positive impact on their return on equity:

$H_0 : \gamma_2 = 0$

$H_1 : \gamma_2 > 0$

(iii) Announcements expected to increase competition in electricity distribution and supply to final customers (DCP) are also expected to have potential for leading to a decline in the profits of generators and thus have a negative impact on their return on equity:

$H_0 : \gamma_2 = 0$

$H_1 : \gamma_2 < 0$

(iv) Announcements expected to lead to a fall in the electricity wholesale (pool) price (GPN) are expected to decrease the profits of the generators and thus have a negative impact on their return on equity:

$H_0 : \gamma_1 = 0$

$H_1 : \gamma_1 < 0$

(v) Announcements expected not to lead to an increase in competition in electricity generation (GCN) are also expected to have the potential for an increase in the profits of the generators, and thus have a positive impact on their return on equity:

$H_0 : \gamma_3 = 0$

$H_1 : \gamma_3 > 0$

(vi) Announcements expected to increase competition in electricity generation (GCP) are also expected to lead to a decline in the generators' profits and thus have a negative impact on their return on equity:

$H_0 : \gamma_2 = 0$

$H_1 : \gamma_2 < 0$

The above hypotheses are formulated on the assumption that the main concern of the electricity regulators is to protect the consumer and there is no regulatory capture. Each of the above hypotheses are tested concurrently using the model in equation (2.5).

2.2.2.2 Hypothesis Formulation for Individual Announcements

The information derived from estimating equation (2.5) is essential for drawing policy conclusions on the effect of different types of regulatory announcements on the cost of equity capital. However, when analysing the announcements in groups, we loose sight of the contribution of each individual announcement to the overall group effect. For example, if an announcement group is found not to have a significant impact on equity returns, this may be due to investors believing that type of announcements not to have an affect on the regulated company's performance. On the other hand, it could also be the consequence of an averaging out effect within the group, with individual announcements causing a significant market reaction, but in different directions. In this latter case, we cannot predict the direction of the effect of that specific type of announcement, but it would be incorrect to believe that investors are indifferent to those announcements being made. Thus, the impact of individual regulatory announcements is further analysed in an attempt to gain more detailed insight on the nature of the market reaction to regulatory information. Given the large number of individual dummies in each announcement group, the model (2.5) is estimated by year, as well as by type of announcements, on the returns of each individual REC.

2.2.2.3 Volatility Around Announcements

When announcements are unanticipated, as it is the case with the type of regulatory announcements investigated in this thesis, the share price is likely to become more volatile around an event date with informational content (Ross, 1989). However, an announcement should produce only a short-lived increase in volatility if markets are efficient. In fact, once the impact of the announcement has been fully incorporated in share prices, volatility should return to normal levels[32]. Indeed, one of the conclusions of the regulatory model of Peltzman (1976) is that regulation, by affecting a regulated company's cash flow, will also affect the variance of returns. Thus, regulatory announcements are expected to impact on the volatility of returns at two levels: the informational level and through the firm's cash flow.

In order to test for the impact of different individual announcements on the volatility of returns, we test the effect on the conditional volatility of the RECs share returns. To this end, the announcement dummies are introduced in the GARCH conditional variance equation in model (2.5) and deleted from the mean equation. More specifically, the following model is estimated:

$$\begin{aligned} R_{it} &= a_i + \beta_i R_{mt} + \varepsilon_{it} \\ h_{it} &= \alpha_0 + \alpha_1 \varepsilon^2_{i,t-1} + \alpha_2 h_{i,t-1} + \sum_{i=j}^{n} \gamma_j D_j \end{aligned} \tag{2.6}$$

Whether an announcements is considered by the market to be good or bad news, the coefficients γ_j should be statistically significant and positive if volatility has been increased by the news.

[32] See Ederington and Lee (1993) for a detailed analysis of the impact of news releases on volatility.

2.3 ANNOUNCEMENT SELECTION AND DATA

In regulatory event studies that use stock price data, the event date is generally unanticipated and is characterised by an unpredictable information set (Binder, 1985b; Schumann, 1988; and Teets, 1992). Since the timing of the announcements cannot always be accurately determined, in this thesis a three-day window is used to capture movements in returns and volatility of returns which may occur around, but not necessarily on, the day chosen as the event date. A three-day window also allows any effect occurring because of market anticipation or delayed reaction to be detected. However, the window cannot be too large if contamination from other unknown events which may occur during the period covered by a larger window must be avoided.

Whatever type of data is used, studies of regulatory announcements have to confront the fact that typically many regulatory events do not involve a single well-defined announcement, but are more likely to involve a series of smaller announcements, or policy decisions. Due to the `lobbying' nature of negotiations between regulators and industry, some information about future announcements is likely to be known ahead of time. As a result, investors' expectations will change before the public announcement is finally made and the expected implications of such a regulatory announcement will be incorporated into the share price at the time of the expectational change (Brown and Warner, 1980; and 1985). In addition, each regulatory announcement may cause the release of new information which affect the market expectations of future regulatory changes.

The announcements considered in this thesis include official announcements by regulatory bodies, such as OFFER in this chapter, as well as news announcements made by the government, representatives of regulatory bodies and regulated companies, and any press announcement related to the relevant regulatory environment. Such news items are included because they may provide information to market participants in anticipation of forthcoming official regulatory announcements. If only official regulatory announcements had been considered, the time of the actual change in investors' expectations may well have been missed. Consequently, the announcements considered include any 'news' believed to have an informational content in relation to the regulatory structure of the electricity industry. The periods preceding and following each announcement have been checked for the presence of other events, such as quarterly earning announcements and announcements believed to be contaminated by other events have been excluded from the sample.

After considering all these issues, the effects of 69 announcements have been tested over the period from January 1991, just after the privatisation of the RECs[33], to December 1994. Appendix 2.2 lists all the announcements considered in chronological order and coded by groups of announcements. There are 38 announcements that refer to the distribution of electricity and 31 to generation. As a proxy for the market return, the difference of the natural logarithms of the FT All Share Index was calculated. In addition, equally weighted portfolios of the twelve RECs and the two generators were constructed. All share prices and the index were obtained from Datastream.

[33] The RECs are listed in Appendix 2.1.

2.4 EMPIRICAL RESULTS

2.4.1 Results of Group Announcements

The results of the announcement group analysis show that regulatory announcements relating to the retail price of electricity supply are the only type of announcements to have a significant impact on the equally weighted portfolio of RECs. The results presented in Table 2.1 are obtained from estimating equation 2.5 over the period from January 1991 to December 1994. These results show that only the coefficients γ_1 and γ_2 are statistically significant and have the expected sign, while all other γ coefficients are insignificant. In other words, the return on equity capital of the RECs, taken as a group, is affected negatively by announcements expected to lead to a decrease in the retail price of electricity and positively by announcements that give an indication of no further cuts in electricity prices. For announcement groups relating to competition in distribution and price and competition in generation (DCP, DSP, GPN, GCP and GCN) the null hypothesis is accepted. This is an interesting result, since it indicates that investors do not appear to react on average to announcements relating to the competitive posture of either electricity distribution (DCP) or generation (GCP and GCN). They also do not appear to be concerned with announcements aimed at containing the wholesale price of electricity (GPN).

Table 2.1

The effect of competition, pricing and service announcements on the return on equity capital of an equally weighted portfolio of REC's

$$R_t = a + \beta R_{mit} + \gamma_1 DPN + \gamma_2 DPP + \gamma_3 DCP + \gamma_4 DSP + \gamma_5 GPN + \gamma_6 GCP + \gamma_7 GCN + \varepsilon_t$$
$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1}$$

Regressor		Coefficient	**T-ratio**
CONSTANT	A	0.0006	2.05*
BETA	β	0.6842	5.07*
DPN	γ_1	-0.9377	-4.10*
DPP	γ_2	0.7886	2.56*
DCP	γ_3	0.2286	0.78
DSP	γ_4	-0.0267	-0.83
GPN	γ_5	0.1377	0.46
GCP	γ_6	-0.0034	-0.61
GCN	γ_7	0.0008	0.93

Notes:
* Denotes statistically significant at the 5% level.

Table 2.2

The effect of competition, pricing and service announcements on the return on equity capital of an equally weighted portfolio of generators.

$$R_t = a + \beta R_{mt} + \gamma_1 DPN + \gamma_2 DPP + \gamma_3 DCP + \gamma_4 DSP + \gamma_5 GPN + \gamma_6 GCP + \gamma_7 GCN + \varepsilon_t$$
$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1}$$

Regressor	Coefficient		T-ratio
CONSTANT	A	0.0007	0.43
BETA	β	0.8897	8.91*
DPN	γ_1	0.4515	1.52
DPP	γ_2	1.1948	8.39*
DCP	γ_3	-0.6589	-0.93
DSP	γ_4	-0.0025	-0.66
GPN	γ_5	-0.3531	-3.37*
GCP	γ_6	0.6278	2.82*
GCN	γ_7	0.3451	0.91

Notes:
* Denotes statistically significant at the 5% level.

The explanation of why announcements relating to competition do not appear to have an unambiguous group impact on the returns of the RECs may lie in the way in which the industry was privatised and the technical characteristics of electricity transmission and distribution. Most of the individual announcements in the DCP group relate to measures that were to a large extent decided at privatisation. The 1988 White Paper (Department of Energy, 1988) had already suggested that large industrial customers may be able to choose their electricity supplier. In 1989, it became clear that competition in the supply of electricity will be extended to all consumers in three stages. Specifically, it was decided that consumers with a maximum demand of more than 1 MW, equivalent to about 30% of all electricity generated, would be able to choose their supplier immediately. From 1994, consumers with a maximum demand of more than 100 kW, and from 1998 all consumers, irrespective of their level of consumption, would be able to choose their supplier. It is thus not surprising that investors do not appear to react when announcements relating to this expected opening up of competition in electricity supply are actually made. In an efficient capital market these expected announcements should be already discounted in the share price.

With respect to competition in generation and its effect on the RECs, the argument is more complex. Irrespective of government and regulator's aims to develop competition, physical laws determine the way in which electricity flows from generating power stations to consumers, through the distributional grid. These physical laws are such that it is impossible to determine in which power station the electricity supplied to a particular consumer was generated. In practical terms, all generators must sell their electricity to the Pool for distribution through the national grid. Therefore, in order to buy electricity directly from a generator, a consumer must sign a contract with the supplier. The consumption of electricity is then monitored half-hourly to determine how much the supplier must buy from the Pool and how much the NGC and the local REC should be paid for their services of transmitting and distributing electricity[34]. On the basis of these technical constraints, competition in electricity generation can be developed in two main ways. Firstly, the government could insure that generation is spread across enough generators, so that no single generator would have enough monopolistic power in the market. Secondly, generators could be induced to sell a good proportion of their output through contracts, and in this way be exposed to the threat of entry if the contract price is not in line with the competitive price. Many argue that the structure of generation at privatisation was not adequately competitive, although contracts and entry threats did restrict generators' market power. However, it has also been argued that the expected complete liberalisation of electricity supply after 1998 would have weaken the development of competition in generation and the threat of entry (Green and Newbery, 1997). Given the above stated limits to the development of competition in generation, it is hardly surprising that announcements relating to competition in generation (GCP and GCN) and wholesale price (GPN) made in the first four years of electricity privatisation do not appear to have a collective effect on the

[34] In practice, most contracts between generators and RECs take the form of 'contracts for differences' (CfD). These contracts are written as financial options, with a strike price: if the Pool Input Price (PIP) exceeds the strike price, then the buyer can exercise the option to buy electricity at the lower strike price (call option); if the PIP falls below the strike price, then the generator receives the higher strike price (put option). These contracts are equivalent to fixing a price for electricity. They are called CfD because the generator receives the PIP and the difference between a specified strike price and the PIP for each unit contracted. Arbitrage takes place between the spot and contract markets, with buyers and sellers switching between them in search of the most favourable terms. Thus, contract prices must be kept close to expected spot prices.

returns of the RECs. Investors were indeed entitled to believe that these types of announcements were unlikely to lead to more competition and lower wholesale prices.

However, the results are quite different when the effects of the same announcement groups are tested on the return on the equity capital of the equally weighted portfolio of generators (Table 2.2). In this case, generators' returns appear to be affected by announcements relating to the relaxation of control rules on retail price (DPP), the tightening of wholesale price's control (GPN) and the increase in competition in generation (GCP) and all coefficients have the expected sign. The significant effects of GPN and GCP announcements are particularly interesting and could be interpreted as a personal achievement of Professor Littlechild, the DGES. At privatisation, the regulatory regime that was put in place seemed to be based on the assumption that there was enough competition in generation not to require much regulation. The regulator had indeed very little power to intervene in the electricity generation market, which in reality was far from competitive. The only threat available to the regulator to affect both the structure of the industry and the working of the Pool was the referral to the MMC. Professor Littlechild used this threat extensively and effectively, particularly in 1993. Voluntary structural changes to electricity generation occurred in this period and no doubt this affected investors' expectations about the returns of the generators.

2.4.2 Results of Individual Announcements

In order to gain more insights into the potential effects of regulatory announcements on the returns of electricity companies, the effect of individual announcements within the groups on both returns and conditional volatility of returns are also tested for each individual REC. Although the observation of an individual announcement's effect cannot be generalised to the group and thus carries no clear policy implications in relation to a particular type of announcement, nevertheless it can shed further light in interpreting the group results. Given the number of RECs and announcements within each group, Equation 2.5 is estimated by year and announcement group. Detailed results of these estimations are provided in Appendix 2.3, while Tables 2.3 and 2.4 summarise the results of the individual announcements found to have a statistically significant impact on at least one company.

As expected, a good proportion of announcements within insignificant groups have a significant impact on the returns of individual RECs. Notably, some of the announcements expected to promote competition in distribution (DCP) have a positive impact on the returns of some RECs, result that appears to run contrary to the formulated hypothesis. Closer investigation, however, reveals the difficulty in interpreting the reaction to announcements without a detailed knowledge of their informational content. For example, DCP2, which announces that the regulator has decided to ignore calls for delaying market liberalisation, causes an increase in the returns of five RECs. This can be explained by the implication of this announcement, made explicit by announcement DC3 that also has a positive impact on some RECs, that this regulator's decision frees the RECs to sign five-year contracts with the generators and thus hedge movements in price until 1998, the year of expected full liberalisation. Investors in some of the RECs have obviously welcomed this news, which reduces the risk of pool electricity price fluctuations. Similarly, DCP8, which announces the regulator's preference for speeding up liberalisation, has a positive impact on a number

Table 2.3

Summary of the effects of individual regulatory announcements on the returns of the RECs (1991-1994)

EVENT	EEL	EME	LEL	MWB	MEL	NEL	NWB	SBD	SEL	SWAE	SWE	YEL
DPN1	✔ –	X	X	X	X	X	X	X	X	✔ –	✔ –	X
DPN3	X	✔ –	✔ –	✔ –	✔ –	X	X	X	X	X	X	X
DPN4	✔ –	✔ –	X	✔ –	✔ –	X	X	X	X	X	X	✔ –
DPN5	✔ –	✔ –	X	✔ –	✔ –	X	X	X	X	X	X	X
DPN6	X	✔ –	✔ –	✔ +	X	✔ +	X	X	✔ –	X	✔ –	X
DPN7	✔ –	✔ –	✔ –	✔ –	✔ –	✔ –	✔ –	✔ –	✔ –	X	✔ –	X
DPN8	✔ –	X	X	X	X	X	X	✔ –	✔ –	X	X	X
DPN9	X	✔ +	X	X	X	X	X	X	X	X	X	✔ +
DPN14	X	X	X	X	X	X	X	✔ +	X	X	X	X
DPN17	X	X	X	X	X	X	✔ –	X	X	X	X	X
DPN18	X	✔ +	✔ +	X	✔ +	✔ +	✔+	X	✔ +	X	✔ +	✔ +
DPN19	X	✔ –	X	✔ –	✔ –	X	X	✔ –	✔ –	X	✔ –	X
DPP1	✔ +	✔ +	✔ +	✔ +	✔ +	✔ +	✔ +	✔ +	✔ +	✔ +	✔ +	✔ +
DPP2	X	X	X	X	X	✔ +	X	X	X	X	X	X
DPP3	X	X	X	X	X	X	X	X	X	✔ +	X	X
DPP4	X	X	✔ +	X	X	X	X	X	X	X	X	X
DPP5	✔ –	✔ +	✔ +	X	✔ +	X	✔ +	✔ +	✔ +	✔ +	✔ +	✔ +
DCP2	✔ +	X	✔ +	✔ +	✔ +	✔ +	X	X	X	X	X	X
DCP3	X	✔ +	✔ +	X	X	X	✔ +	X	✔ +	X	X	X
DCP6	X	X	X	X	X	X	X	X	✔ +	X	X	X
DCP8	✔ +	X	X	✔ +	✔ +	✔ +	✔ +	✔ +	X	✔ +	✔ +	✔ –
DSP1	X	X	X	X	X	X	X	✔ +	X	✔ +	✔ +	X
DSP3	X	X	✔ –	X	X	X	X	X	X	✔ –	X	X
GPN1	✔ +	✔ +	X	X	✔ +	✔ +	✔ +	✔ +	✔ +	✔ +	✔ +	✔ +
GPN3	X	X	X	X	X	X	X	X	X	X	X	✔ +

GCP4	X	X	X	X	X	X	X	✔ -	X	X	X	X
GCP5	X	X	X	X	X	X	X	✔ -	X	X	X	X
GCP6	X	✔ +	X	X	✔ +	X	X	X	✔ +	X	✔ +	X
GCP17	✔ +	X	✔ +	X	X	X	X	✔ +	X	X	X	✔ +
GCN2	X	X	X	X	X	X	X	✔ +	X	X	✔ +	X

Table 2.4

Summary of the effects of individual regulatory announcements on the conditional volatility of the returns of the RECs (1991-1994)

EVENT	EEL	EME	LEL	MWB	MEL	NEL	NWB	SBD	SEL	SWAE	SWE	YEL
DPN1	X	X	✔	X	X	X	X	X	X	X	X	X
DPN2	X	X	X	X	X	X	X	X	X	X	X	✔
DPN3	✔	X	✔	X	X	X	X	X	X	X	X	X
DPN6	✔	✔	✔	✔	✔	X	X	✔	✔	✔	X	X
DPN7	✔	✔	✔	X	✔	✔	✔	X	X	✔	✔	X
DPN13	X	✔	X	X	X	✔	X	X	X	✔	X	✔
DPN14	X	✔	X	X	X	✔	X	X	X	X	X	✔
DPN18	X	X	X	X	✔	X	X	✔	X	✔	X	✔
DPN19	X	X	X	✔	✔	X	✔	✔	✔	X	X	✔
DPP1	X	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
DPP5	X	✔	X	✔	✔	✔	✔	✔	✔	✔	✔	✔
GPN1	✔	✔	✔	X	X	✔	✔	✔	✔	✔	✔	✔
GCP1	X	X	X	X	X	X	X	X	X	✔	X	✔
GCP2	X	X	✔	X	X	X	X	X	X	✔	X	✔

of RECs. This can be explained by the fact that the speeding up of liberalisation was prompted by changes in the gas market due in 1996, which allowed household consumers a choice of gas supplier. Gas companies, which also sell electricity, would have had an unfair advantage over the RECs, unless a similar liberalisation was introduced in the electricity market. It is therefore good news for investors that the regulator is trying to create a levelled playing field in the supply of electricity.

With respect to the announcements relating to the wholesale price of electricity, only GPN1 has a positive impact on the returns of a number of RECs. This announcement, made at an early stage of privatisation in February 1991, was the first of a number of warnings by the regulator that the price charged by generators was too high and would not be tolerated. Not surprisingly, subsequent announcements to this first one had no impact since carried no new information. However, the sensitivity of the RECs' returns to GPN1 is a sign that wholesale price announcements can affect expectations of investors in distribution companies. Among the announcements relating to competition in generation, only two announcement, GCP6 and GCP17, had a positive effect on several RECs. Both announcements relate to the sale of power stations by generating companies and the regulator's view that they should be sold to competitors to increase competition in generation. However, both announcements have the opposite effect than expected on the returns of some of the RECs. The explanation for this result lies in the regulator's expressed view that the RECs should be allowed to buy power stations from generators. If this happens, the RECs may acquire market power by becoming more vertically integrated. This is obviously good news for shareholders.

As explained earlier, when announcements are unanticipated, as it is the case with the type of regulatory announcements investigated in this thesis, the share price is likely to become more volatile around an event date with informational content (Ross, 1989). Table 2.4 summarises the results from testing the effect of announcements on the conditional volatility of the RECs share returns[35]. The significant group DPN appears to have the greater number of announcements with informational content, as measured by their significant effect on the conditional volatility of returns. In addition, the announcements with informational content are often, but not always, the ones who had been found to affect returns. DPP1, DPP5 and GPN1, which affected the returns of many RECs, also appear to have a very strong informational content. Thus, overall, it can be concluded that, although some of the announcements that affect returns do not appear to affect the conditional volatility of returns, the announcements with a systematic effect on the returns of most RECs also have a definite impact on the conditional volatility of returns across the industry.

2.5 CONCLUSIONS

This chapter, after providing an overview of the electricity industry in England and Wales, analyses the impact of unanticipated regulatory announcements on the return of the equity capital of the Regional Electricity Companies (RECs) and the power generating companies in England and Wales. The results of the announcement group analysis show that regulatory announcements relating to the retail price of electricity supply are the only type of announcements to have a significant impact, as a group, on

[35] Detailed results are in Appendix 2.3, Tables A2.3.8-A2.3.11.

the equally weighted portfolio of RECs. This is not surprising when considering that most of the announcements relating to competition could have been to some extent anticipated at the time of privatisation. In particular, the return on equity capital of the RECs, taken as a group, is affected negatively by announcements expected to lead to a decrease in the retail price of electricity and positively by announcements that give an indication of no further cuts in electricity prices. These results are in line with the formulated hypotheses.

Results are however quite different when the effects of the same announcement groups are tested on the return on the equity capital of the equally weighted portfolio of generators. Generators' returns appear to be affected by announcements relating to the relaxation of control rules on retail price, the tightening of wholesale price's control and the increase in competition in generation. All coefficients relating to these significant groups have the expected sign. Since generation was privatised as a duopoly, without clear indication of how competition should evolve, it is to be expected that announcements to promote greater competition in generation would have a significant impact.

When the attention is turned to the impact of individual announcements, it is found that a good proportion of announcements within insignificant groups have a significant impact on the returns of individual RECs, but their effect does not always have the expected sign. Although there appear to be good reasons for the fact that the reaction of investors to some of these announcements goes contrary to expectations, these anomalies illustrate how difficult it is to classify announcements by type and formulate hypothesis about the group effects. There is no doubt that greater competition in any industry should mean lower profits and thus lower investor's returns. However, as seen in the previous section, this generalisation does not take into account cases when a move towards industry's liberalisation has implications beyond the simple competitive posture of incumbent firms. These implications can only be fully considered when analysing individual announcements.

APPENDIX 2.1

List of Regional Electricity Companies at Privatisation

Eastern Electricity	EEL
East Midlands Electricity	EME
London Electricity	LEL
Manweb	MWB
Midlands Electricity	MEL
Northern Electric	NEL
Norweb	NWB
Seeboard	SBD
Southern Electric	SEL
South Wales Electricity	SWAE
South Western Electricity	SWE
Yorkshire Electricity	YEL

APPENDIX 2.2

Regulatory Announcements Relating to the Electricity Industry of England and Wales: January 1991 – December 1994

Announcement Type, Number and Date		Description of Announcement
	1991	
DSP1	Jan 20	OFFER will soon publish a document setting out the 'standards of performance' for the RECs, guaranteeing standards of services for customers.
GCP1	Jan 22	National Power and PowerGen are not allowed to compete for large industrial customers to ensure that independent generators and other entrants to the supplier market can compete.
DPN1	Jan 29	The number of business customers elegible for cheaper electricity will increase.
DPN2	Feb 18	DGES warns that the present price-cap formula may allow electricity price to increase too much.
DPN3	Feb 20	DGES warns RECs that he will not allow prices to rise as much as anticipated.
GPN1	Feb 25	Energy Secretary says that electricity generating companies will have to justify their proposals of price increases to regulators.
GCP2	Apr 15	Energy Secretary says that competition in electricity generation will develop in spite of the recent increase in gas prices.
DPN4	Jun 19	DGES expressed concerns on the profits of electricity companies after East Midland Electricity reported better than expected annual results.
DSP 2	Aug 8	OFFER rules that electricity suppliers should not press late paying business customers for cash deposits. Customers should be given more choice of payment methods.
GCP3	Sep 17	Pool Executive Committee to discuss four options over how much companies generating their own electricity on site should pay the pool, or spot market.
GPN2	Oct 3	OFFER threatens to refer the generators to the MMC over operations in the wholesale market as prices surge against a falling seasonal demand.

DPN5	Oct 22	OFFER warns seven RECs that they may be overcharging customers and urges them to compensate customers. The other five RECs should consider passing on the benefits of lower inflation to customers.
GCP4	Nov 18	Major Energy Users' Council calls for the generators to be split up to break their hold on the wholesale market and change the rules to unable large users to negotiate lower prices.
DSP3	Dec 18	OFFER will consider altering the price formula to provide incentives for the RECs to help customers to save energy.
GCP5	Dec 20	DGES says that generators have used their dominant position to push up prices and recommends changes to the licence to weaken their market power.
	1992	
DPN6	Jan 13	The Coalition for Fair Electricity Regulation (COFFER) plans to take OFFER to court over failure to keep prices down.
DPP1	Feb 6	RECs reach a favourable price deal with the regulator.
DPP2	Feb 28	OFFER likely to be satisfied with Northern Electric's price rise.
GCP6	Mar 5	Barclays de Zoete Wedd warns that OFFER will be tougher than investors anticipate on competition and force generators to offer power stations due to close for sale to their competitors.
GCP7	Mar 9	Commons energy committee of MPs calls for wide-ranging reform to increase competition in generation and OFFER supports this view.
DCP1	Apr 23	OFFER amends market rules to allow more large customers to chose their electricity supplier.
GCP8	Jun 9	DGES agrees with Commons energy committee that National Power, PowerGen and Nuclear Electric are too dominant in the market.
DPN7	Jun 15	OFFER announces that it will not allow RECs to make big profits at the expenses of customers. OFFER's deputy director warns that the price formula is likely to be tighten when reviewed in 1994 and 1995.
DPP3	Jun 25	DTI approves South Wales electricity price cut.
DPN8	Jul 2	OFFER is likely to force the NGC, owned by the RECs, to cut its charges to electricity customers.

DPN9	Jul 7	OFFER proposes new pricing formula that will result in a substantial cut in the NGC's charges.
DSP4	Jul 23	OFFER reports that customers in London get a better service and proposes measures to improve customer's service nationally.
GPN3	Jul 27	DGES asks the generators to explain why pool prices have increased sharply since May.
DPN10	Aug 13	COFFER plans to take DGES to court for failing to keep prices down.
DPN11	Oct 8	OFFER launches review of price controls.
GPN4	Dec 18	DGES accuses generators of using dominant market position to push electricity prices up and suggests that electricity generation could be regulated in future.
	1993	
DCP2	Feb 4	OFFER opposes plans to delay electricity market liberalisation to protect the use of coal in electricity generation, rather than switching to cheaper gas.
DCP3	Feb 12	Government opts not to delay the liberalisation of the electricity market. Generators are free to sign five-year contracts with the RECs, but DGES has yet to decide whether generators' prices are unfair.
GPN5	Feb 22	DGES wants to study generators' coal contracts, following allegations that coal price cuts have not been passed on to customers. If found 'guilty', generators could either be subjected to regulation or referred to the MMC.
GCP9	Mar 9	OFFER suggests that generators should sale eleven power stations due to close.
DPN12	Mar 16	OFFER plans shake-up of supply price control.
DCP4	Apr 1	OFFER allows generators to make unlimited sales direct to customers.
GPN6	May 5	OFFER asks generators to account for the significant price rises.
GPN7	May 24	OFFER warns generators that they will face MMC referral over the latest price rises.
GPN8	Jun 9	A survey by National Utilities Services warns that large industrial groups buying directly from the pool have faced compound price rises of 11%

DPN13	Jul 8	Tomorrow OFFER will announce tougher controls on electricity supply prices.
DPN14	Jul 9	New control measures tough, but manageable, according to the RECs.
GPN9	Jul 30	OFFER reports on pool price increases and warns that generators face referral to the MMC.
DPN15	Aug 4	RECs accept new price controls.
DPN16	Aug 13	Following a decision by the power industry to change the way pool prices are calculated, the largest customers should see a price reduction in the Autumn.
GCP10	Sep 28	The Energy Intensive Users Group claims that members' interests have not been represented in the August poll and pool prices will not decrease enough.
GCP11	Oct 18	Major Energy User's Council urges OFFER to refer generators to the MMC over the operation of the pool.
DCP5	Oct 22	Regulator criticises power companies over attempts to tie customers to long term contracts and instructs them to include escape clauses.
DCP6	Oct 26	OFFER pledges to probe RECs profits as he launches a review of their distribution accounts.
GCP12	Nov 15	Energy Secretary announces that supply licences are no longer required for companies generating their own electricity.
GPN10	Nov 18	Wholesale electricity prices were 23% higher than last year and pressure increases on the regulator to refer generators to the MMC.
DPN17	Nov 23	Energy Intensive User's Group asked OFFER to curb prices after an academic study suggested that consumers are overcharged.
GCP13	Dec 14	DGES to make a statement tomorrow on the generators but unlikely to decide whether to refer them to the MMC.
GCP14	Dec 15	DGES will not refer generators to the MMC if agreement on plant disposals and prices is reached.
GCN1	Dec 20	Big energy users back down from insistence that generators should be referred to the MMC.

1994

GCN2	Feb 10	DGES will not refer the generators to the MMC after agreement on the sale of plants and price-capping has been reached.
DCP7	Mar 3	Regulator call for more competition by 1996.
GCP15	Mar 7	OFFER seeks industry's view on changing the bidding mechanism for the pool and on allowing companies to trade outside the pool.
DPN18	Mar 29	Consumers' committees press DGES to tighten price controls on RECs.
DPN19	Apr 22	DGES's lecture surprises markets with the speed with which the regulator envisages clawing back earnings.
DCP8	May 17	DGES indicates preferences for speeding up liberalisation.
GCN3	May 19	Minister rules out nuclear sell-off in current parliament.
DPP4	Jun 27	Regulator shows signs of compromise with RECs over regulatory changes to distribution prices.
DPN20	Aug 5	DGES review of electricity price controls, due on Thursday, is expected to results in price cuts for 95/96 and tighter controls thereafter.
DPP5	Aug 10	New price controls likely to disappoint customers and please investors: they are less severe than expected.
GCP16	Oct 6	DGES favours privatising nuclear power industry to improve competition
DPP6	Nov 30	DGES confirms and defends expected rise in RECs dividends.
GCP17	Dec 8	DGES warns generators on plant disposal and considers regulatory changes to allow RECs to buy plants from them.
GCN4	Dec 14	Government accepts ruling by OFFER that the case for the widespread trading of electricity outside the pool has not been made.

