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EMPIRICAL STUDIES OF UTILITY REGULATION

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During the past fifteen years, numerous studies have been published that purport to demonstrate quantitatively the effects of price and profit regulation on regulated monopolies. The purpose of this paper is to provide a brief, minimally technical summary and evaluation of these studies. For the most part, the fine theoretical and econometric details are ignored in favor of an exposition of the general approach that researchers have taken to the problem of estimating regulatory effects. While the primary focus is on studies of so-called "natural monopolies," references are also made for purposes of comparison to studies examining the effect of regulation on competitive markets. The Bibliography contains the standard references on the empirical effects of price regulation in all the basic infrastructural industries -- energy, telecommunications and transportation -- whether competitive or monopolistic.

Empirical studies of utility regulation can usefully be divided into three categories: analyses of prices directly, with little or no reference to the cost and production relations of the firms or industries under examination; estimates of cost and/or production functions, which are then used to measure the divergence of output and input mix from the economic optimum; and investigations of the innovative performance of regulated firms. The price studies,

examined more closely in the first section of this report, generally conclude that regulation has had no discernible effect on prices in the utility industries until quite recently. Yet studies based upon estimates of cost and production functions normally conclude that regulation increases costs of the regulated service. The combined implication of these findings is that regulation erodes monopoly profits not by reducing prices and expanding output, but by creating costly inefficiency. The resolution of this apparently paradoxial result is not difficult, for technical flaws of analysis in both sets of studies make the validity of their findings dubious. The final section offers a few conclusions and speculations regarding the true messages contained in the literature under scrutiny.

This paper does not deal in detail with the research on the effect of regulation on technological change. The studies undertaken to date are not successful in proving or disproving a general, pervasive effect of regulation on innovation. The best papers examine the development and diffusion of specific innovations, perhaps then offering a few tentative generalizations based upon these stories. Outstanding examples include the study by Hughes of electrical power generation and by MacAvoy and Sloss of the adoption of the unit train. Other notable studies are those by Gellman, Shepherd and Phillips. Since economists have not been notably successful in estimating empirically the effect of regulation on static efficiency or of conditions in unregulated markets on progressivity of firms, it is, at this date, too early to expect much progress on the more complicated issue of the effect of regulation on innovation.

DIRECT PRICE COMPARISONS

The simplest approach to studying the effects of regulation is to make a straightforward comparison of prices in markets subject to different regulatory schemes, including the complete absence of regulation. Electric utilities are sufficiently numerous and, historically, subject to a sufficiently wide variety of regulatory systems that direct comparisons of their prices are potentially useful.

Kofoglis and Needy have recently published data on the level and dispersion of prices by class of customer for large, privately owned electrical utilities across the country. Table 1 shows the mean price for consumer power and the mean degree of price dispersion, according to their measure,[1] for several states. Unregulated states are, in the table, grouped with contiguous, regulated states which presumably face similar cost and demand conditions. Obviously, the table reveals no visible effect of regulation; more detailed statistical

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[1] Kofoglis and Needy use a version of the gini coefficient to measure rate dispersion, based upon a diagram that plots the percentage of output consumed by a customer class against the percentage of revenues supplied by the same class. The dispersion index measures the extent to which the distribution of revenue diverges from the distribution of power use; the modified index calculates the dispersion that would result if the price structure of each firm were applied to the distribution of output among classes that is the average for all firms.

TABLE 1: ELECTRICITY PRICES BY REGULATORY STATUS, SELECTED STATES[a]

Group		Regulator Status[b]	Average Price: Residences	Measure of Price Spread[c] Crude	Adjusted	Number of Firms in Sample
I	Texas	UR	2.25	.226	.225	11
	Oklahoma	R	2.33	.311	.240	2
	Lousiana	R	2.13	.297	.247	4
II	South Dakota	UR	2.73	.234	.240	1
	North Dakota	R	2.76	.164	.185	2
	Kansas	R	2.32	.223	.207	3
	Montana	R	2.26	.320	.296	1
III	Minnesota	UR	2.45	.181	.176	2
	Wisconsin	R	2.23	.144	.141	9
	Iowa	NR	2.64	.179	.179	6

[a] Calculated from Kofoglis and Needy, Appendix. Figures are unweighted averages of firm data.

