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By
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Private electric and telephone utilities in the United States are regulated on a rate of return on capital basis. For many years, students of regulation have argued that this type of regulation does not provide utilities with any incentive to be efficient in their provision of service. In 1962, Harvey Averch and Leland Johnson provided analytical support for the proposition that such regulation tends to result in inefficient production. Averch and Johnson demonstrate that the firm subject to a regulatory constraint has an incentive to use more capital in production than would be the case if costs were to be minimized.

Averch and Johnson (A-J) consider a monopoly producing a single homogeneous product using two inputs: capital, K; and labor, L. The production function is given by:

\[ Q = Q(K, L) \]

with

\[ k \geq 0, \quad L \geq 0 \]

\[ \frac{\partial Q}{\partial L} \geq 0, \quad \frac{\partial Q}{\partial K} \geq 0 \]

\[ Q(0, K) = Q(L, 0) = 0 \]

The price which Q can be sold for is \( P = P(Q) \) with \( \frac{\partial P}{\partial Q} \neq 0 \). Profits are \( PQ - r_n K - wL \) where \( r_n \) and \( w \) are the factor prices of capital and labor respectively.

The firm is regulated on a rate of return on capital basis. That is:

\[ PQ - wL \leq sK \]

where \( s \) is the allowed return on capital.

The A-J model rests on three basic assumptions. First, it is assumed that the objective of the firm is the maximization of profits. Second, that there is no regulatory lag. That is, the process of regulation is taken to be instantaneous. Excess or deficient profits immediately result in a rate adjustment. Third, the allowed return on capital, \( s \), is greater than the cost of capital, \( r_n \).

In the A-J model, the objective of the firm is to maximize profits subject to the regulatory constraint. The analytical solution is generated by deriving the Kuhn-Tucker necessary conditions for a maximum. For the
unregulated profit-maximizing firm these are the familiar marginal conditions that the negative of the rate of technical substitution between inputs in producing a given level of output be equal to the ratio of the market prices of the inputs.

The imposition of the regulatory constraint results in a different optimizing condition in the A-J analysis:

\[
\frac{-dL}{dK} = \frac{r_n}{w} - \frac{\lambda}{(1-\lambda)} \frac{(s-r_n)}{w}
\]

By assumption \(s-r_n > 0\). The authors show (subject to criticism and refinement by later writers) that \(0 \leq \lambda < 1\). Hence, the expression \(\frac{\lambda}{(1-\lambda)} \frac{(s-r_n)}{w}\) is positive and, thus, the rate of technical substitution is less than the ratio of factor prices. The first order conditions of the model reveal that the labor input is used only until the value of its marginal product is equated to the factor price, \(w\). The above result is obtained because capital is used beyond the point where the value of its marginal product equals its factor price, \(r_n\).

Intuitively, what occurs is that the firm is constrained as to the amount of total profits which it may earn, and seeks means of circumventing the regulatory constraint. This is accomplished by overutilizing capital. In that the firm is allowed to earn more on each additional unit of capital employed than the cost of that capital to the firm, up to some point, profits are increased by substitution of capital for the other input, labor.

Another way of looking at the result is to view the excess return, \(s - r_n\), as a subsidy granted to the use of capital. The firm in its decision-making maximizes profits by using each input until its value in production equals its cost, but because each unit of capital is subsidized, the firm does not use the market cost of capital in the decision process, but some shadow price of capital less than \(r_n\). It utilizes capital until the value of the marginal product of that input is driven down to this shadow price. In this view, the firm behaves in the same manner that any other profit-maximizing firm would behave, but considers different input prices.
The assumption that the allowed return is greater than the cost of capital has been frequently criticized; especially during the late 1960s when capital costs were increasing rapidly. An articulate criticism is that of Corey. He maintains that the "marginal return allowed on an added increment of capital is ordinarily insufficient to cover the marginal cost of the added capital."  

Corey argues that, while the rate of return allowed may be set in excess of the average cost of capital to the firm in compensation for regulatory lag or inflation, the allowed return is considerably less than the marginal cost of new capital under current market conditions. His assessment of current regulatory policy is that:

"To my knowledge, no electric power company has in recent years been allowed a rate of return sufficient to cover the ever-increasing marginal cost of new capital on which plant investment and replacement decisions are based. This is due in large part to the use of historically low embedded costs, a practice which provides a disincentive to invest. Under these conditions, the A-J model may imply that capital inputs of regulated companies are unduly discouraged."