Notes:

DCP	Announcements likely to lead to more competition in electricity distribution
DPN	Announcements likely to lead to lower prices in electricity distribution
DPP	Announcements not likely to lead to lower prices in electricity distribution
DSP	Announcements likely to lead to service improvements in electricity distribution
GCN	Announcements not likely to lead to more competition in electricity generation
GCP	Announcements likely to lead to more competition in electricity generation
GPN	Announcements likely to lead to lower prices in electricity generation

APPENDIX 2.3

Table A2.3.1

The effect of DISTRIBUTION PRICE-NEG (DPN) announcements on the conditional mean of the RECs by year.

$$R_{it} = a_i + \beta_i R_{mt} + \sum_{j=1}^{n} \gamma_j \; DPN_j + \varepsilon_{it}$$

$$h_{it} = \alpha_0 + \alpha_1 \; \varepsilon_{i,t-1}^2 + \alpha_2 \; h_{i,t-1}$$

Regressor		Coefficient	T-ratio
1991			
EASTERN ELECTRICITY			
Constant	a	0.0001	1.36
Beta	β	0.854	65.02*
DPN1	γ_1	-0.0010	-2.14*
DPN2	γ_2	0.0007	0.14
DPN3	γ_3	-0.0064	-1.06
DPN4	γ_4	-0.0005	-2.04*
DPN5	γ_5	-0.0016	-2.37*
EAST MIDLANDS ELECTRICITY			
Constant	a	0.0000	0.58
Beta	β	0.950	230.0*
DPN1	γ_1	0.0004	0.52
DPN2	γ_2	0.0006	0.96
DPN3	γ_3	-0.0014	-2.22*
DPN4	γ_4	-0.0025	-4.06*
DPN5	γ_5	-0.0016	-2.40*
LONDON ELECTRICITY			
Constant	a	0.0000	1.45
Beta	β	0.945	257.85*
DPN1	γ_1	0.0004	0.68
DPN2	γ_2	0.0007	1.03
DPN3	γ_3	-0.0014	-1.90*
DPN4	γ_4	-0.0002	-1.12
DPN5	γ_5	-0.0016	-0.33
MANWEB			
Constant	a	0.0001	1.26
Beta	β	0.845	102.3*
DPN1	γ_1	0.0009	1.05

DPN2	γ_2	0.0005	0.17
DPN3	γ_3	-0.0023	-1.86*
DPN4	γ_4	-0.0007	-2.34*
DPN5	γ_5	-0.0020	-2.47*
MIDLANDS ELECTRICITY			
Constant	a	0.0001	0.85
Beta	β	0.911	145.0*
DPN1	γ_1	0.0007	0.92
DPN2	γ_2	0.0004	1.26
DPN3	γ_3	-0.0019	-2.34*
DPN4	γ_4	-0.0011	-2.53*
DPN5	γ_5	-0.0020	-2.14*
NORTHERN ELECTRIC			
Constant	a	0.0000	2.25*
Beta	β	0.870	89.3*
DPN1	γ_1	0.0006	0.76
DPN2	γ_2	-0.0010	-0.67
DPN3	γ_3	0.0002	0.89
DPN4	γ_4	-0.0001	-1.12
DPN5	γ_5	-0.0019	-0.96
NORWEB			
Constant	a	0.0002	3.11*
Beta	β	0.955	316.3*
DPN1	γ_1	0.0003	0.67
DPN2	γ_2	-0.0007	-0.36
DPN3	γ_3	0.0000	0.03
DPN4	γ_4	-0.0010	-0.09
DPN5	γ_5	-0.0015	-0.49
SEEBOARD			
Constant	a	0.0001	1.67
Beta	β	0.935	195.08*
DPN1	γ_1	0.0007	1.48
DPN2	γ_2	0.0004	0.35
DPN3	γ_3	-0.0007	-0.53
DPN4	γ_4	-0.0009	-0.99
DPN5	γ_5	-0.0006	-0.41
SOUTHERN ELECTRIC			
Constant	a	0.0001	2.27*
Beta	β	0.930	177.5*
DPN1	γ_1	0.0006	1.04
DPN2	γ_2	0.0002	0.28
DPN3	γ_3	-0.0010	-1.20
DPN4	γ_4	-0.0007	-1.09

DPN5	γ_5	-0.0017	-0.83

SOUTH WALES ELECTRICITY

Constant	a	0.0001	2.05*
Beta	β	0.931	258.6*
DPN1	γ_1	-0.0045	-13.08*
DPN2	γ_2	0.0005	0.69
DPN3	γ_3	-0.0011	-1.45
DPN4	γ_4	-0.0015	-1.06
DPN5	γ_5	-0.0011	-1.61

SOUTH WESTERN ELECTRICITY

Constant	a	0.0001	1.59
Beta	β	0.779	41.56*
DPN1	γ_1	-0.0014	-2.34*
DPN2	γ_2	-0.0005	-0.33
DPN3	γ_3	-0.0007	-0.95
DPN4	γ_4	-0.0015	-1.52
DPN5	γ_5	-0.0015	-0.62

YORKSHIRE ELECTRICITY

Constant	a	0.0003	4.91*
Beta	β	0.714	35.17*
DPN1	γ_1	0.0002	0.32
DPN2	γ_2	0.0004	0.50
DPN3	γ_3	-0.0007	-1.06
DPN4	γ_4	-0.0014	-2.34*
DPN5	γ_5	-0.0007	-1.17

1992

EASTERN ELECTRICITY

Constant	a	0.0001	1.43
Beta	β	0.692	53.42*
DPN6	γ_6	0.0012	0.91
DPN7	γ_7	-0.0011	-3.10*
DPN8	γ_8	-0.0012	-2.22*
DPN9	γ_9	0.0005	0.38
DPN10	γ_{10}	0.0007	0.24
DPN11	γ_{11}	-0.0002	-0.08

EAST MIDLANDS ELECTRICITY

Constant	a	0.0002	1.45
Beta	β	0.690	36.34*
DPN6	γ_6	-0.0015	-4.10*
DPN7	γ_7	-0.0017	-4.25*
DPN8	γ_8	-0.0007	-1.20

DPN9	γ_9	0.0017	2.50*
DPN10	γ_{10}	0.0015	1.27
DPN11	γ_{11}	-0.0003	-0.25
LONDON ELECTRICITY			
Constant	a	0.0002	1.51
Beta	β	0.692	46.43*
DPN6	γ_6	-0.0018	-3.76*
DPN7	γ_7	-0.0009	-4.34*
DPN8	γ_8	-0.0005	-0.58
DPN9	γ_9	0.0008	0.92
DPN10	γ_{10}	0.0005	0.31
DPN11	γ_{11}	0.00026	0.26
MANWEB			
Constant	a	0.0001	1.13
Beta	β	0.705	71.60*
DPN6	γ_6	0.0015	1.69*
DPN7	γ_7	-0.0010	-3.87*
DPN8	γ_8	-0.0008	-1.06
DPN9	γ_9	0.0013	1.51
DPN10	γ_{10}	-0.0002	-0.07
DPN11	γ_{11}	0.0001	0.09
MIDLANDS ELECTRICITY			
Constant	a	0.0000	0.68
Beta	β	0.880	149.0*
DPN6	γ_6	-0.0009	-1.47
DPN7	γ_7	-0.0007	-2.98*
DPN8	γ_8	0.0000	0.11
DPN9	γ_9	0.0002	0.32
DPN10	γ_{10}	0.0009	0.98
DPN11	γ_{11}	0.0006	0.55
NORTHERN ELECTRIC			
Constant	a	0.0002	2.86*
Beta	β	0.690	99.6*
DPN6	γ_6	0.0012	2.92*
DPN7	γ_7	-0.0012	-3.11*
DPN8	γ_8	-0.0007	-1.36
DPN9	γ_9	0.0011	1.01
DPN10	γ_{10}	0.0009	0.78
DPN11	γ_{11}	-0.0000	-0.01
NORWEB			
Constant	a	0.0001	1.43
Beta	β	0.700	72.25*
DPN6	γ_6	-0.0006	-1.29

DPN7	γ_7	-0.0017	-4.15*
DPN8	γ_8	-0.0006	-0.92
DPN9	γ_9	0.0011	1.23
DPN10	γ_{10}	0.0011	1.14
DPN11	γ_{11}	-0.0003	-0.29
SEEBOARD			
Constant	a	0.0002	2.54*
Beta	β	0.866	136.70*
DPN6	γ_6	-0.0004	-0.51
DPN7	γ_7	-0.0013	-3.16*
DPN8	γ_8	-0.0012	-1.77*
DPN9	γ_9	0.0000	0.00
DPN10	γ_{10}	0.0001	0.14
DPN11	γ_{11}	-0.0005	-0.52
SOUTHERN ELECTRIC			
Constant	a	0.0001	1.82*
Beta	β	0.880	166.0*
DPN6	γ_6	-0.0011	-3.40*
DPN7	γ_7	-0.0007	-2.78*
DPN8	γ_8	-0.0009	-2.35*
DPN9	γ_9	0.0011	0.73
DPN10	γ_{10}	0.0009	0.92
DPN11	γ_{11}	-0.0000	-0.01
SOUTH WALES ELECTRICITY			
Constant	a	-0.0001	-1.68
Beta	β	0.867	163.8*
DPN6	γ_6	0.0002	0.35
DPN7	γ_7	-0.0001	-1.10
DPN8	γ_8	-0.0005	-1.09
DPN9	γ_9	0.0009	0.25
DPN10	γ_{10}	0.0011	0.92
DPN11	γ_{11}	0.0007	0.51
SOUTH WESTERN ELECTRICITY			
Constant	a	0.0002	2.28*
Beta	β	0.901	162.6*
DPN6	γ_6	-0.0021	-3.34*
DPN7	γ_7	-0.0006	-3.10*
DPN8	γ_8	-0.0006	-0.74
DPN9	γ_9	0.0012	1.06
DPN10	γ_{10}	0.0002	0.11
DPN11	γ_{11}	0.0000	0.00
YORKSHIRE ELECTRICITY			
Constant	a	0.0001	2.29*

Beta	β	0.581	20.31*
DPN6	γ_6	-0.0023	-1.33
DPN7	γ_7	-0.0011	-1.52
DPN8	γ_8	-0.0007	-1.11
DPN9	γ_9	0.0013	2.91*
DPN10	γ_{10}	0.0006	0.67
DPN11	γ_{11}	-0.0003	-0.27

1993

EASTERN ELECTRICITY			
Constant	a	0.0000	0.16
Beta	β	0.622	14.77*
DPN12	γ_{12}	-0.0004	-0.90
DPN13	γ_{13}	0.0003	0.36
DPN14	γ_{14}	-0.0001	-0.16
DPN15	γ_{15}	-0.0004	-0.14
DPN16	γ_{16}	0.0009	0.70
DPN17	γ_{17}	-0.0004	-0.83
EAST MIDLANDS ELECTRICITY			
Constant	a	-0.0000	-0.43
Beta	β	0.667	19.21*
DPN12	γ_{12}	-0.0001	-0.34
DPN13	γ_{13}	0.0003	0.57
DPN14	γ_{14}	-0.0000	-0.00
DPN15	γ_{15}	-0.0005	-0.64
DPN16	γ_{16}	0.0005	0.21
DPN17	γ_{17}	-0.0005	-1.08
LONDON ELECTRICITY			
Constant	a	0.0000	0.13
Beta	β	0.622	17.59*
DPN12	γ_{12}	0.0002	0.27
DPN13	γ_{13}	0.0011	1.42
DPN14	γ_{14}	0.0005	0.63
DPN15	γ_{15}	-0.0007	-0.62
DPN16	γ_{16}	0.0008	0.72
DPN17	γ_{17}	-0.0006	-1.09
MANWEB			
Constant	a	0.0000	0.16
Beta	β	0.609	15.72*
DPN12	γ_{12}	0.0002	0.35
DPN13	γ_{13}	0.0010	0.96
DPN14	γ_{14}	-0.0003	-0.24
DPN15	γ_{15}	-0.0005	-0.41

DPN16	γ_{16}	0.0011	0.39
DPN17	γ_{17}	-0.0004	-0.69
MIDLANDS ELECTRICITY			
Constant	a	0.0000	0.17
Beta	β	0.611	16.73*
DPN12	γ_{12}	0.0000	0.20
DPN13	γ_{13}	0.0006	0.96
DPN14	γ_{14}	0.0007	1.10
DPN15	γ_{15}	-0.0003	-0.08
DPN16	γ_{16}	0.0013	0.99
DPN17	γ_{17}	-0.0004	-1.06
NORTHERN ELECTRIC			
Constant	a	0.0000	0.18
Beta	β	0.548	10.36*
DPN12	γ_{12}	0.0002	0.46
DPN13	γ_{13}	0.0010	0.84
DPN14	γ_{14}	-0.0004	-0.38
DPN15	γ_{15}	-0.0000	-0.01
DPN16	γ_{16}	0.0008	0.85
DPN17	γ_{17}	-0.0002	-0.38
NORWEB			
Constant	a	0.0000	0.18
Beta	β	0.577	11.21*
DPN12	γ_{12}	0.0007	1.11
DPN13	γ_{13}	0.0007	0.68
DPN14	γ_{14}	0.0002	0.23
DPN15	γ_{15}	0.0003	0.19
DPN16	γ_{16}	0.0003	0.15
DPN17	γ_{17}	-0.0007	-1.98*
SEEBOARD			
Constant	a	0.0000	0.19
Beta	β	0.577	15.99*
DPN12	γ_{12}	0.0001	0.34
DPN13	γ_{13}	0.0009	1.72*
DPN14	γ_{14}	0.0005	0.97
DPN15	γ_{15}	-0.0004	-0.29
DPN16	γ_{16}	0.0005	0.21
DPN17	γ_{17}	-0.0003	-0.76
SOUTHERN ELECTRIC			
Constant	a	0.0006	0.80
Beta	β	0.604	16.15*
DPN12	γ_{12}	-0.0057	-1.04
DPN13	γ_{13}	0.0053	0.60

DPN14	γ_{14}	-0.0037	-0.30
DPN15	γ_{15}	-0.0066	-0.33
DPN16	γ_{16}	0.0061	0.39
DPN17	γ_{17}	-0.0072	-1.39
SOUTH WALES ELECTRICITY			
Constant	a	0.0006	0.87
Beta	β	0.544	10.16*
DPN12	γ_{12}	0.0032	0.34
DPN13	γ_{13}	0.0052	0.59
DPN14	γ_{14}	-0.0017	-0.19
DPN15	γ_{15}	-0.0009	-0.08
DPN16	γ_{16}	0.0141	0.34
DPN17	γ_{17}	-0.0058	-0.59
SOUTH WESTERN ELECTRICITY			
Constant	a	0.0000	0.71
Beta	β	0.540	9.54*
DPN12	γ_{12}	0.0002	0.35
DPN13	γ_{13}	0.0007	0.80
DPN14	γ_{14}	0.0000	0.80
DPN15	γ_{15}	-0.0005	-0.58
DPN16	γ_{16}	0.0008	1.24
DPN17	γ_{17}	0.0001	0.22
YORKSHIRE ELECTRICITY			
Constant	a	0.0000	0.74
Beta	β	0.540	10.51*
DPN12	γ_{12}	0.0000	0.18
DPN13	γ_{13}	0.0006	0.89
DPN14	γ_{14}	0.0002	0.24
DPN15	γ_{15}	-0.0004	-0.36
DPN16	γ_{16}	0.0002	0.00
DPN17	γ_{17}	-0.0002	-0.41

1994

EASTERN ELECTRICITY			
Constant	a	0.0117	12.76*
Beta	β	0.639	18.05*
DPN18	γ_{18}	0.0156	1.55
DPN19	γ_{19}	-0.0173	-1.32
DPN20	γ_{20}	0.0008	0.03
EAST MIDLANDS ELECTRICITY			
Constant	a	0.0012	16.67*
Beta	β	0.714	27.71*
DPN18	γ_{18}	0.0015	2.89*

DPN19	γ_{19}	-0.0019	-3.02*
DPN20	γ_{20}	-0.0017	-0.84
LONDON ELECTRICITY			
Constant	a	0.0196	10.26*
Beta	β	0.705	38.88*
DPN18	γ_{18}	0.0229	3.05*
DPN19	γ_{19}	-0.0124	-1.43
DPN20	γ_{20}	-0.0031	-0.14
MANWEB			
Constant	a	0.0111	11.89*
Beta	β	0.548	15.12*
DPN18	γ_{18}	0.0122	1.44
DPN19	γ_{19}	-0.0159	-1.69*
DPN20	γ_{20}	-0.0046	-0.20
MIDLANDS ELECTRICITY			
Constant	a	0.0115	11.10*
Beta	β	0.612	16.79*
DPN18	γ_{18}	0.0164	2.02*
DPN19	γ_{19}	-0.0170	-2.32*
DPN20	γ_{20}	-0.0030	-0.09
NORTHERN ELECTRIC			
Constant	a	0.0117	10.86*
Beta	β	0.665	32.72*
DPN18	γ_{18}	0.0209	2.07*
DPN19	γ_{19}	-0.0187	-0.97
DPN20	γ_{20}	-0.0043	-0.03
NORWEB			
Constant	a	0.0117	11.76*
Beta	β	0.593	13.17*
DPN18	γ_{18}	0.0220	3.06*
DPN19	γ_{19}	-0.0146	-1.29
DPN20	γ_{20}	0.0013	0.03
SEEBOARD			
Constant	a	0.0119	9.90*
Beta	β	0.608	13.62*
DPN18	γ_{18}	0.0157	1.34
DPN19	γ_{19}	-0.0171	-2.26*
DPN20	γ_{20}	-0.0077	-0.54
SOUTHERN ELECTRIC			
Constant	a	0.0132	14.99*
Beta	β	0.302	21.05*

DPN18	γ_{18}	0.0122	1.72*
DPN19	γ_{19}	-0.0195	-2.05*
DPN20	γ_{20}	-0.0004	-0.01
SOUTH WALES ELECTRICITY			
Constant	a	0.0128	14.40*
Beta	β	0.296	3.06*
DPN18	γ_{18}	0.0074	0.90
DPN19	γ_{19}	-0.0146	-1.15
DPN20	γ_{20}	0.0015	0.13
SOUTH WESTERN ELECTRICITY			
Constant	a	0.0122	14.98*
Beta	β	0.305	3.56*
DPN18	γ_{18}	0.0152	2.45*
DPN19	γ_{19}	-0.0214	-2.44*
DPN20	γ_{20}	-0.0078	-0.40
YORKSHIRE ELECTRICITY			
Constant	a	0.0106	11.47*
Beta	β	0.731	38.57*
DPN18	γ_{18}	0.0211	3.01*
DPN19	γ_{19}	-0.0236	-1.47
DPN20	γ_{20}	-0.0022	-0.07

Table A2.3.2

The effect of DISTRIBUTION PRICE-POS (DPP) announcements on the conditional mean of the RECs by year.

$$R_{it} = a_i + \beta_i R_{mt} + \sum_{j=1}^{n} \gamma_j \; DPP_j + \varepsilon_{it}$$

$$h_{it} = \alpha_0 + \alpha_1 \; \varepsilon_{i,t-1}^2 + \alpha_2 \; h_{i,t-1}$$

Regressor	Coefficient		T-ratio
1992			
EASTERN ELECTRICITY			
DPP1	γ_1	0.0011	2.09*
DPP2	γ_2	00.0001	0.03
DPP3	γ_3	-0.0001	-0.12
EAST MIDLANDS ELECTRICITY			
DPP1	γ_1	0.0053	2.34*
DPP2	γ_2	0.0000	0.02
DPP3	γ_3	0.0001	0.04
LONDON ELECTRICITY			
DPP1	γ_1	0.0112	3.11*
DPP2	γ_2	0.0005	0.56
DPP3	γ_3	0.0006	0.64
MANWEB			
DPP1	γ_1	0.0010	1.89*
DPP2	γ_2	0.0003	0.68
DPP3	γ_3	-0.0000	-0.01
MIDLANDS ELECTRICITY			
DPP1	γ_1	0.0075	2.36*
DPP2	γ_2	-0.0003	-0.19
DPP3	γ_3	-0.0002	-0.13
NORTHERN ELECTRIC			
DPP1	γ_1	0.0055	2.13*
DPP2	γ_2	0.0034	4.34*
DPP3	γ_3	0.0004	1.14
NORWEB			
DPP1	γ_1	0.0089	2.76*

DPP2	γ_2	0.0008	0.77
DPP3	γ_3	-0.0001	-0.41
SEEBOARD			
DPP1	γ_1	0.0111	3.11*
DPP2	γ_2	0.0000	0.07
DPP3	γ_3	-0.0003	-0.08
SOUTHERN ELECTRIC			
DPP1	γ_1	0.0089	2.76*
DPP2	γ_2	0.0011	0.08
DPP3	γ_3	-0.0009	-0.28
SOUTH WALES ELECTRICITY			
DPP1	γ_1	0.0086	2.78*
DPP2	γ_2	0.0005	0.15
DPP3	γ_3	0.0105	2.89*
SOUTH WESTERN ELECTRICITY			
DPP1	γ_1	0.0045	1.78*
DPP2	γ_2	0.0006	0.97
DPP3	γ_3	0.0031	0.19
YORKSHIRE ELECTRICITY			
DPP1	γ_1	0.0001	1.65*
DPP2	γ_2	0.0007	0.13
DPP3	γ_3	0.0048	1.13
1994			
EASTERN ELECTRICITY			
DPP4	γ_4	-0.0052	-0.92
DPP5	γ_5	-0.0193	-6.97*
DPP6	γ_6	0.0060	0.73
EAST MIDLANDS ELECTRICITY			
DPP4	γ_4	0.0028	0.25
DPP5	γ_5	0.0118	2.21*
DPP6	γ_6	0.0072	0.47
LONDON ELECTRICITY			
DPP4	γ_4	0.0139	1.86*
DPP5	γ_5	0.0191	5.97*
DPP6	γ_6	0.0130	0.47
MANWEB			
DPP4	γ_4	-0.0004	-0.07
DPP5	γ_5	0.0078	1.40

DPP6	γ_6	0.0072	0.79
MIDLANDS ELECTRICITY			
DPP4	γ_4	0.0091	1.55
DPP5	γ_5	0.0162	2.56*
DPP6	γ_6	0.0109	1.29
NORTHERN ELECTRIC			
DPP4	γ_4	0.0025	0.43
DPP5	γ_5	0.0056	0.53
DPP6	γ_6	0.0131	1.12
NORWEB			
DPP4	γ_4	0.0083	1.44
DPP5	γ_5	0.0093	1.72*
DPP6	γ_6	0.0082	0.74
SEEBOARD			
DPP4	γ_4	0.0016	0.22
DPP5	γ_5	0.0119	1.74*
DPP6	γ_6	0.0121	1.18
SOUTHERN ELECTRIC			
DPP4	γ_4	-0.0011	-0.14
DPP5	γ_5	0.0199	5.59*
DPP6	γ_6	0.0049	0.47
SOUTH WALES ELECTRICITY			
DPP4	γ_4	0.0105	0.87
DPP5	γ_5	0.0112	2.59*
DPP6	γ_6	0.0048	0.45
SOUTH WESTERN ELECTRICITY			
DPP4	γ_4	0.0120	0.77
DPP5	γ_5	0.0170	4.14*
DPP6	γ_6	0.0084	0.86
YORKSHIRE ELECTRICITY			
DPP4	γ_4	0.0153	1.50
DPP5	γ_5	0.0116	2.08*
DPP6	γ_6	0.0066	0.61

Table A2.3.3

The effect of DISTRIBUTION COMP-POS (DCP) announcements on the conditional mean of the RECs by year.

$$R_{it} = a_i + \beta_i R_{mt} + \sum_{j=1}^{n} \gamma_j \ DCP_j + \varepsilon_{it}$$

$$h_{it} = \alpha_0 + \alpha_1 \ \varepsilon_{i,t-1}^2 + \alpha_2 \ h_{i,t-1}$$

Regressor		Coefficient	T-ratio
1992			
EASTERN ELECTRICITY			
DCP1	γ_1	0.0011	0.64
EAST MIDLANDS ELECTRICITY			
DCP1	γ_1	0.0009	1.01
LONDON ELECTRICITY			
DCP1	γ_1	0.0003	0.95
MANWEB			
DCP1	γ_1	0.0002	1.04
MIDLANDS ELECTRICITY			
DCP1	γ_1	0.0007	1.20
NORTHERN ELECTRIC			
DCP1	γ_1	0.0004	1.03
NORWEB			
DCP1	γ_1	0.0002	0.92
SEEBOARD			
DCP1	γ_1	0.0003	1.45
SOUTHERN ELECTRIC			
DCP1	γ_1	0.0006	1.07
SOUTH WALES ELECTRICITY			
DCP1	γ_1	0.0005	1.15

SOUTH WESTERN ELECTRICITY			
DCP1	γ_1	0.0008	0.89
YORKSHIRE ELECTRICITY			
DCP1	γ_1	0.0004	1.46

1993

EASTERN ELECTRICITY			
DCP2	γ_2	0.0011	2.64*
DCP3	γ_3	0.0009	1.56
DCP4	γ_4	-0.0002	-0.39
DCP5	γ_5	-0.0002	-0.14
DCP6	γ_6	0.0004	0.28
EAST MIDLANDS ELECTRICITY			
DCP2	γ_2	0.0010	1.51
DCP3	γ_3	0.0009	1.76*
DCP4	γ_4	-0.0002	-0.40
DCP5	γ_5	-0.0002	-0.08
DCP6	γ_6	0.0004	0.11
LONDON ELECTRICITY			
DCP2	γ_2	0.0013	1.85*
DCP3	γ_3	0.0008	2.01*
DCP4	γ_4	-0.0000	-0.02
DCP5	γ_5	-0.0004	-0.24
DCP6	γ_6	0.0006	0.29
MANWEB			
DCP2	γ_2	0.0092	1.74*
DCP3	γ_3	0.0063	1.06
DCP4	γ_4	0.0012	0.26
DCP5	γ_5	-0.0012	-0.08
DCP6	γ_6	-0.0006	-0.06
MIDLANDS ELECTRICITY			
DCP2	γ_2	0.0019	4.92*
DCP3	γ_3	0.0009	1.38
DCP4	γ_4	-0.0000	-0.14
DCP5	γ_5	-0.0005	-0.41
DCP6	γ_6	0.0005	0.24
NORTHERN ELECTRIC			
DCP2	γ_2	0.0015	1.96*
DCP3	γ_3	0.0006	1.26
DCP4	γ_4	0.0001	0.26

DCP5	γ_5	-0.0002	-0.10
DCP6	γ_6	0.0006	0.37
NORWEB			
DCP2	γ_2	0.0003	0.22
DCP3	γ_3	0.0014	2.16*
DCP4	γ_4	0.0007	1.21
DCP5	γ_5	-0.0004	-0.39
DCP6	γ_6	0.0007	0.42
SEEBOARD			
DCP2	γ_2	0.0008	1.50
DCP3	γ_3	0.0008	1.46
DCP4	γ_4	-0.0000	-0.00
DCP5	γ_5	-0.0004	-0.34
DCP6	γ_6	0.0005	0.04
SOUTHERN ELECTRIC			
DCP2	γ_2	0.0009	1.17
DCP3	γ_3	0.0015	3.32*
DCP4	γ_4	-0.0005	-1.02
DCP5	γ_5	-0.0003	-0.04
DCP6	γ_6	0.0012	2.12*
SOUTH WALES ELECTRICITY			
DCP2	γ_2	0.0004	1.25
DCP3	γ_3	0.0007	0.64
DCP4	γ_4	0.0003	0.47
DCP5	γ_5	-0.0002	-0.17
DCP6	γ_6	0.0006	0.28
SOUTH WESTERN ELECTRICITY			
DCP2	γ_2	0.0005	1.09
DCP3	γ_3	0.0010	0.87
DCP4	γ_4	0.0002	0.41
DCP5	γ_5	-0.0004	-0.46
DCP6	γ_6	0.0004	0.30
YORKSHIRE ELECTRICITY			
DCP2	γ_2	0.0006	1.52
DCP3	γ_3	0.0002	0.00
DCP4	γ_4	0.0000	0.28
DCP5	γ_5	-0.0005	-0.23
DCP6	γ_6	0.0001	0.23

1994

EASTERN ELECTRICITY			
DCP7	γ_7	-0.0000	-0.20
DCP8	γ_8	0.0026	0.12
EAST MIDLANDS ELECTRICITY			
DCP7	γ_7	0.0076	0.78
DCP8	γ_8	0.0315	3.82*
LONDON ELECTRICITY			
DCP7	γ_7	0.0055	0.44
DCP8	γ_8	0.0134	1.58
MANWEB			
DCP7	γ_7	0.0060	0.38
DCP8	γ_8	0.0323	6.13*
MIDLANDS ELECTRICITY			
DCP7	γ_7	0.0042	0.25
DCP8	γ_8	0.0278	5.19*
NORTHERN ELECTRIC			
DCP7	γ_7	0.0047	0.24
DCP8	γ_8	0.0236	7.76*
NORWEB			
DCP7	γ_7	-0.0002	-0.01
DCP8	γ_8	0.0177	2.75*
SEEBOARD			
DCP7	γ_7	0.0050	0.09
DCP8	γ_8	0.0352	2.83*
SOUTHERN ELECTRIC			
DCP7	γ_7	0.0034	0.12
DCP8	γ_8	0.0112	1.29
SOUTH WALES ELECTRICITY			
DCP7	γ_7	-0.0031	-0.18
DCP8	γ_8	0.0261	3.79*
SOUTH WESTERN ELECTRICITY			
DCP7	γ_7	0.0067	0.66
DCP8	γ_8	0.0218	3.82*
YORKSHIRE ELECTRICITY			
DCP7	γ_7	0.0012	0.08
DCP8	γ_8	-0.0166	-5.47*

Table A2.3.4

The effect of DISTRIBUTION SERVICE-POS (DSP) announcements on the conditional mean of the RECs by year.

$$R_{it} = a_i + \beta_i R_{mt} + \sum_{j=1}^{n} \gamma_j \; DSP_j + \varepsilon_{it}$$

$$h_{it} = \alpha_0 + \alpha_1 \; \varepsilon^2_{i,t-1} + \alpha_2 \; h_{i,t-1}$$