[b] Key: UR - Unregulated, R - regulated, NR - newly regulated (1966).

[c] Based upon modified gini coefficient; see text.

tests on firm data would reveal no statistically significant effect of regulation on prices.

One difficulty with the preceeding approach is that with regulation now in force in nearly all states, firms in unregulated jurisdictions may respond to the threat of regulation by matching the performance of regulated firms. Recognizing this possibility, Stigler and Friedland examined historical price data for the early twentieth century when fewer states subjected electrical utilities to regulation. In each of several years, they compared rate levels in the two categories of states, and found no consistent, statistically significant effect of regulation.

Of course, the regulation/no regulation distinction is very crude. So-called unregulated states assign regulatory responsibility to localities, and state regulatory authroities differ significantly in the method of regulation they employ and the diligence with which regulation is pursued. Since the Stigler and Friedland regressions normally find a negative relation between prices and regulation, even though it is statistically insignificant in all but one case, it is possible that their conclusions regarding no causal realtion are unjustified simply because their measure of regulation is too crude.

C. G. Moore attempted to overcome this problem by developing an index of the intensity of regulation. Moore surveyed state public utility commissions to determine their expenditures on electricity regulation, then divided these expenditures by the population served by regulated utilities. This was then used as a measure of the

intensity of regulation in a statistical analysis of interstate differences in electricity prices. Moore found a significant, positive correlation between prices and regulatory intensity, and concluded that the greater is the expenditure on regulation, the higher are the resulting prices to consumers.

This finding is consistent with the results of studies of the effect of regulation in most competitive industries.[1] Levine was the first of many to notice that airline fares are lower in unregulated intrastate markets than for interstate routes regulated by the Civil Aeronautics Board (CAB). Farmer, T. G. Moore (1975), Sloss, and Switzler and Byrne have all made slightly different comparisons between regulated and unregulated trucking prices, and have all concluded that the Interstate Commerce Commission (ICC) causes higher prices than unregulated competition would produce.

One difficulty with most price comparisons is that the results can be due to several causes besides regulation that produce a spurious correlation between costs and the presence of regulation. In transportation, studies of the change in prices at the time regulation was imposed have left little doubt about the causality between regulation and prices. The Switzler and Byrne studies measured the price effect of a change in the list of types of

[1] The only price regulators clearly lower is the field price of natural gas. See Breyer and MacAvoy, Erickson and Spann, Helms, MacAvoy (1973) and Pindyck.

shipments that were exempted from ICC regulation, and Spann and Erickson estimated that the increase in long-haul rates on railroads far more than offset the decrease in short-haul rates following the establishment of the ICC.

In other areas, notably utility pricing, the failure to include cost factors or to examine the effects of changes in regulatory status makes the results of the studies of price differences of dubious value. Interstate differences in costs can arise for numerous reasons: the availability of cheaper hydro-electric power, the availability and price of alternative fuels, the magnitude of the market in franchise areas and the extent of pooling (the last two affect the extent to which scale economies can be captured). C. G. Moore's results, for example, may arise because states with high per capita expenditures on regulation have smaller, more dispersed populations which can be supplied only at higher costs. It would be surprising to find that the number of customers of regulated firms was, in any event, the relevant factor in determining the costs of any given degree of regulatory intensity. The number of firms and the expansion of capacity in the industry presumably affect the costs of any given degree of intensity of regulation more directly than does the number of consumers served.

