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BEHAVIOR OF THE FIRM UNDER REGULATORY CONSTRAINT

By HARVEY AVERCH AND LELAND L. JOHNSON*

In judging the level of prices charged by firms for services subject to public control, government regulatory agencies commonly employ a "fair rate of return" criterion: After the firm subtracts its operating expenses from gross revenues, the remaining net revenue should be just sufficient to compensate the firm for its investment in plant and equipment. If the rate of return, computed as the ratio of net revenue to the value of plant and equipment (the rate base), is judged to be excessive, pressure is brought to bear on the firm to reduce prices. If the rate is considered to be too low, the firm is permitted to increase prices.

The purpose here is (a) to develop a theory of the monopoly firm seeking to maximize profit but subject to such a constraint on its rate of return, and (b) to apply the model to one particular regulated industry—the domestic telephone and telegraph industry. We conclude in the theoretical analysis that a "regulatory bias" operates in the following manner: (1) The firm does not equate marginal rates of factor substitution to the ratio of factor costs; therefore the firm operates inefficiently in the sense that (social) cost is not minimized at the output it selects. (2) The firm has an incentive to expand into other regulated markets, even if it operates at a (long-run) loss in these markets; therefore, it may drive out other firms, or discourage their entry into these other markets, even though the competing firms may be lower-cost producers. Applying the theoretical analysis to the telephone and telegraph industry, we find that the model does raise issues relevant to evaluating market behavior.

I. *The Single-Market Model*

First we shall consider a geometrical and a mathematical framework showing the effect of the regulatory constraint on the cost curves of the

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firm employing two factors. The essential characteristic to be demonstrated is: if the rate of return allowed by the regulatory agency is greater than the cost of capital but is less than the rate of return that would be enjoyed by the firm were it free to maximize profit without regulatory constraint, then the firm will substitute capital for the other factor of production and operate at an output where cost is not minimized.

Figure 1 denotes the firm's production where capital x_1 is plotted on the horizontal axis and labor x_2 on the vertical axis. The market or

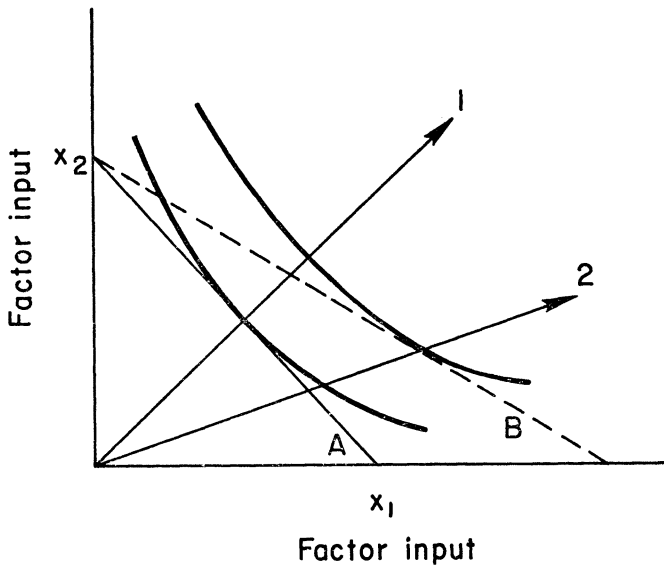


FIGURE 1

“social” cost of capital and labor generates the isocost curve *A* and the *unregulated* firm would move along expansion path 1 where market cost is minimized for any given output. With regulation, however, the cost of capital to the firm—the “private” cost—is no longer equal to market cost. For each additional unit of capital input, the firm is permitted to earn a profit (equal to the difference between the market cost of capital and rate of return allowed by the regulatory agency) that it otherwise would have to forego. Therefore, private cost is less than market cost by an amount equal to this difference. The effect of regulation is analogous to that of changing the relative prices of capital x_1 and labor x_2 : isocost curve *B* becomes relevant and the firm moves along expansion path 2—a path along which market cost is not minimized for any given output. The firm finds path 2 advantageous simply because it is along

that path that the firm is able to maximize total profit given the constraint on its rate of return.

Treating the problem mathematically, we now consider a monopoly producing a single homogeneous product using two inputs. Define

$$(1) \quad \begin{aligned} z &= z(x_1, x_2), & x_1 &\geq 0, & x_2 &\geq 0 \\ \frac{\partial z}{\partial x_1} &> 0, & \frac{\partial z}{\partial x_2} &> 0, \\ z(0, x_2) &= z(x_1, 0) = 0 \end{aligned}$$

as the firm's production function. That is, marginal products are positive, and production requires both inputs.

We write the inverse demand function as

$$(2) \quad p = p(z).$$

Profit is defined by

$$(3) \quad \pi = pz - r_1x_1 - r_2x_2$$

where the r_i ($i=1, 2$) are factor costs presumed constant for all levels of factor input.