Regressor		Coefficient	T-ratio
1991			
EASTERN ELECTRICITY			
DSP1	γ_1	0.0006	1.06
DSP2	γ_2	0.0001	0.08
DSP3	γ_3	-0.0003	-0.33
EAST MIDLANDS ELECTRICITY			
DSP1	γ_1	0.0006	0.82
DSP2	γ_2	0.0004	0.48
DSP3	γ_3	-0.0003	-0.35
LONDON ELECTRICITY			
DSP1	γ_1	0.0010	0.79
DSP2	γ_2	0.0001	0.04
DSP3	γ_3	-0.0013	-1.64*
MANWEB			
DSP1	γ_1	0.0009	1.05
DSP2	γ_2	-0.0004	-0.42
DSP3	γ_3	-0.0001	-0.09
MIDLANDS ELECTRICITY			
DSP1	γ_1	0.0007	1.24
DSP2	γ_2	-0.0002	-0.24
DSP3	γ_3	-0.0003	-0.26
NORTHERN ELECTRIC			
DSP1	γ_1	0.0005	1.31
DSP2	γ_2	0.0004	0.63
DSP3	γ_3	-0.0010	-1.25
NORWEB			
DSP1	γ_1	0.0004	1.01

DSP2	γ_2	0.0005	0.71
DSP3	γ_3	-0.0003	-0.33
SEEBOARD			
DSP1	γ_1	0.0001	3.28*
DSP2	γ_2	0.0004	0.53
DSP3	γ_3	0.0002	0.08
SOUTHERN ELECTRIC			
DSP1	γ_1	0.0009	1.22
DSP2	γ_2	-0.0006	-0.47
DSP3	γ_3	-0.0002	-0.14
SOUTH WALES ELECTRICITY			
DSP1	γ_1	0.0015	2.16*
DSP2	γ_2	0.0002	0.29
DSP3	γ_3	-0.0014	-2.56*
SOUTH WESTERN ELECTRICITY			
DSP1	γ_1	0.0019	3.16*
DSP2	γ_2	0.0005	0.90
DSP3	γ_3	-0.0007	-1.40
YORKSHIRE ELECTRICITY			
DSP1	γ_1	0.0003	0.75
DSP2	γ_2	-0.0004	-0.46
DSP3	γ_3	-0.0006	-0.93
1992			
EASTERN ELECTRICITY			
DSP4	γ_4	0.0003	1.16
EAST MIDLANDS ELECTRICITY			
DSP4	γ_4	0.0002	0.61
LONDON ELECTRICITY			
DSP4	γ_4	0.0007	0.09
MANWEB			
DSP4	γ_4	0.0006	0.55
MIDLANDS ELECTRICITY			
DSP4	γ_4	0.0004	0.24
NORTHERN ELECTRIC			
DSP4	γ_4	0.0011	1.34

NORWEB			
DSP4	γ_4	0.0009	1.23
SEEBOARD			
DSP4	γ_1	0.0012	1.48
SOUTHERN ELECTRIC			
DSP4	γ_4	0.0007	1.52
SOUTH WALES ELECTRICITY			
DSP4	γ_4	0.0013	1.19
SOUTH WESTERN ELECTRICITY			
DSP4	γ_4	0.0006	1.24
YORKSHIRE ELECTRICITY			
DSP4	γ_4	0.0005	1.58

Table A2.3.5

The effect of GENERATION PRICE-NEG (GPN) announcements on the conditional mean of the RECs by year.

$$R_{it} = a_i + \beta_i R_{mt} + \sum_{j=1}^{n} \gamma_j \, GPN_j + \varepsilon_{it}$$

$$h_{it} = \alpha_0 + \alpha_1 \, \varepsilon_{i,t-1}^2 + \alpha_2 \, h_{i,t-1}$$

Regressor		Coefficient	T-ratio
1991			
EASTERN ELECTRICITY			
GPN1	γ_1	0.0005	2.11*
GPN2	γ_2	0.0002	1.18
EAST MIDLANDS ELECTRICITY			
GPN1	γ_1	0.0011	1.72*
GPN2	γ_2	0.0003	0.42
LONDON ELECTRICITY			
GPN1	γ_1	0.0004	1.32
GPN2	γ_2	-0.0006	-1.23
MANWEB			
GPN1	γ_1	0.0012	1.03
GPN2	γ_2	-0.0005	-0.63
MIDLANDS ELECTRICITY			
GPN1	γ_1	0.0006	2.47*
GPN2	γ_2	0.0007	0.41
NORTHERN ELECTRIC			
GPN1	γ_1	0.0010	3.11*
GPN2	γ_2	0.0003	0.92
NORWEB			
GPN1	γ_1	0.0002	2.39*
GPN2	γ_2	-0.0006	-0.37
SEEBOARD			
GPN1	γ_1	0.0004	4.67*
GPN2	γ_2	0.0000	0.06

SOUTHERN ELECTRIC			
GPN1	γ_1	0.0008	3.36*
GPN2	γ_2	0.0002	1.42
SOUTH WALES ELECTRICITY			
GPN1	γ_1	0.0009	3.13*
GPN2	γ_2	-0.0005	-1.25
SOUTH WESTERN ELECTRICITY			
GPN1	γ_1	0.0017	2.97*
GPN2	γ_2	-0.0005	-0.83
YORKSHIRE ELECTRICITY			
GPN1	γ_1	0.0012	2.74*
GPN2	γ_2	-0.0000	-0.06
1992			
EASTERN ELECTRICITY			
GPN3	γ_3	0.0002	1.41
GPN4	γ_4	0.0004	1.04
EAST MIDLANDS ELECTRICITY			
GPN3	γ_3	0.0009	1.42
GPN4	γ_4	0.0003	0.42
LONDON ELECTRICITY			
GPN3	γ_3	0.0005	0.98
GPN4	γ_4	-0.0001	-0.14
MANWEB			
GPN3	γ_3	0.0002	1.21
GPN4	γ_4	-0.0006	-0.83
MIDLANDS ELECTRICITY			
GPN3	γ_3	0.0005	1.34
GPN4	γ_4	0.0002	0.37
NORTHERN ELECTRIC			
GPN3	γ_3	0.0007	1.14
GPN4	γ_4	0.0003	0.92
NORWEB			
GPN3	γ_3	0.0004	1.52
GPN4	γ_4	-0.0002	-0.76
SEEBOARD			
GPN3	γ_3	0.0007	1.27

GPN4	γ_4	0.0001	0.67
SOUTHERN ELECTRIC			
GPN3	γ_3	0.0005	1.41
GPN4	γ_4	0.0003	0.90
SOUTH WALES ELECTRICITY			
GPN3	γ_3	0.0013	1.18
GPN4	γ_4	-0.0001	-1.25
SOUTH WESTERN ELECTRICITY			
GPN3	γ_3	0.0007	0.99
GPN4	γ_4	-0.0003	-0.69
YORKSHIRE ELECTRICITY			
GPN3	γ_3	0.0012	1.71*
GPN4	γ_4	0.0003	1.14
1993			
EASTERN ELECTRICITY			
GPN5	γ_5	-0.0005	-1.11
GPN6	γ_6	0.0001	1.29
GPN7	γ_7	0.0008	1.19
GPN8	γ_8	0.0002	0.31
GPN9	γ_9	0.0000	0.85
GPN10	γ_{10}	0.0007	1.10
EAST MIDLANDS ELECTRICITY			
GPN5	γ_5	0.0001	0.91
GPN6	γ_6	0.0005	0.78
GPN7	γ_7	0.0006	1.24
GPN8	γ_8	0.0003	0.81
GPN9	γ_9	-0.0001	-0.75
GPN10	γ_{10}	0.0003	1.23
LONDON ELECTRICITY			
GPN5	γ_5	-0.0002	-0.29
GPN6	γ_6	0.0003	1.18
GPN7	γ_7	0.0007	1.43
GPN8	γ_8	0.0004	0.78
GPN9	γ_9	0.0002	1.35
GPN10	γ_{10}	0.00011	0.97
MANWEB			
GPN5	γ_5	0.0000	0.61
GPN6	γ_6	0.0003	1.46
GPN7	γ_7	0.0002	0.81

GPN8	γ_8	0.0005	1.03
GPN9	γ_9	-0.0002	-0.65
GPN10	γ_{10}	0.0016	1.19
MIDLANDS ELECTRICITY			
GPN5	γ_5	-0.0019	-1.22
GPN6	γ_6	0.0004	0.69
GPN7	γ_7	0.0010	1.60
GPN8	γ_8	0.0007	0.91
GPN9	γ_9	0.0001	1.27
GPN10	γ_{10}	0.0015	1.33
NORTHERN ELECTRIC			
GPN5	γ_5	-0.0009	-1.08
GPN6	γ_6	0.0028	1.10
GPN7	γ_7	0.0019	1.46
GPN8	γ_8	0.0010	0.45
GPN9	γ_9	0.0001	1.50
GPN10	γ_{10}	0.0022	0.49
NORWEB			
GPN5	γ_5	-0.0010	-1.19
GPN6	γ_6	0.0006	0.53
GPN7	γ_7	0.0003	1.31
GPN8	γ_8	0.0007	1.51
GPN9	γ_9	0.0001	0.09
GPN10	γ_{10}	0.0000	1.16
SEEBOARD			
GPN5	γ_5	0.0001	1.31
GPN6	γ_6	0.0003	0.85
GPN7	γ_7	0.0007	0.19
GPN8	γ_8	0.0002	1.35
GPN9	γ_9	-0.0002	-0.91
GPN10	γ_{10}	0.0004	1.14
SOUTHERN ELECTRIC			
GPN5	γ_5	-0.0004	-1.18
GPN6	γ_6	0.0002	0.99
GPN7	γ_7	0.0001	1.39
GPN8	γ_8	0.0010	0.83
GPN9	γ_9	0.0001	1.05
GPN10	γ_{10}	0.0017	1.60
SOUTH WALES ELECTRICITY			
GPN5	γ_5	-0.0015	-1.01
GPN6	γ_6	0.0007	1.44
GPN7	γ_7	0.0000	0.17

GPN8	γ_8	0.0004	0.88
GPN9	γ_9	0.0012	0.77
GPN10	γ_{10}	0.0009	1.16
SOUTH WESTERN ELECTRICITY			
GPN5	γ_5	0.0014	0.91
GPN6	γ_6	0.0004	1.29
GPN7	γ_7	0.0007	1.47
GPN8	γ_8	0.0000	0.13
GPN9	γ_9	0.0003	0.87
GPN10	γ_{10}	0.0008	1.41
YORKSHIRE ELECTRICITY			
GPN5	γ_5	0.0013	1.53
GPN6	γ_6	0.0006	1.46
GPN7	γ_7	0.0012	1.16
GPN8	γ_8	0.0001	1.00
GPN9	γ_9	0.0003	0.93
GPN10	γ_{10}	0.0010	1.50

Table A2.3.6

The effect of GENERATION COMPETITION-POS (GCP) announcements on the conditional mean of the RECs by year.

$$R_{it} = a_i + \beta_i R_{mt} + \sum_{j=1}^{n} \gamma_j \, GCP_j + \varepsilon_{it}$$

$$h_{it} = \alpha_0 + \alpha_1 \, \varepsilon^2_{i,t-1} + \alpha_2 \, h_{i,t-1}$$

Regressor		Coefficient	T-ratio
1991			
EASTERN ELECTRICITY			
GCP1	γ_1	0.0001	0.11
GCP2	γ_2	0.0002	0.18
GCP3	γ_3	-0.0004	-0.08
GCP4	γ_4	-0.0004	-0.15
GCP5	γ_5	-0.0005	-0.72
EAST MIDLANDS ELECTRICITY			
GCP1	γ_1	0.0053	0.02
GCP2	γ_2	0.0001	0.02
GCP3	γ_3	-0.0003	-0.15
GCP4	γ_4	-0.0002	-0.05
GCP5	γ_5	-0.0010	-0.76
LONDON ELECTRICITY			
GCP1	γ_1	0.0003	0.11
GCP2	γ_2	-0.0002	-0.28
GCP3	γ_3	-0.0005	-0.15
GCP4	γ_4	-0.0019	-0.38
GCP5	γ_5	-0.0009	-0.91
MANWEB			
GCP1	γ_1	0.0015	0.02
GCP2	γ_2	-0.0005	-0.43
GCP3	γ_3	0.0001	0.03
GCP4	γ_4	-0.0000	-0.02
GCP5	γ_5	-0.0001	-0.09
MIDLANDS ELECTRICITY			
GCP1	γ_1	-0.0001	-0.13
GCP2	γ_2	0.0005	0.23
GCP3	γ_3	-0.0003	-0.03

GCP4	γ_4	-0.0016	-0.70
GCP5	γ_5	-0.0002	-0.24
NORTHERN ELECTRIC			
GCP1	γ_1	-0.0002	-0.21
GCP2	γ_2	0.0001	0.02
GCP3	γ_3	-0.0004	-0.11
GCP4	γ_4	-0.0008	-0.69
GCP5	γ_5	-0.0007	-0.74
NORWEB			
GCP1	γ_1	-0.0003	-0.35
GCP2	γ_2	-0.0001	-0.17
GCP3	γ_3	0.0001	0.04
GCP4	γ_4	-0.0007	-0.63
GCP5	γ_5	-0.0002	-0.25
SEEBOARD			
GCP1	γ_1	-0.0002	-0.27
GCP2	γ_2	0.0000	0.01
GCP3	γ_3	-0.0003	-0.06
GCP4	γ_4	-0.0017	-1.62*
GCP5	γ_5	-0.0011	-1.83*
SOUTHERN ELECTRIC			
GCP1	γ_1	0.0004	0.18
GCP2	γ_2	0.0007	0.82
GCP3	γ_3	-0.0001	-0.05
GCP4	γ_4	-0.0012	-1.30
GCP5	γ_5	-0.0002	-0.13
SOUTH WALES ELECTRICITY			
GCP1	γ_1	0.0002	0.06
GCP2	γ_2	-0.0009	-0.25
GCP3	γ_3	-0.0000	-0.00
GCP4	γ_4	-0.0014	-1.46
GCP5	γ_5	-0.0004	-0.14
SOUTH WESTERN ELECTRICITY			
GCP1	γ_1	0.0070	0.27
GCP2	γ_2	-0.0001	-0.01
GCP3	γ_3	-0.0001	-0.08
GCP4	γ_4	-0.0011	-1.33
GCP5	γ_5	-0.0013	-1.31
YORKSHIRE ELECTRICITY			
GCP1	γ_1	0.0002	0.34
GCP2	γ_2	-0.0000	-000

GCP3	γ_3	-0.0002	-0.04
GCP4	γ_4	-0.0012	-1.39
GCP5	γ_5	-0.0007	-0.74
1992			
EASTERN ELECTRICITY			
GCP6	γ_6	0.0004	0.33
GCP7	γ_7	0.0000	0.14
GCP8	γ_8	-0.0010	-0.18
EAST MIDLANDS ELECTRICITY			
GCP6	γ_6	0.0009	2.11*
GCP7	γ_7	0.0008	0.92
GCP8	γ_8	-0.0006	-1.09
LONDON ELECTRICITY			
GCP6	γ_6	0.0003	0.87
GCP7	γ_7	0.0009	0.35
GCP8	γ_8	-0.0002	-0.91
MANWEB			
GCP6	γ_6	0.0013	1.11
GCP7	γ_7	0.0000	0.81
GCP8	γ_8	-0.0004	-1.06
MIDLANDS ELECTRICITY			
GCP6	γ_6	0.0006	2.66*
GCP7	γ_7	0.0003	0.08
GCP8	γ_8	-0.0011	-0.92
NORTHERN ELECTRIC			
GCP6	γ_6	0.0010	1.21
GCP7	γ_7	0.0001	0.56
GCP8	γ_8	-0.0000	-0.07
NORWEB			
GCP6	γ_6	0.0004	1.41
GCP7	γ_7	0.0008	1.18
GCP8	γ_8	-0.0016	-0.18
SEEBOARD			
GCP6	γ_6	0.0007	1.18
GCP7	γ_7	0.0003	0.47
GCP8	γ_8	-0.0012	-0.98
SOUTHERN ELECTRIC			
GCP6	γ_6	0.0002	2.17*

GCP7	γ_7	0.0000	0.31
GCP8	γ_8	-0.0009	-0.78
SOUTH WALES ELECTRICITY			
GCP6	γ_6	0.0011	1.17
GCP7	γ_7	0.0005	0.88
GCP8	γ_8	-0.0018	-0.96
SOUTH WESTERN ELECTRICITY			
GCP6	γ_6	0.0008	1.77*
GCP7	γ_7	0.0004	0.78
GCP8	γ_8	-0.0014	-0.59
YORKSHIRE ELECTRICITY			
GCP6	γ_6	0.0006	1.47
GCP7	γ_7	0.0001	0.87
GCP8	γ_8	-0.0015	-0.34

1993

EASTERN ELECTRICITY			
GCP9	γ_9	0.0005	0.73
GCP10	γ_{10}	0.0003	0.97
GCP11	γ_{11}	-0.0006	-0.42
GCP12	γ_{12}	-0.0011	-0.57
GCP13	γ_{13}	0.0006	1.02
GCP14	γ_{14}	-0.0010	-0.41
EAST MIDLANDS ELECTRICITY			
GCP9	γ_9	0.0010	0.66
GCP10	γ_{10}	0.0001	0.08
GCP11	γ_{11}	-0.0014	-1.48
GCP12	γ_{12}	-0.0006	-0.79
GCP13	γ_{13}	0.0012	1.52
GCP14	γ_{14}	-0.0007	-0.94
LONDON ELECTRICITY			
GCP9	γ_9	0.0001	0.09
GCP10	γ_{10}	-0.0002	-0.53
GCP11	γ_{11}	-0.0005	-0.88
GCP12	γ_{12}	-0.008	-0.14
GCP13	γ_{13}	0.0017	1.27
GCP14	γ_{14}	0.0014	1.30
MANWEB			
GCP9	γ_9	0.0001	1.07
GCP10	γ_{10}	0.0003	0.42
GCP11	γ_{11}	-0.0013	-0.96

GCP12	γ_{12}	-0.0004	-0.47
GCP13	γ_{13}	-0.0000	-0.68
GCP14	γ_{14}	-0.0008	-0.87
MIDLANDS ELECTRICITY			
GCP9	γ_{9}	0.0015	1.12
GCP10	γ_{10}	0.0005	0.08
GCP11	γ_{11}	-0.0011	-0.64
GCP12	γ_{12}	-0.0001	-0.59
GCP13	γ_{13}	0.0004	1.42
GCP14	γ_{14}	-0.0007	-0.45
NORTHERN ELECTRIC			
GCP9	γ_{9}	0.0008	1.17
GCP10	γ_{10}	0.0004	0.37
GCP11	γ_{11}	-0.0005	-0.59
GCP12	γ_{12}	-0.0009	-1.06
GCP13	γ_{13}	-0.0003	-1.34
GCP14	γ_{14}	-0.0011	-0.94
NORWEB			
GCP9	γ_{9}	0.0019	1.43
GCP10	γ_{10}	0.0002	0.65
GCP11	γ_{11}	-0.0007	-0.72
GCP12	γ_{12}	-0.0008	-1.06
GCP13	γ_{13}	0.0020	1.32
GCP14	γ_{14}	-0.0001	-0.67
SEEBOARD			
GCP9	γ_{9}	0.0006	0.80
GCP10	γ_{10}	0.0002	0.59
GCP11	γ_{11}	-0.0004	-1.43
GCP12	γ_{12}	-0.0015	-0.79
GCP13	γ_{13}	-0.0007	-1.32
GCP14	γ_{14}	0.0012	1.50
SOUTHERN ELECTRIC			
GCP9	γ_{9}	0.0009	1.18
GCP10	γ_{10}	0.0000	0.53
GCP11	γ_{11}	0.0001	0.08
GCP12	γ_{12}	-0.0006	-0.27
GCP13	γ_{13}	0.0008	1.32
GCP14	γ_{14}	-0.0007	-0.75
SOUTH WALES ELECTRICITY			
GCP9	γ_{9}	0.0006	1.42
GCP10	γ_{10}	0.0002	0.09

GCP11	γ_{11}	-0.0012	-0.61
GCP12	γ_{12}	-0.0008	-0.39
GCP13	γ_{13}	0.0004	1.27
GCP14	γ_{14}	-0.0007	-0.93
SOUTH WESTERN ELECTRICITY			
GCP9	γ_{9}	0.0008	0.58
GCP10	γ_{10}	0.0002	1.01
GCP11	γ_{11}	-0.0000	-0.05
GCP12	γ_{12}	-0.0005	-0.27
GCP13	γ_{13}	0.0010	1.31
GCP14	γ_{14}	0.0004	0.86
YORKSHIRE ELECTRICITY			
GCP9	γ_{9}	0.0003	0.07
GCP10	γ_{10}	0.0006	0.63
GCP11	γ_{11}	-0.0012	-1.04
GCP12	γ_{12}	-0.0002	-0.35
GCP13	γ_{13}	-0.0007	-1.43
GCP14	γ_{14}	-0.0018	-1.30

1994

EASTERN ELECTRICITY			
GCP15	γ_{15}	0.0011	0.44
GCP16	γ_{16}	-0.0006	-0.87
GCP17	γ_{17}	0.0004	1.89*
EAST MIDLANDS ELECTRICITY			
GCP15	γ_{15}	0.0004	1.06
GCP16	γ_{16}	0.0000	0.03
GCP17	γ_{17}	0.0007	1.48
LONDON ELECTRICITY			
GCP15	γ_{15}	0.0002	0.06
GCP16	γ_{16}	0.0004	0.18
GCP17	γ_{17}	0.0012	2.06*
MANWEB			
GCP15	γ_{15}	0.0009	1.07
GCP16	γ_{16}	0.0004	0.08
GCP17	γ_{17}	-0.0007	-0.74
MIDLANDS ELECTRICITY			
GCP15	γ_{15}	0.0003	0.58
GCP16	γ_{16}	0.0005	0.09
GCP17	γ_{17}	0.0006	1.56

NORTHERN ELECTRIC			
GCP15	γ_{15}	0.0006	0.79
GCP16	γ_{16}	-0.0006	0.27
GCP17	γ_{17}	0.0005	1.21
NORWEB			
GCP15	γ_{15}	0.0008	0.83
GCP16	γ_{16}	-0.0001	-0.30
GCP17	γ_{17}	0.0016	1.18
SEEBOARD			
GCP15	γ_{15}	0.0003	0.67
GCP16	γ_{16}	-0.0002	-0.06
GCP17	γ_{17}	0.0005	2.10*
SOUTHERN ELECTRIC			
GCP15	γ_{15}	0.0006	1.06
GCP16	γ_{16}	0.0002	0.37
GCP17	γ_{17}	0.0017	1.53
SOUTH WALES ELECTRICITY			
GCP15	γ_{15}	0.0007	0.55
GCP16	γ_{16}	-0.0000	-0.03
GCP17	γ_{17}	0.0014	1.32
SOUTH WESTERN ELECTRICITY			
GCP15	γ_{15}	0.0006	0.93
GCP16	γ_{16}	-0.0004	-0.64
GCP17	γ_{17}	0.0014	0.63
YORKSHIRE ELECTRICITY			
GCP15	γ_{15}	0.0012	1.03
GCP16	γ_{16}	-0.0008	-0.77
GCP17	γ_{17}	0.0004	1.74*

Table A2.3.7

The effect of GENERATION COMPETITION-NEG (GCN) announcements on the conditional mean of the RECs by year.

$$R_{it} = a_i + \beta_i R_{mt} + \sum_{j=1}^{n} \gamma_j \; GCN_j + \varepsilon_{it}$$

$$h_{it} = \alpha_0 + \alpha_1 \; \varepsilon_{i,t-1}^2 + \alpha_2 \; h_{i,t-1}$$

Regressor		Coefficient	T-ratio
1993			
EASTERN ELECTRICITY			
GCN1	γ_1	0.0003	0.35
EAST MIDLANDS ELECTRICITY			
GCN1	γ_1	0.0023	0.92
LONDON ELECTRICITY			
GCN1	γ_1	0.0009	1.42
MANWEB			
GCN1	γ_1	0.0018	1.27
MIDLANDS ELECTRICITY			
GCN1	γ_1	-0.0001	-0.21
NORTHERN ELECTRIC			
GCN1	γ_1	-0.0007	-0.98
NORWEB			
GCN1	γ_1	-0.0000	-0.41
SEEBOARD			
GCN1	γ_1	-0.0005	-0.59
SOUTHERN ELECTRIC			
GCN1	γ_1	0.0011	1.31
SOUTH WALES ELECTRICITY			
GCN1	γ_1	0.0004	0.76
SOUTH WESTERN ELECTRICITY			
GCN1	γ_1	0.0006	1.57

YORKSHIRE ELECTRICITY			
GCN1	γ_1	0.0013	1.42
1994			
EASTERN ELECTRICITY			
GCN2	γ_2	0.0012	1.41
GCN3	γ_3	0.0001	0.78
GCN4	γ_4	0.0013	1.32
EAST MIDLANDS ELECTRICITY			
GCN2	γ_2	0.0002	0.16
GCN3	γ_3	-0.0006	-0.51
GCN4	γ_4	0.0003	0.28
LONDON ELECTRICITY			
GCN2	γ_2	0.0004	0.71
GCN3	γ_3	-0.0001	-0.49
GCN4	γ_4	0.0012	1.06
MANWEB			
GCN2	γ_2	0.0005	0.92
GCN3	γ_3	-0.0007	-0.44
GCN4	γ_4	0.0004	0.75
MIDLANDS ELECTRICITY			
GCN2	γ_2	0.0003	0.46
GCN3	γ_3	-0.0013	-1.08
GCN4	γ_4	0.0005	0.94
NORTHERN ELECTRIC			
GCN2	γ_2	0.0011	1.49
GCN3	γ_3	-0.0008	-0.99
GCN4	γ_4	0.0014	0.68
NORWEB			
GCN2	γ_2	0.0005	0.85
GCN3	γ_3	-0.0006	-1.31
GCN4	γ_4	0.0009	0.77
SEEBOARD			
GCN2	γ_2	0.0016	1.83*
GCN3	γ_3	0.0000	0.83
GCN4	γ_4	0.0021	0.19
SOUTHERN ELECTRIC			
GCN2	γ_2	0.0008	1.00
GCN3	γ_3	-0.0006	-0.76

GCN4	γ_4	0.0019	0.93
SOUTH WALES ELECTRICITY			
GCN2	γ_2	0.0006	1.35
GCN3	γ_3	0.0003	0.16
GCN4	γ_4	0.00014	0.77
SOUTH WESTERN ELECTRICITY			
GCN2	γ_2	0.0003	2.09*
GCN3	γ_3	0.0000	0.09
GCN4	γ_4	0.0004	0.45
YORKSHIRE ELECTRICITY			
GCN2	γ_2	0.0004	0.75
GCN3	γ_3	0.0001	0.71
GCN4	γ_4	0.0004	1.17

Table A2.3.8

DISTRIBUTION PRICE-NEG (DPN) announcements with a statistically significant effect on the conditional variance of the returns on the RECs' equity by year.

$$R_{it} = a_i + \beta_i R_{mt} + \varepsilon_{it}$$

$$h_{it} = \alpha_0 + \alpha_1 \varepsilon_{i,t-1}^2 + \alpha_2 h_{i,t-1} + \sum_{j=1}^{n} \phi_j DPN_j$$

Regressor	Coefficient		T-ratio
1991			
EASTERN ELECTRICITY			
DPN3	ϕ_3	5.3270	2.18*
LONDON ELECTRICITY			
DPN1	ϕ_1	0.2205	2.52*
DPN3	ϕ_3	0.1808	2.60*
YORKSHIRE ELECTRICITY			
DPN2	ϕ_2	0.0007	1.79*
1992			
EASTERN ELECTRICITY			
DPN6	ϕ_6	0.0003	4.68*
DPN7	ϕ_7	0.0012	1.82*
EAST MIDLANDS ELECTRICITY			
DPN6	ϕ_6	0.0053	3.15*
DPN7	ϕ_7	0.0010	2.02*
LONDON ELECTRICITY			
DPN6	ϕ_6	0.0018	3.10*
DPN7	ϕ_7	0.0756	2.84*
MANWEB			
DPN6	ϕ_6	0.2011	4.89*
MIDLANDS ELECTRICITY			
DPN6	ϕ_6	0.0175	3.24*
DPN7	ϕ_7	1.4503	2.97*

NORTHERN ELECTRIC			
DPN7	ϕ_7	0.0213	2.33*
NORWEB			
DPN7	ϕ_7	0.0257	2.99*
SEEBOARD			
DPN6	ϕ_6	0.0187	4.01*
SOUTHERN ELECTRIC			
DPN6	ϕ_6	0.3167	4.85*
SOUTH WALES ELECTRICITY			
DPN6	ϕ_6	0.1180	1.98*
DPN7	ϕ_T	0.0045	2.90*
SOUTH WESTERN ELECTRICITY			
DPN7	ϕ_7	0.1965	2.78*
1993			
EAST MIDLANDS ELECTRICITY			
DPN13	ϕ_{13}	0.0008	2.92*
DPN14	ϕ_{14}	0.0012	4.48*
NORTHERN ELECTRIC			
DPN13	ϕ_{13}	0.0070	3.05*
DPN14	ϕ_{14}	0.0086	3.69*
YORKSHIRE ELECTRICITY			
DPN13	ϕ_{13}	0.0051	2.07*
DPN14	ϕ_{14}	0.0063	2.42*
1994			
MANWEB			
DPN19	ϕ_{19}	1.0038	3.43*
MIDLANDS ELECTRICITY			
DPN18	ϕ_{18}	0.0200	17.36*
DPN19	ϕ_{19}	0.0097	5.34*
SEEBOARD			
DPN18	ϕ_{18}	0.0153	7.67*
DPN19	ϕ_{19}	0.0487	5.00*
SOUTHERN ELECTRIC			
DPN19	ϕ_{19}	0.0165	3.07*

SOUTH WALES ELECTRICITY			
DPN18	ϕ_{18}	0.0131	4.95*
YORKSHIRE ELECTRICITY			
DPN18	ϕ_{18}	0.0116	3.62*
DPN19	ϕ_{19}	0.0077	3.68*

Table A2.3.9

DISTRIBUTION PRICE-POS (DPP) announcements with a statistically significant effect on the conditional variance of the returns on the RECs' equity by year.

$$R_{it} = a_i + \beta_i R_{mt} + \varepsilon_{it}$$

$$h_{it} = \alpha_0 + \alpha_1\, \varepsilon_{i,t-1}^2 + \alpha_2\, h_{i,t-1} + \sum_{j=1}^{n} \phi_j\, DPP_j$$

