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PUBLIC UTILITIES

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Abstract

In this chapter, I review the literature on public utilities. Public utilities include a wide range of industries, such as electricity, water, telecommunications, cable television, and railroads, among others. These industries share similar characteristics. I first examine utilities generally in the Introduction, focusing on issues common to them. I review alternative theories of why utilities have historically been either regulated or government-owned. In Part A, I examine the effects of regulatory reform, and the distortionary effects of utility regulation. I find that the effect of utility regulatory reform in the US has been positive. In Part B, I apply many of these general concerns to the US electric utility industry. I examine the regulatory history of this industry, the effects of structural change, the recovery of stranded costs, the natural industry structure, and issues of reliability. In Part C, I provide a brief overview of the literature on other utilities, including telephones, natural gas, and water utilities. In Part D, I summarize the literature on European utilities.
JEL classification: K23, L43, L51, L9
Keywords: Utilities, Network Industries, Regulatory Reform

1. Introduction

The term 'public utility' encompasses a wide variety of industries including, among others, airlines, telecommunications, oil, natural gas, electricity, trucking, cable television and railroads. These industries share a common 'network' structure, in that they have an extensive distribution system of lines, pipes, or routes requiring the use of public rights of way, often with strong physical linkages between component parts. In some cases, such as airlines, government owns a part of the infrastructure. Public utilities typically have substantial sunk costs because of the need for extensive infrastructure. Historically, utilities, where privately owned, have been rate-of-return regulated. Utilities are government-owned in some jurisdictions. In almost all cases, utilities have been granted legally enforced monopolies over their service territories.

Public utilities have, in many jurisdictions, experienced regulatory reform. Reform has typically been in the form of increased competition through more

liberal entry. In some cases, the oil price shocks of the early 1970s de-stabilized the regulatory process. In others, new technologies made the old regulatory regime untenable. The paradigm for utility regulation has therefore changed dramatically. Where once regulated or government-owned monopolies dominated because of the belief that most utilities were 'natural monopolies', there is now a growing consensus that competition can perform a broader and more effective role.

The social importance of public utilities collectively is huge, and the literature on them is correspondingly vast. I therefore focus on several salient issues. In Part A below, I survey several areas of the literature which are relevant for all utilities, including their structural similarities, the rationale for regulation, and the experience with regulatory reform. In Part B, I examine a more specific case, that of US electric utilities, and indicate how these general concerns apply in that industry. I then follow in Part C with brief discussions of telephone, natural gas, and water utilities. In Part D, I review the literature on European utilities.

A. An Overview of Utilities and Regulation

In this part, I provide an overview of literature concerning regulation and utilities generally. I first discuss the structural similarities shared by utilities. I then review the literature on the various rationales for government intervention in these industries. This includes the 'public interest', 'capture', 'economic' and 'contestability' theories. In Section 4, I survey the distortionary effects of regulation, and then move on to the effects of regulatory reform. I conclude the part with a brief review of the literature on ownership form.

2. The Structural Similarities of Utilities

Utilities typically create a good or service at one location, and then distribute it over a 'network' where it is delivered to numerous customers for end use. The use of a network structure creates special issues for utilities. The network often exhibits economies of scale and involves substantial sunk costs, so the issue of natural monopoly has played an important role in utility literature. The network may require the use of public streets or other rights of way, so government involvement is of particular concern. Since several firms often utilize the network, there are 'network externalities' or congestion if its use is not properly priced.

The activities of utilities can be broken down into three components: production, transmission, and distribution. While the production component has, in the US, been almost exclusively privately owned, the transmission and distribution stages have been either private or government-owned. For example,

in trucking and airlines, government-owned street, highways and airports are utilized. A useful way of describing this common structure in six utilities is illustrated in Table 1.

Table 1
The Three Components of Six Utilities

Industry	Production	Transmission	Distribution
Airlines	Airplanes	Air traffic control	Airports
Trucking	Trucks	Highways	Local streets, distribution centers
Telecoms	Telecom terminal equipment	Long-distance cos. and local telecoms	Local telecoms
Electricity	Generating plants	High-voltage lines	Local power lines
Natural gas	Gas wells	Interstate pipelines	Local distribution companies
Railroads	Trains	Trunk lines	Local sidings

Source: Crandall and Ellig (1997, p. 70)

In some regulated utilities, the firm is fully 'vertically integrated' into all three activities, and a salient issue is the 'unbundling' of these functions under competition. Most commentators now agree that the production stage is inherently competitive in most utilities, so that different firms may perform the production and transmission/distribution functions (Crandall and Ellig, 1997). The focus is then on the proper structure for the transmission and distribution segments of the business, with particular attention paid to the question of entry by competitors, or 'access' to transmission and distribution infrastructure.

3. The Rationale for Regulation of Utilities

As noted above, government entities have historically regulated utilities extensively. The debate in the academic literature over the rationale for this

intervention has accordingly been considerable. The literature falls into two broad categories: positive and normative. The normative, or 'public interest' strand provides rationales for how and why government ought to intervene in utilities, typically pointing out 'market failures', or situations in which government intervention could, in theory, improve market operation. According to this approach, government enacts regulation in response to a market failure. This view was dubbed 'normative analysis as positive theory' (or NPT) by Joskow and Noll (1981) since it purports to explain what regulation ought to do.

Natural monopoly theory has historically provided perhaps the most important public interest rationale for utility regulation. This theory holds that an industry is 'naturally monopolistic' if its product can be produced at least cost by a single firm. Traditionally, this was thought to be the case where a firm produces a single good and its long-run average cost curve is declining throughout the entire range of output. Therefore, to achieve productive efficiency, it is necessary to have only one firm operating in the industry (thus justifying legally protected, monopoly service territories). At the same time, this monopoly had to be regulated to prevent price gouging and to ensure it earned a 'fair' rate of return on its investment (Moorhouse, 1995, p. 423). Alternatively, this could be achieved through state ownership of the utility, as was more frequently the case in Europe. In this way, regulation (or ownership) would ensure both productive and allocative efficiency.

There are at least four reasons why scholars, over time, became dissatisfied with the normative approach to utility regulation. Perhaps most importantly, it is at odds with empirical evidence. The incidence of regulation appears to be unrelated to the incidence of the observed characteristics of natural monopoly (Posner, 1974). Regulation occurs in many industries where the normative approach provides no rationale for it, such as potentially very competitive industries, including trucking and taxicabs. Second, since a firm's profits are likely to be reduced if they are regulated in the public interest, the normative approach implies that firms are unlikely to favor regulation. Yet history shows that many regulated utilities actually lobbied for regulation (Viscusi, Vernon and Harrington, 1995, p. 326). Third, empirical evidence suggests that the prices of regulated firms do not behave as suggested by the normative approach. If regulation is designed to prevent monopoly gouging, then prices should decline when regulation is imposed. Stigler and Friedland (1962) examined electric utility prices from 1912 to 1937 and found that regulation had an insignificant effect on output prices. Fourth, this approach has been criticized because of its lack of a mechanism to translate market failure into regulation. That is, no model is provided of the economic behavior of regulators and interest groups which would lead to the suggested outcomes. Many bodies of research have dealt with these issues. I discuss two below: the 'economic theory of regulation' and 'contestability theory'.

The shortcomings of the normative approach led to the development of alternative theories of utility regulation. The initial attempt was provided by what came to be known as 'capture theory' (Jordan, 1972). Whereas regulation under the normative theory was presumed to be in the interest of consumers, under capture theory it was presumed to be in the interest of producers. This theory was able to provide answers to criticisms one, two and three, and was more consistent with available data. However, it also suffered from the fourth criticism. The capture theory did not provide any theoretical underpinnings of regulatory behavior.