Let x_1 denote the physical quantity of plant and equipment in the rate base, c_1 the acquisition cost per unit of plant and equipment in the rate base, u_1 the value of depreciation of plant and equipment during a time period in question, and U_1 the cumulative value of depreciation. Let x_2 denote the quantity of labor input and r_2 the labor wage rate. The regulatory constraint is:

$$(4) \quad \frac{pz - r_2x_2 - u_1}{c_1x_1 - U_1} \leq s_1$$

where the profit net of labor cost and capital depreciation constitutes a percentage of the rate base (net of depreciation) no greater than a specified maximum s_1 .

For simplicity, we assume that depreciation (u_1 and U_1) is zero and we define capital so that its acquisition cost or value c_1 is equal to 1, i.e., the value of the rate base is equal to the physical quantity of capital.¹ The "cost of capital" r_1 (to be distinguished from the acquisition cost of plant and equipment measured by c_1) is the interest cost involved in holding plant and equipment. The allowable rate of return s_1 is the rate of return allowed by the regulatory agency on plant and equipment in order to compensate the firm for the cost of capital—the interest

¹ Alternatively, one could construct a dynamic rather than a static model and consider positive values for depreciation; but to do so would complicate the results without contributing much additional insight into the behavior of the firm.

cost—involved in holding plant and equipment. Therefore, the constraint may be rewritten as

$$(5) \quad \frac{pz - r_2x_2}{x_1} \leq s_1$$

or

$$(6) \quad pz - s_1x_1 - r_2x_2 \leq 0.$$

For $s_1 < r_1$, the allowable rate of return is less than the actual cost of capital, and the firm withdraws from the market. For, from (6), if $x_1 > 0$,

$$pz - r_1x_1 - r_2x_2 = pz - s_1x_1 + (s_1 - r_1)x_1 - r_2x_2 \leq (s_1 - r_1)x_1 < 0.$$

If $x_1 = 0$, $\pi = -r_2x_2$ from (3), and the firm can further reduce its loss by setting $x_2 = 0$. Then $\pi = 0$. Therefore, $s_1 \geq r_1$; the allowable rate of return must at least cover the actual cost of capital.

The problem then is to maximize (3) subject to (6).² Define the Lagrangian expression:

$$(7) \quad L(x_1, x_2, \lambda) = pz - r_1x_1 - r_2x_2 - \lambda[pz - s_1x_1 - r_2x_2].$$

The Kuhn-Tucker necessary conditions³ for a maximum at $\bar{x}_1, \bar{x}_2, \bar{\lambda}$ are

$$(8.1) \quad r_1 \geq (1 - \lambda) \left[p + z \frac{dp}{dz} \right] \frac{\partial z}{\partial x_1} + \lambda s_1, \quad x_1 \geq 0$$

$$(8.2) \quad r_1 > (1 - \lambda) \left[p + z \frac{dp}{dz} \right] \frac{\partial z}{\partial x_1} + \lambda s_1 \quad \text{implies} \quad \bar{x}_1 = 0$$

$$(8.3) \quad (1 - \lambda)r_2 \geq (1 - \lambda) \left[p + z \frac{dp}{dz} \right] \frac{\partial z}{\partial x_2}, \quad \bar{x}_2 \geq 0$$

$$(8.4) \quad (1 - \lambda)r_2 > (1 - \lambda) \left[p + z \frac{dp}{dz} \right] \frac{\partial z}{\partial x_2} \quad \text{implies} \quad \bar{x}_2 = 0$$

$$(8.5) \quad pz - s_1x_1 - r_2x_2 \leq 0, \quad \bar{\lambda} \geq 0$$

$$(8.6) \quad pz - r_2x_2 < s_1x_1 \quad \text{implies} \quad \bar{\lambda} = 0.$$

Assuming $\bar{\lambda} > 0$, it is clear from (8.1) that $\lambda = 1$ if and only if $r_1 = s_1$. If $\lambda = 1, r_1 = s_1$. This does not involve any variables, and it follows that any x_1, x_2 which satisfies (8.5) is a solution.

² Since (6) is an inequality, we are faced with a nonlinear programming problem. However, the similarity of the results to ordinary marginal conditions is obvious.

³ If the total revenue function, pz , is concave in the relevant range of operation, it is clear that the Kuhn-Tucker conditions in this case are also sufficient. Given a concave pz , it is possible to define the dynamic gradient process corresponding to the static Kuhn-Tucker conditions showing the firm's input variation over time. But we do not do this here since we are primarily interested in equilibrium and the optimal inputs under regulation.