Regressor	Coefficient		T-ratio
1994			
EAST MIDLANDS ELECTRICITY			
DPP1	ϕ_1	0.0062	3.45*
DPP5	ϕ_5	0.0060	5.73*
LONDON ELECTRICITY			
DPP1	ϕ_1	0.0090	2.03*
MANWEB			
DPP1	ϕ_1	0.0061	2.77*
DPP5	ϕ_5	-0.0056	-4.22*
MIDLANDS ELECTRICITY			
DPP1	ϕ_1	0.0061	2.33*
DPP5	ϕ_5	0.0050	3.09*
NORTHERN ELECTRIC			
DPP1	ϕ_1	0.0060	2.56*
DPP5	ϕ_5	-0.0056	-3.92*
NORWEB			
DPP1	ϕ_1	0.0062	2.10*
DPP5	ϕ_5	0.0050	2.64*
SEEBOARD			
DPP1	ϕ_1	0.0070	2.16*
DPP5	ϕ_5	-0.0047	-2.25*
SOUTHERN ELECTRIC			
DPP1	ϕ_1	0.0069	2.19*
DPP5	ϕ_5	-0.0050	-2.45*

SOUTH WALES ELECTRICITY

DPP1	ϕ_1	0.0068	2.10*
DPP5	ϕ_5	-0.0049	-2.31*

SOUTH WESTERN ELECTRICITY

DPP1	ϕ_1	0.0071	2.14*
DPP5	ϕ_5	-0.0049	-2.25*

YORKSHIRE ELECTRICITY

DPP1	ϕ_1	0.0069	2.07*
DPP5	ϕ_5	0.0049	2.26*

Table A2.3.10

GENERATION PRICE NEGATIVE (GPN) announcements with a statistically significant effect on the conditional variance of the returns on the RECs' equity by year.

$$R_{it} = a_i + \beta_i R_{mt} + \varepsilon_{it}$$

$$h_{it} = \alpha_0 + \alpha_1\, \varepsilon^2_{i,t-1} + \alpha_2\, h_{i,t-1} + \sum_{j=1}^{n} \phi_j\, GPN_j$$

Regressor		Coefficient	T-ratio
1991			
EASTERN ELECTRICITY			
GPN1	ϕ_1	0.4503	4.03*
EAST MIDLANDS ELECTRICITY			
GPN1	ϕ_1	-0.0349	-3.76*
LONDON ELECTRICITY			
GPN1	ϕ_1	0.0071	5.60*
NORTHERN ELECTRIC			
GPN1	ϕ_1	0.0014	2.16*
NORWEB			
GPN1	ϕ_1	0.0045	3.06*
SEEBOARD			
GPN1	ϕ_1	-0.0563	-2.86*
SOUTHERN ELECTRIC			
GPN1	ϕ_1	0.0222	3.10*
SOUTH WALES ELECTRICITY			
GPN1	ϕ_1	0.0099	2.59*
SOUTH WESTERN ELECTRICITY			
GPN1	ϕ_1	0.0117	4.80*
YORKSHIRE ELECTRICITY			
GPN1	ϕ_1	0.0113	2.77*

Table A2.3.11

GENERATION COMPETITION POSITIVE (GCP) announcements with a statistically significant effect on the conditional variance of the returns on the RECs' equity by year.

$$R_{it} = a_i + \beta_i R_{mt} + \varepsilon_{it}$$

$$h_{it} = \alpha_0 + \alpha_1 \varepsilon_{i,t-1}^2 + \alpha_2 h_{i,t-1} + \sum_{j=1}^{n} \phi_j GCP_j$$

Regressor		Coefficient	T-ratio
1991			
LONDON ELECTRICITY			
GCP2	ϕ_2	0.0126	1.69*
SOUTH WALES ELECTRICITY			
GCP1	ϕ_1	-0.0139	-1.93*
GCP2	ϕ_2	0.0125	6.22*
YORKSHIRE ELECTRICITY			
GCP1	ϕ_1	-0.0130	-2.01*
GCP2	ϕ_2	0.0121	5.21*

Chapter 3

The Effects of Regulatory Announcements on the Systematic Risk of British Telecom: A Time-Varying Approach

3.0 INTRODUCTION

The analysis conducted in the previous chapter offers interesting insights into the effects of regulation on the rate of return of equity capital. However, it also suffers from a number of methodological drawbacks. Firstly, it is impossible to identify whether regulation affects the rate of return by impacting on the intercept or on the slope of the capital market line. In other words, the effect of regulation on the company's performance cannot be distinguished from the effect on the company's systematic risk. Secondly, the parameters of the market model are assumed to remain constant over time. The assumption of the stability of the beta coefficient has been criticised for a long time, with much of the literature agreeing that in reality the beta of firms tends to vary over time with changes in the firm's size, product mix and financial leverage (Blume, 1975). In the case of newly privatised utilities, the assumption of a stable beta coefficient is even less credible, given the uncertainty surrounding the future structure and competitive posture of utility industries and their regulatory constraints. Following decades of state monopoly, after privatisation, firms in these industries are likely to face a fast changing environment at the level of both firms and industry. In addition, there is considerable theoretical and empirical evidence to suggest that regulation itself has an impact on the regulated firm's systematic risk. However, the theory is inconclusive as to the direction of this impact and thus the effect of regulation on firms' systematic risk remains an interesting empirical question.

On the basis of the above observations, this chapter will model the impact of regulation on the systematic risk of British Telecom (BT), using a time-varying approach. The remainder of this study is organised as follows. Section 3.1 discusses the main economic issues relating to the privatisation of the telecommunications industry in the UK, with particular emphasis on the promotion of competition and price controls. Section 3.2 discusses the theoretical and empirical relationship between regulation and systematic risk of regulated firms. Methodological issues relating to unanticipated event studies and the methodology adopted in the chapter are discussed in Section 3.3, along with the formulation of the tested hypotheses. Section 3.4 describes the announcement selection procedure and the data and Section 3.5 presents the empirical results for both group and individual regulatory announcements. Concluding remarks are contained in section 3.6.

3.1 THE PRIVATISATION AND REGULATION OF THE BRITISH TELECOMMUNICATIONS INDUSTRY

The first network utility industry to be privatised in Britain was the telecommunications industry. This privatisation provided a learning experience for policy decisions about appropriate competitive and regulatory frameworks for the future privatisation of other utilities. For example, the RPI-X price cap regulation was first applied to British Telecom, before its subsequent widespread use in several other utility industries. In addition, the privatisation of the British telecommunications industry came at a time of great advancement in technology and changes in the use of the telecommunications network by customers. Today, customers use the network for more than just basic voice transmission and this imposes different demands on the network. The switching and transmission technology is now similar to those used in the computing and broadcasting industries and the links with these industries are strong.

Basically, the telecommunications industry comprises of three main functions: i) the operation of the network; ii) the supply of the equipment attached to the network; and iii) the supply of services over the network[36]. A telecommunications network operates by means of exchanges and transmissions links, with local exchanges, trunk or long-distance lines and international networks being configured hierarchically. The new technology for transmission makes use of fibre-optic cables and modern exchanges are electronic and programmable, rather than electromagnetic. The use of fibre-optic technology has dramatically reduced the cost of long-distance calls and increased the carrying capacity of cables, so that sufficient information can be conveyed to give high quality TV signals. In addition, the cost of increasing capacity, once the cable has been laid down, is independent of the length of the cable. In mobile networks, the final local link is a radio link, able to transmit digital rather than analog signals. The types of terminal apparatus that can now be attached to the network is expanding and includes answering machines, fax and telex machines, private automatic branch exchanges, TV sets and computers. Equally, the variety of services provided over the network is also expanding.

From an economic point of view, the key features of the telecommunications industry are that it is a multi-product industry, with a non-storable output subject to time-varying and stochastic demand. In addition, the structure of costs tends to change very often with the rapidly changing technology. In general, it can be said that the telecommunications industry has sunk costs, as well as capacity constraints, externalities, elements of natural monopoly and a complex vertically integrated structure. Regulation mainly relates to the last three

[36] Although for the purpose of analysis it is useful to distinguish among these three functions, in reality it is not always possible to make this distinction. For a more detailed treatment of the economics of telecommunications see Brock (1981); Sharkey (1982, ch 9); Armstrong, Cowan and Vickers (1994, ch 7); Cave and Williamson (1996); Grout (1996); and Armstrong (1997).

attributes. In relation to externalities, there are very important positive *network* externalities[37], which arise because it is in the interest of existing customers that new customers subscribe for the service. The obvious example in voice telephony is that any individual customer benefits from being connected to a larger number of users. The presence of network externalities can affect the pricing policy for new subscribers as well as for the interconnection of rival networks. In addition, there are social benefits in providing telephone services to remote or sparsely populated areas, or specialised services to disabled people. This justifies some cross-subsidisation among types and geographical location of users. Finally, the main negative externality arises from network congestion due to the limited capacity of the network and the variation of demand over time. Although the introduction of electronic technology has reduced the problem of congestion and short-run variable costs, this still justifies the use of peak-load pricing schemes for some services.

Aspects of natural monopoly have traditionally thought to be present in the construction and operation of the network, although not in the supply of services over the network, or in the supply of equipment. This is a controversial issue with a weak theoretical support and mixed empirical evidence. Although it may seem obvious at first sight that wires and exchanges from several suppliers over the same territory would be a wasteful duplication[38], the empirical evidence on the existence of natural monopoly characteristics in network operations does not always provide support for this view[39]. Traffic on trunk and international

[37] In the case of telecommunications the use of the terminology 'network' externality is slightly confusing, since individual users do not strictly speaking benefit from the number of other network users, but from the number of customers using the same service, which could be provided over several networks. For a definition of network externality, see Tirole (1988, section 10.6).

[38] However, it must be noted that in New Zealand Clear Communications Inc. is duplicating local network in most main cities to compete against New Zealand Telecom.

[39] For example, Evans and Heckman (1983) and Hunt and Lynk (1991) found evidence that, prior to divestiture, the Bell network in the USA was not a natural monopoly; Shin

lines is so heavy that it has been argued that economies of scale have been long exhausted. Even local telephony is becoming more competitive (Baumol and Sidak, 1994), with large users bypassing the local network to connect directly to the long-distance network and mobile telephony becoming more and more widespread. It is however recognised that there are substantial costs for a single user to connect to more than one fixed network and/or more than one mobile network. This in turns makes it expensive to switch to a different network, once the first connection choice has been made. This creates some monopoly power in local connections and thus a role for regulation to protect consumers. The presence of monopoly power and network externalities also explains why network interconnection is so important for competition policy in telecommunications. Entry of new suppliers into the market is only possible if there is full network interconnection, so that customers of one network can make and receive calls from customers of another network at reasonable access charges. If this were not possible, then the smaller network would not be able to compete on equal footing with the larger network

Competition in the industry is further impeded by several vertical relationships. The fact that local, long-distance and international operations are hierarchically configured means that, when making a long-distance call, a customer utilises wires and exchanges of two local networks, in addition to trunk exchanges and long-distance lines. For international calls, the networks of two or more countries also need to connect, bringing in the need for international agreements. Calls from mobile phones usually involve the use of fixed-link networks, which then become inputs for mobile network operators. In addition, the operations of suppliers of

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and Ying (1992) reached the same conclusion for the regional networks in the USA; while Röeller (1990) found evidence of natural monopoly characteristics in the US Bell network.

services over the network and suppliers of apparatus to be connected to the network are strongly related to the availability and technical specification of the network.

3.1.1 The Privatisation of BT and the Promotion of Competition.

In Britain, British Telecom (BT) enjoyed a statutory monopoly on all aspects of the telecommunications network operation and almost all aspects of apparatus supply until 1981. Back in July 1980, the then Secretary of State for Industry, Sir Keith Joseph, had announced to Parliament the government's intention to relax BT's monopoly[40]. However, a second licence as a national network operator was issued to Mercury only in 1982 and Mercury did not launch its main services until 1986. In November 1983 the government announced that no further licences to provide fixed-link services would be issued for the next seven years, to allow Mercury to establish itself in the market without threat of further entry[41]. However, entry into other parts of the telecommunications market, including apparatus and the value-added network and services (VANS), was completely liberalised. BT was privatised in 1984 as a vertically integrated network operator and service provider. Soon after BT's privatisation, the government awarded the first cable television franchises. However, because of the restricted duopoly policy, these networks were not allowed to offer telecommunications services. Mercury's competition affected two main areas of service[42]. Firstly, Mercury

[40] For a detailed discussion of the main issues involved in the liberalisation of the British telecommunications' network see Beesley (1981); and Beesley and Laidlaw (1993).
[41] During the period of restricted entry, however, the government issued two licences to cellular radio network operators to sell services to customers through service providers and in 1989 four licences were issued for Telepoint, a service using portable telephones.
[42] For an economic analysis of the effects of the entry of Mercury into the British telecommunications industry see Beesley and Laidlaw (1997).

targeted large customers to be connected directly to its network by a microwave link, thus bypassing BT's network at the operating end. Secondly, Mercury marketed its services to smaller users for long-distance and international calls, while still using BT's network at the local level. Although the first marketing strategy was quite successful with a number of large customers connecting into Mercury's network, especially in the City of London, Mercury was never able to attract a significant share of small users.

At the end of the seven years of restricted entry, the government issued a consultative document on the liberalisation of the telecommunication services, followed in March 1991 by a White Paper. The recommendation was that the duopoly should end[43] and that every application to offer telecommunication services in the UK over fixed-link networks should be considered on its own merits. This made the UK one of the most liberalised telecommunications markets in the world, although BT still dominated fixed-link network operations, among many other services. Because of BT's market power, a regulatory body was constituted, the Office of Telecommunications (OFTEL), to monitor and enforce operators' licence conditions and advise the government on any regulatory matter. OFTEL also plays an advisory role on the issuing of new licences by the Department of Trade and Industry. In addition, it was decided that BT and Mercury would not be allowed to carry television services over their networks until at least 2001, to allow the cable television companies to strengthen their presence in the local fixed telecommunications market[44].

[43] However, the duopoly policy for international network operations was retained until 1996.

[44] BT's competitive advantage was also limited by other measures. For example, BT was not allowed to use radio links in its local loops, to encourage entry by local operators, such

From 1991 several new operators entered the market. At the level of small residential customers, the main competitors included the cable television companies, nationwide networks such as Energis and Ionica, regional operators such as Norweb, Scottish Telecom and Torch, and specialised business sector operators such as COLT and MFS. In addition, in the few months following then end of the duopoly in the international networks in 1996, about 50 license applications for international services were submitted (OFTEL, 1996a). However, there is little doubt that over the sample period of this thesis, up to December 1993, the competition faced by BT was very limited and BT remained dominant in fixed network operations. According to OFTEL (1996b), in December 1995 BT still supplied 94% of the exchange lines in Britain, with Mercury supplying about 1% and the cable operators about 5%. Less than 4% of residential customers use indirect access over BT lines for rival long-distance and international services. In terms of revenues, BT's market shares for all calls were 92% for local calls, 81% for national long-distance calls and 70% for international calls.

Particularly contentious has been the issue of interconnection charges. All networks require BT to deliver a large proportion of their calls, while a much smaller proportion of calls from BT's users are to customers on other networks, including mobile networks. Thus, BT has been asking for higher interconnection charges than other networks. In addition, BT's retail prices are not always in line with their cost. For example, rural users are charged the same prices for services, although it is more expensive to offer these services in geographically isolated areas. Equally, connection and quarterly fixed rental charges do not cover the fixed costs of providing and running the network, so that

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as Ionica, who were permitted to use this new technology. More recently, BT has been licensed to use radio links in its fixed networks in rural areas.

usage charges need to be above the marginal cost of using the network. These pricing policies could work against BT, if BT were obliged to set interconnection charges equal to the marginal cost of providing interconnection. For example, the new market entrants could chose to service only more profitable customers and routes and as a consequence BT would loose the more profitable markets, which uses to cross-subsidise the loss-making operations. In addition, competitors could afford to be profitable even if they were less efficient than BT. Therefore, interconnection charges must be greater that their cost, if BT has to offer some services at prices below their cost.

In mobile network operations, the government followed another duopoly policy, with Cellnet, in which BT had a controlling interest, and Vodafone being the only operators from 1985 to 1991[45]. Mobile network operators, however, could not sell their services directly to the general public, but they had to wholesale their airtime to service providers. Although they were allowed to own, or control, service providers, they were not allowed by the license conditions to favour 'tied' over independent service providers. This allowed competition to develop at the level of end-user services, with a great variety of packages being retailed. In 1991, two additional operators were licensed, Mercury One-2-One and Orange, with no further licenses issued until at least 2005. The four operators are now allowed to retail their services directly to the public and there is no control over the prices charged for mobile services.

[45] For more detailed on mobile telephony in the UK see Cave and Williamson, 1996.

3.1.2 Price Regulation for BT

When the privatisation of the main public utilities was first considered by the Department of Industry, the original intention was to adopt a modified version of the rate-of-return regulation. However, it was finally agreed that a direct control on prices, or price-cap, was a better solution for the privatised BT and versions of it have been ever since used for the regulation of other privatised utilities in the UK and elsewhere (Littlechild, 1983)[46]. Since 1984, BT's prices have been controlled by RPI-X regulation, which limits the price rises allowed for a specified basket of services to a given percentage, X, less than the Retail Price Index (RPI).

The main decision parameters in determining BT's price-cap regulation were the composition of the basket, whether to allow unrestricted resale of BT's leased lines and the value of factor X in the price formula. All three parameters had serious implications for BT's prices and profits. The main debate on the first parameter was whether to restrict the basket to connection and local call charges, or whether to include inland trunk calls[47]. BT's argument was that local connections and local calls were already under-priced and there was little scope for further price reductions. Inland trunk calls, on the other hand, offered a greater scope for price reductions since they were priced considerably above costs, impending new technology gave good prospects for further cost reductions and competition was expected soon from Mercury. With respect to the unrestricted resale of BT's leased lines, this would allow competitors to use low-priced

[46] The main features of the price-cap are analysed in chapter 1.

[47] International calls were not really considered for regulation, although they were highly profitable, since at the time the USA was the only other country pursuing a policy of liberalisation in telecommunications.

BT circuits to undercut high-priced BT phone calls and thus push prices down. Finally, the importance of the correct setting of factor X is obvious. The final regulatory package included inland trunk calls, no resale of leased lines and X equal to 3%, although the details of how this figure of three was reached were never published, nor have any of the calculations of other subsequent X factors across public utilities been revealed.

The chosen form of price cap was the so called 'tariff basket' type, according to which the RPI-X price-cap is applied to a weighted average of prices of specified services, rather than having separate indices for each service. This formula was chosen on grounds of simplicity and flexibility and gave BT considerable discretion to change relative prices within the regulated basket[48]. Connection and international call charges, charges for leasing private lines and for value-added network and data services (VANS), and apparatus manufacture and supply were not regulated. There was no cost passthrough component, unlike in the formula of other utility industries privatised later. Finally, quality was not explicitly regulated, although the brief of the regulator was to promote the interests of consumers and producers with respect to price, quality and variety of services. Under the 1984 licence, BT's price control was RPI-3% to remain fixed for five years. In 1989, this was tightened to RPI-4.5% and, in 1991, it was tightened again to RPI-6.25%, with international calls included into the basket. From 1993, the price-cap was further increased to RPI-7.5% and fixed for four years. In addition to this tightening of the price-cap formula, the scope of regulation also broadened, to include connection and international charges and a separate price-cap for

[48] This discretion however was limited by an undertaking not to increase line rental charges by more than RPI+2% and to apply uniform connection and rental charges among customers, irrespective of the cost of serving any one user.

leased lines, and the regulatory control over the re-balancing of the price structure also increased[49]. During the first decade of regulation, the services subject to price-cap regulation have risen from 48% to 70% of BT's turnover. In the same period, national calls experienced the largest change in price, with a cumulative price decrease of 64.6% for 'peak' calls and 26.8 for 'off-peak' calls. Local call prices also fell by 17.8% (peak) and 19.6% (off-peak). On the contrary, residential line rental charges have been gradually rising, experiencing a cumulative increase of 4.6%[50].

In spite of the regulatory constraints and the above price trends, BT's profits as a privatised company prospered, partly because of efficiency gains and the declining costs of new technology[51], and the question whether they were excessive arose. Interestingly, although the rate of return of BT was not regulated, nevertheless the regulator published an assessment of the 'appropriate' rate of return concluding that the then earned 18% on book value was 'fair' (Director General of Telecommunications, 1996)[52]. In reality, BT kept its prices below the allowed maximum level for two years, although there was some re-balancing between the prices of local and long-distance calls. In spite of the original hope that regulation would become increasingly lighter as competition

[49] In 1987, OFTEL's staff even published an analysis of a proposed BT's price structure based on Ramsey prices (Culham, 1987); however, this remained a paper exercise.

[50] For more details on BT's pricing policy and regulated price reviews, see Armstrong, Cowan and Vickers (1994).

[51] It must be noted in this respect that, although BT's return on capital employed increased from 9.1% in 1980 to 22.4% in 1991, Beesley and Laidlow (1989) argue that the efficiency gains achieved were a modest 2% per annum, well below BT's potential gains. During this same period, BT's turnover rose from £3.5 billion to £13 billion, while Mercury had a small market share and a turnover of only £702 million by 1991. This prompted the duopoly review of the late 1980s.

[52] For a debate on this first assessment of BT's price regulation see Beesley, Gist and Laidlaw (1987) and Carsberg (1987).

developed, price regulation became tighter and more encompassing over time, with virtually all aspects of network operation being regulated by the early 1990s.

3.2 REGULATION AND SYSTEMATIC RISK

As already discussed in section 1.5 of this thesis, there is no agreement in the literature about the direction of the effects of regulation on company's systematic risk and on whether the cost of capital is endogenous to the regulatory process itself. The regulatory model of Peltzman (1976)[53] shows that regulators, who are assumed to maximises political support, tend to 'buffer' shocks to the cash flow of the firm and suggests that this could impact on the regulated company's systematic risk, as measured by the beta coefficient of the firm's assets. In particular, regulation is expected to decrease the asset beta, since shocks tend to be smoothed by regulatory action. Other authors emphasise institutional arrangements as important in lowering regulated firms' risk by shifting some of the risk of exogenous shocks from producers to consumers (Joskow, 1974; and Clarke, 1980). There are, however, a number of studies that argue that regulation tends to increase systematic risk, especially during periods when factor prices are rising, because of the stickiness of regulated prices (Keran, 1976). In this case, profit streams become more volatile and thus systematic risk increases. There are also other factors than simply cash flows that affect the company's beta and regulation may impact on these factors. For example, there is some empirical evidence that regulation tend to increase capital intensity by distorting the factor mix (Joskow and Noll, 1981) and that in turn higher capital intensity leads to higher systematic and

[53] Peltzman's model has been analysed in chapter 1, section 1.2.

unsystematic risk (Lev, 1974). On the basis of the extant literature, therefore, it can be concluded that the total effect of regulation on risk is uncertain.

Focusing more closely on measures of systematic risk and in particular on the Sharpe-Lintner CAPM formulation, the beta of firm *i*'s assets can be defined as follows:

$$\beta_i = \frac{COV(R_i, R_m)}{VAR(R_m)} \qquad (3.1)$$

where R_i is the return of firm *i*'s assets and R_m is the return on the market portfolio. In turn, the return is a function of the price of the asset at the beginning of the period, P_i, and the uncertain end-of-period payoff, V_i. Thus, the return can be expressed as:

$$R_i = \frac{V_i - P_i}{P_i} \qquad (3.2)$$

Substituting equation (3.2) into equation (3.1), beta can be defined as:

$$\beta_i = \frac{COV(V_i, R_m)}{P_i\ VAR(R_m)} \qquad (3.3)$$

Since P_i is in the denominator of the above formulation of beta, any regulatory action that has an impact on the firm's cash flow will also affect beta inversely, ceteris paribus, through its effect on the firm's value. This provides a link between the literature that finds that entry and price regulation tend to increase profits (Stigler, 1971; and Jarrell, 1978) and the literature that finds that regulation is often accompanied by a decrease in beta (Peltzman, 1973; Ray, 1974; Clarke, 1980; Hogan, Sharpe and Volker, 1980; Chen and Sanger, 1983; Norton, 1985; Mitchell and Mulherin, 1988; Wallace, Watson and Yandle, 1988; Spudeck and Moyer, 1989; and Fraser and Kannan, 1990)[54]. In particular, Binder and Norton (1999) show that beta is inversely related to profits; that is, the more profitable a firm is, the lower its beta[55].

In addition to the effect explained above, regulation can alter beta through other factors. Specifically, a regulated firm's beta is affected by factors present in the firm's cost, revenue and demand functions. To see these effects, let us assume a single period framework, where all firms in a regulated industry charge the same price for their output, set at the beginning of the period. Total costs, *TC*, paid at the end of the period, comprise of a fixed component, *FC,* and a variable component, *AVC,* multiplied by the quantity of output, *Q*. Thus, firm *i* will have total costs equal to:

$$TC_i = FC_i + AVC_i\, Q_i \qquad (3.4)$$

The market clearing output sold at the end of the period is assumed to be stochastic with multiplicative uncertainty and can be expressed as follows:

$$Q_i = E(Q_i)\,(1+\varepsilon_i) \qquad (3.5)$$

[54] It must however be said that not all the empirical literature in this area agrees that regulation has a negative effect on beta. For example, Lenway, Rehbein and Starks (1990) find that beta increases with regulation, while Davidson, Chandy and Walker (1984 and 1985), Chen and Merville (1986), Allen and Wilhelm (1988) and Fraser and Kolari (1990) find no significant change in beta.

[55] For a survey of the empirical evidence between asset beta and profitability, see Binder (1992).

where $E(.)$ is the expectations operator and ε_i is the random shock to output with an expected value of zero.

In a regulatory environment where the regulator controls both entry and price, Peltzman (1976) shows that the regulator buffers the random shock, ε_i, to the firm's cash flows by means of either tax or subsidy to the firm, depending on the sign of ε_i[56]. The size of the tax/subsidy is equal to Φ, for $0 \leq \Phi < 1$, times the difference between the cash flow expected at the beginning of the period and the actual cash flow at the end of the period. In this way, any shock will only have an impact of $(1-\Phi)$ on the firm's cash flow and will be shared with the public as a whole.

Following Binder (1992) and Binder and Norton (1999), on the basis of equations (3.4) and (3.5), the value of the regulated firm, expressed as the value of its cash flows, can be defined as follows:

$$V_i = E(Q_i)(p_r - AVC_i) - FC_i - (1-\Phi)\, E(Q_i)\,(p_r - AVC_i)\,\varepsilon_i \qquad (3.6)$$

Substituting (3.6) into equation (3.3) and simplifying yields the following definition of beta:

[56] The role of taxes/subsidies in this single-period model is the same as the role of changes in regulated prices from period to period, due to shifts in demand and thus profits. In both cases, the change in the value of the firm due to output shocks will be less than in an unregulated situation.

$$\beta_i = \frac{(1-\Phi)\,(p_r - AVC_i)\,E(Q_i)\,COV(\varepsilon_i, R_m)}{P_i\,VAR(R_m)} \qquad (3.7)$$

It is clear from the above equation (3.7) that the value of the beta of the firm's assets depends on three main types of factors: i) the covariance of the output shock with the returns on the market portfolio and the variance of the market; ii) firm's, or industry's, specific factors, such as prices and costs; and iii) the extent of the regulatory buffering.

When moving from the above theoretical framework to the empirical testing, a number of issues need to be considered. In particular, the beta coefficient derived above is a measure of the systematic risk of the firm's assets. However, in practice, only the equity beta can be directly estimated, thus ignoring the effects on asset beta of the firm's capital structure. This may appear to be particularly problematic since there is ample evidence that regulation increases the firm's gearing ratio (Ulmer, 1955; and Chaplinsky, 1982). In particular, it has been argued that regulated firms rely more heavily on debt for the following reasons: i) the regulatory agency may control the issue of equity by the firm; ii) if regulated firms decide on capital structure by balancing the tax advantage of debt against expected bankruptcy costs, the marginal cost of using debt will be relatively low, because the buffering effect of regulation lowers expected bankruptcy costs; and iii) the agency costs of debt may be reduced by regulation. The implicit assumption in empirical tests of the effects of regulation on equity beta is that the regulated firm's debt and preferred stock is riskless. In the case of regulated utilities, this assumption is not too unreasonable and, thus, the asset beta can be measured simply as a proportion, equal to the percentage of equity capital in the firm's capital structure, of the equity beta[57]. Therefore, changes in asset beta are only caused by changes in equity beta and equity beta becomes a good proxy for asset beta.

In summary, there is extensive evidence, at both the theoretical and empirical levels, that regulation affects the regulated company's beta. The precise direction of these effects is however ambiguous, with ample theoretical arguments and empirical evidence for believing that regulation may either increase and/or decrease beta. In addition, regulation-induced changes in beta could be a by-product or a prerequisite of the regulatory process. The direction of the aggregate effect of regulation on beta remains an empirical question.

3.3 METHODOLOGY AND HYPOTHESIS FORMULATION

The primary objective of this chapter is to extend the investigation on the effects of regulation carried out in the previous chapter. However, unlike the previous chapter, the focus here is on the telecommunications industry and, specifically, on the impact of announcements that affect competition, pricing and the supply of services in the telecommunications industry on BT's systematic risk as measured by the beta coefficient. Usually, the standard methodology adopted in the existing literature is the extended market model with dummy variables [Karafiath (1988) and Binder (1985a and 1985b)]. This methodology assumes that the company's systematic risk is constant for the whole period under investigation. However, this seems unlikely in this case, because of changes in BT's political and competitive environment during the estimation

[57] Of the empirical studies cited here, only Norton (1985) controls for the firm's gearing.

period, from December 1984 to December 1993. After testing for the stability of BT's beta coefficient and finding it unstable over the estimation period, the methodology adopted allows beta to vary over time, unlike previous studies and the previous chapter of this dissertation. Specifically, a two-step procedure is followed. In the first stage, we estimate a simple market model recursively to allow both the alpha and beta coefficients to vary with time:

$$R_t = \alpha_t + \beta_t R_{mt} + \varepsilon_t \qquad \varepsilon_t \sim \mathrm{N}(0,\sigma_\varepsilon^2) \qquad (3.8)$$

More precisely, the model in equation (3.8), which shows how the returns on BT's shares at time t, R_t, are determined by the information updating process influencing market returns at time t, R_{mt}, is estimated. Equation (3.8) can be viewed as a time-varying parameters model and the coefficient on the market returns, β_t, can be estimated using the Kalman Filter (Harvey, 1982). The Kalman Filter enables (3.8) to be written as a measurement equation, and the time-varying parameter, β_t, is allowed to be generated stochastically by the transition equation shown below:

$$\beta_t = \beta_{t-1} + u_t \qquad u_t \sim \mathrm{N}(0,\sigma_u^2) \qquad (3.9)$$

Equation (3.9) shows that β_t evolves as a random walk process. The intuition behind this specification is that beta changes in response to new information. Following the argument in Ross (1989), information arrives stochastically and thus beta evolves in the same way. Equations (3.8) and (3.9) are estimated to obtain time-varying estimates of β_t.