All price studies suffer from still another problem. The decision to regulate or to increase the amount of resources available to regulatory authorities is presumably based on some rational calculus by actors in the political system. Hence, the decision to adopt particular state regulatory policies would not be independent of

the performance of utilities. If regulation is a response to general public sentiment for lower prices, one might expect states with higher prices to be among the first to impose regulation and to devote the most resources to regulating. Or, if, as Stigler maintains, regulation is a response to protectionist demands of regulated firms, one would expect, _cetris paribus_, that regulation would be imposed first, and most extensively, in jurisdictions with lower prices owing to greater competition. In either case, a single equation estimate of the relation between prices and regulation proves nothing; it measures the composite effects of prices on the propensity to regulate and of regulation on prices.

Studies of the relationship between regulation and profits also show no significant correlations. MacAvoy (1971), and Breyer and MacAvoy, provide evidence that the Federal Power Commission (FPC) sets the allowed rate of return sufficiently high that firms do not earn it. Eads (1971) makes the same point with respect to CAB regulation. Stigler and Friedland notice no effect of regulation on equity returns of electric utilities. McDonald, without referencing the effects of regulation directly, estimates that the cost of equity capital for most firms is about one percentage point higher than the interest rate it pays on long-term bonds. If so, assuming a debt/equity ratio of unity, the allowed rate of return need only be one-half a percentage point above the long-term bond rate for the utility, yet, until recently, allowed rates of return were normally substantially higher than this.

Recently unusually rapid inflation has depressed the

prices of utility securities (Keran). Joskow (1974) argues that this is to be expected. Rising nominal costs substantially increased the case load of regulatory authorities and shifted the costs of delay from consumers to producers, since the ultimate consequence of regulatory decisions shifted from reductions to increases in prices after inflation and environmental policies began raising nominal costs.

Joskow and MacAvoy, in analyzing the financial condition of electric utilities, have estimated that current capital market conditions will enable electric firms to raise sufficient capital to equate energy supply and demand only if allowed rates of return are raised to between fourteen and sixteen percent. These results appear in conflict with the findings of Keran and McDonald; the one percent rule of the latter suggests allowed rates of return of around ten percent, while the finding of the former regarding the behavior of utility equities prices, holding dividends constant, suggests a similar figure. Unfortunately, the Joskow and MacAvoy analysis has not yet appeared in sufficient detail to permit comparison of these studies. One potential problem with the study is the possiblility that its projections are heavily influenced by disequilibrium conditions in the early 1970s arising from increasingly stringent environmental policies, rising (rather than higher but steady) interest rates, rapid increases in fuel prices, and the unavailability of natural gas due to interstate regulatory policies. Nevertheless, all findings are consistent in one respect: rate of return limits on regulated firms have, indeed, become binding during the past few years. Whether the constraint is so tight that it

pushes the returns of the firm below the competitive level, or just erodes some monopoly fat that was included in the old limits, remains an open issue.

COST AND PRODUCTION STUDIES

The most interesting empirical work on the effects of regulation uses the conventional building blocks of microeconomics, supply and demand relationships, to measure the effects of regulation.

Several studies of the effect of regulation on the electrical utilities industry are based on cost analyses. Emery provides evidence that electrical utilities were not participants in the equipment manufacturers' conspiracies of the late 1950s by showing that prices paid by regulated firms for generating equipment did not differ by type of regulation. His approach is to estimate a cost function for installed electrical capacity, and then test the residual errors in that equation for systemmatic relationships with the type of regulation imposed upon the firm. Unfortunately, Emery confines his test to measuring the difference between regulation based upon replacement costs and regulation based upon original cost; he does not include in his sample either unregulated private firms or municipally owned utilities, nor does he explore in more than cursory fashion the possible presence of systemmatic changes in prices paid when regulatory status changed. Empirically, his proposition that no conspiracy existed remains unproven, although his theoretical argument is persuasive.