For $s_1 > r_1$, which is the interesting case, it follows that $0 \leq \lambda < 1$: From (8.6), s_1 may be chosen large enough so that $\lambda = 0$ (i.e., at some high level of allowable rate of return s_1 , the value $x_1 (s_1 - r_1)$ exceeds the level of unconditionally maximized profit, and the constraint is ineffective). If we now let $s_1 \rightarrow r_1$, λ varies continuously, and since $\lambda \neq 1$, we have $0 < \lambda < 1$. For the unregulated monopoly, the marginal conditions are:

$$(9) \quad r_i = \left[p + z \frac{dp}{dz} \right] \frac{\partial z}{\partial x_i}, \quad (i = 1, 2).$$

Under conditions of effective regulatory constraint ($\lambda > 0$) equations (8.3) and (9) disclose that, as in the case of unregulated monopoly, the input of x_2 is such that its marginal cost r_2 is equal to its marginal value product. In contrast, equations (8.1) and (9) disclose that the input of x_1 is such that its marginal cost r_1 is greater than its marginal value product,⁴ i.e., its use is expanded beyond the point at which its marginal cost would be equal to its marginal value product.

From equations (8.1) and (8.3) when the equalities hold, the marginal rate of substitution of factor 1 for factor 2 is:

$$(10) \quad \frac{-dx_2}{dx_1} = \frac{r_1}{r_2} - \frac{\lambda}{(1-\lambda)} \frac{(s_1 - r_1)}{r_2}.$$

Since

$$\frac{\lambda}{(1-\lambda)} \frac{(s_1 - r_1)}{r_2} > 0, \quad \lambda > 0, \quad s_1 > r_1,$$

then

$$(11) \quad \frac{-dx_2}{dx_1} < \frac{r_1}{r_2}.$$

The firm adjusts to the constraint, then, by substituting capital for the cooperating factor and by expanding total output. Comparative equilibrium outputs are shown in Figure 2. If the regulated firm were constrained to move along the socially efficient expansion path 1 in Figure 1, it would operate at OC in Figure 2. Here price is slightly above

⁴ Clearly

$$\frac{r_1 - \lambda s_1}{1 - \lambda} = r_1 - \frac{\lambda}{1 - \lambda} (s_1 - r_1) \geq \left[p + z \frac{dp}{dz} \right] \frac{\partial z}{\partial x_1}.$$

Since $0 < \lambda < 1$, $s_1 > r_1$, it follows immediately that:

$$r_1 > \left[p + z \frac{dp}{dz} \right] \frac{\partial z}{\partial x_1}.$$

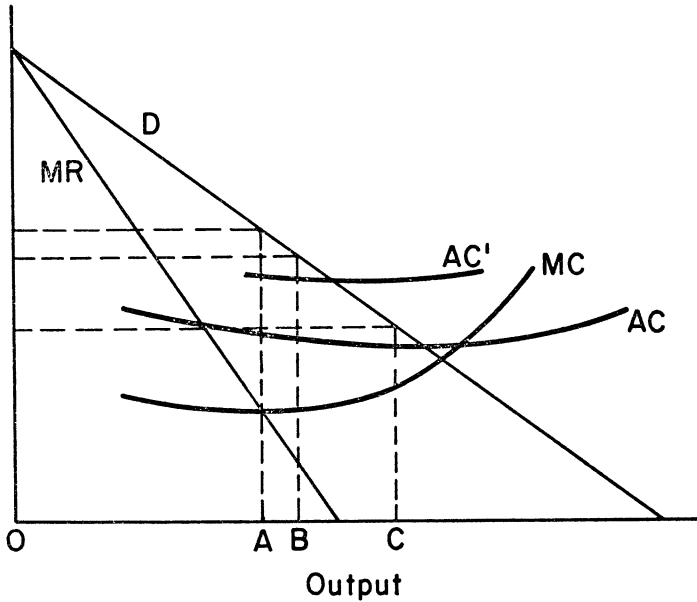


FIGURE 2

average cost AC to reflect the fact that $s_1 > r_1$ (profit is not entirely eliminated). Since the regulated firm moves along path 2, the social cost curve rises from AC to AC' , and the regulatory constraint is satisfied at the lower output OB . The effect of regulation is to force the firm to expand output from the unregulated position OA , but output does not expand to C because a portion of what would otherwise be profit is absorbed by cost. The extent to which regulation affects output depends upon the nature of the production function. If it involves fixed proportions, i.e., $\min\left(\frac{x_1}{a}, \frac{x_2}{b}\right)$, the regulated firm is constrained to the efficient expansion path and it moves all the way to OC . If the production function is linear and if the iso-output curves have a slope equal to $-\frac{r_1}{r_2}$, the firm could substitute x_1 for x_2 and, with no change in marginal rate of substitution, hold output constant. In this case it could remain at OA , the unregulated monopoly output, under the condition that at output OA

$$pz - s_1x_1 - r_2x_2 \leq 0, \quad x_2 = 0.$$

II. *The Multimarket Case*

Suppose that in addition to operating in a single market, the firm can also enter other regulated markets, and that the regulatory agency

bases its "fair rate of return" criterion on the firm's over-all value of plant and equipment for all markets taken together rather than computing a separate rate of return for each market. In this case the firm may have an incentive (that it would not have in the absence of regulation) to enter these other markets, even if the cost of so doing exceeds the additional revenues. Expanding into other markets may enable the firm to inflate its rate base to satisfy the constraint and permit it to earn a greater total constrained profit than would have been possible in the absence of second markets.