In the second stage, the impact of regulatory announcements on the time-varying estimates of BT's systematic risk is tested. As discussed in the previous chapter, the actual timing of the impact of an announcement cannot always be accurately determined and thus a three-day window is used to capture movements in the systematic risk that may occur around, but not necessarily on, the day chosen as the event date. A three-day window allows any effect occurring because of market anticipation or delayed reaction to be detected. However, the window cannot be too large because of possible contamination from other unknown events that may occur during the period covered by a larger window.

3.3.1 Hypothesis formulation for groups of announcements

As in the previous chapter, announcements are initially grouped by their expected impact on the level of competition, prices and the supply of services in the telecommunications industry. Equation (3.10) below is estimated over the whole nine year sample period using OLS to analyse the impact of the announcements groups on the estimated time-varying beta coefficient:

$$\begin{aligned}\beta_t = \gamma_0 &+ \gamma_1\, COMP-NEG_t + \gamma_2\, COMP-POS_t \\ &+ \gamma_3\, PRICE-NEG_t + \gamma_4\, PRICE-POS_t \\ &+ \gamma_5\, SERV-NEG_t + \gamma_6\, SERV-POS_t \\ &+ \delta_1\, DEL87 + \delta_2\, DEL92 + \varepsilon_t\end{aligned} \qquad (3.10)$$

where β_t is the time-varying coefficient estimated from equations (3.8) and (3.9) and represents BT's systematic risk; COMP-NEG_t is a dummy variable that equals one on the three days around each regulatory announcement which is expected to decrease competition, and zero otherwise; COMP-POS_t is a dummy variable that equals one on the three days around each regulatory announcement which is expected to increase competition, and zero otherwise; PRICE-NEG_t, PRICE-POS_t, SERV-NEG_t and SERV-POS_t are dummy variables constructed like COMP-NEG and COMP-POS for the groups of announcements affecting pricing and service supply; DEL87 and DEL92 are dummy variables that capture the effects of the 1987 and 1992 UK General Elections and equal one over the period from when the elections were announced until the day after the election results are known, and zero otherwise; $\gamma_{0,...,6}$ and $\delta_{1,2}$ are parameters; and ε_t is a random component or error term. More specifically, the parameters $\gamma_{1,...,6}$ detect changes in BT's systematic risk due to particular types of regulatory announcements within a three-day window; that is, they measure any effect on the beta coefficient due to any of the six types of announcements defined.

Estimating equation (3.10) allows for the testing of the following hypotheses about the effect of each group of announcements on BT's systematic risk, on the assumption that the main concern of BT's regulators is to protect the consumer and there is no regulatory capture:

(i) Announcements which are expected to decrease competition (COMP-NEG) are also expected to decrease beta and thus decrease the cost of equity capital:

$$H_0 : \gamma_1 = 0 \qquad ;H_1 : \gamma_1 < 0$$

(ii) Announcements which are expected to increase competition (COMP-POS) are also expected to increase beta and thus increase the cost of equity capital:

$$H_0 : \gamma_2 = 0 \qquad ;H_1 : \gamma_2 > 0$$

(iii) Announcements which are expected to decrease the price of BT's services (PRICE-NEG) are also expected to increase beta and thus increase the cost of equity capital:

$H_0 : \gamma_3 = 0 \quad ;H_1 : \gamma_3 > 0$

(iv) Announcements which are expected to increase the price of BT's services (PRICE-POS) are also expected to decrease beta and thus decrease the cost of equity capital:

$H_0 : \gamma_4 = 0 \quad ;H_1 : \gamma_4 < 0$

(v) Announcements which are expected to decrease the range of services which BT is allowed to supply (SERV-NEG) are also expected to increase beta and thus increase the cost of equity capital:

$H_0 : \gamma_5 = 0 \quad ;H_1 : \gamma_5 > 0$

(vi) Announcements which are expected to allow BT to offer a wider range of services to customers (SERV-POS) are also expected to decrease beta and thus increase the cost of equity capital:

$H_0 : \gamma_6 = 0 \quad ;H_1 : \gamma_6 > 0$

3.3.2 Hypothesis formulation for individual announcements

The information derived from estimating equation (3.10) is essential for drawing policy conclusion on the effect of different types of regulatory announcements on the cost of equity capital. However, as mentioned in the previous chapter, when analysing the announcements grouped by type, the contribution of each announcement to the overall group effect is lost. For example, if an announcement group is found not to have a significant impact on systematic risk, this may be because of investors believing that type of announcements not to have an affect on the regulated company's risk. On the other hand, it could also be the consequence of an averaging out effect within the group, with individual announcements causing a significant market reaction, but in different directions.

In this latter case, the direction of the effect of a specific type of announcement cannot be predicted, but it would be incorrect to believe that investors are indifferent to those announcements being made. Thus, the impact of individual regulatory announcements is further analysed in an attempt to gain more detailed insights on the nature of the market reaction. Once again, as for equation (3.10), BT's time-varying beta coefficient is regressed against dummy variables, but in equation (3.11) below each dummy variable captures the effect of individual announcements within a specific group:

$$\beta_t = \phi_0 + \sum_{i=1}^{n} \phi_i \, D_{it} + \theta_1 \, DEL87 + \theta_2 \, DEL92 + u_t \qquad (3.11)$$

where β_t is the time-varying coefficient estimated from equations (3.8) and (3.9) and represents BT's beta coefficient; D_{it} are individual announcement dummy variables that equal one on the three days around each i^{th} regulatory announcement, and zero otherwise; $\phi_{0,\dots,n}$ and $\theta_{1,2}$ are parameters; and u_t is a random component or error term. Thus, the parameters $\phi_{1,\dots,n}$ detect changes in BT's systematic risk due to individual regulatory announcement within a group. Equation (3.11) is estimated for each of the six groups of announcements separately over the whole nine year sample period.

3.4 ANNOUNCEMENT SELECTION AND DATA

The announcement selection in this chapter follows the same approach to that adopted in the previous chapter. Specifically, the regulatory announcements considered include reports by regulatory bodies, such as OFTEL, and news announcements made by the

Government and representatives of the regulatory bodies. Such news items provide information to market participants that enable them to anticipate forthcoming official regulatory announcements. Thus, if only official OFTEL announcements had been considered, the time when investors' expectations change as a consequence of expected changes in regulation would have been often missed. The announcements considered here are believed to have an informational content and thus a potential to impact on the regulatory structure of BT. Given the absence of any previous research in this area relating to the UK telecommunications industry and the difficulty of identifying important unanticipated regulatory announcements, the history of the chosen announcements has also been investigated. The periods preceding and following each announcement have been checked for the presence of other events, such as quarterly earnings announcements and general elections, and announcements believed to be contaminated by other events have been excluded from the sample. The dates of the announcements relate to the day when the announcement was released to the public.

After considering all these issues, the effects of 123 regulatory announcements, listed in Appendix 3.1, are tested over the period from BT's privatisation, in December 1984, through to the end of 1993. In all the equations estimated, the return on BT's shares is defined as the difference of the log of share prices, thus assuming that dividends are continuously reinvested. As a proxy for the market return, the difference of the log of the FT All Share Index is calculated. All price series have been obtained from Datastream.

3.5 EMPIRICAL RESULTS

Firstly, the stability of BT's beta coefficient was tested over the whole sample period. Figures 3.1 and 3.2 in Appendix 3.1plot the results of the Cumulative Sum (CUSUM) and the Cumulative Sum of Squares (CUSUMSQ) tests (Brown, Durbin and Evans, 1975) from estimating the simple market model in equation (3.8) recursively. Both the CUSUM and the CUSUMSQ tests suggest that the parameters of the market model are unstable and this can be readily verified by looking at the recursive Least Squares estimates. In particular, the instability of the beta coefficient is even more obvious from the plot of the Kalman Filter estimates of beta shown in Figure 3.3 in Appendix 3.1[58].

3.5.1 Results of Group Announcements

The results of the announcement group analysis show that regulatory announcements that allow prices to increase and announcement relating to the supply of services are the only type of announcements to have an unambiguous impact on BT's systematic risk. For all the other groups of announcements, the null hypothesis is accepted; that is, their γ coefficients are not statistically different from zero. Table 3.1 presents the results from estimating equation (3.10) over the nine year period, from December 1984 to December 1993.

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[58] The time-varying estimates of the beta coefficient appear to be relatively high in the first two years of estimation. This may be a reflection of partial payment and the characteristics implicit in delayed interim and final instalments for the shares.

Table 3.1

The effect of competition, pricing and service announcements on BT's systematic risk as measured by the time-varying beta coefficient

$$\begin{aligned}\beta_t &= \gamma_0 + \gamma_1\, COMP-NEG_t + \gamma_2\, COMP-POS_t \\ &+ \gamma_3\, PRICE-NEG_t + \gamma_4\, PRICE-POS_t \\ &+ \gamma_5\, SERV-NEG_t + \gamma_6\, SERV-POS_t \\ &+ \delta_1\, DEL87 + \delta_2\, DEL92 + \varepsilon_t\end{aligned}$$

Regressor		Coefficient	T-ratio
CONSTANT	γ_0	1.1160	14.39*
COMP-NEG	γ_1	0.0384	1.24
COMP-POS	γ_2	-0.0278	-0.34
PRICE-NEG	γ_3	-0.0020	-0.05
PRICE-POS	γ_4	0.1289	1.83*
SERV-NEG	γ_5	-0.0918	-2.12*
SERV-POS	γ_6	-0.0690	-1.70*
DEL87	δ_1	0.2122	2.73*
DEL92	δ_2	-0.1712	-2.29*

Notes:
Ordinary Least Squares estimation based on Newey-West adjusted S.E., Parzen weights, truncation lag=767
* Denotes statistically significant at the 5% level.

These results indicate that the group of price announcements which is expected to decrease BT's systematic risk, PRICE-POS, has a statistically significant coefficient, γ_4, but its positive sign goes contrary to our hypothesis. In fact, the estimates suggest that when the regulator allows the prices of telecommunication services to increase, investors perceive that BT becomes a riskier company. An explanation for this result could be found under the regulatory capture hypothesis discussed earlier in the thesis: by keeping prices low, the regulator actually imposes a barrier to entry to potential competitors who are likely to face higher costs than the incumbent firm. A regulated price increase thus may actually eliminate this barrier to entry. In addition, a significant proportion of the PRICE-POS announcements in our sample relates to services for which BT is facing international competition and whose prices had during the sample period a world-wide tendency to fall. Therefore, if BT does increase its prices for those services, its international competitiveness may well deteriorate. For these reasons, investors may actually perceive BT to be a `safer' company when regulation keeps the prices of regulated services low. To strengthen this point, it needs to be considered that many services offered by BT are not subject to price-cap regulation.

It is interesting to note that competition announcements and announcements expected to decrease prices are not found to significantly affect BT's systematic risk. According to the previously formulated hypotheses on the effects of regulation, BT's shares might not react in the expected way to regulatory announcements because of BT's well-established competitive advantage on potential and actual competitors. Thus, a further decrease in competition may not be seen by investors as a great improvement in a market that is already highly concentrated, while more competition is not a threat to a company with established cost advantages. Potential price reductions may also have no effect on BT's share price, if investors believe that BT is in a stronger position than its competitors to face those reductions in prices. In this case, in fact, the loss of revenue per unit sold could well be compensated by a strengthening of BT's competitive position vis a vis incumbent and potential entrants in the industry at national level, but possibly more importantly at international level.

Another prima face surprising result is that, following announcements that affect the supply of services, either positively or negatively, BT's systematic risk has a statistically significant tendency to fall. In connection with regulation intended to allow BT to offer a wider choice of services, this result is in line with our hypothesis; but, when regulation is intended to tighten the rules on the supply of services, we would expect BT's beta coefficient to increase. The opposite result of our analysis can however be justified if we consider the specific nature of the SERV-NEG announcements in our sample. Most of these announcements, in fact, relate to controversial services, such as the provision of chat-lines, which suffered from bad publicity in the media. It is not therefore surprising that, when the regulator intervenes to tighten the control on those type of services, and thus the public image of BT improves, investors react positively to the news.

Finally, it is interesting to comment on the impact on BT's systematic risk of the two General Election periods in our sample, since both election coefficients, δ_1 and δ_2, are statistically significant. The 1987 and the 1992 election dummy variables are constructed to capture the effect of the whole period from when a General Election is called to the day after the election results are known, and not just the impact of the election results alone. Our estimates suggests that, during the period coming up to the 1987 General Election, BT's systematic risk increased, while it decreased during the 1992 election period, in spite of a Conservative Party's win in both cases and a stronger threat from the Labour Party in 1992. These results may be explained by the different policies of the Labour Party towards privatised utilities in the two election campaigns. In 1987, in fact, the Labour manifesto still included the re-nationalisation of the telecommunications industry, while in 1992 this policy objective had been abolished. Thus, had the Labour Party won the 1992 General Election, BT was envisaged to remain a private company.

3.5.2 Results of Individual Announcements

Beside the analysis of the impact of different groups of announcements, the effects of individual announcements within the groups are also tested. Although this analysis does not have clear policy implications in relation to the impact of specific types of regulatory announcements, it can be invaluable in interpreting the results. Tables 3.2-3.7 summarise the results of the analysis of the individual announcements from estimating equation (3.11). As expected, a large proportion of announcements within insignificant groups have a significant impact on BT's systematic risk. However, the impact of different announcements within the same group is often of opposite sign and thus overall the group appears to have no impact.

The insignificant group with the largest proportion of significant announcements is COMP-NEG (Table 3.2). Out of thirteen announcements, nine are significant; of these announcements, seven increase systematic risk, while only two decrease it. In an attempt to understand why so many of the announcements that are expected to decrease competition increase systematic risk, the nature of those specific announcements

Table 3.2

The effect of COMP-NEG announcements on BT's systematic risk as measured by the time-varying beta coefficient

$$\beta_t = \phi_0 + \sum_{i=1}^{n} \phi_i \, D_{it} + \theta_1 \, DEL87 + \theta_2 \, DEL92 + u_t$$

Regressor		Coefficient	T-Ratio
CONSTANT	ϕ_0	1.1691	9.95*
CN1	ϕ_1	0.2773	2.36*
CN2	ϕ_2	0.2722	2.32*
CN3	ϕ_3	0.1235	1.05
CN4	ϕ_4	0.1808	2.28*
CN5	ϕ_5	-0.3452	-2.94*
CN6	ϕ_6	-0.3521	-2.99*
CN7	ϕ_7	-0.1047	-0.89
CN8	ϕ_8	0.1750	4.88*
CN9	ϕ_9	0.0813	2.27*
CN10	ϕ_{10}	0.0786	2.19*
CN11	ϕ_{11}	0.1497	4.18*
CN12	ϕ_{12}	0.0391	1.09
CN13	ϕ_{13}	-0.0296	-0.82
DEL87	θ_{14}	0.1546	2.33*
DEL93	θ_{15}	-0.1217	-3.24*

See notes to table 3.1.

needs to be analysed more closely. It can be argued that most of them increase uncertainty about either the competitive strategy of BT or the next regulatory move of OFTEL or the government. For example, CN2 announces the *intention* of a joint venture without specifying the terms of it; in CN3 OFTEL *defers* a decision; with CN9 OFTEL *criticises* the Government for wanting to introduce too much competition in telecommunications. On the contrary, the two COMP-NEG announcements for which the hypothesis of a lower beta is accepted refer to the decision not to refer BT to the Monopolies and Mergers Commission and the granting of a licence to BT, both of which are announcements that decrease uncertainty. Thus, uncertainty appears to have a greater impact on BT's systematic risk than the likely effects of announcements. In other words, even if the news carries favourable information about BT's future competitive position, it is likely to have a negative effect on BT's perceived risk if it also increases uncertainty. Once again, this may be due to the strength of BT vis a vis potential competitors, and thus the fact that investors do not perceive that BT will necessarily benefit from less competition.

A similar argument can also explain the finding that announcements expected to increase competition can decrease beta. In fact, of the fifty-four announcements in the COMP-POS group (Table 3.3), twenty-three announcements are significant: eleven increase systematic risk and twelve decrease it. Once again, these results could be interpreted as a consequence of investors believing that it does not really matter if BT faces greater competition. If, following a change in regulation, the 'rules' of the competitive game become clearer and thus there is less uncertainty, investors will perceive that BT's systematic risk has decreased. Examples of this argument are given by announcement CP6 that discloses the details of a BT's licence; CP31 and CP37 that disclose government plans; CP46 and CP48 that announce the granting of new licences by the government. The

Table 3.3

The effect of COMP-POS announcements on BT's systematic risk as measured by the time-varying beta coefficient

$$\beta_t = \phi_0 + \sum_{i=1}^{n} \phi_i \, D_{it} + \theta_1 \, DEL87 + \theta_2 \, DEL92 + u_t$$

Regressor		Coefficient	T-Ratio
CONSTANT	ϕ_0	1.4257	5.50*
CP1	ϕ_1	0.3672	3.40*
CP2	ϕ_2	0.3095	3.37*
CP3	ϕ_3	0.1615	1.76*
CP4	ϕ_4	-0.0295	-0.32
CP5	ϕ_5	-0.0677	-0.74
CP6	ϕ_6	-0.2026	-2.20*
CP7	ϕ_7	0.0956	1.04
CP8	ϕ_8	0.1381	1.50
CP9	ϕ_9	0.1160	1.26
CP10	ϕ_{10}	0.1719	1.87*
CP11	ϕ_{11}	0.0838	0.91
CP12	ϕ_{12}	-0. 1002	-1.09
CP13	ϕ_{13}	-0.1117	-1.21
CP14	ϕ_{14}	-0.0805	-0.99
CP15	ϕ_{15}	-0.1596	-1.95*
CP16	ϕ_{16}	-0.1302	-1.59
CP17	ϕ_{17}	-0.0990	-1.21
CP18	ϕ_{18}	-0.1022	-1.25
CP19	ϕ_{19}	-0.0985	-1.20
CP20	ϕ_{20}	-0.0815	-0.99
CP21	ϕ_{21}	-0.1024	-1.25
CP22	ϕ_{22}	-0.1038	-1.27

Cont...\

CP23	ϕ_{23}	-0.1167	-1.42
CP24	ϕ_{24}	-0.1201	-1.46
CP25	ϕ_{25}	-0.1702	-2.08*
CP26	ϕ_{26}	-0.0900	-0.10
CP27	ϕ_{27}	-0.0521	4.67*
CP28	ϕ_{28}	-0.0346	-1.13
CP29	ϕ_{29}	-0.0661	-2.16*
CP30	ϕ_{30}	-0.0521	-1.70*
CP31	ϕ_{31}	-0.0852	-2.78*
CP32	ϕ_{32}	-0.0493	-1.61
CP33	ϕ_{33}	0.0148	0.48
CP34	ϕ_{34}	0.0032	0.10
CP35	ϕ_{35}	-0.0202	-0.66
CP36	ϕ_{36}	-0.0409	-1.77*
CP37	ϕ_{37}	-0.0428	-1.87*
CP38	ϕ_{38}	0.0007	0.02
CP39	ϕ_{39}	0.0715	2.33*
CP40	ϕ_{40}	0.1122	2.68*
CP41	ϕ_{41}	0.1096	2.61*
CP42	ϕ_{42}	0.0965	2.30*
CP43	ϕ_{43}	0.1329	3.17*
CP44	ϕ_{44}	0.0933	3.80*
CP45	ϕ_{45}	0.0877	3.40*
CP46	ϕ_{46}	-0.0882	-2.11*
CP47	ϕ_{47}	-0.0760	-1.81*
CP48	ϕ_{48}	-0.1113	-2.65*
CP49	ϕ_{49}	-0.0164	-0.39
CP50	ϕ_{50}	-0.0368	-0.88
CP51	ϕ_{51}	0.0574	1.37
CP52	ϕ_{52}	0.0106	0.25
CP53	ϕ_{53}	-0.0110	-0.26
CP54	ϕ_{54}	0.0200	0.48
DEL87	θ_1	0.3717	4.67*
DEL92	θ_2	-0.0899	-2.06*

See notes to Table 1

Table 3.4

The effect of PRICE-NEG announcements on BT's systematic risk as measured by the time-varying beta coefficient

$$\beta_t = \phi_0 + \sum_{i=1}^{n} \phi_i D_{it} + \theta_1 DEL87 + \theta_2 DEL92 + u_t$$

Regressor	Coefficient		T-Ratio
CONSTANT	ϕ_0	1.1126	4.41*
PN1	ϕ_1	0.2019	2.61*
PN2	ϕ_2	0.1077	1.39
PN3	ϕ_3	0.1864	2.41*
PN4	ϕ_4	0.2055	2.66*
PN5	ϕ_5	0.4697	6.08*
PN6	ϕ_6	0.1381	1.79*
PN7	ϕ_7	0.0601	0.78
PN8	ϕ_8	-0.3061	-3.96*
PN9	ϕ_9	-0.1347	-1.74*
PN10	ϕ_{10}	0.0231	0.30
PN11	ϕ_{11}	0.0979	1.27
PN12	ϕ_{12}	-0.0471	-0.61
PN13	ϕ_{13}	-0.0664	-0.85
PN14	ϕ_{14}	-0.0459	-0.59
PN15	ϕ_{15}	-0.0243	-0.31
PN16	ϕ_{16}	-0.0404	-0.52
PN17	ϕ_{17}	0.0091	0.12
PN18	ϕ_{18}	0.0141	0.30
PN19	ϕ_{19}	0.0597	1.27
PN20	ϕ_{20}	-0.1504	-1.92*
PN21	ϕ_{21}	-0.1224	-1.56
PN22	ϕ_{22}	-0.1224	-1.56
PN23	ϕ_{23}	-0.1535	-1.96*
PN24	ϕ_{24}	-0.1084	-1.39
PN25	ϕ_{25}	-0.2599	-3.32*
DEL87	θ_1	O.2142	2.71*
DEL92	θ_2	-0.1882	-2.40*

See note to Table 1

Table 3.5

The effect of PRICE-POS announcements on BT's systematic risk as measured by the time-varying beta coefficient

$$\beta_i = \phi_0 + \sum_{i=1}^{n} \phi_i D_{it} + \theta_1 DEL87 + \theta_2 DEL92 + u_t$$

Regressor	Coefficient		T-Ratio
CONSTANT	ϕ_0	1.1132	4.47*
PP1	ϕ_1	0.0935	1.22
PP2	ϕ_2	0.2086	2.71*
PP3	ϕ_3	0.2718	3.53*
PP4	ϕ_4	-0.0511	-0.66
DEL87	θ_1	0.2163	2.78*
DEL92	θ_2	-0.1861	-2.41*

See note to Table 1

Table 3.6

The effect of SERV-NEG announcements on BT's systematic risk as measured by the time-varying beta coefficient

$$\beta_t = \phi_0 + \sum_{i=1}^{n} \phi_i \, D_{it} + \theta_1 \, DEL87 + \theta_2 \, DEL92 + u_t$$

Regressor	Coefficient		T-Ratio
CONSTANT	ϕ_0	1.1579	2.64*
SN1	ϕ_1	0.3682	3.70*
SN2	ϕ_2	0.2182	2.19*
SN3	ϕ_3	-0.3541	-3.56*
SN4	ϕ_4	-0.3291	-3.31*
SN5	ϕ_5	-0.2897	-2.91*
SN6	ϕ_6	-0.3085	-3.10*
SN7	ϕ_7	-0.3007	-3.02*
SN8	ϕ_8	-0.2847	-2.86*
SN9	ϕ_9	0.0846	2.04*
SN10	ϕ_{10}	-0.1226	-2.96*
SN11	ϕ_{11}	-0.0315	-6.38*
SN12	ϕ_{12}	0.0105	2.27*
SN13	ϕ_{13}	-0.0605	-1.46
SN14	ϕ_{14}	0.0797	1.92*
SN15	ϕ_{15}	0.0205	0.49
DEL87	θ_1	0.1717	1.71*
DEL92	θ_2	-0.1010	-2.31*

See note to Table 1

Table 3.7

The effect of SERV-POS announcements on BT's systematic risk as measured by the time-varying beta coefficient

$$\beta_t = \phi_0 + \sum_{i=1}^{n} \phi_i D_{it} + \theta_1 DEL87 + \theta_2 DEL92 + u_t$$

Regressor	Coefficient		T-Ratio
CONSTANT	ϕ_0	1.1151	4.41*
SP1	ϕ_1	0.2614	3.38*
SP2	ϕ_2	0.2740	3.54*
SP3	ϕ_3	0.2908	3.76*
SP4	ϕ_4	-0.3283	-4.24*
SP5	ϕ_5	-0.3126	-4.04*
SP6	ϕ_6	-0.2500	-3.23*
SP7	ϕ_7	-0.2652	-3.43*
SP8	ϕ_8	-0.2553	-3.30*
SP9	ϕ_9	-0.1004	-1.28
SP10	ϕ_{10}	-0.1327	-1.72*
SP11	ϕ_{11}	-0.0440	-0.57
SP12	ϕ_{12}	-0.0192	-0.25
DEL87	θ_1	0.2144	2.74*
DEL92	θ_2	-0.1880	-2.42*

See note to Table 1

informational content on these announcements ends uncertainty and the positive effect of decreasing uncertainty prevails over the potential negative effect from increased competition.

In relation to PRICE-NEG announcements (Table 3.4), only ten out of twenty-six announcements are found to be significant: five increase systematic risk, as it was expected, while five decrease risk. As it has been noticed earlier, it is hard to believe that BT would be threatened by regulation designed to keep prices low. In this case, in fact, the barrier to entry created by the regulator may well stabilise BT's revenue, decrease uncertainty and stand BT in good stead to face its international competitors. To summarise, the unexpected sign of a number of coefficients can be explained by one of three factors. Firstly, the day of the public release of an announcement may not capture its effect, because the informational content of the announcement might have been anticipated by the market. In this case, the market might have anticipated the regulatory change to be more damaging/beneficial to BT than when the announcement is finally made and thus days or weeks before the event there might have been a market overreaction to the expected change. Therefore, at the time of the announcement, we would observe a change of opposite direction than expected, since the market is simply eliminating the excess decrease\increase in share prices. For example, both announcements CP15 and CP19 relate to the loss by BT of its monopoly in payphones; however, both announcements caused a decrease in BT's systematic risk. These results must be interpreted against the sharp increase in BT's systematic risk four months before, when OFTEL indicated that more competition in the payphone market was desirable. When the following announcement was made and then the monopoly was finally abolished, investors readjusted their perception of BT's risk in the opposite direction.

Secondly, according to the previous hypotheses on the effects of regulation, investors might expect BT to acquire more, rather than less, market power following some regulatory changes designed to increase competition. For instance, deregulation for the whole industry may not be damaging for BT, which is in a strong position to compete. In fact, deregulation and the subsequent increase in competition may be seen favourably by investors who perceive that they understand the 'laws' of market competition better than the behaviour of an heavily regulated industry. In this case, investors would associate less uncertainty with less regulation.

The third consideration, which may conflict with the previous explanation, is that investors may actually react positively to strict regulation because they perceive that this would reduce uncertainty about the overall regulatory framework in which BT operates. In other words, announcements that appear to weaken BT's position may in fact decrease uncertainty about the future standing of the company. In this case investors may react positively to such announcements. Finally, the announcements which were found to have no statistically significant impact on BT's systematic risk within the three-day window may not necessarily have zero informational content. In fact, some of these announcements could have caused a market reaction either well ahead, or possibly after, the official announcement. In this case, the analysis would have not registered any effect.

3.6 CONCLUSIONS

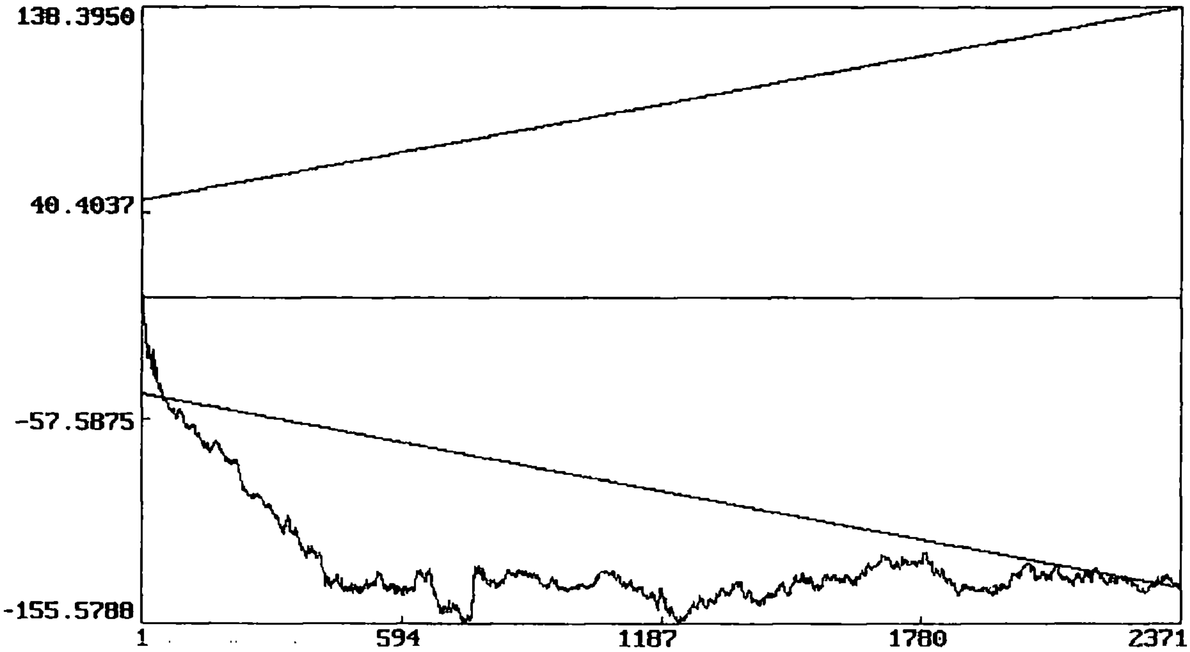
The objective of this chapter is to contribute to the literature on the effects of regulation on the regulated firm's systematic risk by analysing the impact of regulatory announcements on BT's shares in the period December 1984 - December 1993. The impact of regulatory announcements on BT's systematic risk has been investigated, by applying for the first time to this problem a methodology that allows the beta coefficient to vary over time. When announcements are grouped by their expected impact on BT's competitive position, pricing policy and supply of services, only price announcements which are expected to allow prices to increase and service announcements appear to have a significant impact upon BT's shares. However, the direction of these effects is not always in line with the stated hypotheses and these results can be interpreted as a consequence of regulatory capture in the presence of one dominating company in the industry, such as BT. In fact, in this case, measures to increase consumer protection may not necessarily lead to lower returns for the company since they may hit the actual and potential competition harder than the dominating incumbent company.