Petersen has also estimated cost functions for electric utilities with the objective of identifying shifts in the cost function attributable to regulation. His cost functions include three variables that measure the extent of regulation: a zero-one dummy representing states which have public utilities commissions, another zero-one dummy for states that estimate allowed costs on an original cost basis, and the difference between the allowed rate of return and equity cost of capital. Petersen's results are that the regulation dummy and the measure of monopoly return are statistically significant in the cost function, and of the expected sign -- that is, regulated firms have higher costs, while high profit firms have lower costs -- but that the type of regulation is not significant.

Petersen's results do not prove that regulation increases costs, and increasingly so as regulation tightens. McKay has shown that the regulation dummy measures primarily whether a firm is located in Texas, which, in addition to having no state regulation, also has had more readily available supplies of natural gas. Building thermal plants designed only for burning gas reduces capital costs, and McKay shows that in states with ample gas supplies capital costs are lower, regardless of regulatory status, than in other states. In addition, Petersen's results with respect to monopoly rents are also of uncertain meaning. They could, for example, reflect a tendency on the part of regulators to reward more efficient firms by allowing higher profits, or they could simply reflect a regulatory lag effect -- the high profit firms may have lower costs because, on average, they capture greater productivity

increases between regulatory reviews. One would expect, for example, that as long as productivity advances exceed the rate of factor cost inflation, firms in rapidly growing jurisdictions would have higher profits since they would add more new, highly productive facilities between rate cases. None of these aspects of the problem are considered by Petersen.

T. G. Moore (1970) and MacAvoy and Noll have attempted to estimate the effects of regulation by estimating both cost and demand functions, and then investigating the divergence of regulated prices from unregulated, profit maximizing ones. Moore's study examines electric utility prices, while MacAvoy and Noll consider interstate pipelines. Both studies reach ambiguous conclusions, with some variants of the models showing no price effect of regulation and others showing a small price-reducing effect. Moore applies his model to publicly owned utilities, and does find that they charge significantly lower prices than would a profit-maximizing monopolist, so that even if regulation does have some price effect, Moore concludes, it is small compared to the effect of public ownership.

Both studies suffer from the problem of trying to estimate a demand function without having access to appropriate price data. Both electric utilities and pipelines use multipart tariffs, and marginal price data are not readily available. Moore uses the average price for customers purchasing 250 kwh per month. As Taylor has argued, such a procedure produces biased estimates of the elasticity of demand. Furthermore, it eliminates variability in

the price structure as part of the profit-maximizing strategy of the firm; Moore has, essentially, found the revenue maximizing point on the average price curve, given the mean price structure of utilities, but not necessarily the combination of price structure and average price that is optimal to the firm.

MacAvoy and Noll were able to gather data on marginal prices for regulated pipeline sales, but could not locate such data for unregulated sales. Their paper makes two comparisons: average prices in both markets, and marginal price in regulated markets contrasted to average price for unregulated sales. The latter shows a small, negative effect of regulation on prices, while the former indicates that the regulatory constraint is not binding.

Another indirect test of the effects of regulation can be inferred from Primeaux. Using cost data from electrical utilities that have overlapping franchise areas in which two firms, one private and one public, compete for customers, Primeaux estimated cost functions for municipally owned monopolistic and duopolistic producers. Primeaux found that duopolistic firms have significantly lower average costs, and that only monopolistic firms exhibit scale economies. At an output of 222 million kwh per year, the scale economies offset the average cost advantage, so that, Primeaux concludes, duopolistic markets can be justified on cost grounds only in small markets. This conclusion, however, is not justified, for only three of the twenty-three competitive firms in Primeaux's sample produce more than 200 million kwh per year, while ten of the twenty-four monopolistic firms produced more than this amount of

power. Consequently, the error in estimated costs of large monopolistic firms, being well within the range of observations from which the equation was estimated, is likely to be considerably smaller than the errors in estimates of costs for competitive firms. This problem is a natural consequence of Primeaux's decision rule for selecting his sample of monopolistic firms: to hold constant as many extraneous factors as possible, Primeaux attempted to match each competitive firm with a noncompetitive one in the same state, with the same power source, and of the same size. If the last criterion could not be satisfied, a larger monopolistic firm satisfying the other criteria was matched against the competitive one, hence the difference in mean firm size in the two samples.