This led to a series of papers which attempted to provide a theoretical model and generate refutable hypotheses about the effects of regulation. This body of work became known as the 'economic theory of regulation' (ET). Its literature includes, among others, Coase (1959), Posner (1971, 1974), Stigler (1971) and Becker (1983). An excellent summary of this debate and its literature is provided in Priest (1993).

Perhaps the most comprehensive theoretical treatment was provided in Peltzman (1976). While there are several implications of the theory, three are critical: (i) in a regulated environment, groups with low organization costs are likely to receive a disproportionate amount of economic rent; (ii) cost-based cross-subsidization is a likely outcome of the regulatory process; and (iii) in general, rents are likely to be spread among several competing groups, including politically influential consumers, rather than captured by only one constituency group, such as producers.

Perhaps the most important prediction of the economic theory is that small, highly organized groups will be net winners in the regulatory process. Stigler (1971) emphasized the information and organization costs that groups face in delivering benefits to regulators. Groups that are low-cost providers of these benefits enjoy a comparative advantage in the regulatory process. The numerically smaller group will tend to face lower organization costs. Typically, the number of buyers is less than the number of sellers, so the theory predicts that regulation will benefit producers at the expense of consumers, as is frequently observed.

An additional refinement of the ET in Peltzman (1976) is that regulators will allocate rents across both consumer and producer groups so as to maximize their total political support, and rents will likely fall into the hands of some consumers as well. Rent-spreading among consumers manifests itself through prices which attenuate differences in marginal cost across consumers. The ET predicts that there will be a tendency for high-cost consumers to receive a relatively low price-marginal cost ratio, which constitutes a cross-subsidy from low-cost to high-cost consumers. Indeed, a substantial empirical literature bears out many predictions of the economic theory, but inconsistencies with the data remain. Viscusi, Vernon and Harrington (1995, p. 341) provide a summary.

A second line of research, which also questioned the natural monopoly rationale for regulation began with Demsetz (1968). He showed that there is a theoretical inconsistency in natural monopoly theory: the existence of a single producer in the market need not lead to monopolistic pricing. It is possible for competitors to bid for the right to serve the market. The threat of potential entry may discipline markets which have very few, or only one, producer actually in the market.

Demsetz's work highlighted the notion of what is now termed 'potential competition'. This basic concept was vigorously analyzed in a series of papers developing 'contestability' theory. Willig (1980) first examined this notion in detail by applying it to postal markets. His inquiry led to a benchmark idealized market termed a 'contestable' market. As Baumol, Panzar and Willig (1988, p. xiii) state, 'A perfectly contestable market is defined as one in which entry and exit are easy and costless, which may or may not be characterized by economies of scale or scope, but which has no entry barriers'. This notion was further developed in a series of papers, including Baumol, Bailey and Willig (1977) and Bailey and Panzar (1981). Eventually, Baumol, Panzar, and Willig (1988) published this body of work in a book entitled *Contestable Markets and the Theory of Market Structure*. This work called into question the original notion of natural monopoly and therefore the justification for monopoly rate-of-return style regulation of these firms.

This theoretical approach encouraged a number of studies of the contestability of natural monopolies, including Coursey, Issac and Smith (1984) who used an experimental approach and concluded that (p. 111):

> The most significant result ... is that the behavioral predictions of the contestable market hypothesis are fundamentally correct. It is simply not true that monopoly pricing is a 'natural' result of a market merely because firms in the market exhibit decreasing costs and demand is sufficient to support no more than a single firm.

Moreover, serious theoretical problems with the traditional natural monopoly view arise when multi-product firms are considered. Almost all utilities produce more than one product. For example, utilities produce both peak and off-peak power, and telephone companies provide both local and long-distance phone service.

In an important article, Baumol (1977) investigated the relationship between economies of scale and natural monopoly. He showed that the correct definition of natural monopoly is not that long-run average costs decline, but that the cost function is 'sub-additive'. Briefly, subadditivity asks the question of whether it is more or less costly for two or more firms to produce the output rather than one firm. This is, therefore, a more appealing definition of natural monopoly. The cost curve is subadditive if one firm can produce a given output

more cheaply than two or more firms. This analysis pointed out that economies of scale are a sufficient but not a necessary condition for the existence of natural monopoly. In the multi-product case, Baumol showed that economies of scale are neither necessary nor sufficient for the sub-additivity of costs. This is because of the interdependence of outputs in the multi-product case. An industry is a natural monopoly only if the firm's cost function is subadditive over the entire range of outputs (Baumol, Panzar and Willig, 1982, p. 17). Inspired by Baumol, Panzar and Willig and other contestability literature, Gilsdorf (1995) tests for the subadditivity of vertically integrated electric utilities, and finds that there is no evidence for subadditivity in this industry. Gilsdorf thus concludes that integrated utilities are not multistage natural monopolies, thereby casting further doubt on the natural monopoly status of electric utilities.

In interpreting the contestability literature, Moorhouse (1995, p. 425) concludes, 'Thus this research suggests that competition can be substituted for government regulation and state ownership to assure good performance in, at least, the generation of electricity'. These literatures have led to a widespread change of perceptions in the need for and rationale for utility regulation. It is probable that they helped promote regulatory reform in many industries. An important question is the consequences of reform, which I discuss below.

4. The Effects of Regulatory Reform

The term 'regulatory reform' itself has a variety of meanings. Here I focus on 'deregulation', using it in the sense of Stigler (1981) and Winston (1993): the withdrawal of the state's legal powers to direct the economic conduct of non-governmental bodies. While this can occur in a variety of ways, most typically in utilities it refers to the relaxation of price, entry and/or exit controls. A wave of deregulation which began in the mid-1970s and which continues today has swept aside some of the most restrictive regulatory structures created in the US in the late nineteenth and early twentieth centuries. Regulated industries produced 17 percent of US GNP in 1977; by 1988 this had fallen to 6.6 percent (Winston, 1993, p. 1263). Continuing deregulation of electric utilities in some states, and of some aspects of telecommunications, further reduces this proportion.

In this section, I review US deregulation's effects in six industries, including airlines, trucking, telecommunications, cable television, railroads and natural gas. Winston's (1993) survey of the literature provides an excellent overview of the outcomes. Since most economic deregulation in the US was complete by that time (and had a chance to have its full effect) it is possible to study its impact meaningfully. Winston compiled estimates of deregulation's

effects across a vast literature, and presented the range of estimates in the form of billions of annual 1990 US dollars. More recently, Crandall and Ellig (1997) summarized a large body of evidence on five industries (natural gas, telecommunications, airlines, railroads and trucking), examining evidence on price, quantity and quality. Here I report Winston's estimates for selected industries and variables, and review Crandall and Ellig's results, where applicable.

In Table 2 below, I summarize estimates from Winston (1993) on the effects of deregulation on prices and, in some cases, service. A positive number in column 3 indicates a gain for consumers due to lower prices or improved service. With the exception of the lowest estimates for railroads, US consumers uniformly benefited from deregulation. For example, airline customers gained between $4.3 billion and $6.5 billion per year (in 1990 dollars) through lower fares from deregulation of airlines. They gained approximately $8.5 billion from greater frequency of service, but lost $3 billion from increased travel restrictions.

Table 2
Summary of the Assessed Effects of Regulatory Reform on Prices and Service

Industry	**Effect on:**	**Outcome ($ bill.)**
Airlines	Fares	(4.3, 6.5)
	Service frequency	8.5
	Travel restrictions	-3.0
Trucking	Common carrier rates	7.8
	Private carrier rates	6.0
Long-Distance Telecommunications	Rates	(0.73, 1.6)
Cable TV	Price and Service	(0.37, 1.3)
Railroads	Rates	(-2.1, 0.43)

Source: Winston (1993, pp.1274-1275). Positive values indicate consumer gains. Values are in billions of 1990 dollars.