This interpretation is supported by further evidence when the impact of individual announcements is analysed. Within the insignificant groups, many individual announcements are found to significantly affect BT's systematic risk. However, the direction of their effect varies within the same group. Closer analysis of these individual announcements shows more evidence that regulatory capture is likely to be present and that the uncertainty created by ambiguous signals from the regulator, the government and even BT itself increases systematic risk even when the announcement is expected to have the opposite effect. Investors obviously believe that regulation cannot endanger BT's market dominance and thus will revise their expectations only following announcements that change the level of uncertainty.

In conclusion, regulators need to be aware that their actions may indeed affect a regulated company's systematic risk, and thus its cost of capital, but the direction of these effects is not always easy to predict. Clearly, further investigation is needed to determine whether the results presented in this chapter are industry specific.

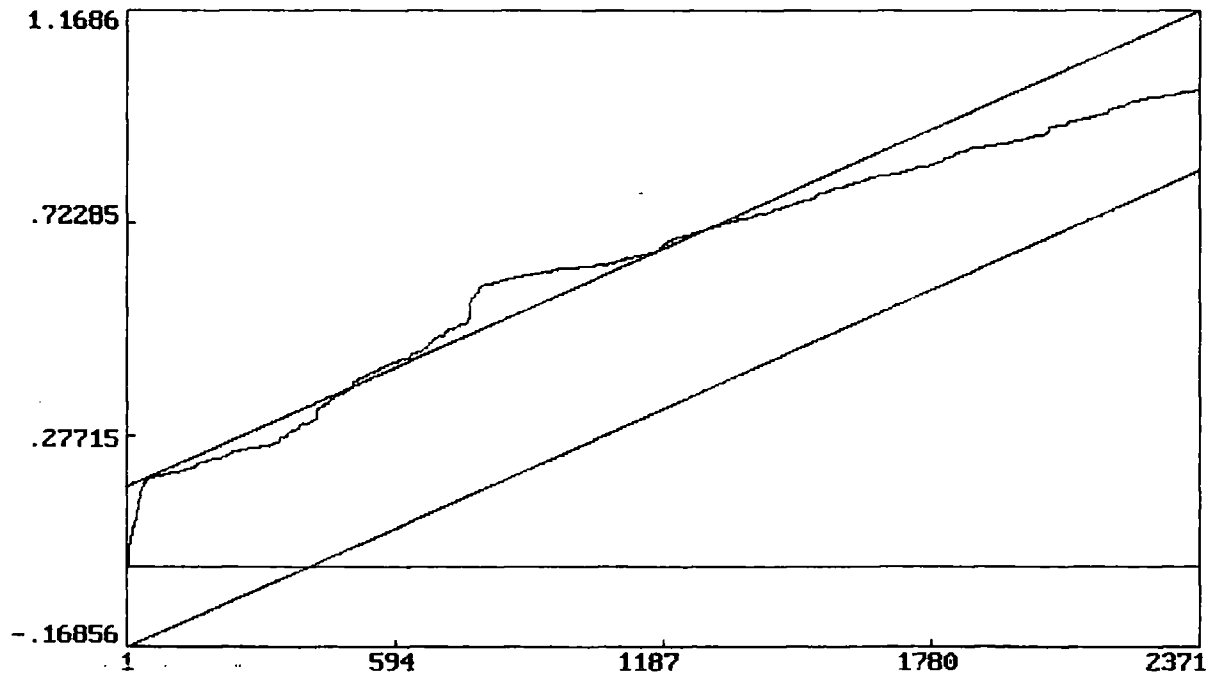
APPENDIX 3.1

Figure 3.1 - CUSUM Test for Stability of Beta Estimates (1984 - 1993)



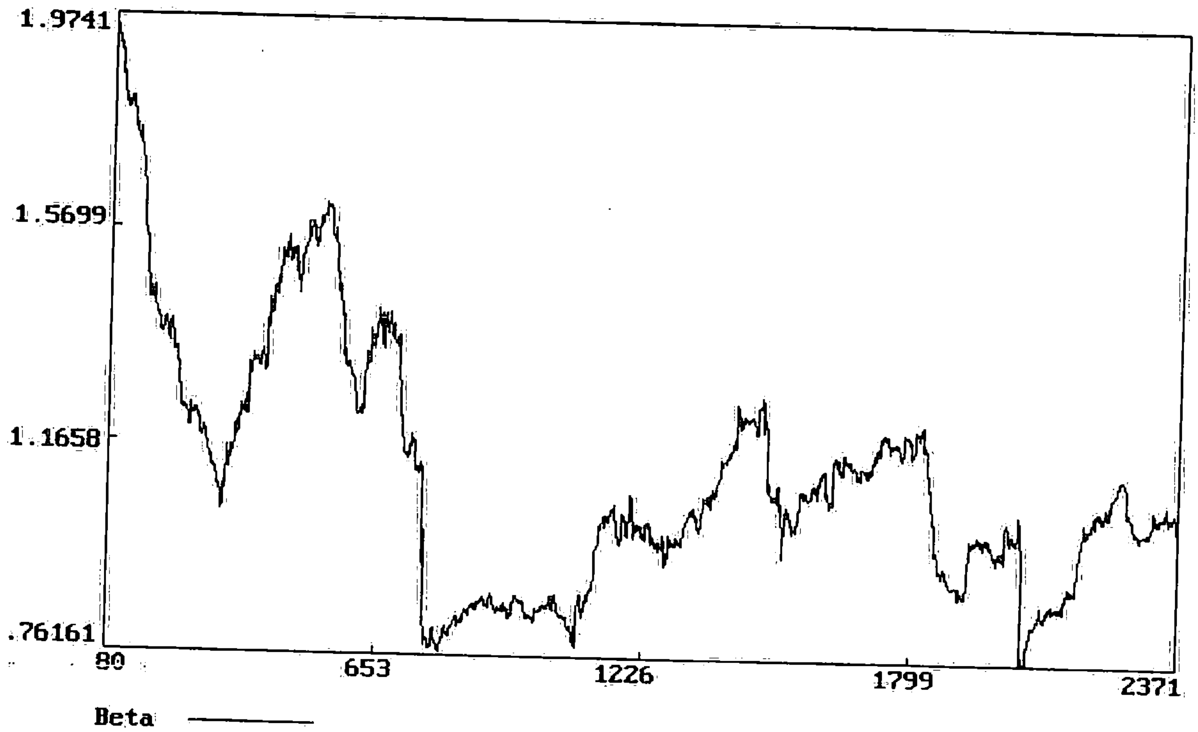
The straight lines represent critical bounds at 5% significance level

Figure 3.2 - CUSUMSQ Test for Stability of Beta Estimates (1984 - 1993)



The straight lines represent critical bounds at 5% significance level

Figure 3.3 - Time-Varying Estimates of BT's beta Coefficient (1984 - 1993)



APPENDIX 3.2

Regulatory Announcements Relating to the Telecommunications Industry: December 1984 - December 1993

Announcement Type, Number and Date		Description of Announcement
	1985	
CP1	May 19	OFTEL studies options over BT plan to buy Mitel.
CP2	Jun 6	Government to change rules for company services on value added network services.
CP3	Jun 25	BT-Mitel deal referred to MMC.
SN1	Jul 3	Director General of OFTEL says complaints against BT are hard to probe.
CN1	Jul 23	BT launches a direct-dialled Freephone service; and BT is planning a joint venture with KDD to set up a high speed digital link between Japan and Britain.
SP1	Aug 22	OFTEL asks for change in BT billing: separate billing for radio paging customers required.
CP4	Sep 4	OFTEL may seek change in BT licence to ensure fair competition.
CP5	Oct 1	OFTEL to rule on how BT should `interconnect' network with Mercury.
PN1	Oct 15	Row between BT and OFTEL over price increases for residential customers.
PN2	Nov 29	Pricing policy to be reviewed by OFTEL.
CP6	Dec 4	OFTEL changes BT's licence for radiopaging.
PP1	Dec 16	OFTEL accepts latest BT price increases.
	1986	
PN3	May 20	OFTEL investigates BT repair charges.
PP2	Jun 4	OFTEL set to clear BT of over special line charges.
PN4	Jun 17	Bryan Carsberg warns of high costs of some telecommunication services recently introduced by BT.
PP3	Jul 9	OFTEL softens BT charges plan.
CP7	Aug 21	BT clashes with OFTEL over radio phone policy.
CP8	Oct 26	Ministry to order end of BT ban on Mercury links.
PN5	Nov 12	OFTEL to monitor BT's price of `party' service.
CP9	Nov 25	OFTEL names products for BT to put out to tender.
CP10	Dec 15	OFTEL agrees to mediate formally between BT & Mercury
	1987	
CP11	Jan 27	BT's monopoly on installation approval to be suspended.
CN2	Feb 9	OFTEL defers decision on liberalisation proposals.

CP12	Feb 25	Government announces moves to extend the liberalisation of UK telecoms.
CP13	Mar 4	OFTEL to persuade overseas operators to accept Mercury as BT competitor.
CN3	Mar 16	Telecommunications industry criticises OFTEL's report into the effectiveness of competition in the telephone supply industry.
PN6	Mar 30	OFTEL to monitor BT's repair fees.
CN4	Jun 1	OFTEL to speed up procedures for approval of new equipment; OFTEL's proposals are weaker than those in the Birtwistle report in February.
SP2	Jul 1	OFTEL may introduce penalty on BT due to poor record of repairs and installation for private customers.
SP3	Jul 6	Bryan Carsberg calls for more payphones.
SN2	Jul 14	BT may have to compensate customers over service delays; since the quality of services has improved, there is no need of further regulatory action in this respect.
PN7	Sep 8	OFTEL to monitor cases where BT has overcharged customers.
CP14	Oct 27	EDS wins special licence to manage voice traffic.
CP15	Nov 25	BT may lose monopoly on call-boxes as Government wants more user choice.
PN8	Nov 30	OFTEL warns BT to curb price increases next year due to excessive profits.
SP4	Dec 7	Safeguards for BT clients demanded by the National Consumer Council

1988

SN3	Jan 8	Minister wants report on Talkabout after children run up large bills.
SP5	Jan 11	OFTEL reply to minister expresses reluctance to ban Talkabout service.
CN5	Jan 27	OFTEL announces review of BT pricing system and Bryan Carsberg believes that it will not be necessary to refer BT to the MMC.
SN4	Feb 8	OFTEL to recommend tougher control on Talkabout service.
CP16	Feb 17	The Government to introduce further competition in satellite communications, although BT/Mercury duopoly over basic telephone network remains unchanged.
CP17	Mar 22	OFTEL ruling prevents BT blocking first private transatlantic satellite.
CP18	Apr 1	OFTEL may stop BT's monopoly of the approval of telecommunications equipment installed by private contractor on business premises.
SP6	Apr 13	OFTEL gives go-ahead for trials of Cordless Creditphone handsets.
CP19	May 3	OFTEL abolishes BT's monopoly on payphones.
SN5	May 12	OFTEL proposes curbs on all chatline services.
SN6	Jun 29	OFTEL scheme for independent monitoring of metering systems of BT.
SN7	Jul 19	MMC to investigate BT's chat-lines.
CP20	Jul 27	OFTEL chief plans to allow competitive services to run on private premise.
SP7	Oct 9	OFTEL will tell BT to compensate customers if later in repairing lines.

SP8	Oct 19	OFTEL may require Cellnet to produce regular quality of service reviews.
CP21	Oct 31	Minister asks OFTEL to introduce more competition into payphone market.
CP22	Nov 29	OFTEL announces liberalisation moves to begin next year.
CP23	Dec 5	OFTEL may resolve dispute on terms of Mercury's access to BT network.
CP24	Dec 13	OFTEL intervenes over Mercury/BT networks use for expensive calls.

1989

CN6	Jan 3	OFTEL advises Government to grant BT one of 4 Cellular licences.
CP25	Jan 26	The government proposes expansion of the mobile communications services and the introduction of more competition.
CP26	Jan 30	OFTEL plans liberalisation of private networks market.
SN8	Feb 3	OFT will publish MMC report on Chatlines at the end of the month.
CP27	Apr 4	OFTEL will not allow BT to make equipment approvals from next year.
CP28	Jun 15	The Government announces measures to liberalise private networks.
CP29	Jun 23	DTI to licence two or three new mobile phone companies including Mercury.
CN7	Jul 10	OFTEL to issue new regulations for private leased telephone lines.
SP9	Jul 26	OFTEL to announce that chatlines will be allowed to resume.
CP30	Aug 30	OFTEL advises DTI that BT should lose sole right to inspect private exchanges.
PN8	Nov 2	OFTEL to examine whether BT increases are abuse of dominant position.
CP31	Nov 8	Government announces regulations liberalising private networks come into effect.
SP10	Dec 7	OFTEL allows resumption of chat-lines provided that a code of practice is followed.
CP32	Dec 11	Government awards PCN licences to international consortium to compete with cellular networks.

1990

CP33	Mar 21	DTI starts review of telecoms industry.
PN9	Apr 9	OFTEL to probe international pricing.
CN8	Jun 27	OFTEL warns Government against introducing too much competition into market.
PN10	Jul 23	OFTEL to investigate BT's price structure.
CP34	Sep 2	Report to DTI advocates sell off of BT's international division.
PN11	Sep 17	OFTEL challenges BT's attempt to increase telephone rental charges.
PN12	Oct 1	OFTEL plans to reduce BT's charges for international calls.
CP35	Oct 18	Adam Smith Institute urges the Government to open the telecommunications market to all-comers.
CP36	Nov 9	Government plans to increase competition and abolish BT/Mercury duopoly.
CP37	Nov 13	Government unveils far-reaching proposals to increase competition.

SP11	Nov 26	The interest of customers is condition to enter UK market according to OFTEL.
PN13	Dec 23	OFTEL plans to make proposals to BT about pricing of international calls.

1991

PN14	Jan 10	OFTEL urges BT/Mercury to cut prices to USA.
SN9	Jan 28	OFTEL to press BT to disclose more information about costs of its services.
PN15	Feb 17	National Consumer Council urges lower telephone charges for domestic users.
PP4	Mar 3	Government may allow rise in BT's line rental charges as part of deal to open up market.
CP38	Mar 5	Government unveils plans for far-reaching reforms on telecoms industry.
CP39	Apr 19	OFTEL may publish documents on telecoms due to confusion with Government white paper.
CN9	May 9	OFTEL to introduce access charges for competitors using BT lines.
CP40	Jul 3	OFTEL may waive access charges for use of BT network by competitors.
CP41	Jul 10	OFTEL warns BT could be forced to split its long distance and local operations.
CP42	Jul 17	Report on price of OFTEL's U-turn on BT charges for access to its network.
CN10	Jul 23	BT escapes MMC referral after deal with OFTEL; as a result Government proceeds with privatisation.
PN17	Jul 28	OFTEL to press BT to disclose more information about costs of services.
CP43	Sep 23	Government to introduce legalisation for tougher regulation in next session of Parliament.
PN18	Nov 1	OFTEL announces that BT's pricing policy will probably be referred to MMC when the price cap system will be renewed.
PN19	Nov 4	OFTEL to publish consultative document on BT's prices.
CN11	Nov 12	OFTEL approves regulatory section of BT's share sale prospectus.
CP44	Dec 5	OFTEL expected to announce tighter regulation of BT's equipment supply business.
CP45	Dec 6	OFTEL announces regulations to prevent cross-subsidies in BT equipment supply business.

1992

PN20	Jan 12	OFTEL to publish consultative document to start examination of BT prices.
CP46	Jan 26	Government plans to licence operators who can lease BT/Mercury lines in bulk.
CP47	Jan 30	OFTEL launches its most comprehensive review of BT since privatisation.
CP48	Feb 20	UK Government licences two new companies to provide satellite services.

SN10	Mar 2	OFTEL plans to stop BT/Mercury from providing chat-line services.
SN11	Apr 6	Chat-lines discontinued after operators fail to meet OFTEL deadline for compensation.
SN12	Apr 10	High Court ruling enables people to sue most of former operators of chat-line.
PN21	Apr 29	Consumers organisation says BT should make one-off cuts in prices due to excess profits.
PN22	Jun 9	OFTEL urges BT to accept tougher new pricing regime or face MMC investigation.
SN13	Jun 25	OFTEL investigates alleged unfair practices in mobile phone market.
PN23	Jul 1	Accounting rate system reform may lead to companies cutting international charges.
CP49	Aug 11	Government confirms plans to award licences in order to increase competition.
PN24	Sep 4	OFTEL to investigate large increase in BT telex charges.
PN25	Nov 12	BT amends tariff to business customers following OFTEL pressure.

1993

CP50	Mar 15	DTI grants telecoms licence to company selling transatlantic calls at discount to BT.
CN12	Jun 23	OFTEL annual report signals shift to higher regulatory regime for BT competitors.
SN14	Jun 29	OFTEL may ask BT to modify or withdraw future special offers to customers.
SP12	Jul 27	Government decides not to give OFTEL power in disputes over bills with BT and customers.
CP51	Jul 29	OFTEL proposes subjecting BT satellite business to more regulation.
SN15	Aug 2	OFTEL rules that BT special offers to customers was discriminatory.
CP52	Aug 18	Government grants licences to 3 foreign companies to offer UK telecom services.
CN13	Aug 19	OFTEL reject complaints that Mercury cheap mobile service is unfair to competitors.
CP53	Sep 5	OFTEL gives signal that AT&T may compete with BT in UK telecoms.
CP54	Oct 17	OFTEL unveils range of initiatives to speed up competition in Telecoms market.

Notes:

CN	Announcements not likely to lead to more competition
CP	Announcements likely to lead to more competition
PN	Announcements likely to lead to lower prices
PP	Announcements not likely to lead to lower prices
SN	Announcements not likely to lead to service improvements
SP	Announcements likely to lead to service improvements

Chapter 4

The Effects of Regulatory Announcements on the Systematic Risk of the Water Industry of England and Wales: An Alternative Time-Varying Approach

4.0 INTRODUCTION

This chapter analyses the impact of regulatory policy on the systematic risk of the water and sewerage companies of England and Wales (WaSCs). Like the previous chapter, this chapter too analyses the impact of regulatory announcements relating to competition, price and service quality on the time-varying systematic risk of equity capital for the WaSCs. However, in this chapter a multivariate GARCH methodology is used to allow for time variation, not only in the systematic risk, but also in the covariance between the market and individual stock, and in the variance of the market. In addition, this chapter provides a first attempt to estimate the overall regulatory risk over the period of estimation.

The chapter is organised as follows. Section 4.1 reviews some of the aspects of privatisation and regulation in the water industry. The data and the testing methodology are presented in section 4.2. Section 4.3 presents and analyses the results, whilst the concluding remarks are presented in section 4.4.

4.1 ISSUES IN THE PRIVATISATION AND REGULATION OF THE WATER INDUSTRY

The state of the water industry in England and Wales at privatisation was undoubtedly one of neglect. A serious lack of investments had left a leaking infrastructure, which delivered water of questionable quality and contributed to the pollution of rivers and beaches. Substantial capital expenditures were needed, also in the light of new EC directives on water quality and sewerage services (Shaoul, 1997).

The industry was privatised in November 1989 with the creation of 10 water and sewerage companies, based on the designated geographical areas of the old water authorities. As the previous authorities, the new private water companies worked on the principle of 'integrated river basin management' and thus performed all the water-related activities of abstraction, treatment, distribution, sewerage, sewerage treatment and disposal, within the catchment area of major rivers. However, the activities of pollution monitoring and control, water resources management, fisheries and land drainage were taken over by the National Rivers Authority (now incorporated into the Environment Agency). Although Hunt and Lynk (1995) argue that this division of responsibilities resulted in a considerable loss of economies of scope, the privatised water companies remained vertically integrated in production, distribution and supply. In addition, the industry also comprised of 29 water only companies, which were already in private ownership, but statutorily controlled, and supplied about a quarter of the total population of England and Wales. These water only companies were allowed to acquire Plc status under the 1989 Water Act. Licences to companies covering mutually exclusive geographical areas were granted for an initial period of 25 years, with a 10 year notice period. This implies that notice cannot be given until 2004 for termination of service in 2014. Regulatory responsibility was assigned to a number of organisations: the Office of Water Services (OFWAT) took charge of the economic regulation[59], while HM Inspectorate of Pollution, the Drinking Water Inspectorate and the National Rivers Authority shared the responsibility for environmental regulation.

[59] For a summary of the activities of OFWAT, see Rees and Vickers (1995).

All these bodies however shared some responsibility for issues of water quality and consumer protection.

4.1.1 Economic Features of Water Supply

The special features that differentiate the water industry from other utilities justify this relatively complex regulatory framework. In the supply of water, almost all of the traditional instances of markets failure are to be found, namely, natural monopoly conditions, capital intensity, very low price elasticity of demand, seasonal characteristics, negative externalities and the public good nature of domestic water consumption.

In the case of other network utilities, such as electricity and gas, the standard argument is that, while the network is naturally monopolistic, supply of the services over the network can have competitive features. In relation to water, however, at the time of privatisation, the assumption was that all aspects of the industry were naturally monopolistic and thus there was little scope for competition. There is indeed some empirical evidence to justify the assumption of natural monopoly. Firstly, the industry is likely to exhibit increasing economies of scale in a number of its operations. In particular, there are likely to be increasing returns to density of supply wherever there are capacities of storage and delivery, which depend upon the square of the linear dimension, as recognised by the regulator itself (OFWAT, 1994). In addition, the results of empirical analysis also suggest that operating costs rise less than proportionally with output in both water and sewerage services, and thus marginal costs are below average variable costs (MMC, 1996). This finding has been supported by evidence from OFWAT (1996a), which reports that, following the increase in the demand for water and sewerage due to the 1995 dry weather conditions, unit costs, including capital costs, decreased. However, the evidence of the existence of natural monopoly conditions is weaker when the total long-run costs of the vertically integrated business is considered. For example, OFWAT (1994) estimates that long-run marginal costs, including resource, bulk transfer and treatment costs, tend to increase with the total quantity supplied. This suggests that some competitive forces may be able to operate in the industry, as analysed in the following section.

That the water industry is capital intensive in relation to other utilities is clearly suggested by the examination of the capital expenditure to sales ratio for the different UK utility industries in 1995: water industry 36%, telecommunications 17%, gas 15%, electricity distribution 8%[60]. This feature means that costs may rise sharply with demand for improved quality and environmental considerations. In addition, negative externalities are encountered in several stages of the water cycle; for example, rivers and lakes can be polluted by industrial waste or acid rain; underground sources can be polluted by fertilisers and agricultural chemicals. On the one hand, domestic water consumers pay for the removal of the effects of pesticides and fertilisers used by the agricultural sector and of waste caused by industrial and other activities. On the other hand, water and sewerage services impose costs on local economies when frequent maintenance work causes traffic congestion. Coastal population pays for the additional sewerage capacity necessary to cater for holiday-makers in the Summer, without necessarily sharing the benefits of the tourist industry. About half of the sewerage costs

[60] Source: SG Warburg, "Utilities Group Modeller", 1996.

relate to highway surface water drainage. There is indeed scope for debating who should bear some of the costs that at present water and sewerage companies simply pass on to domestic households (Smith, 1995).

Finally, most of the water is still supplied 'unpriced' at the point of consumption, since its consumption is not measured. With a sharp decline in industrial demand during the 1970s and early 1980s, the proportion of unmeasured domestic consumption has grown sharply and it is set to remain high for a long time. The declared aspiration of the regulator is that 33% of households will be metered by 2014, as compared with the present 6% (Glaister, 1996). Thus, a large proportion of consumers has no choice on either the quantity, or the quality, of the water consumed. These features of water supply make water an excellent example of a public good.

4.1.2 Types of Feasible Competition in Water Supply

The above evidence on market failure in the supply of water and sewerage services does not completely rule out the possibility of some form of competition. It is however revealing to notice that the 1989 Water Act, subsequently consolidated into the 1991 Water Industry Act, places emphasis on the regulator's duty to *facilitate* competition in the industry, in contrast to regulators in other utilities who have a stronger statutory duty to *promote* competition. The theoretical literature recognises five types of competition that can be applied to the water industry (Cowan, 1997), namely, yardstick competition, competition for the market, contracting out of services, capital market competition, and product market competition.

Yardstick competition can be applied to regulated industries where firms are geographically separated. In its simplest form, the regulator decides the price allowed to one firm on the costs of another firm, thus creating an incentive for firms to lower their own costs. Such regulation works better the greater the correlation between the various exogenous factors that affect costs of different firms in the industry. Shleifer (1985) suggests that yardstick competition can be applied simply by regressing unit costs on the exogenous factors driving costs. In practice, however, yardstick competition cannot really be applied in any mechanical way, especially considering the diversity of external conditions that affect the supply of water in different geographical areas. In addition to this diversity, the other main issue relating to yardstick competition in the supply of water and sewerage in England and Wales has been the alleged efficiency gains of proposed mergers within the industry. Water and sewerage companies have argued that their geographical boundaries are somewhat arbitrary and that there would be efficiency gains if mergers were allowed. However, mergers would also reduce the number of companies in the industry and thus the ability of the regulator to apply yardstick competition. On this latter ground, the Monopolies and Mergers Commission has stopped mergers bids that would reduce the number of water and sewerage companies (MMC 1996a and 1996b), judging that "no remedy, even in the shape of very significant price reductions, would be sufficient to compensate for the loss of [South West Water Services] as a comparator"[61].

Competition for the market can be achieved by franchising services. However, franchising is more successful the lower sunk costs are, since the franchisee has to

[61] MMC (1996a), p. 4.

recover sunk investments before the contract expires. It is thus often desirable to keep the main sunk assets in public ownership. In the UK, franchising has been used in the case of train services[62], while for the water supply it has been used in France and a number of developing countries (World Bank, 1994). Given the structure of the privatised industry and the high sunk investments faced by individual companies, franchising is not really suitable in the supply of water and sewerage services in England and Wales.

On the contrary, some contracting out of services has taken place in the industry. Activities relating to information technology, billing and revenue collection, and maintenance have been contracted out. The obvious advantage of this practice is that the competition in the supply of a specific service can bring about efficiency gains. However, in the UK privatised utilities some services have been contracted out to in-house teams or associated companies. In these cases, further market testing and competitive tendering may be desirable to insure competitive gains.

Competition in capital markets is often referred to as a market mechanism for managerial control and the water industry is no exception (Littlechild, 1986). In an efficient capital market, inefficient companies can be penalised by investors who continuously compare performance between companies in the same industry, as well as across industries. The main market threat to inefficient companies, however, is the threat of take-overs. In a regulated industry such as the water industry, this threat will

[62] When the privatisation of Scottish water services was being considered in the early 90s, franchising was one of the options discussed (McMaster and Sawkins, 1993).

not work if mergers are not allowed to go ahead because of the desire to maintain a large enough number of independent companies.

Finally, with respect to direct product-market competition in the supply of water, it is inconceivable that a proliferation of competing networks of water mains and sewers will ever prove to be efficient, given the current technology and market conditions. Although there can be some cross-border competition and a scope for diversifying the ownership of the network when additional pipes are linked to the existing network, it must be argued that the main boost to competition would come from allowing a number of competing suppliers to share a common network, like in the case of other network utilities. However, the present vertical integration of the water industry acts as constraint to the development of this type of competition and the wisdom of separating the industry vertically, as it has been done for electricity and gas, has been questioned. There is some agreement in the literature that there is limited scope in the water industry for product market competition (Armstrong, Cowan and Viskers, 1994; and Cowan, 1997) and thus more regulation than in other utility industries has to be accepted.

One of the main attempts to facilitate competition has been the introduction of *inset appointments* by OFWAT. With an inset appointment a company can be entrusted with the responsibility to supply water services to a defined geographical area, with an existing licence holder. The area must include a customer consuming at least 250 megalitres of water per year, who has to agree to the proposed inset appointment, or have no existing customers, a so-called green-field development[63]. Although there has

[63] For more details on inset appointments in the water industry see OFWAT (1995) and Pethick (1996).

been more than twenty applications for insets, only very few have been granted and the new companies have acted only as brokers, or retailers, leaving the existing licence holder to continue the provision of the service. In other words, the existing licence holder carries out the treatment, transportation and supply of water and charges the inset appointee a wholesale price covering the relevant costs. If the inset holder and the original licence holder cannot agree the wholesale price, then the regulator intervenes and determines the terms of trade.

Traditionally, larger industrial customers have cross-subsidised smaller domestic users. In recent years, though, the existence of inset appointments has induced more competition in the supply to large customers and thus many water companies have introduced different tariffs for large users. Since 1995, most large customers have a choice of contracts, such as standard two-part tariffs, or a higher fixed charge and lower charge per unit of consumption, or non-linear tariffs with declining prices for successive blocks of consumption. Some customers do not have to choose the preferred contract ex-ante, but can choose the cheapest contract ex-post. The regulator, needing to ensure that this re-balancing does not result in a cross-subsidisation from domestic to industrial users, has removed large users from the regulated tariff basket from April 2000, opening up the competition in the supply of water to large users (OFWAT, 1999).

In conclusion, it is clear that, because of the unique characteristics of the water industry, the creation of a competitive framework is a difficult and controversial task, and the result is likely to be different from the existing solutions for other network utilities. Vertical integration of water companies and their geographical strongholds means that any increase in competition is likely to require a restructuring of the industry.

Common-carriage agreements have been discussed for a long time (OFWAT, 1996b). However, without a national water grid, this type of competition can only take place within regions. Considering that the cost of implementing common-carriage competition is rather high, it is unclear whether any benefit from it will exceed the costs (Cowan, 1997).

4.1.3 Price Regulation

Negative externalities and capital intensity were the main 'official' reasons behind the government's cash injections at privatisation[64] and the lenient RPI+K pricing formula applied to the water utilities. The 'K' factor in the formula is equal to (-X+Q), where X is the usual productivity factor, while Q is the cost of quality and reflects the massive investment programme that water companies had to face to improve the quality of water and other services. Furthermore, the K factor is company specific to acknowledge the diversity across companies in the costs of meeting environmental and quality obligations and in the scope for efficiency savings between different WaSCs[65]. It is also an instrument for inducing 'yardstick' competition (Shleifer, 1985), penalising under-performing and rewarding over-performing companies in relation to the industry's average.

[64] The Government wrote off the industry's debts of £4.95 billion before privatization and injected an additional £1.5 billion cash towards the costs of the investment programme.

[65] At the time of privatization, K factors ranged between 5.5 for Anglian Water to 0 for Southern Water, with an average of 3.8.