One possible criticism of Primeaux's work is that it deals only with nonprofit firms. Lacking the profit incentive, monopolistic municipals may be prone to be inefficient, whereas competitive municipals, facing the benchmark of a profit-oriented firm, can not afford that luxury. If so, Primeaux's finding may not be applicable to privately owned utilities. The likelihood that this is the case is somewhat mitigated by the finding of T. G. Moore [1970] that municipals do have significantly lower average prices than do for-profit firms, at least for the large firms in Moore's sample.

The significance of Primeaux's work lies in the nature of the "regulatory bargain" between utilities and the political system. Regulation was imposed on firms in return for acquiescence to the creation of monopolistic franchise areas. Primeaux's finding,

if valid, suggests that creating these local monopolies generated production inefficiencies which, for small firms at least, offset whatever scale economies monopolization might have made possible.

Recently several scholars have undertaken to test empirically the most famous of theoretical propositions about regulation, the hallowed A-J effect, named after the celebrated paper by Averch and Johnson. The theory predicts that, at current output, firms subject to regulation based upon a fair return to capital will use excessively capital intensive production technologies.

To test the A-J effect requires specification of the production trade-offs facing a firm.[1] This enables a test of the

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[1] Petersen's test of the relationship between total cost and excess profits is not a test of the A-J effect, although his finding is consistent with the A-J predictions. One result of the A-J theory is the prediction that the more binding the regulatory constraint on profits, the greater the propensity of the firm to substitute capital for labor and hence to incur unnecessarily high production costs (see Baumol and Klevorick).

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extent to which the factor proportions of a firm diverge from the cost-minimizing optimum for the rate of output selected. Four recent studies have performed such a test: Boyes, Courville, McKay and Spann. The score thus far is two to two.

Boyes, Courville and Spann all take essentially the same

approach. Each estimates a production function for the annual electricity output of a thermal power plant, with one of the inputs being the capital costs of the facility. Courville and Spann use labor and fuel as the other two inputs to the production function, while Boyes uses these plus maintenance expenditures. Each estimates a different form of production function: Courville -- Cobb-Douglas, Spann -- translog, and Boyes -- CRES. Courville's test is based upon data from the period 1948 to 1966, excluding 1956-59 because (1) it produced different results than the other vintages and (2) it was the period of the electrical machinery manufacturers' conspiracy (see Emery). Spann uses data from 1959 to 1963, and Boyes considers only data from the conspiracy period -- 1956-59. All include in their sample only new plants. Courville and Spann find a significant A-J effect, and Boyes does not; however given Courville's statement that the period used by Boyes was excluded because it produced strange results, it is certainly likely that Courville and Boyes agree on the 1956-59 results, and conceivable that Boyes would have reached different conclusion had he used a different set of data.

Unfortunately, data problems are the least of the worries surrounding these papers. McKay has offered several killing points about any test structured along the lines of these studies.

McKay's central point is that the use of capital costs as the measure of capital inputs confuses two distinct components of capital inputs: the capacity of the individual generating unit and, given the capacity, the selection of a thermal efficiency

for the plant. With respect to the latter, a firm can substitute capital for fuel by spending more money on a plant that converts fuel to electical energy more efficiently. The A-J effect would be observable at the plant level only if firms selected facilities that were excessively efficient in converting fuel to electricity; consequently the relevant measure of capital for testing the A-J hypothesis is the "heat rate" or energy loss of the plant, not total capital expenditures, and the relevant measure of output is instantaneous power supply, not annual production.

Second, picking up on a suggestion by Spann, McKay has noted that taxation can offset the A-J effect. If utility investments are taxed more heavily than other forms of capital, taxation will to some degree offset the incentive the regulated firm has to use capital excessively. McKay shows that Spann's results disappear if account is taken of the effects of taxation.