In terms of percentage declines in airline fares, Crandall and Ellig (1997, p. 34) note that 'yields' (the average amount of revenue received per passenger mile) are commonly used by analysts to measure fare trends, and state:

> ... the average yield fell from 21.65 cents in 1977 to 13.76 cents in 1995, a 37-percent reduction. Much of this decline occurred during the first 10 years of deregulation, when the yield fell by 29 percent, from $21.65 to $15.32. Interestingly, yields fell almost immediately in response to deregulation.

Crandall and Ellig (1997) also document the fall in the price of natural gas after deregulation. Adjusting for inflation, they find that wellhead prices fell by 60 percent between 1984 and 1995. They discovered that the prices actually paid by various classes of consumers (for example, residential, commercial, electric utility) also decreased significantly. Regarding interstate telecommunications rates, they find that after the AT&T divestiture in 1984, the Consumer Price Index for interstate long distance rates decreased from approximately 60 in 1984 to about 30 today. The intrastate rates have also fallen, but somewhat less rapidly.

In Table 3, I report the findings of Crandall and Ellig on percent price reductions in five utilities two, five and ten years after deregulation. For ten years, they range from a low of 27 percent to a high of 57 percent, but they were uniformly positive. Collectively, these results suggest that deregulation of utilities provide benefits for consumers.

Table 3
A Summary of Price Reductions from Deregulation in the United States

Industry	**Percent price reduction after . . .**		
	2 years	**5 years**	**10 years**
Natural Gas	10-38% (1984-86)	23-45% (1984-89)	27-57% (1984-94)
Long-distance telecomm.	5-16% (1984-86)	23-41% (1984-89)	40-47% (1984-94)
Airlines	13% (1977-79)	12% (1977-82)	29% (1977-97)
Trucking	N.A.	3-17% (1980-85)	28-56% (1977-87)
Railroads	4% (1980-82)	20% (1980-84)	44% (1980-90)

Source: Crandall and Ellig (1997, p. 2)

Winston also examined the effects of regulatory reform on profits. In Table 4 below, I report the effects of US deregulation on profits. Positive numbers represent profit gains.

Table 4
Summary of the Assessed Effects of Regulatory Reform on Profits

Industry	**Outcome ($ bill.)**
Airlines	4.9
Trucking	-4.8
Long-distance Telecommunications	Small change
Cable TV	Increase
Railroads	3.2

Source: Winston (1993, pp. 1278-1279). Positive values indicate a profit gain. Values are in billions of 1990 dollars.

Most utilities experienced a profit gain from deregulation, with airlines enjoying the largest gain of $4.9 billion annually. The trucking industry is an anomaly, since it lost $4.8 billion annually from deregulation. The political economy behind trucking deregulation remains a mystery, since the economic theory of regulation predicts that the relatively small number of highly organized trucking companies would have successfully blocked deregulation, but did not. For most industries, then, deregulation increased profits, or at least did not significantly reduce them.

In Table 5 below, I present Winston's summary of the estimates of deregulation's effect on wages and employment. Positive numbers indicate a gain to labor. While airlines experienced a small decline in wages, deregulation there led to an increase in employment, most likely due to an increase in the frequency of flights. Trucking experienced a decline in both wages and employment, suggesting that firms and workers shared the lost monopoly rents (Rose, 1985). Railroad workers also suffered a substantial decline in wages, while employment was not affected.

Table 5
Summary of the Assessed Effects of Regulatory Reform on Wages and Employment

Industry	Effect on:	Outcome ($ bill.)
Airlines	Wages Employment	Small decline Increase 6%
Trucking	Wages Employment	(-1.1,-1.9) Decline
Long-distance telecommunications	Wages (comm.) Wages (equip.)	No change Decline
Cable TV	Wages Employment	No assessment Increase
Railroads	Wages Employment	Decline 20% No Effect

Source: Winston (1993, p. 1282). Positive values indicate a gain to labor. Values are in billions of 1990 dollars.

Given that some groups benefited while others lost, it is important to consider the net effects of deregulation. In Table 6, I report findings from Winston (1993) on the overall effects of regulatory reform in the US. This table sums the effects on both consumers and producers to obtain a total or 'net' effect of deregulation in that industry. Positive numbers in the 'Total' column indicate that deregulation overall produced a welfare gain. For all six industries examined here, the net effect was clearly positive, indicating that any welfare loss by producers (for example, truckers) were outweighed by consumer gains. Net gains thus suggest improvements in economic efficiency, most of which were captured by consumers. Winston notes that, when gains are summed across industries, society gained at least $36-$46 billion annually from deregulation. Estimates of total social gains are higher if firms are assumed to adjust optimaly to deregulation.

Table 6
Summary of the Assessed Effects of Regulatory Reform Overall

Industry	Consumers	Producers	Total
Airlines	(8.8, 14.8)	4.9	(13.9, 19.7)
Trucking	15.4	-4.8	10.6
Long-distance telecommunications	(0.73, 1.6)	___	(0.73, 1.6)
Cable TV	(0.37, 1.3)	___	(0.37, 1.3)
Railroads	(7.2, 9.7)	3.2	(10.4, 12.9)

Source: Winston (1993, p. 1284). Positive values indicate a gain to labor. Values are in billions of 1990 dollars.

These estimates suggest that deregulation of numerous utilities in the US produced substantial social gains. It is therefore probable that utility regulation created a variety of economic distortions, which I discuss below.

5. Distortionary Effects of Regulation

Several branches of research relating to utilities have focused on the distortionary effects of rate-of-return regulation. Here I review two branches of this extensive literature. One branch studies the effect of rate-of-return regulation on the firm's input mix. In a seminal article, Averch and Johnson (1962) developed a model which implied that rate-of-return regulation would cause an industry to utilize a greater than optimal amount of capital. Early studies, including those by Baumol and Klevorick (1970), and Bailey and Malone (1970) and Zajac (1970), generalized the Averch-Johnson conclusions and found that there is an incentive for overuse of the rate-regulated input and over-production of output. Studies by Courville (1974), Spann (1974) and Boyes (1976) found empirical support for the Averch-Johnson predictions. These models were often based on certainty of demand and price, and were subsequently criticized for this. A new series of papers by Perrakis (1976), Meyer (1976), Peles and Stein (1976) and Das (1980) introduced uncertainty, and concluded that the existence of the effect was dubious. Baron and Taggert (1977) found under-capitalization. The results appear to be susceptible to the type of uncertainty introduced.

A relatively new area of inquiry involves the question of the effect of the regulatory process on the internal structure of the firm. While this research itself has several branches, a main focus is regulation's effects on senior executive behavior. Important variables considered include CEO pay and turnover. Alternative views of regulation's effect on CEO pay include a 'productivity hypothesis', in which regulation reduces the complexity of the tasks performed by managers (Peltzman, 1989). Under these circumstances, it is efficient for firms to pay CEOs less, and to hire less able CEOs. An alternative is a 'political pressure' hypothesis, which suggests that the regulatory process politicizes certain firm choices, including CEO pay. Joskow, Rose and Shepard (1993) for example, argue that there are political constraints on executive compensation.

A body of research has established that CEOs of regulated firms are, in fact, paid significantly less than those of unregulated firms. Joskow, Rose and Shepard (1993), after controlling for firm size, firm performance and characteristics of the CEO, find that the chief executive is paid less if the firm is regulated. Carroll and Ciscel (1982) find that regulation reduces the basic annual compensation of the chief executive. They suggest that lower risk, less CEO discretion, and political constraints may all help explain the lower observed compensation.

Joskow, Rose and Wolfram (1996) attempt to distinguish between these explanations by examining differing regulatory environments. They evaluate alternative environments by how 'pro-consumer' they are as rated by an investment bank. They find that CEOs are paid less in relatively pro-consumer environments, and conclude that a political pressure view is supported.