The RPI+K formula is a 'tariff basket', which takes into account the multi-product nature of the water industry by dividing output into five categories: metered and unmetered water, metered and unmetered sewerage, and trade effluent. The weighted-average increase in the prices of these five items must not grow by more than RPI+K. The weights of each item are given by the share of that item in total revenue in the previous accounting year[66]. In the initial five years of regulation, the K factor for the water and sewerage companies was at its highest, the average formula being RPI+5%. This fell to an average of RPI+1.4% in the subsequent five-year period. The price of water in real terms increased by 30.2% in the first regulatory period and by only 4.5% in the second period. The setting of the K factor was mainly linked to the need for investment, paramount in the water industry where the most important issues at privatisation were the need to improve water quality, safeguard the environment, replace depleted capital stock and provide for future growth in demand. Any consideration about possible productivity gains was low on the list of priorities, unlike in other utilities. Thus, in setting the initial K factor the regulator was mainly concerned with the need to finance the much needed investment, rather than provide any incentives for increased productivity[67]. The Department of the Environment estimated by means of the capital asset pricing model that the cost of capital for new investment would be about 7% for the water and sewerage companies and about 8-8.5% for the water only companies. The problem in setting a 'fair' value of K was that the WaSCs at the time of privatisation were earning only about 2% on the replacement value of assets. Thus, valuing the existing assets at replacement cost for setting K would have meant an

[66] At the end of the 1990s, about 90% of domestic households had still no meter and were charged according to the rateable values of their properties.
[67] For a description of the process of setting the K factor for the water industry, see MMC (1990) and OFWAT (1991).

increase in prices too large to be politically acceptable. In the end, it was decided that existing assets should continue to earn a rate of return of 2% on their replacement costs, but new assets should earn the market rate of return of 7%, or 8% in the case of water-only companies. In addition, there is a provision for 'cost pass through', which allows water companies to pass on any increase in capital investment costs resulting from new environmental legislation to consumers through higher prices.

The specific features of the water industry outlined in the previous sections aggravate the problem discussed in the previous chapter of estimating the systematic risk of water companies and thus their associated desirable rate of return. In addition, as pointed out earlier, when considering the role of risk in designing regulation, it is important to realise the circular nature of the relationship between regulation and risk. Although regulators rely on estimates of risk to decide on an appropriate rate of return, it is also generally accepted that the actions of regulators in turn affect risk. The ability of the regulator to allocate stochastic future costs and benefits between consumers and investors means that the investment risk of the regulated firm is endogenous, being a function not only of technical and market uncertainties, but also of regulatory policy[68].

4.1.4 Environmental and Quality Regulation

As mentioned earlier, in the supply of water, issues of quality control and environmental concerns are of paramount importance. Thus, water companies also faced right from the beginning though environmental and quality regulation, in addition to OFWAT's

[68] See Brennan and Schwartz (1982) for a theoretical treatment of this problem.

price regulation. Most of these regulations were imposed by the European Community, such as the Drinking Water Directive, the Bathing Beaches Directive, and the Urban Waste Water Treatment Directive. They were administered in the UK by the HM Inspectorate of Pollution, the Drinking Water Inspectorate and the National Rivers Authority.

The potential inefficiency from having separate agencies to regulate price and quality have been discussed for a long time in the theoretical literature (Baron, 1985). It is a special case of the problem of common agency, where one agent, the firm, has several principals, the regulators, with diverse objectives[69]. The solution of the theoretical model is that the firm makes higher excess profits when the regulators do not co-operate than when they do co-operate. In the case of the water industry in England and Wales, Byatt (1991) has argued that the environmental and quality obligations should be carefully costed and implemented in consultation with the industry. The cost and benefit of new quality standards should be fully assessed and those standards that are likely to be adopted should be taken into account when setting the K factor. The implementation by firms should also be monitored closely to avoid any possible Averch-Johnson over-investment effect, over-statement of future investment costs and an inefficient abatement of pollution (Helm, 1991 and 1993). Depending on the costs and benefits of pollution abatement, the desirability of quantitative controls, pollution tax and trading permits, or various combinations of these, have also been considered in the literature (Hahn, 1989; and Helm, 1993).

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[69] For a general analysis of the common agency problem with moral hazard, see Bernheim and Whinston (1986), and for an analysis with adverse selection, see Stole (1991).

4.2 METHODOLOGY AND HYPOTHESIS FORMULATION

4.2.1 Estimating the Cost of Equity Capital Using a Time-Varying Methodology

The standard methodology usually adopted in the literature for the investigation of this type of issue is the extended market model with dummy variables (Karafiath, 1988; Binder, 1985a and 1985b). This methodology, however, assumes that the systematic risk of the portfolio is constant for the whole period under investigation. This seems unlikely, especially in this case, because of the changes in the political and economic environment in the UK and more particularly the development of quality, health and environmental issues relating to the supply of water and sewerage services during the period under study[70].

Furthermore, it has long been recognized that the uncertainty of speculative prices, as measured by the variances and covariances, are also changing through time (Mandelbrot, 1963; and Fama, 1965). Thus, this study adopts a method of estimation of the systematic risk that incorporates these two features, i.e. time variation in beta and changes in variances and covariances over time. More specifically, following Merton (1980) the expected return on the market portfolio can be written as:

$$E(R_{mt}) = \lambda_t E(\sigma_{mt}^2) \qquad (4.1)$$

[70] In order to examine whether the systematic risk of the ten water utilities and the industry portfolio is stable over time, their betas were estimated recursively. Results confirmed that the systematic risk was not constant for the period under investigation.

Assuming expectations are correct on average, then equation (4.1) can be re-written in terms of ex-post returns as follows:

$$R_{mt} = \lambda_t E(\sigma^2_{mt}) + \varepsilon_{mt} \tag{4.2}$$

where ε_{mt} is a white noise error term implying that the conditional variance of the market portfolio is:

$$E(\sigma^2_{mt}) = E(\varepsilon^2_{mt}) \tag{4.3}$$

The excess return of a stock *i* is given by the following equation, assuming again that expectations are correct on average:

$$R_{it} = \beta_t E(R_{mt}) + \varepsilon_{it} \tag{4.4}$$

where ε_{it} is a white noise error term. The substitution of equation (4.3) into equation (4.2) yields the following:

$$R_{mt} = \lambda_t E(\varepsilon^2_{mt}) + \varepsilon_{mt} \tag{4.5}$$

Furthermore, substituting equation (4.1) into equation (4.4) gives[71]:

$$R_{it} = \lambda_t E(\varepsilon_{mt}, \varepsilon_{it}) + \varepsilon_{it} \tag{4.6}$$

Equations (4.5) and (4.6) are estimated using a multivariate GARCH model that allows for changes in correlation in estimating the covariance between the market and individual stocks and the variance of the market. In particular, the following multivariate GARCH system was estimated:

$$\begin{aligned}
R_{it} &= a_{0i} + \lambda_t E(\varepsilon_{mt}\varepsilon_{it}) + \varepsilon_{it} \\
R_{mt} &= a_{0m} + \lambda_t E(\varepsilon_{mt}^2) + \varepsilon_{mt} \\
h_{it} &= \alpha_{0i} + \alpha_{1i}^2 \varepsilon_{it-1}^2 + \delta_{1i}^2 h_{it-1} \\
h_{mt} &= \alpha_{0m} + \alpha_{1m}^2 \varepsilon_{mt-1}^2 + \delta_{1m}^2 h_{mt-1} \\
h_{imt} &= \alpha_{0im} + (\alpha_{1i}\alpha_{1m})(\varepsilon_{it-1}\varepsilon_{mt-1}) + (\delta_{1i}\delta_{1m})(h_{imt-1})
\end{aligned} \tag{4.7}$$

where a_{oi} and a_{om} are constants; λ_t is the market price for risk; ε_{it} and ε_{mt} are error terms; h_{it}, h_{mt} and h_{imt} are the conditional variances and conditional covariance respectively; α and δ are the coefficients of the conditional variances and covariance to be estimated. The estimate of beta is simply the conditional covariance divided by the conditional variance from the above GARCH system. This measure of time-varying betas is then used to carry out the rest of the investigation.

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[71] Note that $\beta_t = \dfrac{Cov(R_{it}R_{mt})}{\sigma_{mt}^2}$ and $E(\,Cov(R_{it}R_{mt})\,)=E(\varepsilon_{it}\varepsilon_{mt})$.

4.2.2 Hypothesis Testing for Groups of Announcements

Initially, announcements were grouped by their expected impact on the level of competition, prices, and the supply of services in the water industry. Equation (4.8) below was then estimated over the entire sample period using OLS to analyze the impact of the announcement groups on the systematic risk, i.e. the estimated time-varying beta coefficient, of the water industry portfolio:

$$\begin{aligned}\beta_{wpt} &= \gamma_0 + \gamma_1 COMP-POS_t + \gamma_2 PRICE-NEG_t + \\ &\gamma_3 PRICE-POS_t + \gamma_4 QUAL-NEG_t + \gamma_5 QUAL-POS_t + e_t\end{aligned} \tag{4.8}$$

where β_{wpt} is the time-varying coefficient that represents the systematic risk of the water industry, COMP-POS_t, PRICE-NEG_t, QUAL-NEG_t, QUAL-POS_t, PRICE-POS_t, and COMP-POS_t are dummy variables that equal one on the three days[72] around each regulatory announcement and zero otherwise; e_t is a random error term. The parameters $\gamma_{0,\ldots,5}$ detect changes in the industry's systematic risk due to particular types of regulatory announcements within a three-day window; that is, they measure possible effects on the beta coefficient due to any of the five types of announcements defined.

Using equation (4.8), the following hypotheses about the effects of each group of announcements on the water industry's systematic risk were tested[73]:

[72] It is desirable that the window should be small to avoid contamination from other events. This is particularly acc0eptable in a developed and active stock market such as the London market.

[73] These hypotheses were formulated on the assumption that the main concern of OFWAT is to protect consumers and that there is no regulatory capture.

(i) Announcements that are expected to increase competition are also expected to increase beta and thus increase the cost of equity capital (γ_1>0);

(ii) Announcements that are expected to decrease the price of services are also expected to increase beta and thus increase the cost of equity capital (γ_2>0);

(iii) Announcements that are expected to increase price of services are expected to decrease beta and thus decrease the cost of equity capital (γ_3<0);

(iv) Announcements that lower the quality threshold, and thus reduce the need for future investment expenditure, are expected to reduce beta and thus decrease the cost of equity capital (γ_4<0);

(v) Announcements that are expected to improve quality, and thus increase the need for future investment expenditure, are also expected to increase beta and thus increase the cost of equity capital (γ_5>0).

4.2.3 Testing the Impact of Individual Announcements

If investors believe that a certain type of announcement does not have an effect on the systematic risk of a company, then this group of announcements should be found insignificant in testing equation (4.8). However, groups of announcements may result as having no significant impact as a consequence of an averaging out effect within the group, with individual announcements causing a significant market reaction, but in different directions. Although in this case the direction of the overall effect of the specific type of announcements is unpredictable, it would nevertheless be incorrect to believe that investors are indifferent to these types of announcements. Thus, in order to gain more detailed insights in the nature of market reaction, the impact of individual regulatory announcements was further analysed by regressing the water industry's time-varying beta coefficient against dummy variables that capture the effects of individual announcements within a specific group. The following equation was thus estimated:

$$\beta_{wpt} = \phi_0 + \sum_{i=1}^{n} \phi_i D_{it} + u_t \tag{4.9}$$

where β_{wpt} is the time varying systematic risk of the industry as described above; D_{it} are individual announcement dummy variables that equal one on the three days around each i^{th} regulatory announcement, and zero otherwise; and u_t is a random error term. The parameters $\phi_{0,\dots,n}$ detect changes in the water industry's systematic risk due to individual regulatory announcements within a group. Equation (4.9) is estimated for each of the five groups of announcements separately over the whole sample period.

4.2.4 Hypothesis Testing for the Impact of Group Announcements on Individual Company's Systematic Risk

Given the heterogeneity of water companies and the fact that they face different 'K' factors, as explained in the introduction, it is important to examine whether the group announcements have the same impact across the industry. Therefore, this chapter first examines whether each group of announcements has an impact on the systematic risk of each utility, rather than on the industry as a whole. Secondly, it also examines whether the significant groups of announcements have the same impact across all companies. To this end, the following regression is estimated:

$$\beta_{it} = \eta_0 + \eta_1 COMP-POS_t + \eta_2 PRICE-NEG + \eta_3 PRICE-POS_t + \eta_4 QUAL-NEG_t + \eta_5 QUAL-POS_t + u_{it} \tag{4.10}$$

where, β_{it} is the systematic risk of company *i*; the parameters $\eta_{0,....,5}$ detect the changes in each company's systematic risk due to particular types of regulatory announcements. The regulatory announcement variables are defined as in equation (4.8) and u_t is a random error term. In addition, a Wald test was used to examine whether any statistically significant impact of a group of announcements was the same across all companies. This was done by computing pair-wise Wald tests under the null hypothesis that the effect (i.e. the coefficient) of a group of announcements, such as PRICE-POS, on the systematic risk of, for example, company 1 was the same as the effect of PRICE-POS on the systematic risk of company 2.

4.2.5 The Overall Effect of Regulation on the Industry's Systematic Risk

Another important issue relates to the overall effect of regulation on the industry's systematic risk. The relevant question here is whether the effect of regulation can be isolated by calculating a measure of systematic risk, free of regulatory risk. A proxy of the industry's systematic risk without the effect of regulation can be obtained by replacing the value of the time-varying betas in the 3-day announcement windows with the constant from equation (4.8), i.e. the beta coefficient's mean value uncontaminated from regulatory effects. In other words, during announcement windows, the effect of regulation on beta is eliminated by replacing its values estimated in a time-varying framework, with its mean value estimated as the constant term in equation (4.8). The mean of the compensated beta can then be compared with the mean of the estimated time-varying beta. The statistical equality of these two means is then tested using a z-statistic. This is an important part of the analysis, since it can provide useful insights on the overall effects of regulation on the industry's systematic risk and thus on the cost of equity capital for the water utilities.

4.3 ANNOUNCEMENT SELECTION AND DATA

As in previous chapters, the regulatory announcements considered in this paper include any news published in the Financial Times that either relate directly, or are expected to lead, to regulatory changes. These include announcements by regulatory bodies, such as OFWAT, general announcements by the government, and news expected to influence regulation. The periods preceding and following each announcement have been checked for the presence of other events, such as quarterly earnings announcements and general elections, and announcements that are contaminated by other events have been excluded from the sample. The dates of the announcements relate to the day when the announcement was released to the public. In all, the effects of the 116 regulatory announcements listed in the Appendix were tested over the period December 1989 to August 1995[74]. Announcements were grouped by their expected impact on the level of competition, prices, and the supply of services in the water industry. Of these announcements, 5 were expected to increase competition (COMP-POS), 57 were expected to decrease prices (PRICE-NEG), 22 were expected to increase prices (PRICE-POS), 12 were expected to decrease the quality of services (QUAL-NEG), and 20 were expected to increase the quality of services (QUAL-POS). No announcement was expected to decrease competition.

The utilities included in the sample were Anglian Water, North West Water, Northumbrian Water, Severn-Trent, South West Water Services, Southern Water Services, Thames Water, Welsh Water, Wessex Water and Yorkshire Water. Share returns were defined as the difference of the log of daily share prices, thus assuming that dividends are continuously reinvested. As a proxy for the market return, the difference of the log of the FT All Share Index was used. An equally weighted portfolio of returns for the water industry was also calculated. All price series were obtained from Datastream.

4.4 EMPIRICAL RESULTS

4.4.1 Portfolio Results for Group Announcements

The results from estimating equation (4.8) over the sample period are presented in Table 4.1 and suggest that only regulatory announcements which affect competition and the quality of services have an impact on the water industry's systematic risk. In particular, the COMP-POS group has a positive and statistically significant coefficient, which

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[74] The sample used ends in August 1995 because after this period mergers between water companies started to take place.

confirms the hypothesis that, when the regulator takes steps to increase competition, investors perceive that the water industry becomes more risky. This is to be expected, as increasing competition will reduce firms' market power and probably require lower price levels and profit margins.

The statistical significance of the QUAL-POS and QUAL-NEG coefficients suggests that these announcements also have an impact on the industry's systematic risk. The positive sign of the QUAL-POS coefficient confirms the stated hypothesis that announcements that have an improving effect on the quality of service increase the systematic risk. A possible explanation for this result can be found in the high capital intensity of the water industry: regulatory announcements that require water utilities to increase the quality of their services are perceived by investors to be associated with high costs of replacing capital equipment and/or new investments. This increases costs and reduces profit margins, and thus makes the companies more risky. However, the positive sign of the QUAL-NEG coefficient contradicts the stated hypothesis that these announcements would reduce systematic risk. Once again this result may be linked to the high capital intensity of the industry. The fact that a regulator may allow UK water companies to maintain a low level of quality could lead to a deterioration of the capital equipment and make these companies more vulnerable to future tighter environmental and public health regulation and consumer dissatisfaction. The question of quality control is indeed a complex one for the water industry, with several bodies dealing with it, from the National River Authorities, to the Environment Agency and the Drinking Water Inspectorate, among others, and the possibility of legislation being imposed from outside the UK. This coupled with a decaying and aging network, and a serious

Table 4.1

The effect of competition, pricing, and quality of service announcements on the water industry's systematic risk as measured by the time-varying beta coefficient

$$\beta_{it} = \gamma_0 + \gamma_1 COMP - POS_t + \gamma_2 PRICE - NEG_t + \gamma_3 PRICE - POS_t + \gamma_4 QUAL - NEG_t + \gamma_5 QUAL - POS_t + \varepsilon_t$$

Regressor		Coefficient	T-ratio
CONSTANT	γ_0	0.68152	23.59*
COMP-POS	γ_1	0.06127	1.884**
PRICE-NEG	γ_2	-0.0036	-0.21
PRICE-POS	γ_3	0.01489	0.402
QUAL-NEG	γ_4	0.11271	3.384*
QUAL-POS	γ_5	0.08271	2.456*

Notes:

Ordinary Least Squares estimation based on Newey-West adjusted S.E.

* denotes statistically significant at the 5% level
** denotes statistically significant at the 10% level

COMP-POS : announcements likely to increase competition
PRICE-NEG : announcements likely decrease the price of services
PRICE-POS : announcements likely to increase price of services
QUAL-NEG : announcements likely to decrease quality/efficiency
QUAL-NEG : announcements likely to increase quality/efficiency

problem of under-investment (see Shaoul, 1997) can rationalise the positive effect of the QUAL-NEG group of announcements.

It is interesting to note that announcements that are expected to affect prices have no statistically significant impact on the industry's systematic risk. While at first sight this result appears surprising, it could be explained by the fact that investors anticipate price regulation and thus discount it in their pricing mechanism. Indeed, if the regulator correctly sets the price-cap, it is only the abnormal profits that will be eliminated. Thus, as the evidence suggests, price regulation has no overall impact on the industry's systematic risk.

4.4.2 Portfolio Results for Individual Announcements

The results from estimating equation (4.9) are presented in Tables 4.2-4.6. As expected, a large proportion of announcements within the insignificant price groups has a significant impact on the industry's systematic risk. However, the effect of different announcements within the same group is often of opposite sign and thus overall the group appears to have no impact. For example, the PRICE-NEG group has forty-five significant announcements out of fifty-seven. Of these announcements twenty-four decrease systematic risk and twenty-one increase it. In order to understand why so many announcements that are expected to decrease prices also decrease the systematic risk, we need to look at the specific announcements more closely. The first thing to note is that fifteen of the twenty-four announcements that resulted in a reduction in beta occurred during the first two years of privatisation (PN2-PN20), a period where the

Table 4.2

The effect of COMP-POS announcements on the water industry's systematic risk as measured by the time-varying beta coefficient

$$\beta_{it} = \phi_0 + \sum_{i=1}^{n} \phi_i D_{it} + u_t$$

Regressor		Coefficient	T-ratio
CONSTANT	ϕ_0	0.6906	25.8*
CP1	ϕ_1	-0.0113	-0.42
CP2	ϕ_2	0.1343	5.03*
CP3	ϕ_3	-0.0719	-2.69*
CP4	ϕ_4	0.0214	0.80
CP5	ϕ_5	0.1880	7.04*

Notes: see notes to Table 4.1.

Table 4.3

The effect of PRICE-NEG announcements on the water industry's systematic risk as measured by the time-varying beta coefficient

$$\beta_{it} = \phi_0 + \sum_{i=1}^{n} \phi_i D_{it} + u_t$$

Regressor		Coefficient	T-ratio
CONSTANT	ϕ_0	0.6921	25.2*
PN1	ϕ_1	-0.0433	-1.57
PN2	ϕ_2	-0.1764	-6.43*
PN3	ϕ_3	-0.1382	-5.04*
PN4	ϕ_4	-0.2200	-7.97*
PN5	ϕ_5	-0.0060	-0.22
PN6	ϕ_6	0.1271	4.62*
PN7	ϕ_7	-0.0967	-3.53*
PN8	ϕ_8	-0.1953	-7.13*
PN9	ϕ_9	0.0641	2.34*
PN10	ϕ_{10}	0.0982	3.57*
PN11	ϕ_{11}	-0.0960	-3.49*
PN12	ϕ_{12}	-0.0526	-1.91*
PN13	ϕ_{13}	0.2336	8.51*
PN14	ϕ_{14}	-0.0276	-1.00
PN15	ϕ_{15}	-0.1487	-5.41*
PN16	ϕ_{16}	-0.1328	-4.79*
PN17	ϕ_{17}	-0.0940	-3.39*
PN18	ϕ_{18}	-0.5365	-19.6*
PN19	ϕ_{19}	-0.2384	-8.74*
PN20	ϕ_{20}	-0.1853	-6.75*
PN21	ϕ_{21}	0.0770	2.84*
PN22	ϕ_{22}	-0.1761	-6.52*
PN23	ϕ_{23}	0.0946	3.47*
PN24	ϕ_{24}	-0.0323	-1.19
PN25	ϕ_{25}	0.0025	0.093

Cont...\

PN26	ϕ_{26}	0.0395	1.45
PN27	ϕ_{27}	0.0511	1.92*
PN28	ϕ_{28}	0.0191	7.09*
PN29	ϕ_{29}	0.0223	0.82
PN30	ϕ_{30}	0.0411	1.52
PN31	ϕ_{31}	0.2214	8.18*
PN32	ϕ_{32}	0.2835	10.4*
PN33	ϕ_{33}	0.0570	2.10*
PN34	ϕ_{34}	0.2936	10.8*
PN35	ϕ_{35}	0.0733	2.70*
PN36	ϕ_{36}	0.1318	4.87*
PN37	ϕ_{37}	0.1547	5.71*
PN38	ϕ_{38}	0.0150	0.56
PN39	ϕ_{39}	-0.1379	-5.11*
PN40	ϕ_{40}	-0.1033	-3.83*
PN41	ϕ_{41}	0.1395	5.09*
PN42	ϕ_{42}	-0.2764	-10.1*
PN43	ϕ_{43}	0.0380	1.38
PN44	ϕ_{44}	-0.1194	-4.37*
PN45	ϕ_{45}	-0.1684	-6.15*
PN46	ϕ_{46}	0.0407	1.49
PN47	ϕ_{47}	0.0801	2.92*
PN48	ϕ_{48}	0.0748	2.73*
PN49	ϕ_{49}	-0.1778	-6.50*
PN50	ϕ_{50}	-0.0709	-2.58*
PN51	ϕ_{51}	-0.1737	-6.36*
PN52	ϕ_{52}	0.0722	2.64*
PN53	ϕ_{53}	0.0314	1.14
PN54	ϕ_{54}	0.1696	6.20*
PN55	ϕ_{55}	0.2485	9.08*
PN56	ϕ_{56}	-0.1049	-3.83*
PN57	ϕ_{57}	0.1321	4.82*

Notes: see notes to Table 4.1

Table 4.4

The effect of PRICE-POS announcements on the water industry's systematic risk as measured by the time-varying beta coefficient

$$\beta_{it} = \phi_0 + \sum_{i=1}^{n} \phi_i D_{it} + u_t$$

Regressor		Coefficient	T-ratio
CONSTANT	ϕ_0	0.6909	26.8*
PP1	ϕ_1	-0.1909	-7.46*
PP2	ϕ_2	-0.3803	-14.8*
PP3	ϕ_3	-0.0681	-2.64*
PP4	ϕ_4	-0.0995	-3.85*
PP5	ϕ_5	-0.2255	-8.78*
PP6	ϕ_6	0.0407	1.58
PP7	ϕ_7	0.2019	7.84*
PP8	ϕ_8	0.1143	4.44*
PP9	ϕ_9	-0.1354	-5.27*
PP10	ϕ_{10}	-0.1479	-5.74*
PP11	ϕ_{11}	0.1624	6.31*
PP12	ϕ_{12}	-0.1920	-3.57*
PP13	ϕ_{13}	-0.1403	-5.46*
PP14	ϕ_{14}	0.1619	6.29*
PP15	ϕ_{15}	0.2584	10.0*
PP16	ϕ_{16}	0.0893	3.46*
PP17	ϕ_{17}	0.2952	11.4*
PP18	ϕ_{18}	0.1200	4.67*
PP19	ϕ_{19}	0.1224	4.75*
PP20	ϕ_{20}	-0.0188	-0.73
PP21	ϕ_{21}	0.0721	2.81*
PP22	ϕ_{22}	-0.0213	-0.82

Notes: see notes to Table 4.1

Table 4.5

The effect of QUAL-NEG announcements on the water industry's systematic risk as measured by the time-varying beta coefficient

$$\beta_{it} = \phi_0 + \sum_{i=1}^{n} \phi_i D_{it} + u_t$$

Regressor		Coefficient	T-ratio
CONSTANT	ϕ_0	0.6882	25.4*
QN1	ϕ_1	-0.1282	-4.73*
QN2	ϕ_2	0.1433	5.30*
QN3	ϕ_3	0.1171	4.32*
QN4	ϕ_4	0.2649	9.78*
QN5	ϕ_5	0.1960	7.24*
QN6	ϕ_6	-0.0471	-1.73
QN7	ϕ_7	0.0518	1.92*
QN8	ϕ_8	0.1409	5.19*
QN9	ϕ_9	0.1125	4.15*
QN10	ϕ_{10}	0.1147	4.24*
QN11	ϕ_{11}	0.1766	6.52*
QN12	ϕ_{12}	0.1231	4.53*

Notes: see notes to Table 4.1

Table 4.6

The effect of QUAL-POS announcements on the water industry's systematic risk as measured by the time-varying beta coefficient

$$\beta_{it} = \phi_0 + \sum_{i=1}^{n} \phi_i D_{it} + u_t$$

Regressor		Coefficient	T-ratio
CONSTANT	ϕ_0	0.6882	24.8*
QP1	ϕ_1	-0.1494	-5.39*
QP2	ϕ_2	0.2101	7.58*
QP3	ϕ_3	0.2078	7.50*
QP4	ϕ_4	0.1243	4.48*
QP5	ϕ_5	0.0772	2.78*
QP6	ϕ_6	0.2023	7.30*
QP7	ϕ_7	-0.0681	-2.45*
QP8	ϕ_8	0.0950	3.43*
QP9	ϕ_9	0.1189	4.29*
QP10	ϕ_{10}	0.0206	0.74
QP11	ϕ_{11}	-0.0441	-1.60
QP12	ϕ_{12}	0.1756	6.31*
QP13	ϕ_{13}	0.0516	1.86*
QP14	ϕ_{14}	0.0013	0.04
QP15	ϕ_{15}	0.0812	2.93*
QP16	ϕ_{16}	0.0265	0.95
QP17	ϕ_{17}	-0.0788	-2.84*
QP18	ϕ_{18}	0.1401	5.04*
QP19	ϕ_{19}	0.1587	5.72*
QN20	ϕ_{20}	0.1206	4.35*

Notes: see notes to Table 4.1

market was very sensitive to price regulation and as a result, most of the announcements were deemed to be important in influencing beta.

More specifically, the perceived reduction in risk linked to price announcements in this period could be due to a number of factors. Investors could have initially been more pessimistic than necessary and the announcements relating to price regulation in this period may thus have been less restrictive than anticipated. If this were to be the case, we would observe reductions in perceived risk whenever a milder than anticipated regulatory announcement is made. In addition, a number of announcements were related to Ofwat's intention to question customers on preferred charging methods and on the debate on the metering of water consumption. This suggests that the market believes that a charging system linked to consumption may well reduce future uncertainty and allow a more efficient use of resources. Finally, two announcements that stress the opportunity for the water utilities to increase productivity and thus reduce prices result in a reduction of beta, suggesting that the market believes that these types of measures may well result in a more efficient water industry. The situation is similar with the PRICE-POS group where there are nineteen significant announcements out of twenty-two; nine decrease systematic risk and ten increase it. A more detailed examination of the ten announcements which increase systematic risk reveals that most of them refer to price increases following the tightening of environmental and quality controls. In these cases, perceived systematic risk may increase due to the uncertainty surrounding the cost repercussions of new quality regulation. In other words, it is not at all clear that the price increases will cover for the imposed additional cost of production. In relation to COMP-POS announcements, out of five relevant announcements three are significant and only one has a negative sign contrary to the initial hypothesis that announcements that increase competition should increase systematic risk. However, this latter announcement refers to OFWAT's opinions and not to specific measures.

In the QUAL-NEG group, eleven out of twelve announcements are found to be significant. In line with the findings about the overall effect of this group of announcements previously presented and discussed, ten announcements increase systematic risk, while only one announcement decreases it. In the QUAL-POS group sixteen out of twenty announcements have a significant impact on systematic risk; only four announcements decrease systematic risk and twelve increase it. As argued above, a possible explanation for the results relating to quality announcements can be found in the high capital intensity of the water industry and the considerable costs and uncertainty associated with increasing quality standards. Indeed, one announcement refers to 'capital programmes on track'; another announces that the investment boom takes off; one calls for extension of integrated pollution and quality control; and another one announces that the Government wants the water utilities to spend £500 million on clean-up. Thus, these announcements are, on the one hand, expected to increase quality of services and thus decrease the systematic risk, but on the other hand they are also expected to raise the industry's costs considerably, thus reducing profit margins and increasing uncertainty.

In summary, when announcements are tested individually, rather than in groups, the large majority of them appears to affect the water industry's systematic risk. Even individual price announcements, which as a group were found to have no effect on risk, are significant; however, they have opposite effects which cancel out when considered as a group. Most competition and quality announcements tend to increase the industry's systematic risk and thus the groups relating to those types of announcements are found to have the same combined effect.

4.4.3 Company Results for Group Announcements

The results from testing the effect of competition, pricing and quality of service announcements on the systematic risk of each water utility are presented in Table 4.7 and suggest that only the regulatory announcements that affect negatively the price are significant for all companies. Also, the announcements that affect competition positively are significant for only three companies, namely Anglian Water, North West Water and Thames Water, all of which had relatively high 'K' factors of 5.5, 5 and 4.5 respectively. This meant that they were allowed to keep prices relatively high and thus they were particularly vulnerable from 'comparative competition'.