A noteworthy implication is that the firm operating in oligopolistic second markets may have an advantage over competing firms. The regulated firm can "afford" to take (long-run) losses in these second markets while competing firms cannot. Under these circumstances, it is conceivable that the firm could drive out lower-cost producers—the loss it willingly takes in second markets could exceed the difference between its costs and the lower costs of other firms. It may succeed, therefore, in either driving lower cost firms out of these markets or of discouraging their entry into them. This is unlike the textbook case of "predatory price-cutting" where the regulated monopolist may temporarily cut prices in outside competitive markets to drive out rivals and subsequently raise prices to monopoly levels. The monopolist would ordinarily engage in such a practice only if he had the expectation that in the long run he would make a positive profit in these additional markets; but here even in the case of a long-run loss the regulated firm may find operations in such markets to be advantageous as long as the firm is permitted to include its capital input in these markets in its rate base.

Moving to a mathematical treatment, let us consider an extreme example where operating in a second market permits the firm to act as an unconstrained monopoly in the first market, i.e., operating in the second market permits satisfaction of the regulatory constraint such that the firm can operate in the first market at output OA in Figure 2. We shall assume that for any combination of factors along the socially optimal expansion path in market 2 the firm is just able to break even in that market. That is, for any equilibrium x_{12} , x_{22}

$$(12) \quad p_2 z_2 - r_1 x_{12} - r_2 x_{22} = 0.$$

The constraint for n markets is written:

$$(13) \quad \sum_{i=1}^n p_i z_i - s_1 \sum_{i=1}^n x_{1i} - r_2 \sum_{i=1}^n x_{2i} \leq 0.$$

Denoting output and factor inputs in market 1 as \bar{z}_{11} and \bar{x}_{11} , \bar{x}_{21} respectively at the output at which profit is unconditionally maximized

in market 1, we have

$$(14) \quad p_1\bar{x}_1 - s_1\bar{x}_{11} - r_2\bar{x}_{21} = m, \quad m > 0$$

where m is the value of “excess” profit in market 1 that would violate the constraint (13) if the firm operated only in market 1. However, by moving along its expansion path in market 2 the firm can choose a level of capital input such that

$$(15) \quad p_2\bar{x}_2 - s_1\bar{x}_{12} - r_2\bar{x}_{22} = -m.$$

Adding (14) and (15) we see that the firm can now satisfy constraint (13) without foregoing any profit in market 1. While the unregulated firm would be indifferent about operating in market 2, the regulated firm in this example finds market 2 attractive because it can add capital to the rate base at “no loss”; i.e., for any capital input in market 2 the output generates revenues just equal to factor cost. Since in market 2 the actual cost of capital is below the allowed rate of return, the firm can apply the difference in satisfying the constraint in market 1 and thereby enjoy additional profit equal to $s_1 - r_1$ for each unit of capital in market 2.

This analysis suggests that even if the firm suffers a loss in market 2 (measured in terms of social costs r_1 and r_2) it may still operate there provided the value of x_{12} ($s_1 - r_1$) exceeds this level of loss. If it suffers a loss it would no longer operate in market 1 at the profit-maximizing output OA in Figure 1; seeking to equate the marginal value product of capital in both markets, it would move toward OB .

In the literature on public utility economics, concern is frequently expressed that the firm will attempt to inflate its rate base to increase its profit. However, the problem is generally viewed as one of proper valuation of rate base, i.e., the firm would always have an incentive to have its property stated at a value higher than its cost. The problem has given rise to a great deal of controversy about proper valuation, especially concerning original versus reproduction cost, and depreciation policy.⁵ In the present study the problem of rate-base inflation is not viewed as one of valuation but rather as one of *acquisition*—quite apart from the problem of placing a valuation upon the rate base, the firm has an incentive to acquire additional capital if the allowable rate of return exceeds the cost of capital.

III. *The Telephone and Telegraph Industry*

Turning to the domestic telephone and telegraph industry, we find that the market structure and the regulatory setting are consistent with

⁵ For examples of the manner in which the problems has previously been treated see [5, Ch. 19, 20] [10, Ch. 12, 17] [14, pp. 515-16].

those described in the model. And the implications drawn from the model, concerning relative factor inputs and incentives to operate in some markets even at a loss, raise issues relevant to assessing market behavior of firms in the industry.

For our purposes, the notable feature of the industry's market structure is that the degree of competition does vary from one subsector to another. Common carriers have monopoly positions with regard to public message telephone and telegraph services, while they compete with each other in supplying private line services to customers who, in addition, are free to construct private wire facilities for their own use as an alternative to purchasing from the common carriers.