Regarding turnover, Geddes (1997) examines the turnover of senior executives of regulated firms and finds that it is not sensitive to the financial performance of the firm. This is important since researchers examining non-regulated firms have found such a relationship. Turnover of utility executives is, however, related to changes in the price of output. Higher electricity prices increase the probability that the identity of the CEO will change. This result is consistent with estimates in Joskow, Rose and Wolfram (1996) which show that pay is inversely related to the rate of growth of electricity prices. These latter results are also consistent with a 'political pressure' view of CEO behavior.

In addition to regulation, the effects of and correct type of ownership form for utilities has been a matter of much discussion. Below I review literature in this area.

6. Ownership Form

The debate over government versus private ownership of utilities has always been a lively one. Early economists believed that there was a strong case for government ownership, which was dependent on their 'natural monopoly' structure, as discussed above. As Hausman and Neufeld (1991, p. 414) state, '[p]rominent founding members of the American Economic Association, including Richard T. Ely, Henry C. Adams, E.W. Bemis, Edmund J. James, and E.R.A. Seligman, rejected *laissez-faire* public policy and advocated government ownership of a class of businesses which they designated "natural" monopolies, including municipal gas companies, water-works, and electric utilities'. While there appears to be no generally accepted formal model of the effects of ownership form on firm behavior, Boardman and Vining (1989, p. 2) state 'the dominant positive model of the effect of ownership is the public choice, or property rights, model'.

Some authors have argued on theoretical grounds that privately owned firms should exhibit greater internal efficiency in the production of goods and services than publicly owned firms. De Alessi (1974, 1980) suggested that this was due to the inability of the owners of public enterprises to effectively incorporate the benefits of additional managerial monitoring into current transfer prices of the firm:

> The crucial difference between private and political [publicly owned] firms is that ownership in the latter effectively is nontransferable. Since this rules out specialization in their ownership, it inhibits the capitalization of future consequences into current transfer prices and reduces owners' incentives to monitor managerial behavior. (De Alessi 1980, pp. 27-28)

Owners of public firms thus have less incentive to monitor managers, and the cost to public managers of taking additional non-pecuniary benefits, including shirking, is lower. De Alessi argued that public managers have more job security which will be manifested in longer tenure periods. He tested this proposition in De Alessi (1974) and found that public managers did exhibit longer tenure periods. Geddes (1997), however, re-estimated the De Alessi tests with a larger data set and more control variables, and found no significant difference in tenure periods across the two ownership forms.

Spann (1977) attributed expected efficiency differences to two factors. First, public firms do not have the incentive to minimize costs as do private, profit-maximizing firms. Second, private firms naturally gravitate to the optimal size while public firms are restricted by political boundaries. Alchian and Demsetz (1972) and Frech (1976) suggested that there is a greater incentive for public employees to shirk since their wealth is not as closely tied

to the work decisions they make. Other researchers have argued in a similar vein, including, among others, Davies (1971, 1977), Moore (1970), and Crain and Zardkoohi (1978). The available evidence indicates that the relative performance of public and private enterprise is also dependent upon the structure of the industry in which they operate, as well as ownership form. For example, Boardman and Vining (1989) examine the effect of ownership form on profitability and efficiency in a number of competitive industries. They find that dummy variables for both mixed and state-owned enterprises exert significant and negative effects on profitability and other measurers of performance. For valuable surveys of this literature, see De Alessi (1980) or Boardman and Vining (1989).

Numerous researchers have examined the question of the efficiency of public versus privately owned electric utilities in particular. The literature has been characterized by increasing rigor in the econometric tests of efficiency used as well as changes in the conclusions of these tests. Moore (1970) used a model with linear input and cost equations and found that private electric utilities are 5 percent more efficient than municipal utilities. Meyer (1975a) used a quadratic function to estimate costs for public and private utilities, and concluded that publicly owned utilities are more efficient. Neuberg (1977) estimated that public firms are 6-20 percent more efficient, and Pescatrice and Trapani (1980) estimated public firms to be 33 percent more efficient.

Using a variety of econometric methods, more recent investigations of relative cost efficiency have indicated that the two ownership forms display few significant differences. This list includes DiLorenzo and Robinson (1982), and Fare, Grosskopf and Logan (1985). Atkinson and Halvorsen (1986) estimated relative efficiency using a translog cost function and reached a similar conclusion. As Vickers and Yarrow (1988, p. 41) state:

> Taken in conjunction with the research on U.S. electric utilities, we are therefore led to the conclusion that, where firms face little output market competition and are extensively regulated, there is no generally decisive evidence in favor of one type or the other type of ownership.

A unique alternative approach is taken in Hausman and Neufeld (1991). They examine the very early period in the industry's history (1897/98) in order to examine the relative efficiency of government versus privately owned utilities prior to state rate-of-return regulation. Using a non-parametric approach, they find that in this period government-owned utilities were relatively more efficient than their privately owned counterparts. They suggest that this finding is inconsistent with the property rights view of ownership, and attribute the observed difference to a greater 'public spirit' associated with the operation of government-owned utilities.

The question of ownership and efficiency is still very much alive. Most recently, Pollitt (1996) in the *Oxford Economic Papers* examines government and privately owned nuclear power plants in the US and UK, using data envelopment analysis. He found that, when vintage effects and poor investment decisions were taken into account, there was some evidence that privately owned nuclear plants had lower costs.

B. The US Electric Utility Industry

In this section, I examine a particular utility industry in detail. I focus on the electric utility industry in the United States. Many of the issues discussed above that are common to many utilities are particularly important in the electric utility industry. I first examine the history of regulation of this industry, and some interpretations of it.

I focus on electricity for four reasons. First, as measured by total assets, it is an extremely large industry. In the US, it is the largest. Second, of all the services, electricity may be the most 'fundamental' in that most other utilities require it for their operation. Third, it is often considered the industry with the most 'natural monopoly' characteristics. Finally, many of the issues in electric utilities (such as the unbundling of services and the distortionary effects of rate-of-return regulation) are similar to those in other public utilities.

I examine several aspects of the industry. I first review the regulatory history of the industry. This history is particularly pertinent today, since regulatory reform is underway in many places and under consideration in others. It is also illustrative of the application of the economic theory of regulation. In Section 8, I examine the effects of the economic shocks of the early 1970s on the industry, and discuss institutional changes that occurred as a result. In Section 9, I look at legislative acts which affected the industry, including the Public Utility Regulatory Policies Act of 1978, and the Energy Policy Act of 1992. I then move on, in Section 10, to summarize the current thinking on a critical policy question resulting from deregulation: whether or not utilities should be allowed to recover the cost of investments that are 'stranded' through open access to the transmission grid. In Sections 11 and 12, I examine the issues of industry structure and reliability, respectively.

7. Regulatory History of the Industry

The founding of the electric utility industry is generally placed at 1879, when electricity was first used to light streets and some buildings (Bradley, 1996, p. 60). In its earliest stage, neither the states nor the federal government regulated

the industry. Since cities and towns had to grant utilities the right to use public streets, the regulation of entry was *de facto* controlled by municipalities. Jarrell (1982) argues that at this time there was competition between firms, as cities often granted franchises to numerous companies in the same area. Indeed, this era of contending municipal franchises is known as 'regulation by competition' (Bradley, 1996, p. 60).

With the passage in New York and Wisconsin in 1907 of landmark statutes which granted utilities monopoly power and created strong state utility commissions, the states entered the regulatory arena. The justification for this early state regulation of the industry has spawned substantial controversy, which continues today. Economists such as John R. Commons enjoyed formulating justifications for powerful regulation (Michaels, 1996, p. 48). These early economists explained that the industry had been regulated in order to correct 'natural monopoly-style' market failures, as discussed above.

Questioning such a view, Jarrell (1982) argued that state electricity regulation was not designed to counter natural monopoly problems, the theory of which was developed later (Bradley, 1996; Priest, 1993). Instead, he asserted that utilities sought out the state's regulation in order to protect them from intensively competitive conditions under municipal franchising. Jarrell thus relies on the economic theory of regulation to explain the evolution of electricity regulation.