Testing whether the significant effect of the PRICE-NEG announcements is the same across all companies, using pair-wise Wald tests for equality of coefficients, reveals that for the majority of pair-wise comparisons the null hypothesis of equal impact of this group of announcements across companies is rejected at the 10% significance level. However, for the effect of the COMP-POS announcements, the null hypothesis of equal impact on the systematic risk of the three above-mentioned companies is accepted. These results suggest that regulatory announcements that affect price in a negative way have a different impact on each company's systematic risk, while the announcements that affect competition, where significant, have the same effect across companies.

Table 4.7

The effect of competition, pricing, and quality of service announcements on the systematic risk of each water company

$$\beta_i = \eta_o + \eta_1 COMP-POS_t + \eta_2 PRICE-NEG_t + \eta_3 PRICE-POS_t + \eta_4 QUAL-NEG_t + \eta_5 QUAL-POS_t + u_t$$

Regressor		β_1	β_2	β_3	β_4	β_5
Constant	η_0	0.54187* (32.93)	0.69809* (27.67)	0.53982* (18.54)	0.71225* (37.17)	0.55069* (21.56)
COMP-POS	η_1	0.03806* (2.32)	0.04150** (1.80)	0.05101 (1.30)	0.02206 (1.00)	0.08831 (1.34)
PRICE-NEG	η_2	-0.02129* (-2.58)	-0.03498** (-1.80)	-0.04084* (-2.23)	-0.02862* (-2.30)	-0.03059* (-2.49)
PRICE-POS	η_3	-0.1419E-3 (-0.0120)	-0.01554 (-0.8462)	0.00456 (0.2785)	-0.00253 (-0.1599)	0.02235 (1.52)
QUAL-NEG	η_4	0.00379 (0.3899)	-0.01826 (-0.9519)	-0.01192 (-0.7720)	-0.00425 (-0.3239)	-0.00281 (-0.3297)
QUAL-POS	η_5	0.01378 (1.2220)	-0.00636 (-0.2652)	0.3971E-3 (0.01361)	0.00779 (0.4763)	0.00335 (0.1262)
		β_6	β_7	β_8	β_9	β_{10}
Constant	η_0	0.59144* (11.55)	0.67473* (24.03)	0.58600* (27.67)	0.62884* (12.72)	0.57055* (15.48)
COMP-POS	η_1	0.10172 (1.45)	0.05393** (1.77)	0.05362 (1.52)	0.04745 (0.9648)	0.06202 (1.3316)
PRICE-NEG	η_2	-0.06976** (-1.687)	-0.03931* (-2.08)	-0.02863* (-2.95)	-0.06018** (-1.91)	-0.04360* (-2.42)
PRICE-POS	η_3	-0.00567 (-0.2031)	-0.00976 (-0.5388)	0.01125 (0.8415)	-0.00687 (-0.2381)	0.00352 (0.1858)
QUAL-NEG	η_4	-0.03320 (-0.9995)	-0.01878 (1.007)	-0.7500E-3 (-0.0909)	-0.03615 (-1.1592)	-0.02512 (-1.3808)
QUAL-POS	η_5	-0.03502 (-0.6655)	-0.00115 (-0.0448)	0.8449E-3 (0.04328)	-0.01879 (-0.4208)	-0.00669 (-0.2118)

Notes:
See notes Table 4.1.

Ordinary Least Squares estimation based on Newey-West adjusted S.E., Parzen Weights, t-statistics appear in parenthesis.

Systematic risk: β_1 is for Anglian Water, β_2 North West Water, β_3 Northumbrian Water, β_4 Severn-Trent, β_5 South West Water Services, β_6 Southern Water Services, β_7 Thames Water, β_8 Welsh Water, β_9 Wessex Water and β_{10} Yorkshire Water.

These results confirm that water companies are vulnerable to price regulation by different degrees. This is well justified by the disparity in size and profitability of the water companies[75].

4.4.4. The Overall Effect of Regulation

The comparison of the estimated systematic risk of the water industry with the constructed systematic risk that excludes the effects of regulation in Table 4.8 suggests that overall the regulatory announcements have a small effect on the systematic risk of the industry. Furthermore, the null hypothesis that the means of the two measures of systematic risk are equal cannot be rejected according to a t-test. The implication of these findings is that the overall impact of regulation on the industry's cost of equity capital is very small if any at all. Given the findings in the previous sections, this is hardly surprising. With the impact of regulation being so diversified by both type of announcement and company, there is obviously an averaging out effect when a more aggregated investigation is conducted. The fact that the 'cost' of regulation appears to be insignificant leads to the conclusion that, in the case of water, regulation is not overall distorting the market evaluation of risk.

[75] During the period examined, the difference in turnover between the smallest and the largest WaSC was fivefold; similarly, the largest WaSC had three times as much operating profits as the smallest company.

Table 4.8

A comparison of the systematic risk of the water industry with and without the effects of regulation

Descriptive statistics	Systematic risk	Systematic risk with the effects of regulation removed
Maximum	1.8648	1.8648
Minimum	0.0000	0.0000
Mean	0.69217	0.68199
Standard Deviation	0.18326	0.17027

Estimated Correlation Matrix of Variables

	Systematic risk	Systematic risk with the effects of regulation removed
Systematic risk	1.0000	.92900
Systematic risk with the effects of regulation removed	.92900	1.0000

Testing H_0: mean of systematic risk = 0.68199 z-statistic:-0.00144

4.5 CONCLUSIONS

Unlike previous studies, which assume that systematic risk is constant through time, this chapter employs a dynamic GARCH methodology in order to estimate a time-varying systematic risk for the water industry. Announcements are grouped by their expected impact on the water industry's competitive posture, pricing policy, and quality of services. Only announcements that are expected to increase competition and announcements that relate to the quality of services appear to have a significant impact upon the water industry's systematic risk. However, further evidence when the impact of individual announcements is analyzed suggests that, within the insignificant price groups, many individual announcements are found to significantly affect the industry's systematic risk. When the systematic risk of individual companies is considered, a slightly different picture emerges: the group of announcements that affect price negatively seems to have a significant - but not uniform - impact on all utilities. Finally, the overall impact of regulation on the industry's cost of equity capital seems to be insignificant over the sample period.

Overall the results reveal some important issues. Firstly, individual regulatory announcements do affect systematic risk and this confirms the existence of a circular problem in regulation, namely that while risk affects regulation, in turn regulation affects risk. Secondly, when announcements are grouped by type and tested on the water industry as a whole, announcements relating to quality of services and competition appear to alter investors' perception of risk. This confirms that the issue of quality is critically important in the water industry, it has an uncertain future and that quality regulation is expected to play a fundamental role in determining both profitability and pricing policies. The water industry also appears to be sensitive to the regulator's attempt at introducing 'comparative' competition. This suggests that the industry views this type of regulation as being effective. Thirdly, when the WaSCs are analysed individually, the heterogeneous nature of these companies becomes clear. The systematic risk of all companies decrease in response to PRICE-NEG announcements; however, the size of the reaction is different for different companies. Finally, this chapter attempts to measure the overall effect of regulation on the systematic risk of the industry and finds that, in the case investigated, the long-term effect of regulation is insignificant.

In conclusion, although the industry's systematic risk does not appear to have been altered overall by regulatory action over the sample period, regulators need to be aware that their actions may indeed affect the systematic risk of individual regulated companies, and thus their cost of equity capital. However, the direction of these effects is not always easy to predict. This result, coupled with the finding of a heterogeneous impact of price announcements across the industry, indicates that regulation alters risk perceptions at the level of individual companies and thus regulators need to be sensitive to the effects of their actions on individual firms.

APPENDIX 4

Regulatory Announcements for the Water Industry of England and Wales: April 1990 - September 1995

1. Announcements that are expected to have a positive effect on Competition (COMP-POS).

CP1	Apr 27 1990	DG welcomes decision on Three Valleys merger inquiry.
CP2	Jul 04 1990	DG welcomes water mergers decision but emphasises need for "comparative competition".
CP3	Oct 31 1991	"Competition in water industry is feasible and should be welcomed" says OFWAT.
CP4	Jul 04 1995	More competition is needed in the industry - OFWAT introduces new measures to this end.
CP5	Jul 26 1995	OFWAT welcomes outcome of MMC report into the merger between Lyonnaise Des Eaux and Northumbrian Water.

2. Announcements that are expected to have a negative effect on prices (PRICE-NEG).

PN1	Jun 19 1990	DG reports on the first 7 months of regulatory regime.
PN2	Oct 30 1990	OFWAT proposes changes to infrastructure charging systems.
PN3	Nov05 1990	"Have your say on how you pay" urges DG.
PN4	Nov26 1990	OFWAT asks WaSCs to canvas customers on charging methods.
PN5	Dec05 1990	OFWAT calls for co-operation to stop rising prices.
PN6	Dec20 1990	OFWAT consults on proposed changes to infrastructure charging schemes.
PN7	Jan 28 1991	OFWAT proposes maximum price for resale of water services.
PN8	Feb08 1991	DG suggests no 100% pass-through of increased environmental expenditure.
PN9	Apr 11 1991	Debate on water metering intensifies.
PN10	May09 1991	Water industry must consider customers, says OFWAT.
PN11	Jul 01 1991	Data of financial performance of industry in 1990-1991 published by OFWAT.
PN12	Jan 17 1992	Land disposal rules for WaSCs changed.
PN13	Mar04 1992	DG says customer involvement is essential in price reviews.
PN14	May12 1992	OFWAT warns WaSCa on meter installation and charges.
PN15	Jul 07 1992	Suggestion that reports of public support for metering are misleading rejected by OFWAT.
PN16	Jul 20 1992	Competition may lead to varying water prices.
PN17	Aug 24 1992	OFWAT consults on license changes to protect customers.
PN18	Sep 22 1992	Better deal for water customers put forward.
PN19	Oct 19 1992	OFWAT seeks reductions in charges for 1993.
PN20	Oct 20 1992	Most WaSCos settle for lower charges for 1993.
PN21	Nov10 1992	OFWAT consults on framework for return on capital to be used at periodic review.
PN22	Dec23 1992	DG resets North West Water price limits.
PN23	Jan 12 1993	DG scrutinises use of water profits.

PN24	Feb10 1993	OFWAT consults on paying for growth.
PN25	Mar04 1993	DG secures further protection for customers.
PN26	Mar15 1993	DG spells out that unending price escalation must stop.
PN27	Mar24 1993	Responses to "Cost of Quality" consultation to be announced.
PN28	Mar29 1993	DG launches "National Customer Council".
PN29	Apr 29 1993	DG welcomes progress towards fairer meter charges.
PN30	May12 1993	OFWAT takes further steps to prevent cross-subsidisation.
PN31	Jun 22 1993	OFWAT warns that consumers will not accept continuing increases in charges.
PN32	Jul 14 1993	OFWAT publishes costing of new EU regulations on water standards.
PN33	Aug12 1993	Report published on the effects of different charging methods.
PN34	Sep 13 1993	DG welcomes National Meter Trials Report.
PN35	Sep 17 1993	OFWAT clarifies programme and process for 1994 review of price limits.
PN36	Oct 07 1993	Customers to benefit from proposed license amendments.
PN37	Oct 19 1993	OFWAT welcomes response of Government to costs of water quality improvements.
PN38	Jan 07 1994	More customers to benefit from proposed license changes.
PN39	Mar14 1994	WaCSs have opportunities to reduce costs says DG.
PN40	Mar24 1994	OFWAT wins better deal for metered customers.
PN41	Apr 05 1994	Major review of all price limits gets underway.
PN42	May30 1994	Row ensues over new price controls.
PN43	Jun 16 1994	1993 Annual Report published. OFWAT strives to limit price rises.
PN44	Jun 21 1994	OFWAT warns WaSCs that customers will not accept ever higher bills.
PN45	Jul 15 1994	OFWAT plans tough price limits, forcing WaSCs to work harder for profits.
PN46	Jul 25 1994	OFWAT expects to limit price rises over next 5 years.
PN47	Jul 28 1994	A new financial climate for the industry - caps on rising water bills and orders to become more efficient.
PN48	Sep05 1994	PM calls meeting to discuss policy towards utilities.
PN49	Sep21 1994	Non-domestic bills rose by twice inflation.
PN50	Sep29 1994	Appeals against price limits referred to MMC.
PN51	Oct17 1994	Local watchdogs to challenge ministers over SW bills.
PN52	Feb14 1995	OFWAT strengthens ring-fencing protection for customers when WaSCs plan to diversify.
PN53	Mar14 1995	Rate of increase in bills slows. Average bills falling.
PN54	May16 1995	OFWAT publishes new report on water companies' tariffs.
PN55	Jun 21 1995	1994 Annual Report published.
PN56	Jun 27 1995	Article looking at increasing risk of investing utilities.
PN57	Aug24 1995	OFWAT in talks with WaSCs over possibility on compensating customers for recent hose-pipe bans.

3. **Announcements that are expected to have a positive effect on prices (PRICE-POS).**

PP1	May30 1990	Environment minister says water charges will have to rise to meet EU standards.
PP2	Aug 071990	Charges for business users rising fastest in Western world.
PP3	Sep 12 1990	"Step by step" approach to costing of large projects encouraged by OFWAT.
PP4	Feb 28 1991	New rules on infrastructure charges to come into effect on 1st April.
PP5	Mar 11 1991	Survey findings show "considerable support" for metering.
PP6	May25 1991	Lords EU committee warns bills to rise to meet EU standards.
PP7	Jul 31 1991	DG calls for tougher regulatory regime.
PP8	Sep 09 1991	Regional watchdogs have their say on how customers pay.
PP9	Dec13 1991	DG says he will allow higher prices due to greater risk from metering.
PP10	Dec23 1991	South West Water charges to increase to finance environmental improvements.
PP11	Feb 17 1992	WaSCs say curbs on licenses to take supply from rivers will result in increased prices.
PP12	Aug06 1992	OFWAT to publish assessment on prospects for future bills.
PP13	Aug13 1992	OFWAT sets out prospects for future bills.
PP14	Jun 17 1993	Standards could result in 16% rise in real charges.
PP15	Jul 12 1993	DG warns that water bills could treble due to EU impositions.
PP16	Aug30 1993	Financial institutions call for tighter controls on OFWAT's decision-making powers.
PP17	Sep24 1993	EU concedes standards are unrealistic and agrees to modify rules that are financially affecting WaSCs.
PP18	Nov27 1993	Debate rages over future charging methods.
PP19	Dec15 1993	DG urged to soften its treatment of WaSCs in price review.
PP20	Mar29 1994	OFWAT interferes less in changing WaSCs' price limits.
PP21	Nov21 1994	Trial installation leads to 16% rise in bills.
PP22	Apr 04 1994	OFWAT welcomes Government decisions on charging methods.

4. **Announcements that are expected to have a negative effect on quality (QUAL-NEG).**

QN1	Aug 151990	1989/1990 water supply disconnection figures published.
QN2	Jun 18 1991	OFWAT consults on proposed changes to protect water companies' core business.
QN3	Jan 22 1992	EU court finds UK has exceeded maximum allowable nitrate levels in water.
QN4	Jun 01 1992	Customers have their say about water services (MORI).
QN5	Jun 05 1992	Disconnections increase: OFWAT expresses concern.
QN6	Nov16 1992	OFWAT publishes interim water disconnection figures.
QN7	Dec01 1992	OFWAT publishes report on water costs and water losses.
QN8	Oct 28 1993	OFWAT publishes costs of water delivered and sewage collected.
QN9	May16 1994	Water and electricity firms write off 1 billion pounds on failed diversification programme.

QN10	Aug01 1994	Report claims OFWAT has ended industry profit spree but not row over high bills.
QN11	Aug12 1994	WaSCs in forefront of criticism over executive payoffs.
QN12	Mar30 1995	DG sounds note of caution to industry on large dividend payouts.

5. Announcements that are expected to have a positive effect on quality (QUAL-POS).

QP1	Oct 24 1990	OFWAT publishes report on levels of service in industry.
QP2	Jun 05 1991	OFWAT to take action on WaSCs diversification.
QP3	Sep19 1991	DG to ask customers what they want.
QP4	Oct01 1991	WaSCs cut price increases. Capital programmes on track.
QP5	Oct08 1991	Water industry investment boom takes off.
QP6	Oct18 1991	Business customers urged to cut their water costs.
QP7	Nov28 1991	WaSCs chiefs claim Government is undermining its own plans to improve water quality by using political pressure to interfere with water regulation.
QP8	Dec05 1991	OFWAT publishes report on water industry standards of service for 1990/1991.
QP9	Feb 26 1992	Calls for extension of integrated pollution and quality control.
QP10	May01 1992	OFWAT acts to implement measures in Citizen's Charters Act.
QP11	Nov04 1992	OFWAT responds to consultation paper "Using Water Wisely".
QP12	Dec17 1992	OFWAT reports on standards of service - overall improvement.
QP13	May11 1994	Water disconnections down by a third.
QP14	Jul 07 1994	Government wants WaSCs to spend 500 million pounds on clean-up.
QP15	Nov10 1994	OFWAT publishes paper on future water demand and supply.
QP16	Nov15 1994	OFWAT reports on continuing fall in water disconnections.
QP17	Dec13 1994	Water industry service standards continue to improve.
QP18	Mar01 1995	OFWAT calls on government to promote efficient use of sewage services.
QP19	May11 1995	Disconnections continue to fall following OFWAT guidelines.
QP20	Aug08 1995	OFWAT release letter on incentives for efficiency and cost cutting.

CONCLUDING REMARKS

Following the privatisation programme of public utilities implemented by the UK government in the 1980s and early 1990s, an interesting debate on the impact of regulation on the cost of equity capital has emerged. While the effects of regulatory announcements have been studied extensively in the USA, there is very little systematic evidence in the UK. The objective of this thesis is partly to redress this imbalance by analysing the impact of regulatory announcements on the returns of equity capital and systematic risk of three utility industries in the UK.

The review of the main issues in the economics of regulation conducted in chapter 1 highlights the lack of precise theoretical predictions and empirical evidence in relation to the impact of regulation on regulated firms. This uncertainty about the outcomes of regulation extends to the effects on the regulated firm's cash flows and the investor's required rate of return. In particular, a two-way feedback effect between the regulator's decisions and the cost of capital has been identified by the literature, without however any agreement as to the direction of the overall effect. Thus, the issue of the impact of regulation on the cost of capital remains largely an empirical question, which the thesis has tried to partly address. In addition, the cost of equity capital is a very important variable for regulators because it determines the appropriate level of the rate of return. While in the UK regulators do not directly control the rate of return, a 'fair' rate of return is considered when price controls are set and revised.

Since a regulatory process can be described as a chain of events, an event study methodology has been chosen to investigate the effects of regulation. The thesis proposes and tests various extensions of the traditional model used in regulatory event studies (Binder, 1985b; and Karafiath, 1988). As indicated in the introduction, the aim of the empirical analysis conducted in the thesis is twofold. Firstly, the impact of regulatory announcements has been analysed on three industries that, especially during the estimation period, differed quite remarkably by both market structure and technological innovation. At one extreme, the regulated telecommunications services were mostly supplied by a monopolist; whereas, at the other extreme, the distribution of electricity was regulated with a clear agenda for developing competition. In the water industry, on the other hand, although the development of some form of competition was not ruled out, it was recognised from the outset that only limited forms of competition could be developed, as discussed in section 4.1.2. Similarly, while telecommunications services were the subject of significant technological innovations, technology had less of an impact in the reshaping of the electricity distribution and water markets after privatisation.

Secondly, the empirical analysis presented in the thesis tests different ways of extending the event study methodology to overcome some of the well-documented statistical problems. In chapter 2, the multivariate regression model of Binder (1985b) is estimated as a GARCH(1,1) process to capture the commonly accepted existence of serial correlation in the volatility of asset returns. The announcement dummy variables are firstly introduced in the return equation to test for the potential effects of regulatory announcements on the stock returns of the RECs. Subsequently, the announcement dummy variables are introduced in the conditional variance equation to test for the possible impact of different individual announcements on the volatility of stock returns of individual firms, since unanticipated announcements with informational content are expected to have an impact on return volatility.

The methodology adopted in chapter 2 assumes that the systematic risk of firms, as measured by β, is constant for the whole estimation period. However, there is evidence that this is unlikely to be the case for most firms, but especially for British Telecom, given the changes in its political and competitive environment during the estimation period. Therefore, the methodology adopted in chapter 3 allows β to vary over time. More specifically, a two-step procedure is followed. In the first stage, a simple market model is estimated using the Kalman Filter. In the second stage, the impact of regulatory announcements is tested on the estimated time-varying beta coefficient. The methodology in chapter 4 goes one step further by adopting a method of estimation of the systematic risk that incorporates both time variation in beta and changes in variances and covariances of returns. In this last empirical chapter, conditional covariances and conditional variances are estimated using a multivariate GARCH system. The time-varying beta is simply calculated as this estimated conditional covariance divided by the conditional variance. Once again, the impact of regulatory announcements was then tested against this time-varying beta coefficient.

More specifically, chapter 2 analyses the impact of unanticipated regulatory announcements on the return of the equity capital of the Regional Electricity Companies (RECs) and the power generating companies in England and Wales by using an extended market model to include dummy variables and with the residuals modelled as a GARCH (1,1) process. When estimating the impact of the group announcements, announcements relating to the retail price of electricity supply are found to be the only type of announcements to have a significant impact on the equally weighted portfolio of RECs. Since most of the announcements relating to competition could have been to some extent anticipated at the time of privatisation, this is not a surprising result. It simply shows that capital markets discount expected changes in advance of the actual implementation and clear regulatory objectives reduce the uncertainty perceived by investors. When the effects of the same announcement groups are tested on the return of the equity capital of the equally weighted portfolio of generators, the results are different. Generators' returns seem to be affected, in addition to retail price announcements, by announcements relating to the tightening of wholesale price control and the increase in competition in electricity generation. This confirms that the important issues in electricity generation are quite different to the main issues in distribution. While distribution was privatised with a clear agenda for developing competition, generation was privatised as a duopoly, without a clear mandate given to the regulator. Thus, it could be argued that there is much more uncertainty about the future structure of electricity generation than distribution.

When the impact of individual announcements is tested, a good proportion of announcements within insignificant groups have a significant impact on the returns of individual RECs, although their effect does not always have the expected sign. These anomalies illustrate how difficult it is to classify announcements by type of expected effect and formulate hypothesis about group effects. There is no doubt that greater competition in any industry should mean lower profits and thus lower investor's returns. However, this generalisation does not take into account cases when a move towards industry's liberalisation has implications beyond the simple competitive posture of incumbent firms. Specifically, in the case of the electricity industry, an early liberalisation of the RECs was taken as good news by investors, since finally the RECs were able to compete on equal footing with gas suppliers. This type of effects can only be analysed when individual announcements are considered and highlights the importance of testing for the effects of both group and individual announcements. Finally, chapter 2 also provides evidence that announcements that have a systematic effect on returns across the industry also appear to affect return volatility. This confirms that some regulatory announcements have an informational content, which affects investor's risk perceptions, as argued by Peltzman (1976).

In the light of the findings in chapter 2 and some of the limitations of the methodology adopted, chapter 3 focuses on the impact of regulatory announcements on the systematic risk of British Telecom. As outlined in chapter 3, there is extensive theoretical and empirical evidence that regulation can impact upon a regulated firm's systematic risk. In particular, Binder and Norton (1999) identify a number of factors through which regulation may affect systematic risk. If systematic risk is affected, this has obvious implications on the cost of equity capital. The chapter develops and utilises a methodology that allows the beta coefficient to vary over time. The results are once again consistent with the characteristics of the industry under consideration. Of the group announcements, only price announcements which are expected to allow prices to increase and service announcements appear to have a significant impact upon BT's shares. The direction of the effect of the price announcement group, however, contradicts the stated hypothesis and shows that more lenient price regulation is associated with 'bad' news. This finding can be interpreted as an indication of the existence of regulatory capture in the presence of one dominating company in the industry, such as BT. Given the structure of the telecommunications industry in the UK during the sample period, measures to increase consumer protection did not necessarily lead to lower returns for BT since they were perceived by investors as likely to hit the potential competition harder than the dominating incumbent company. This interpretation is supported by further evidence when the impact of individual announcements is analysed. Closer analysis of individual announcements shows additional evidence that regulatory capture is likely to be present and that the uncertainty created by ambiguous signals from the regulator, the government and even BT itself increases systematic risk, even when the announcement is expected to have the opposite effect. Overall, there is evidence that investors believe that regulation cannot endanger BT's market dominance and thus revise their expectations only following announcements that change the level of uncertainty.

Finally, chapter 4 examines the impact of regulatory announcements on the systematic risk of the water industry of England and Wales. The specific characteristics and regulatory features of the water industry aggravate the problems of estimating systematic risk and the associated desirable rate of return. A dynamic GARCH methodology is thus used to estimate the time-varying systematic risk for both an equally weighted portfolio of water and sewerage companies and the individual companies. Only group announcements that are expected to increase competition and announcements that relate to the quality of services appear to have a significant impact upon the water industry's systematic risk. With respect to quality related announcements, whether they are expected to increase or not the quality of water supply, they appear to increase systematic risk. This is interpreted as evidence of the great uncertainty and complexity of quality controls in water, which are determined by several national and EU agencies. In addition, the high capital intensity of the water industry means that high costs of new and replacement investments are associated with any change in quality. Overall these results confirm that investors expect quality regulation to play a fundamental role in determining both profitability and pricing policies. The significance of the announcements relating to increased competition, however, may seem at first sight surprising, especially considering that there is less scope for developing competition in water than in other utilities investigated. Nevertheless, they indicate that investors are sensitive to the regulator's attempt at introducing 'comparative' competition and view this type of regulation as being effective. It must also be pointed out in relation to this result that, when the impact of this group announcement is tested for individual water and sewerage companies, only three companies' systematic risk appear to be affected by it.

Although it is surprising that groups of price announcements are found to have no significant effect on the water industry as a whole, when the impact of individual announcements is analysed within the insignificant price groups, many individual announcements are found to significantly affect the industry's systematic risk. However, within the same group, announcements have opposing effects and thus neutralise each other on aggregate. As discussed in chapter 4, this is an industry where there is great uncertainty relating to environmental regulation and associated future costs. During the sample period, it was also subject to several regulatory agencies, with different and sometimes conflicting objectives. It is thus not surprising that the investors' reaction to price announcements is not always as predicted. In addition, the diversity of the water and sewerage companies investigated must have an influence on the aggregate results and this is confirmed by the results from testing the effects of group announcements on the systematic risk of individual companies. When individual companies are considered rather than their portfolio, a different picture emerges: the group of announcements that affect price negatively seems to have a significant - but not uniform - impact on all companies across the industry. Finally, chapter 4 also attempts to measure the overall effect of regulation on the systematic risk of the water industry and finds that the long-term effect of regulation is in this case insignificant.

Overall the results in the empirical chapters reveal some important issues. Firstly, individual regulatory announcements can affect both ex-post returns and systematic risk. This finding lends support to the theoretical view that there is a circular problem in regulation, namely that while risk affects the regulatory parameters through the determination of a 'fair' rate of return, in turn regulation affects both ex-post returns and risk. Secondly, while grouping announcements and testing the effects of these groups on the industry as a whole leads to more general policy conclusions, it can also be misleading about investors' reactions to announcements. The results from testing for the effects of individual announcements show that some types of announcements have a great informational content, but they also have a heterogeneous impact. Thus, when grouped, their effects average out on aggregate. Thirdly, when companies within an industry are analysed individually, the heterogeneous nature of these companies becomes clear. In most cases, although the sign of the impact of an announcement is the same across companies, the size of the reaction is different for different companies and some companies are not affected at all. Finally, the way in which regulation impacts on an industry's cost of equity capital crucially depends on the structure and competitive posture of that industry, as well as technological and market conditions and the parameters of the regulatory system.

In conclusion, whichever regulatory system is implemented, it is clear from the debate in the literature that the cost of equity capital plays an important role in price regulation, at least as long as the price of regulated services is related in some way to the cost of providing them. In the case of the price cap system, this relationship between cost of capital and prices of regulated services is not direct, but it is embedded in the setting of the parameters on which the scheme is based. However, there is also a reverse relationship, since regulation in turn affects the cost of capital. This thesis has provided supporting evidence for this latter causal relationship. Regulators need to be aware that their actions may indeed alter risk perceptions at the level of both individual regulated companies and industries; they affect companies' ex-post returns and systematic risk, and thus their cost of equity capital. However, the direction and size of these effects are not always easy to predict, although they crucially depend on the parameters of the regulatory system.

Having provided evidence to suggest that regulation may alter ex-post returns and systematic risk, two key questions remain: (i) Does regulation increase the inherent variability of earnings?; and (ii) Can regulation be made endogenous to the process of estimating the cost of capital? The first question is important because, if regulation is found to increase earnings variability, then the specific way in which price regulation operates becomes an important consideration in estimating the cost of capital. One of the main effects of price cap regulation is to shift most of the risks of cost variability from consumers to shareholders. This may provide a disincentive for managers to take risk and thus earning variability may decline. The effects of this decline in earning variability on the cost of capital are uncertain and crucially depend on the specific parameters of the regulatory control. In particular, they depend on the upper and lower limits of the rate of return, which are used by the regulator to decide whether there is scope for a review of the price cap. If the upper limit is more tightly controlled than the lower limit, then regulation will tend to neutralise the gains to the firm from increased earnings, but not the losses from lower earning. Thus, a greater regulation-induced variability of earnings will increase perceived risk and thus the cost of capital will also increase. On the contrary, if the lower limit is more tightly controlled than the upper limit, then the firm will be protected against a decline in earnings, while it will be allowed to earn the benefit of higher earnings. In this case, a greater regulation-induced variability of earnings will reduce perceived risk and thus the cost of capital.

With respect to including regulation explicitly into the model for estimating the cost of capital, this thesis provides empirical evidence that it is important to consider regulation as endogenous to the estimation of the cost of capital. This is an issue that requires further investigation. Multi-factor models used to estimate systematic risk allow for several sources of risk, so it would be possible for one of the factors to represent regulation. However, this has never been attempted and several authors have expressed doubts that one factor could fully represent the dynamic regulatory process. A theoretical solution to this problem can be found in the theory of contingent claims. Brennan and Schwartz (1982) first developed a contingent claim model for analysing the dynamic effects of regulation on firm's value and risk. This model treats regulation as an on-going process, in which cash flows to investors are randomly dependent on future regulatory decisions and are subject to dynamic shifts. In other words, cash flows are contingent on stochastic events and price regulation. Contingent claims models suggest that beta is a poor indicator of a fair rate of return for a regulated company and that there are important regulatory variables that can affect the cost of capital, such as the upper and lower limits for regulatory intervention. Although at present contingent claims models remain theoretical, they represent the only methodology that explicit accepts the potential changes in risk arising from regulatory decisions.

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