The principal supplier of public message telephone service is the Bell Telephone System. Besides the parent corporation, American Telephone and Telegraph Company, the Bell system includes 22 subsidiary "associated" companies of which 20 are primarily or wholly owned by AT&T. Each of the associated carriers provides local exchange and toll service within the state or group of (contiguous) states that comprises its "operating territory."⁶ The Bell system holds about 98 per cent of all facilities employed in long-distance message toll telephone service in the United States, and about 85 per cent of all facilities employed in local telephone service. The remaining 15 per cent of local exchange facilities are in the hands of about 3,200 "independent" telephone firms, most of which are very small. These carriers connect with the Bell system, under service- and revenue-sharing agreements, and provide an integrated nationwide network. Competition does not exist among firms in the public message telephone business. Although many firms are in the industry, each has its own exclusive local marketing area.⁷

In the telegraph field, in contrast to telephone, public message telegraph service is offered only by the Western Union Telegraph Company. This is a much smaller subsector in terms of revenues than public message telephone service. In 1959 Western Union revenues for the former were about \$170 million, while Bell and independent connecting carrier revenues for the latter were \$7 billion.

Bell and Western Union compete in common markets in providing other services. Until recently Bell (together with independent connecting carriers) was sole supplier of private-line telephone service. How-

⁶ AT&T, through its Long Lines Department, provides interstate line and radio facilities to connect the separate operating territories of the associated companies; in addition, in some cases Long Lines participates in providing interstate service internally within the territories of the multistate associated companies.

⁷ A good description of the industry and its present-day market structure is contained in [8, pp. 4-34].

ever, in 1961 Bell and Western Union negotiated facilities contracts⁸ that enable Western Union to offer private-line telephone service in competition with Bell. Western Union and Bell both provide telegraph exchange service and private-line telegraph service—Bell's teletype-writer or TWX service is similar to Western Union's Telex, and Bell's teletype private-wire service is similar to Western Union's leased circuit teleprinter offering. In addition, a new competitive element has recently been introduced: as an alternative to purchasing private-line telephone and telegraph services from the common carriers, firms outside the communications industry may now operate their own microwave facilities to provide communication among their geographically separated plants.⁹

Intrastate services of the common carriers are regulated by individual state regulatory commissions; interstate operations are regulated by the Federal Communications Commission. These agencies use a "fair rate of return" criterion in regulating prices within their respective jurisdictions. The services of each common carrier are generally lumped together in computing the rate of return to be regulated. For example, in regulating Bell's service the FCC routinely considers together all revenues, plant investment, and operating costs of Bell's interstate services in computing a rate of return to serve as the basis for decisions about price adjustments.¹⁰ Likewise, most state agencies compute an over-all rate of return for each carrier for all of its intrastate operations within the state in question.

Since the interesting implications of the model rest on the assumption that the allowable rate of return exceeds the actual cost of capital, the question arises as to whether revenues of the industry do exceed factor costs. While it is impossible to treat this question exhaustively here, there is some reason to believe that revenues are generally in excess of costs. We have been told by representatives in both the industry and in regulatory agencies that justification exists for allowing a return in excess of cost to give firms an incentive to develop and adopt cost-saving techniques. If the firm is left only indifferent as among a wide range of activities it has no positive incentive to mini-

⁸ These contracts permit Western Union to lease Bell communications facilities in order to enter markets that it could not feasibly serve if confined to its own facilities.

⁹ While railroads and public utilities, the so called "right-of-way" companies, have historically been permitted by law to employ privately owned radio communications facilities for their internal needs, it was not until 1960 that the way was cleared (by a final decision of the Federal Communications Commission in Docket 11866) for other firms to provide their own communications facilities.

¹⁰ It is true that special studies of the separate services are occasionally made by the FCC in order to determine individual rates of return. Evidence from one such study will be presented below.

mize costs for any given activity. Consequently, regulatory agencies do not typically view with disfavor rates of return which are (within broad limits) somewhat in excess of rates they would judge to reflect cost. Positive profit is sometimes generated by the "regulatory lag" phenomenon: As the firm adopts new cost-saving technology or as its business volume rises for output subject to decreasing costs, its rate of return rises. However, the regulatory agency does not react immediately to force prices down. Rather, a lag of years may be involved. An example of this can be drawn from the interstate telephone operations of the Bell System. In its over-all interstate operations Bell experienced a decline in its rate of return from 7.5 per cent to 5.2 per cent from 1950 to 1953. Reasoning that a rate in the neighborhood of 5 per cent was too low, it filed revised tariff schedules increasing interstate message toll rates by about 8 per cent—an increase expected to bring the rate of return up to about 6.5 per cent. The FCC, agreeing that earnings under the old tariff were inadequate, allowed the new tariff to go into effect. There is a strong implication in the FCC staff memoranda written at the time that a fair rate of return was considered to be in the neighborhood of 6 per cent.¹¹ After the increase went into effect in 1953, the rate of return rose to 6.6 per cent in 1954, 7.7 per cent in 1955, reached a peak of 8.5 per cent in early 1956, and continued in excess of 7 per cent during 1957 and 1958. Despite an interstate toll rate reduction in 1959, the rate of return amounted to almost 8 per cent in 1959 and 1960. The fact that the rate of return remained above a 6 per cent level during most of the decade meant that for a number of years revenues in interstate operations exceeded the FCC Staff estimate of cost.¹²