To test these alternatives, Jarrell divided states into two groups: those which passed regulation in an early wave of state reforms from 1912 to 1917, and those which passed regulation later and more slowly, after 1917. The normative theory predicts that regulation will be supplied earliest in states where natural monopoly problems are the most severe; where prices and profits are the highest, and output the lowest, since these states were most in need of regulation. The economic theory predicts the opposite; since regulation was established to create economic rents by shielding firms from competition, regulation will occur first in those states where prices and profits were the lowest. Jarrell found that those states which adopted regulation early had, on average, 45 percent lower prices, 30 percent lower profits and 25 percent higher per capita output before regulation than the states which adopted regulation later. This and other evidence lead Jarrell to conclude that regulation was passed in order to shield firms from competitive conditions prevailing when municipalities were the sole regulators.

Bradley (1996) also examines the origins of state regulation of electricity. He focuses on the effect of utility interests (for example, Samuel Insull) pushing for regulation and suggests that it was an act of political opportunism designed to protect utilities from competition. Bradley concludes that, because the original motivation for government intervention in the utility industry was not due to market failure, the case for the industry's deregulation today is stronger.

8. The Effects of Structural Change

Regardless of their justification, these regulatory arrangements were relatively stable until at least the late 1960s. Joskow (1989) presents a comprehensive analysis of the changes in the industry through the 1960s, 1970s and 1980s. He documents the economic forces which led to major changes in the industry's regulation. The same basic economic forces were operating on utilities throughout the world. Joskow's discussion is briefly summarized here.

The decades of the 1950s and 1960s were relatively uneventful for the electric utility industry. The industry benefited from technological progress and economies of scale in generation, which led to falling nominal and real prices for electricity. Utilities performed well financially and rarely filed for rate increases, but instead often voluntarily decreased their rates. The regulatory system of extensive price and entry review by state and federal agencies worked well during this period. Electric utilities were able to keep their part of the regulatory bargain by providing reliable power to their customers while regulators allowed them an adequate return on investment. Public involvement in the regulatory process was minimal and rate changes were infrequent.

Several factors worked in concert in the early 1970s to change this situation. Productivity gains slowed due to the exhaustion of scale economies in electric generation, while the cost of fuel and capital increased. The OPEC oil price shocks had a substantial effect on utilities. State public utility commissions, responsible for regulating electricity rates, were slow to respond to these changing factors. Rate increases often required a full year from inception at the utility to approval by the commission (Joskow, 1989, p. 159). Also, many commissions relied on a historical test year, which reflects outdated input costs, to set future rates. This regulatory lag resulted in inflexible rates which, in the face of rising costs, caused electric utilities to become less profitable. Rate hearings became more frequent after 1973 as utilities faced rapid fuel price increases.

At the same time, numerous consumer groups were organizing to resist increases in electricity rates. This ratepayer activism made it increasingly difficult for utilities to adequately adjust to unexpected fuel price changes. Additionally, demand growth slowed in response to the rate increases that had occurred. Electricity demand grew at a 7.3 percent annual rate from 1960 to 1973, but slowed to 2.5 percent a year from 1973 to 1985 (Joskow, 1989, p. 150). This hurt the financial performance of many electric utilities, as construction projects were undertaken with the expectation of continued demand increases, thus decreasing capacity utilization. Under pressure from consumer groups, regulators were loath to include these new, under-utilized plants in the rate base. Traditional cost-of-service regulatory arrangements began to erode as public utility commissions adopted new tests for inclusion of

capital in the rate base, such as requiring the economic value of the plant to be greater than its accounting cost, called the 'used and useful' test (Joskow, 1989, p. 161). Under these new rules, regulatory disallowances became more common, especially for nuclear capacity after the 1979 Three Mile Island accident. Electric utility profitability declined even more. After 1975, electric utility common stock price to book ratios fell below one, and earned rates of return fell far below allowed rates (Joskow, 1989, p. 157). The difference between utility return on equity and the yield on new debt fell from 1974 onward, reaching !3.91 percentage points by 1981. The financial condition of utilities did not improve until 1985. Under these pressures, it became clear that substantial reforms of the regulatory process were necessary.

Reform came in several ways. In order to deal with regulatory lag, a number of states instituted fuel adjustment mechanisms (FAMs) which allowed utilities to adjust rates without a formal rate hearing when fuel costs changed. Many states embraced these mechanisms in the mid-1970s, so that by 1979 all but five states had adopted some sort of FAM. This reform shifted the risk of fuel cost changes from the utility to the consumer.

A number of economists have studied the effects of FAMs. For example, Kendrick (1975) developed a framework of automatic adjustment clauses to protect utilities from general price increases. Gollop and Karlson (1978) empirically tested the effect of FAMs by estimating translog functions. Baron and DeBondt (1979) provided a history of FAMs and analyzed their effect on incentives for efficiency. Clarke (1980) examined the effect of FAMs on input choice and showed that the effect is in the opposite directions of the rate-of-return distortion. Isaac (1982) examined their impact when input prices are uncertain.

Despite the adoption of FAMs, however, utilities confronted a number of significant problems. Regulatory disallowances made utilities reluctant to plan new capacity. Environmental concerns resulted in legislation which greatly increased costs. Additional reforms, therefore, were clearly needed. These came at the federal level and dealt chiefly with the emerging wholesale power market. Two important laws were the Public Utility Regulatory Policies Act of 1978 (PURPA), and the Energy Policy Act of 1992 (EPAct).

9. Legislative Steps Toward Regulatory Reform

An important result of the political and economic upheavals of the 1970s was a growing wholesale power market. Heightened opportunities for wholesale trade in electricity materialized as a result of unanticipated price differences between alternative fuels, as well as excess generating capacity (Joskow, 1989). A critical piece of legislation which encouraged the growth of the wholesale market was the Public Utility Regulatory Policies Act of 1978 (PURPA). Title

I of PURPA directs the states to consider introducing time-of-day rates and interruptible rates, which are alternatives to traditional ratemaking methods. The more important section, Title II, requires utilities to purchase power from companies that attach generation equipment to an existing heat source (cogeneration) or companies that use renewable sources and waste fuels. Small independent generation facilities are included in this section if they meet certain guidelines laid out in the Act. These cogenerators and independent power producers are referred to as 'qualifying facilities'. While PURPA was passed in 1978, it did not have significant effects until the mid-1980s. The FERC did not issue regulations regarding PURPA until 1980, and several key issues were not resolved until court rulings in 1983.

PURPA gave little guidance as to how these transactions were to be carried out, aside from stating that utilities had to purchase excess electricity from qualifying facilities at a price that could not exceed the 'incremental cost to the utility of alternative electric energy'. PURPA was important because it created an independent generation sector, not subject to rate-of-return regulation that provided alternative energy sources at a time when established utilities were reluctant to construct their own additional generating capacity. This law, along with economic change, provided the first real opportunity for independent firms to produce electricity without encumbering rate and entry regulations. Available evidence reveals that the resulting wholesale power market is quite competitive. Joskow (1989, p. 189) summarizes:

> The experience since the enactment of PURPA indicates that there exists a very elastic supply of capacity that independent producers are willing to offer at attractive prices. In addition, active markets for short- and medium-term power in excess of the current needs of integrated utilities have emerged in most areas of the country. These markets are subject to only very loose FERC regulation. As a result of extensive interconnections, coordination arrangements, and voluntary wheeling, the anecdotal evidence suggests that these markets are often very competitive.

This independent generating sector has become an important component of the industry. As Baumol and Willig (1995) note, additional units of generating capacity are now just as likely to be provided by non-utility generators (NUGs) as by utilities. During 1990-91, NUGs added more net capacity then did utilities. Furthermore, forecasts suggest that the importance of NUGs will increase in the future. Michaels (1993) notes that, in 1983, NUGs provided only 2.5 percent of total US generating capacity. By 1991, however, NUGs were constructing over half of the new capacity installed in the US and provided over 9 percent of the total.