As a case in point, he cites Commonwealth Edison's most recent (at the time) experience with the Illinois Commerce Commission:

"... the 7-percent return more recently allowed in our July 10, 1970 rate order was clearly below the marginal rates of 8½ percent to 9½ percent paid on new money securities sold in 1970."

It is the contention of this author that a much closer look at the cost of capital to the firm versus the return allowed by the commission is required to determine whether the "excess return over capital cost" assumption of the A-J model is met. Corey correctly observes that it is the marginal return on new investment which must be greater than the marginal cost if there is to be an over-capitalization incentive. The point to be argued here is that these marginal conditions may hold even though the average allowed return as specified by the commission is less than the marginal cost of new capital if the commission adheres to a rather common practice in determining the rate of return. A simple mathematical exercise is used to illustrate the contention in the abstract, then the actual results of two commission cases, one in Montana, and the other the very case referred to by Corey in his argument against the excess return assumption will be presented as evidence as to what can happen in actual rate cases. It is the author's belief that the two cases
cited are representative of the practice of a number of state commissions. The Montana case has been selected because the results are rather dramatic, but the Illinois case was chosen solely because it was presented by Corey as being evidence against the excess return assumption.

In developing a simple model to demonstrate the robustness of the excess return assumption it is assumed that the firm over-capitalizes by adding non-productive capital (e.g., rate base padding). This is an innocuous simplifying assumption. Zajac has shown this strategy always to be dominated by the incentive to substitute capital for other inputs in the production process.6

The important aspect of the model is the manner in which the cost of capital is determined by the regulatory commission. The assumed procedure is that the cost of capital is taken by the commission to be the weighted average of embedded costs of debt, preferred, and equity capital. When new capital is added, the firm goes to the commission for an adjustment which is made by recomputing the embedded cost of capital in the same manner so that it includes the cost of the newly-acquired investment.

An important question is the accuracy of the result of the cost of capital determination. There is usually a considerable discrepancy between the numbers claimed by the firm and those presented by the commission staff. The final decision by the commission usually falls somewhere in between. For the present we assume the commission deliberations have resulted in the true embedded cost of capital to the firm. The consequences of error in this part of the procedure are considered later.

The embedded or "bare-bones cost of capital" is not always equal to the rate of return allowed by the commission. An increment may be added in recognition of future financing plans of the firm, the reality of regulatory lag, and/or the effects of inflation. We turn next to an analysis of the results of such an "add-on." The following notation is adopted:

\[ K = \text{capital base of the firm} \]

\[ r_a = \text{average cost of capital as determined by the commission} \]
\[ r_a^* = \text{new average cost of capital as computed by the commission after the addition of new capital by the firm} \]
\[ r_n = \text{marginal cost of new capital} \]
\[ s = \text{average return as allowed by the regulatory commission} \]
\[ s_n = \text{average allowed return after the addition of new capital} \]
\[ b = \text{percent increase in } K \text{ of non-productive capital} \]
\[ d = \text{percent of the bare-bones cost of capital which the commission adds on or substracts as a matter of policy or judgment.} \]

If \( K \) is the original rate base, then \( K + bK = (1+b)K \) is the new rate base after the acquisition of non-productive capital. The proportion of new capital in the rate base is \( b/(1+b) \) and of old, \( 1/(1+b) \). These are the weights which will be applied to each cost component. Thus,

\[ r_a^* = \frac{br_n}{1+b} + \frac{r_a}{1+b} \]

is the new embedded cost of capital. The new allowed rate of return is

\[ s_n = r_a^*(1+d). \]

Prior to the capital expansion, total cost of capital to the firm was \( r_aK \) and the total return allowed was \( r_a(1+d)K \). Thus, allowed excess profits were \( dr_aK \). After addition of new capital, the cost is \( r_a^*(1+b) \) and the allowed return is \( s_nK(1+b) \). Excess profits are then \( (dr_a + db r_n)K \). The change in excess profits is \( d(r_a + bK) \).