One implication drawn from the model is that the firm increases its ratio of capital input to cooperating factor input in a manner that increases social costs at the equilibrium output. Do the common carriers in this industry overinvest in this fashion? Unfortunately, empirical evidence is not available to us on the issue of bias in favor of investment

¹¹ A clear, concise account of the manner in which the FCC regulates interstate telephone and telegraph services is contained in [12, pp. 3427-45].

¹² The rise in Bell's rate of return is partly attributable to Bell's striking success in developing and adopting new cost-saving technology. The average book cost per circuit mile of Long Lines plant declined from roughly \$230 in 1925 to \$30 in 1960. The strong long-run incentives apparent in Bell's activities to cut costs may be construed as prima-facie evidence that it enjoys positive profits. Of course, one could argue that another factor is present—entrepreneurship—whose cost would more or less offset the positive profit; i.e., in the economic sense (in contrast to the accounting sense) revenue may just cover cost and the firm still has incentive to minimize cost. But here we are concerned with the *marginal* cost of capital to the firm compared to the *marginal* return to capital allowed by the regulatory agency. If the latter exceeds the former, the "regulatory bias" emerges regardless of whether total cost includes a fixed charge attributable to an additional factor.

in plant and equipment. However, one point should be made: the regulatory agencies exert little direct control over investment decisions that would force the firm to follow the socially optimal expansion path. The FCC, for example, follows a "used and useful" criterion in judging whether a given item is to be included in the rate base of plant and equipment. If the item is being employed in operations, and if it is useful (judged partially on subjective grounds), it is included. While common carriers are required routinely to provide a formidable list of reports concerning current operations, the relatively small staffs of the regulatory agencies available for research and investigative tasks, the lack of satisfactory criteria upon which to make judgments, and the heterogeneity of both factor inputs and service outputs would make extremely difficult if not impossible the task of detecting such bias.

The second implication drawn from the model is that due to the nature of regulation the firm has an incentive to operate in some markets even at a loss. Again, there is no clear-cut evidence which shows whether common carriers in this industry do, in fact, operate at a loss in some markets. However, evidence is available disclosing that (1) fears of "unfair" competition based on operations at "noncompensating" prices play a prominent role as a source of conflict between the carriers themselves and between the carriers and the FCC; and (2) in attempting to establish a commercial communications satellite system, the federal government has enacted a law containing provisions that (to serve "public ends") appear to exploit the willingness of common carriers to operate in markets at a loss. We shall now discuss some of this evidence.

The FCC undertook a study in 1956 of interstate private-line services offered by the common carriers in order to determine the relationship between price and cost for these services on a more precise basis than is possible by considering only the over-all rate of return for each carrier on all its interstate services. In the course of the study Bell submitted data (based on 1955 operations) showing that its telephone grade services were earning at a rate of 11.7 per cent, and its teletypewriter (telegraph) grade services at 2.6 per cent.¹³ On the basis of this evidence, the FCC ordered interim price reductions in telephone grade services (in which Bell at the time was sole supplier) and permitted an increase for both Bell and Western Union for telegraph services (in which the two carriers do compete). The FCC expected the price adjustments to reduce substantially the spread between Bell's rates of return on telephone and telegraph grade services and to increase Western Union's rate of return on telegraph services.

¹³ The initial decision of the FCC staff in this study (not adopted by the Commission at this writing) is contained in [6].

During the study Western Union criticized Bell's behavior that allegedly resulted in Bell's relatively low rate of return on the telegraph services competitive with Western Union's own offerings. In the words of the FCC staff [6, p. 54]:

Western Union refers to evidence of record indicating that during the twenty-year period preceding this investigation, all principal private line telegraph rate adjustments were initiated by AT&T and, with one exception, all were rate reductions. Western Union alleges that AT&T has received a noncompensatory return on its private line telegraph service while enjoying a substantial return from services not competitive with Western Union. . . . According to Western Union, it follows that AT&T has engaged in unfair competition by maintaining unreasonably low rates for a competitive service and shifting the resulting financial burden to other services.¹⁴