More recently, the Energy Policy Act of 1992 facilitated wholesale competition. This act gave the FERC expanded authority to order utilities to

provide wheeling services, thus further opening the wholesale power market (Baumol, Joskow and Kahn, 1995, p. 14; Walters and Smith, 1993). Pursuant to this provision, the FERC issued an order that requires all transmission-owning public utilities to open their transmission lines to eligible wholesale customers on a non-discriminatory basis. Providing access to the transmission network will increase competitiveness at the wholesale level and make the state regulator's job easier and their regulation more effective. However, it also creates considerable problems regarding utilities' existing investments, as discussed below. Importantly, the Energy Policy Act did not promote retail wheeling, which would enable retail customers to purchase power directly (Baumol, Joskow and Kahn, 1995, p. 14).

The Act also removed barriers to acquisitions contained in the Public Utility Holding Company Act of 1935 (PUHCA). It defined a new class of wholesale generators which are exempt from regulation under PUHCA, called 'exempt wholesale generators' or EWGs. It permits any person, including a registered holding company, to acquire an EWG, wherever located, or a foreign utility company (FUCO) without seeking prior approval from the Securities and Exchange Commission (which would have been required under PUHCA). Thus, owners of EWGs are exempt from PUHCA regulation. The exempt wholesale generators now constitute an important source of non-utility generation.

Therefore, the unintended consequence of PURPA was to move toward increasing competition in US wholesale electricity (Moorhouse, 1995). The Energy Policy Act then substantially strengthened this trend. In these laws, states retained much discretion to restructure their energy markets. As discussed in Lenard, Geddes and Block (1996), 46 states are currently studying options for restructuring their energy markets. California instituted a plan under which all consumers were able to choose their electricity provider on January 1, 1998. Massachusetts legislators recently announced that, beginning March 1, 1998, electric utilities will have to compete for customers. A rate reduction of 15 percent is guaranteed in the bill, and power companies are allowed to recover all of their past investments in generating facilities. Many other public utility commissions or state legislatures are close to adopting specific restructuring plans.

Each of these states is proposing that retail customers buy electricity directly from generators or other alternative suppliers. In such transactions, the traditional franchise utility would merely transmit and distribute power. The benefits to customers of such market arrangements are obvious: consumers will not be captive customers of a franchise utility, relying on regulators to assure that their utility does not charge excessive prices. Instead, consumers will be able to shop for power the same way they shop for long distance telephone carriers.

Competition between generators ultimately will lead to lower prices. For example, Maloney and McCormick (1996) estimated that retail competition would, in the long term, reduce the average residential customer's bill by 43 percent, or about $30. They also predicted large price reductions for commercial and residential customers. They estimate that the total gains to consumers are between $422.1 and $107.6 billion annually.

As a result of the growing competition in the industry, there has been increasing consolidation. As McLaughlin and Mehran (1995) document, for the entire period from 1960 to 1986 there were only 9 hostile takeover attempts in the industry, and none were successful. In the five years from 1986 to 1990, there were 13 takeover attempts, with one being successful. Recently, a number of utility mergers have been announced.

There has been much discussion of the importance of repealing old laws which encumber the industry in preparation for eventual complete deregulation. It is important that firms have the ability to optimally adjust to new market conditions. One focus of this research is on the Public Utilities Holding Companies Act. PUHCA was passed during the Great Depression in response to the failure of a number of utility holding companies and subsequent investor losses. The Act defines a utility holding company as 'any company which directly or indirectly owns, controls, or holds with the power to vote, 10 per centum or more of the outstanding voting securities of a public utility' (Section 2(a)(7)(A) of PUHCA). Numerous holding-company activities are subject to regulation under PUHCA, including the acquisition and sale of securities, the acquisition of utility assets, intercompany transactions, service, sales and construction contracts, and reports and accounts. Importantly, PUHCA places restrictions on mergers involving registered holding companies.

PUHCA remains a major barrier to utility takeovers. Numerous authors have discussed economic inefficiencies associated with the Act. For example, Geddes (1996) emphasizes its effects in inhibiting the market for corporate control. Lenard, Geddes and BLock (1996) emphasize its effects on limiting experiments in deregulation on the state level, as well as its redundancy. For additional analysis in a similar vein, see Joskow (1992) and Gordon (1992).

10. The Recovery of Stranded Costs

A prominent aspect of the electric utility deregulation debate involves the question of the recovery of utilities' 'stranded investments'. These are investments made under regulation which electric utilities, in a fully deregulated setting, would be unable to recover through prices. This question is relevant for many utilities that are facing regulatory reform.

Electric utilities estimate that they own between $100 and $300 billion of these investments, and almost one-third of the average electric bill in California is dedicated to paying off these costs (Michaels, 1996, p. 47). In some cases the potentially stranded costs exceed the entire equity value of the firm (Baumol, Joskow and Kahn, 1995, p. 36). This issue is crucial because it affects the pace and structure of deregulation.

There are several perspectives on the recovery of stranded costs. According to one view (see for example Baumol and Sidak, 1996; Sidak and Spulber, 1996) in the course of state regulation of utilities, the utility and the state formed an implicit 'regulatory compact'. Regulators imposed a burden on utilities to serve all customers and to construct plants in expectation of demand growth. In return, the utility received a legal monopoly and a 'fair' rate of return. This view implies that utilities are deserving of compensation for investments that were made under the compact which, in a deregulated setting, would not receive a fair rate of return. These authors thus contend that deregulation constitutes a form of breach of contract. They also suggest that (even if one does not accept the notion of a preexisting 'regulatory compact') utilities deserve compensation for what amounts to a 'deregulatory taking'.

Arguing in a somewhat different vein, Baumol, Joskow and Kahn (1995) present arguments in favor of the recovery of stranded costs. They suggest that both equity and efficiency considerations work in favor of recovery. In terms of equity, they argue that utility shareholders have not been previously compensated through allowed returns for such 'deregulatory risk', and that regulators approved these risk-allocation arrangements. They also contend that ratepayers benefited from the previous regulatory arrangement, in that much old equipment produced substantial value for ratepayers, even while some relatively new equipment has not. On the efficiency side, they submit that without stranded cost recovery it is unlikely that the most efficient supplier of electricity will prevail, since incumbent firms will be burdened by disproportionately large historic costs, and may not be able to effectively compete even if they are the least-cost provider. In other words, in order to provide a 'level playing field' for utilities in a deregulated setting, it is necessary to share these historical costs on a non-discriminatory basis. Otherwise the true efficient supplier will not be revealed through the market process.

On the opposite side of this debate, commentators, such as Michaels (1996), reply that there never was a regulatory compact and that utilities therefore should not receive compensation for stranded investments. They argue that, unlike typical contracts, there is no indication that a voluntary agreement was made between utilities and customers, whom the regulation was ostensibly created to serve. Indeed, Michaels (1996, p. 49) notes that the term 'regulatory compact' first appeared in 1983 in a legal decision. They also point out that many of these now stranded investments were made at utilities' urging. The

conclusion here is clear: utilities should not be compensated for losses associated with stranded investments.

In an interesting third view, Niskanen (1996) suggested that the problem of stranding is only necessitated by *forcing* utilities to provide access to their transmission services, a policy which does not respect property rights to the grid. That is, stranding of investment is created by the legislated deregulation of electricity markets through forced 'open access'. This has been recognized by other commentators as well. As Baumol, Joskow and Kahn (1995, p. 35) state, '[t]he possibility of these costs being "stranded" would obviously be greatly increased if franchised utilities were required to offer competing generators direct access to their retail customers via the utility-owned transmission and distribution systems'. Such a requirement is an element of recent legislative proposals.