Since \( r_n, K, \) and \( b \) are all positive, whether or not there is an incentive to expand the rate base to earn additional excess profits depends on "d", the commission's policy on the allowed rate of return versus the embedded cost of capital. If the commission tacks something on, then the firm can increase profits by adding capital. If not, the firm is indifferent. If "d" is negative, then there is an incentive to under-capitalize.

The model says nothing about plausible values for "d". This is a question to be determined on the basis of factual evidence. The model does demonstrate, however, that the incentive to over-invest does not require that the fair return allowed by commissions on all capital be greater than the cost of new capital to the firm. What is required is that the marginal
return be greater than the marginal cost. If "d" is positive, this condition is met. The firm acquires new capital at a marginal cost of \( r_n \), and is allowed a marginal return of \( (1+d)r_n \).

The next few pages are devoted to arguing that "d" is often positive, i.e., that the marginal rate of return allowed on new capital is frequently set above the marginal cost of capital. Two examples are included for purpose of illustration.

Commission practices differ with respect to the manner of determining the rate base. At one extreme are original costs states which take capital at its book value. Reproduction cost states are at the other end of the spectrum.

In such states the cost of reproducing the capital stock is considered. Fair value states lie in between these extremes. In these states, the commission gives some recognition to inflation, but has discretion as to the degree of recognition.

In original cost rate base jurisdictions the decision process of the commission is relatively explicit. The rate base can be modified somewhat by choice of items to be excluded or included, but commission latitude is slight compared to fair value and reproduction cost states. Fair value and reproduction cost rate bases may vary anywhere from equal to original cost to almost double. In the Montana case to be examined, the fair value was set at 172% of original cost. This is extreme, however, usually fair value is set in the range of 100 to 135% of original cost.

Studies by Eiteman and Stuart suggest that the allowed return is higher in fair value states than in original cost jurisdictions. If original cost states allow a return at least equal to the cost of capital, then, unless capital costs are much higher in fair value states, the latter type of rate base valuation may result in an allowed return in excess of the cost of capital.

Thus far it has been assumed that the commission accurately computes the true embedded cost of capital to the firm, but the lack of an accepted method for determining equity costs leaves room for considerable doubt. If commissions err on the high side in deriving the embedded cost, then the firms have an incentive to over-capitalize. If the embedded cost is set lower than the true average cost of capital and there is no add-on, then there may be an incentive to under-capitalize.
Two examples demonstrate that the excess return assumption of A-J is more robust than might be assumed. On April 14, 1961, the Montana Power Company filed with the Montana Public Service Commission a petition to increase rates on natural gas sales. This petition was granted in part on February 2, 1962.8

Montana is a fair value state by statute and decision of the state supreme court. The original cost rate base as accepted by the commission was $52,378,413 as of December 31, 1962. The commission determined fair value to be $89,900,000, which is 171.6% of original cost. The reasoning behind the fair value figure is not given, it is simply stated that the commission "has considered the elements of value."9

The capital structure of the firm was determined to be 49% equity, 11% preferred, and 40% debt. The average costs of debt, preferred, and equity were taken as 3.22%, 4.60%, and 8.36% respectively. Thus, the embedded or average cost of capital is:

<table>
<thead>
<tr>
<th></th>
<th>Weighted Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debt 3.22% X 40%</td>
<td>1.2880</td>
</tr>
<tr>
<td>Preferred 4.60% X 11%</td>
<td>0.5060</td>
</tr>
<tr>
<td>Equity 8.36% X 49%</td>
<td>4.0964</td>
</tr>
<tr>
<td></td>
<td>5.8904%</td>
</tr>
</tbody>
</table>

The 5.89% cost of capital figure was also the rate of return allowed by the commission. The salient point is that in determining the amount of net income which was to be allowed the firm, this return was applied to the fair value, not the original cost rate base. On an original cost rate base the firm was allowed a return of 5.89 X 1.714 = 10.109%.

To demonstrate how fair value rate making may provide an A-J incentive even in times of very high capital costs, we consider the Illinois case previously cited by Corey.10 At the time the case was heard (1970), capital costs were very high; the interest rate on long-term debt was on the order of 9%.