Western Union's allegations, if true, would indicate that in conformity with the model, Bell is operating in private-line telegraph at a loss. However, it is impossible, for two reasons, to determine from the evidence in the FCC study whether this is in fact the case. First, the evidence in the record is simply not sufficient to determine what earnings level is "proper", i.e., what earnings level would just cover the cost of capital.¹⁵ Second, the rates of return quoted above are based on "fully allocated cost" as opposed to marginal cost. In our model, the firm operates at a loss in a market only if the additional revenues it receives by operating in that market are below the additional costs it incurs. And whether operations in that market impose a "financial burden" (to use Western Union's words) on the other services depends on whether additional revenues do cover the additional costs.¹⁶ But fully allocated costs are something else again. These include the costs of facilities used solely for the service in question and, in addition, they include an allocation of the "common" costs incurred by the carrier. For example, the telephone instrument itself is necessary in providing both intrastate and interstate message toll service as well as local exchange service; a transcontinental microwave system carries both public message toll and private-line traffic. In computing a rate of return for each of these services, it is necessary to allocate the costs of facilities having multiple uses. In general, the FCC allocates these costs in accordance with relative time of use. If a given facility is employed by service A 50 per

¹⁴ For AT&T's reply see [4, pp. 14-18].

¹⁵ The FCC staff concluded that AT&T's proper earnings levels is $7\frac{1}{4}$ per cent and for Western Union 9 per cent. This conclusion was contested by Bell in its reply brief: "These [FCC staff] findings are made despite the fact that there is not a word of testimony in the record concerning the over-all costs of capital to either carrier, much less the costs of capital for their private line services" [4, p. 3]. See also [2, p. 27].

¹⁶ A good statement of this point is contained in [1, pp. 7-10].

cent of the time and by service B 50 per cent of the time, the cost of the facility is split equally between A and B. For our purposes, however, the crucial question is whether the cost of the facility could have been cut in half if either service A or service B had not been offered.¹⁷ Is allocation on the basis of relative time in use an accurate reflection of marginal costs generated by each service? We may presume an affirmative answer only if the industry is subject to constant costs. However, the available evidence is not sufficient to determine whether the industry is, in general, subject to constant costs in the relevant range of output. If, on the contrary, it is subject either to decreasing or to increasing costs, use of the conventional cost allocation procedures would tend either to overstate or to understate marginal costs for particular services. Because of these possibilities, the rates of return commonly quoted for a particular communications service cannot be used as a reliable guide in determining whether a loss, in the relevant sense, is being incurred in providing that service and whether a financial burden is thereby being imposed upon the other services.

Competition between Bell and Western Union will probably continue to be a lively issue in future FCC investigations. In February 1962, the FCC was reported to have had "under consideration for some time an over-all study of telephone vs. telegraph competition"; in the same month the American Communications Association (a union representing Western Union employees) "formally petitioned for an investigation into the extent and effect of participation by the American Telephone and Telegraph Co. in domestic and international telegraph communications."¹⁸

Our model suggests that apprehension about the nature of competition in the industry is justified since a common carrier, regulated as described above, would (under certain conditions) have an incentive to operate at a loss in competitive markets and to shift the financial burden to its other services. In this sense, it would have an "unfair" advantage over other firms which do not have other markets sufficiently profitable to bear the loss of competing with it.¹⁹ Unfortunately, however, the FCC and other regulatory bodies are so wedded to the fully allocated cost criteria rather than to marginal cost criteria in judging the "fairness" of competition, that evidence drawn from future hearings and investigations will probably not throw much light on the question

¹⁷ For purposes of this simple illustration, we are assuming a zero elasticity of demand substitution between A and B.

¹⁸ [9, February 26, 1962, p. 1].

¹⁹ That is, the unconditionally maximized profits of the other regulated firms may be sufficiently low so that imposition of the regulatory constraint does not induce them to operate at a loss in competitive markets.

whether common carriers in some markets do, in fact, operate at a loss measured in the relevant economic sense.

Finally, the model appears useful in treating economic implications of the Communications Satellite Act passed by Congress in August 1962, after long and bitter debate [13]. The Act specifies establishment of a new, private corporation regulated as a separate entity by the FCC to develop and operate the satellite system. The corporation is to be financed in two ways: (1) It may issue capital stock, carrying voting rights and eligible for dividends, to be sold "in a manner to encourage the widest distribution to the American public [13, Sec. 304 (a)]. Purchase of this stock is also permitted by "authorized" communications common carriers²⁰ subject to the constraint that the aggregate of shares held by these carriers together not exceed 50 per cent of the total shares issued and outstanding. This stock is *not* eligible for inclusion in the carrier's rate base. For convenience in subsequent analysis we shall refer to these securities as "type I securities." (2) The Corporation may issue "nonvoting securities, bonds, debentures and other certificates of indebtedness as it may determine." Communications common carriers are permitted to hold these securities without specified limit, and these securities *are* eligible for inclusion in the rate base of the carrier "to the extent allowed by the Commission [FCC]" [13, Sec. 304 (b)]. For convenience we shall refer to these as "type II securities."