Consequently, these writers maintain that concerns about deregulation constituting a 'taking' are justified only if access to the network is forced. Niskanen (1996, p. 17) states, '[m]andatory wheeling, whether at the wholesale or retail level, should be recognized as a restriction, a taking, of the property rights of a utility'. Regarding stranded costs, Niskanen's view is that property rights consist of the right to use, exclude, partition and sell property, but the property owner does not have a right to the *value* of his or her property. By suggesting that deregulation requires compensation because of a preexisting regulatory compact, utilities are asserting a right to the value of their property, which overextends their true property right.

Both the stranded investments and the takings issues could then be solved simultaneously if government would simply divest itself from the institutional setting. By eliminating state-enforced monopolies, and by letting utilities open the grid on their own, there would be no takings and no stranding. As an intermediate solution, this would allow utilities to recover some of their costs through the market process while respecting private property rights. Regardless of the approach that is ultimately adopted, it is likely that the 'stranded investments' issue will be central to the utility deregulation debate. Useful summaries of these views are contained in Baumol, Sidak and Michaels (1995) and Brennan, et al. (1996).

Interestingly, very similar issues of cost stranding are now arising in other industries which are in different stages of deregulation. In railroads, an important stranding issue arises when captive shippers of coal are given access to rails. A wave of mergers in this industry has brought about this concern. A similar issue arises in local phone networks between long-distance and regional carriers. Long-distance carriers are seeking access to the local carrier networks at a government-determined fee. Local phone companies respond that such access would strand much of their sunk investment. Therefore, the stranding of investment is an important issue in deregulation which cuts across numerous

industries.

11. The Natural Industry Structure

There has been considerable debate over the 'natural' market structure of electricity provision, and therefore the expected structure if complete competition were allowed. It has long been supposed that natural monopoly characteristics inherent in the industry, as discussed above, precluded effective competition, and that regulated, legally granted monopolies were necessary. Moorhouse (1995, p. 423) concisely summarizes this perspective:

> The traditional economic justification for the regulation or state ownership of electric utilities is that utilities are natural monopolies. Economies of scale and scope, and the economies associated with vertical integration mean that unit costs decline throughout the relevant range of production as output increases. Such economies preclude competition, according to the conventional view, because a single firm could supply the entire service area at lower cost than could two or more firms. Given its cost structure, an established utility could undercut its rivals and drive them from the market. Moreover, attempted entry represents a waste of resources either because of an unnecessary duplication of facilities or because such investment would not be viable in the face of undercutting. Secure from competition, the monopolist would exploit the consumer if not for regulation or state ownership.

This view implies that important variables for empirical examination include the degree of economies of scale and scope. Thus a number of studies of electric utilities involve these questions. For example, Hulbert (1969) concluded that economies of scale could be achieved in systems up to 25,000 megawatts. Alternatively, Johnston (1960) and Nerlove (1963) determined that scale economies were exhausted even for firms of relatively small size. Barzel (1964) used a input demand model which showed scale economies at the plant level. Galatin (1968) found both scale effects as well as technical change. Atkinson and Halvorsen (1976) used a profit function specification. Cowing and Smith (1978) provided a survey of the literature on estimates of production technologies.

In their landmark study, Christensen and Green (1976) examined economies of scale for US electric utilities and found that in 1955 there were significant economies of scale for almost all firms, but that by 1970 these economies had been virtually exhausted, and by then almost all utilities were operating in the flat portion of their average cost curves. Importantly, given how early this paper appeared in the deregulation debate, they submit that: 'We conclude that a small number of extremely large firms are not required for efficient production and that policies designed to promote competition in

electric power generation cannot be faulted in terms of sacrificing economies of scale'.

12. Reliability

A related branch of research focuses on the question of reliability. It deals with the 'public good' nature of reliability, as well as the optimal level of reliability for an electrical system. This question is particularly relevant under competition. Telson (1975) examined the question of the optimal level of reliability and found that current levels in the US were excessive. Munasinge and Gellerson (1979) developed a model for finding the optimal level of reliability. Bental and Ravid (1986) and Sanghvi (1983) discussed methods to measure the costs of outages.

There is a set of articles which emphasize that price, reliability and capacity should be jointly determined. Reliability is a feature of papers by Brown and Johnson (1969), Crew and Kleindorfer (1976, 1978), Sherman and Visscher (1978) and Chao (1983). Reliability is uniform throughout an electrical system, but customers differ according to their outage costs. Some articles have examined how prices should be set for customers with differing outage costs, but who consume the same level of reliability. Such studies include Chao (1983), Chao and Wilson (1986, 1987) and Woo and Toyama (1986).

C. The Experience in Other Utilities

In this part, I review literature focusing on several utilities besides electricity. I first review selected work on telephone utilities. In Section 14, I describe several studies in natural gas, and in Section 15, I review work in water utilities.

13. Telephone Utilities

Numerous interesting aspects of utility regulation are illustrated by the phone industry. I first briefly describe the regulatory history of the industry, and then review several important studies. In the US, the Mann-Elkins Act of 1910 first gave the Interstate Commerce Commission (ICC) the authority to regulate the intercity telecommunications market. Through entry control by the ICC, American Telephone and Telegraph (AT&T) obtained monopoly power in long-distance telephony, and was treated as a 'natural monopoly' (Viscusi, Vernon and Harrington, 1995, p. 487). It was believed that the need to string open-wire line (or coaxial cable) between cities raised the fixed costs of entering the market to the point were economies of scale were realized by single-firm operation. The Communications Act of 1934 transferred the power

to regulate price and entry into the inter-city phone market to the Federal Communications Commission (FCC), which continues to regulate telecommunications today. Thus, AT&T was a rate-regulated monopolist until the late 1950's.

The impetus for regulatory reform in this industry came from new technology: microwave transmission. This technology can transmit large amounts of information via radio beams, that is, without the use of extensive networks of wire or cable. Therefore, physical connection between two points was no longer needed for communications. In the 1950s, many firms began asking the FCC for permission to build private networks (Viscusi, Vernon and Harrington, 1995, p. 488). These requests led the FCC, in 1959, to issue the 'Above 890 Mc' decision, in which frequencies above 890 megacycles would be shared with private users. However, other users were not allowed to sell telecommunications services, so true competition was not established.

In 1963, Microwave Communications Incorporated (MCI) petitioned the FCC to allow it to enter a specific inter-city market (St. Louis-Chicago), as a competitor to AT&T. It was not until 1969 that the FCC approved the request. This decision began a process of partial deregulation of the industry by the FCC, but with extensive built-in cross-subsidies and AT&T as the dominant supplier. After seven years of antitrust litigation by the US Department of Justice, AT&T was broken up into seven holding companies, called the regional Bell operating companies. AT&T is now no longer involved in any monopoly markets. Additionally, local phone companies face competition from several sources, including cellular phones. Below, I review several specific studies of the telecommunications industry.

Oum and Zhang (1995) examine the effect of competition on the productive efficiency of the US telephone industry. Their model predicts that competition will reduce allocative inefficiency in the use of inputs, as caused by rate-of-return regulation (that is, the Averch-Johnson effect, discussed above). This is in addition to the usual improvements in technical efficiency observed when competition is introduced. They examine data over the 1951-90 period, and find that competition did in fact improve the allocative efficiency of incumbent firms.

There are several studies which examine the effect of 'incentive regulation' in telephones. Incentive regulation suggests alternative regulatory approaches, such as 'sliding scale' plans and 'price cap' regulation, as reviewed by Joskow and Schmalensee (1986). Some studies have found efficiency improvements from these methods. For example, Majumdar (1997) examined the effectiveness of incentive regulation on the productivity of US local exchange carriers. He found that there was a lagged but substantial effect on technical efficiency from a pure price-cap scheme. He also found positive effects on scale efficiency. However, Kridel, Sappington and Weisman (1996) conducted a survey of studies on the effects of incentive regulation in the telecommunications

industry. Collectively, the studies examine productivity, investment, profit levels, new service offerings and regulatory proceedings. They find no strong evidence that incentive regulation significantly reduced the costs of providing telephone service, nor has it substantially streamlined regulatory proceedings.