On August 15, 1969, Commonwealth Edison petitioned the Illinois Commerce Commission for a general electric rate increase. On July 10, 1970, the company was granted a portion of the proposed increase. Like Montana, Illinois is, by judicial decision, a fair value state.
The original cost rate base as adopted by the commission was $2,056,462,836 as of June 30, 1969. Fair value was set as $2,414,558,000, which is 117.4% of original cost. Again, the commission did not specify the exact procedure used in determining fair value, it merely states that it has given "full and proper consideration to all the evidence." The commission allowed $170,621,000 as a justifiable return to capital. This translates to 7.066% on a fair value rate base and 8.297% on original cost.

The method used by the commission in determining the cost of capital is not given. A more detailed case for the cost of capital is made by the company. We will adopt the numbers as claimed by Commonwealth Edison, recognizing that the result may be much higher than the cost of capital implicitly determined by the commission. In doing so, we present the strongest case against the excess return allowance. The true excess return should be at least as great as is found using the numbers proposed by the company. Edison's witnesses claimed the cost of equity capital was 13%, preferred 8%, and the average cost of debt 4.94%. The capital weights are not given, but those reported to the Federal Power Commission as of December 31, 1969 will be used. The embedded cost of capital is:

\[
\begin{align*}
\text{Equity} & \quad 13\% \times 36.2\% = 4.706 \\
\text{Preferred} & \quad 8\% \times 5.4\% = 0.432 \\
\text{Debt} & \quad 4.94\% \times 58.4\% = 2.885 \\
\text{Weighted Average} & \quad 8.023
\end{align*}
\]

The computed cost of capital of 8.023% compares favorably with the estimate of the company witnesses of 7.98 - 7.99%. The allowed rate of return was set at 8.297 on original cost; the cost of capital is computed to be 8.023, thus, the allowed return is 103.4% of the cost of capital. In terms of the model, "d" is positive, and there exists an incentive to over-capitalize. A simple example of possible behavior of Commonwealth Edison is provided to demonstrate the incentive.

Assume that the firm proposes to add 10% to its rate base in non-productive capital and then go to the Illinois Commerce Commission for a rate adjustment. The expansion is to be financed using proportions of debt and equity equal to the present capital structure. Further, suppose that
The cost of equity and new preferred stock is unchanged, but debt jumps to 9%. Relaxing these assumptions alters only the size of the numbers; the conclusion is unaffected.

The commission first recomputes the embedded cost of capital to include the newly-acquired debt. The weights of each component of capital are unchanged as are the average cost of equity and preferred capital. The average cost of debt must be recomputed to reflect 10/11 of total debt at the previous average cost of 4.94% and 1/11 at a marginal cost of 9%. The average cost of debt is now 5.30%. Thus, the new embedded cost of capital as determined by the commission is:

\[
\begin{align*}
\text{Equity} & \quad 13\% \times 36.2\% = 4.706 \\
\text{Preferred} & \quad 8\% \times 5.4\% = 0.432 \\
\text{Debt} & \quad 5.3\% \times 58.4\% = 3.095 \\
\text{Weighted Average} & \quad 8.233\% 
\end{align*}
\]

If the commission maintains its policy of setting the allowed return at 103.4% of the computed cost of capital, then the allowed return is 8.513% on the original cost rate base which has been expanded 10% to $2,262,109,110. Thus, the total net return allowed on the new rate base is $192,573,349 as compared to the previously-granted return of $170,621,000 on the old rate base—an increase of $21,952,349. The rate base is 10% or $205,646,284 larger, so the marginal return of the added capital is $21,952,349 / $205,646,284 or 10.675%. The marginal cost of the new capital is the weighted cost of the new equity, preferred, and debt, and is determined to be 10.394%. The firm thus, has an incentive to undertake the proposed capital expansion in that the marginal return is greater than the marginal cost.

The discussion can be summarized as follows. If the commission allows more than the bare-bones cost of capital, and if the embedded cost of capital is re-computed to include newly-acquired capital, then the firm increases profits by adding additional capital even though the allowed rate of return on all capital is less than the marginal cost of new capital. Thus, the A-J assumption on cost of capital vs. the allowed return on capital is more likely to be met than it would appear to be on the basis of casual analysis.
REFERENCES


8. 42 PUR 3d (1962), pp.241-273. PUR refers to Public Utilities Reports, a compilation of decisions rendered by state and federal regulatory commissions and of reviews of these decisions by the judiciary.