The model suggests that, given the provisions of the Act, communications common carriers would have a special incentive to invest in type II securities, and that their financial support might constitute a partial subsidy for the satellite corporation. By holding type II securities the common carrier incurs an interest cost (r_1) and collects whatever interest or dividends are forthcoming on type II securities (r_1'). Were the carrier unregulated or were the securities not eligible for inclusion in its rate base it would purchase securities only under the condition that $r_1' \geq r_1$. Since, however, the investment in type II securities can be included in the over-all rate base of the carrier, the carrier has an incentive (again under certain conditions) to invest more than would otherwise be the case.

Consider the example where the carrier receives a zero return on its investment in type II securities, i.e., $r_1' = 0$ at all levels of investment; therefore, the carrier suffers a loss of r_1 for each dollar of investment. If, however, the allowable rate of return (s_1) is greater than the interest cost (r_1) the regulatory constraint on the carrier's other services is relaxed, permitting prices and profits to be raised in the other

²⁰ Authorized common carriers presumably would include AT&T, Western Union and eight U.S. overseas radio and cable telegraph companies.

sectors. For each dollar in type II securities, the carrier's over-all profit would *rise* by the value $(s_1 - r_1)$: The loss involved in the investment in type II securities would be more than offset by the increased profits elsewhere resulting from inflation of the rate base and relaxation of the regulatory constraint. The carrier, then, may have an incentive to hold type II securities even if a direct loss is involved.

Two closely related implications arise from this analysis: First, the costs to the satellite corporation of obtaining money capital will fall if it can sell type II securities to common carriers at a return that is below their own interest cost (and if their own rate of interest is no higher than that which the satellite corporation would otherwise have to pay). To the extent that these funds provided at reduced cost to the satellite corporation permit a shift downward in its cost curves, the communications toll rates it charges to users of satellite services would also fall below the level that would have been established had the satellite corporation been forced to resort to conventional financing.²¹

Interestingly, a reduction in satellite communications toll rates by reducing financing costs to the satellite corporation, shifting the burden to other services, was intended by the sponsors of the bill that led to the Satellite Act. Senator Kerr, when introducing the bill to the Senate in February 1962, stated [11, p. 1670]:

[This bill strives for] . . . a privately owned corporation in which the existing American companies engaged in the international communications business would be able to invest, with their investments treated the same as the acquisition of new equipment and thus includable in their rate bases. This important feature permitting the rate of return for all communication services to be spread over a broad base would insure lower charges for communication satellite services.

Second, inclusion of type II securities in the carrier's rate base may permit the satellite corporation to operate even if its total revenues do not cover total market costs. In this case type I securities issues may be small, since little if any dividends would be earned, and the bulk of financial support might come from common carriers holding type II securities at a return below the market rate of interest.²² Again, the losses in satellite operations would be covered by revenues from telephone and telegraph services provided by the carriers.

²¹ These users include both U.S. and foreign international common carriers who would employ the satellite relays primarily for transoceanic communications links in combination with or as a substitute for submarine cable and radio. To the extent that users of the satellite system are the same carriers which invest in type II securities, their subsidy to the satellite corporation would be more or less offset by the reduction in toll rates they pay to the satellite corporation. However the Act specifies no particular relationship between the amount of type II securities they respectively hold and their relative use of the satellite system.

²² In this case type I securities would be attractive primarily because of the voting rights they confer.

IV. *Conclusions*

The preceding analysis discloses that a misallocation of economic resources may result from the use by regulatory agencies of the rate-of-return constraint for price control. The firm has an incentive to substitute between factors in an uneconomic fashion that is difficult for the regulatory agency to detect. Moreover, if a large element of common costs exists for the firm's outputs in the various markets, the widely used "fully allocated" cost basis for rate-of-return computation is likely to prove unsatisfactory in determining whether the firm is operating at a loss in any given market, or whether its activities in some markets tend to restrict competition in an undesirable manner. At the same time, regulatory practices that provide an incentive for the firm to operate in some markets even at a loss may constitute a convenient mechanism through which certain activities of the firm judged to be in the "public interest" can be subsidized.

Our analysis suggests lines of further inquiry: We have considered only the telephone and telegraph industry, but the issues raised by the model may be relevant to evaluating market behavior in other industries as well. It is notable that Gardner Means in a recent study [7] has advocated that certain large nonregulated firms judged to be "collective enterprises" be encouraged, by tax incentive, to engage in "target pricing" where they aim for a profit equal to a fair rate of return on investment. By following this approach to pricing, which is similar to that employed in public utilities, the danger exists (which he does not recognize) that these firms would be exposed to the same pressures discussed above of inflating their rate bases by substituting capital for labor and by expanding into unprofitable new lines in order to satisfy the authorities that they were using "proper" target pricing. It might prove worthwhile to examine the effect of target pricing in steel and other industries discussed by Means in the light of the preceding analysis. Furthermore, it might be interesting to explore alternative forms of government control that, by avoiding the return-on-investment criterion for price regulation, do not generate the bias disclosed here.

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