As suggested above, a critical policy issue is whether or not the pre-divestiture Bell System was a natural monopoly. This requires detailed tests of the subadditivity of the cost function, as mentioned in Section 2. Previous studies of this issue, such as Evans and Heckman (1983), suffered from poor data quality (as they note). However, Shin and Ying (1992) attempt to overcome these data problems by focusing on local exchange carriers (which allow more degrees of freedom than previous tests). Their global subadditivity tests demonstrate that the cost functions of these firms are definitely not subadditive. Their results suggest that permitting entry and increasing competition in the local exchange market would enhance efficiency.

There have been many studies of the local telephone market, where there has been rapid regulatory change. For example, Green and Lehn (1995) suggest that recent developments in the telecommunications industry have increased the likelihood that the regional Bell operating companies (RBOCs) will face new competition in the local telephone service market. They detail major developments in these markets, including the FCC's decision to facilitate entry and application of new technology to the local telephone market, as well as strategic decisions by AT&T, MCI and Time-Warner to enter the market. They use event-study methodology to estimate the announcement effect of several events on the equity values of the RBOCs. They find that there is a negative and significant collective effect on their values. Cramer (1994) focuses on access and cable competition in local telephone systems in the US. He provides an overview of the development and scope of local phone competition, and some predictions as to the future of local service. In particular, he believes that policies will evolve to encourage cable companies to enter the telephone business.

14. Gas Utilities

In this section, I review several studies of the natural gas industry. Crandall and Ellig (1997) provide a summary of natural gas regulatory reform in the 1980s and 1990s. Barcella (1996) provides an overview of the current structure of the industry. She finds that competition is well entrenched in the production sector of the industry, and is moving downstream into the transportation sector as well. She finds that there is increased 'unbundling' in the industry, as gas production is being separated from the sale of pipeline transportation services and local distribution services. 'Gas marketing' has emerged as a new industry, which will likely be affected by upcoming electric utility deregulation, and

transformed into a multi-fuel marketing industry.

De Vany and Walls (1994) examine recent regulatory changes in the gas market. Their article describes the institutions that were developed to support exchange in gas markets, and studies the performance of these institutions. They find that spot gas prices have converged and become highly correlated. Doane and Spulber (1994) examine the spot market in natural gas. They focus on the wellhead spot price of gas from 1984 to 1991 to see if open access affected the geographic scope of the spot market. They apply three statistical tests, including spot price correlations, Granger causality, and cointegration, and find that open access integrated the regional markets into a national competitive market for gas. King and Cuc (1996) also study the degree of price convergence in the US spot gas market since deregulation. Using a Kalman Filter (time-varying parameters) approach, which allows measurement of the strength of price convergence, they find that the degree of price convergence has increased significantly since deregulation in the mid-1980s. However, they emphasize that it is not yet correct to speak of 'one price' in North American gas markets.

In reference to Europe, Grais and Zheng (1996) examine the potential benefits of East-West gas trade within the context of a game-theoretic model. They emphasize that economic change in the former Soviet Union and Eastern Europe have heightened uncertainties in this gas trade. Their model shows how to modify the trade contract to accommodate changes in the economic environment.

15. Water Utilities

Water utilities have been somewhat less frequently studied than other utilities. Nevertheless, there are many interesting contributions, several of which I review here. Many of these focus on the proper pricing for water services. For example, Zarnikau (1994) examines economically efficient water rates. He advocates the application of short-run marginal cost or spot market pricing principles to the pricing of water resources. Kim (1995) also examines the pricing of water services. The article's focus is on current pricing systems relative to marginal cost and second-best pricing rules. He estimates a translog multi-product cost function for US water utilities, and finds that the existing price structure does not depart significantly from second-best pricing principles, but does depart from marginal cost pricing. Similarly, Renzetti (1992) examines water supply costs and demands using data from Vancouver, Canada in order to estimate the welfare gain from altering water prices. His results show that a move to seasonally differentiated pricing raises aggregate surplus by four percent, which is higher than previous estimates. Raffiee et al. (1993) examine the efficiency of public versus private water providers by calculating

the difference between the observed cost and the optimum cost. The latter is found using the 'Weak Axiom of Cost Minimization' for each water utility. They find that privately owned water utilities are more efficient than public.

D. Utilities in Europe

16. Utilities in Europe

In this section, I briefly review several contributions to the literature on European utilities. Since Europe is introducing competition in several utilities, this literature is rapidly growing. With regard to environmental issues, Burtraw (1993) discusses the use of international tradable sulfur dioxide emission permits in Europe, with an emphasis on electric utilities. Because tradable permits provide agents with powerful economic incentives to reduce emissions at least cost, this method of controlling for acidification has met with great success in the US. Environmental goals have been met at low cost. Burtraw argues that, because of economic unification and the liberalization of energy markets in Europe, permits have wide potential application there. However, he points to several institutional features of the European electric utility industry that may undermine the effectiveness of transferable permits.

Grohnheit and Olsen (1995) discuss the consequences of introducing a competitive electricity market in the Nordic countries. They note that Britain and the Nordic countries are instituting many competitive reforms in their power sectors, and argue that opening up a competitive electricity market has the potential to create substantial efficiency gains. They focus on the use of combined heat and power for district heating, and demonstrate that it would be competitive in an open electricity market.

Percebois (1994) focuses on natural gas markets in Europe. He finds that natural gas is being increasingly used in the generation of electricity, and examines the likelihood and desirability of deregulation of the industry. He argues that the prospects for its growth in Europe are promising, but only with continued government involvement. Monnier (1993) focuses on the electricity market in Europe. The first part of his article provides a survey of the economics of electricity, and an overview of the structure of the industry in Europe. The second part examines the debate over electricity restructuring in Europe, but focuses on three questions: (1) What is the future of the electric utility industry in Europe?; (2) How will competition evolve in Europe?, and (3) How will this affect government versus private ownership of utilities?

Doyle and Maher (1992) also focus on electricity. They find that electricity supply is under increasing pressure to become competitive, and that the experience in the United Kingdom demonstrates the feasibility of regulatory

reform in Europe. They examine the relationship between the generation, transmission, and distribution sectors of the industry, and find that open access to the grid is desirable if accompanied by common carriage requirements and a competitive generation sector. They also examine the pricing of transmission services under open access.

Amundsen and Singh (1992) examine risk-sharing arrangements which allow consumers and producers to hedge their price-risk in European electricity markets. Specifically, they examine the feasibility of establishing futures markets in electricity in Europe, with a focus on the United Kingdom and Norway. While there is sufficient price uncertainty to justify such arrangements, they are skeptical about the competitiveness of new spot-markets.

17. Summary and Conclusions

In this chapter, I have attempted to provide an overview of the utility literature. Since the term 'utility' has been used to refer to a broad range of industries, this literature is quite large. I discuss several issues important for utilities generally. These issues include a discussion of the original justification for utility regulation, a comparison of alternative theories of regulation, an examination of the distortionary effects of regulation, an overview of the effects of utility deregulation, and a discussion of ownership form. These issues were then applied to the specific case of the electric utility industry. This industry is of particular importance today, perhaps most importantly because it is very large and is now undergoing substantial regulatory change.

It appears that reform of utility regulation has been very successful, with large net welfare gains accruing to society. While many studies focus on the US case, the results have important implications for utilities in Europe and elsewhere. Utilities face differing ownership structures across countries, but they share common structural characteristics. Thus, it is likely that utility regulatory reform will have similar beneficial effects in other institutional settings.

Acknowledgements

I am grateful to William Niskanen, Juri Hwang, and two anonymous referees for helpful comments, and to Yi Luo for capable research assistance.

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