McKay also reestimates Courville's model, using the same data, but including more appropriate measures of inputs and outputs. He finds that, if anything, generating facilities are not as thermally efficient as would be economically optimal. Of course, McKay's results do not prove that the A-J effect is not present; it could occur in other forms related to the design of the entire electrical generation and distribution system, for example. But his results do indicate that the A-J effect is not present in the form of substitutions of capital for fuel at the plant level.

Studies of the effects of regulation in monopolistic industries must be regarded as inconclusive. This is not the

state of affairs in the literature regarding regulation of competition. Eads (1975), Keeler, and Douglas and Miller, have documented the cost-increasing effects of service competition in the airline indsutry, and illustrated how CAB regulation has produced this result. Friedlaender, Harbeson, T. G. Moore (1975), Meyer et al. and Peck have produced a series of cost-based estimates of the resource misallocation due to the regulation of surface freight transportation. Sparling has shown that, with a few corrections, these studies can be brought to rough conformity. Although the magnitude of the misallocation Sparling estimates is about half that of previous studies, it is nevertheless substantial, and there remains no widespread disagreement over this fundamental qualitative conclusion. Obviously, the state of affairs is not so settled in examinations of the effect of regulation on monopolies.

Conspicuous by its absence in the preceding discussion is reference to studies of the effect of regulation on the telecommunications industry. Unfortunately, there is simply no empirical literature on the effects of regulation on costs, input choices and prices in telecommunications. Part of the problem is the difficulty that researchers outside of the industry face in assembling data to estimate valid demand, cost and production relations, with only demand studies prominent in the literature (see, especially, Littlechild). The internally produced studies, while occasionally interesting (see, especially Davis, Caccapolo and Chaudry) tend to avoid all possible explicit connections of performance to regulation. Another part of

the problem is the difficulty in sorting out the effects of regulation from the effects of AT&T's large market share. Since both AT&T and regulation of telecommunications are ubiquitous, a researcher faces an enormous task, indeed, in separating one effect from the other.

CONCLUSIONS

The folklore of regulatory economics that has developed in the past decade is that regulation does not affect prices or profits, but it does create inefficiency. Stated so bluntly, the inconsistency of the prevailing wisdom is embarrassing: obviously you can not have your A-J and Stigler, too.

Well-behaved members of the research cartel must conclude all surveys with a call for more research. Certainly no field of economics needs solid empirical work more desperately.

While the existing literature is frought with difficulties that make its findings ambiguous, a few problems stand out as especially important, and perhaps within human control.

First, economists have not been especially careful in selecting functional forms to estimate when trying to characterize costs or production functions. Good empirical research on regulated industries, especially those employing relatively complex technology, probably requires at least a passing familiarity with the engineering, as well as the economic, realities of the production relations faced by regulated firms. Research on transportation industries has probably been more successful in this regard (perhaps the task is

easier), although the results do not appear to have filtered down to the Interstate Commerce Commission (see Grilliches).

Second, regulators should pay some attention to the advice of staff economists in deciding upon the kinds of data that they require from regulated firms. Data that are inappropriately aggregated -- such as FPC data on average fuel bills -- are next to useless in econometric modeling, and prevent regulatory authorities from acquiring maximum possible understanding of the consequences of their actions.

Third, economists should follow the lead of studies such as MacAvoy (1971) and the three papers by Joskow (1972, 1973 and 1974) by devoting more attention to the process by which regulatory decisions are made. Such studies provide some insight into what regulators believe they are regulating and what basis they perceive to have for the decisions they make. Models based upon the stated objectives and actual procedures of regulatory agencies may generate empirically testable hypotheses about the effects of regulation -- intended and unintended -- that present research has not considered. In any event, the voluminous A-J literature, ignoring as it does the facts that most regulators are principally interested in regulating prices and costs, not profits, and that firms are concerned with optimization over time when making long-term capital investments, probably has been more obfuscating than illuminating to empirical researchers.

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