




UNIVERSITY OF  
ILLINOIS LIBRARY  
AT URBANA-CHAMPAIGN  
BOOKSTACKS



Digitized by the Internet Archive  
in 2011 with funding from  
University of Illinois Urbana-Champaign

<http://www.archive.org/details/rateofreturnrate468prim>



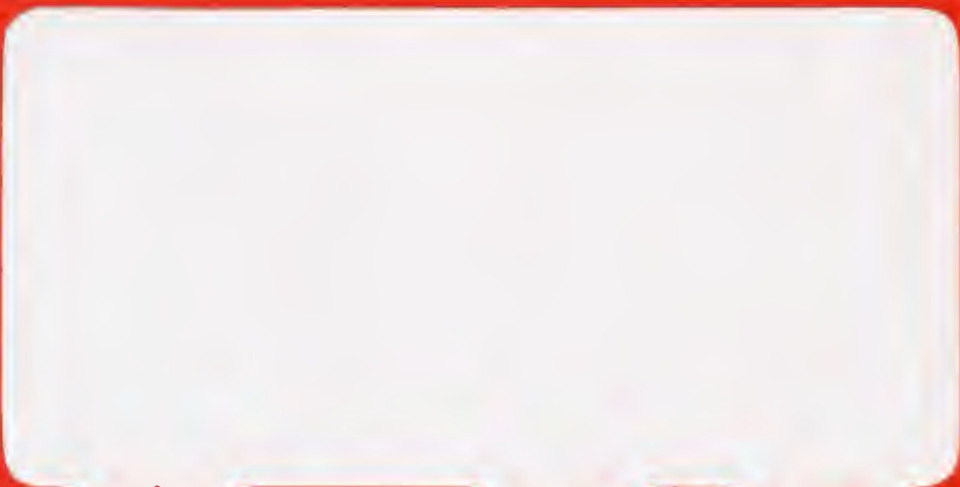
## Faculty Working Papers

THE RATE OF RETURN, RATE BASE METHODS, AND THE  
REGULATORY CONSTRAINT

Walter J. Primeaux, Jr., Professor of Business  
Administration and Randy A. Nelson, Graduate  
Student in Economics

#463

College of Commerce and Business Administration  
University of Illinois at Urbana-Champaign



FACULTY WORKING PAPERS

College of Commerce and Business Administration

University of Illinois at Urbana-Champaign

February 17, 1973

THE RATE OF RETURN, RATE BASE METHODS, AND THE  
REGULATORY CONSTRAINT

Walter J. Primeaux, Jr., Professor of Business  
Administration and Randy A. Nelson, Graduate  
Student in Economics

#468

Summary:

The rate of return constraint is an important aspect of the Averch-Johnson theoretical formulation and it is also an important variable in the actual regulatory process used in public utility rate making. However, the lack of independence between the regulatory constraint and the method of establishing the rate base, which actually exists in practice, has been ignored in the original A-J analysis as well as subsequent studies. This study shows that failure to incorporate these important dimensions into the A-J theory raises serious questions concerning the validity of both the basic theory and the large number of studies which have followed this seminal work.





# THE RATE OF RETURN, RATE BASE METHODS, AND THE REGULATORY CONSTRAINT

by

Walter J. Primeaux, Jr. and Randy A. Nelson

## INTRODUCTION

The article published by H. Averch and L. Johnson in 1962 constitutes seminal work in every sense. Not only did they theoretically formulate important aspects of the behavior of regulated firms but they stimulated a very large number of theoretical and empirical studies which attempted either to introduce refinements to the theory or to assess its validity.

During the fifteen years since its formulation, however, the basic theory, the subsequent theoretical refinements, and the empirical work have ignored an important aspect of the behavior of regulatory commissioners as they regulate public utility firms.

The rate of return constraint is an important aspect of the Averch-Johnson theoretical formulation and it is also an important variable in the actual regulatory process used in public utility rate making. However, the lack of independence between the regulatory constraint and the method of establishing the rate base, which actually exists in practice, has been ignored in the previous analyses. This study shows that failure to incorporate these important dimensions into the Averch-Johnson theory raises serious questions concerning the validity of both the basic theory and the large number of studies which have followed this seminal work.

## PREVIOUS STUDIES

Rate of return regulation, according to Averch-Johnson (1962), encourages a firm to use more capital than it should because of the larger profits which the firm will earn from such behavior. The explanation of



this behavior is rather straightforward. When firms are regulated by regulatory commissions, they face profit constraints. "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." Averch-Johnson (1962, p. 1052).

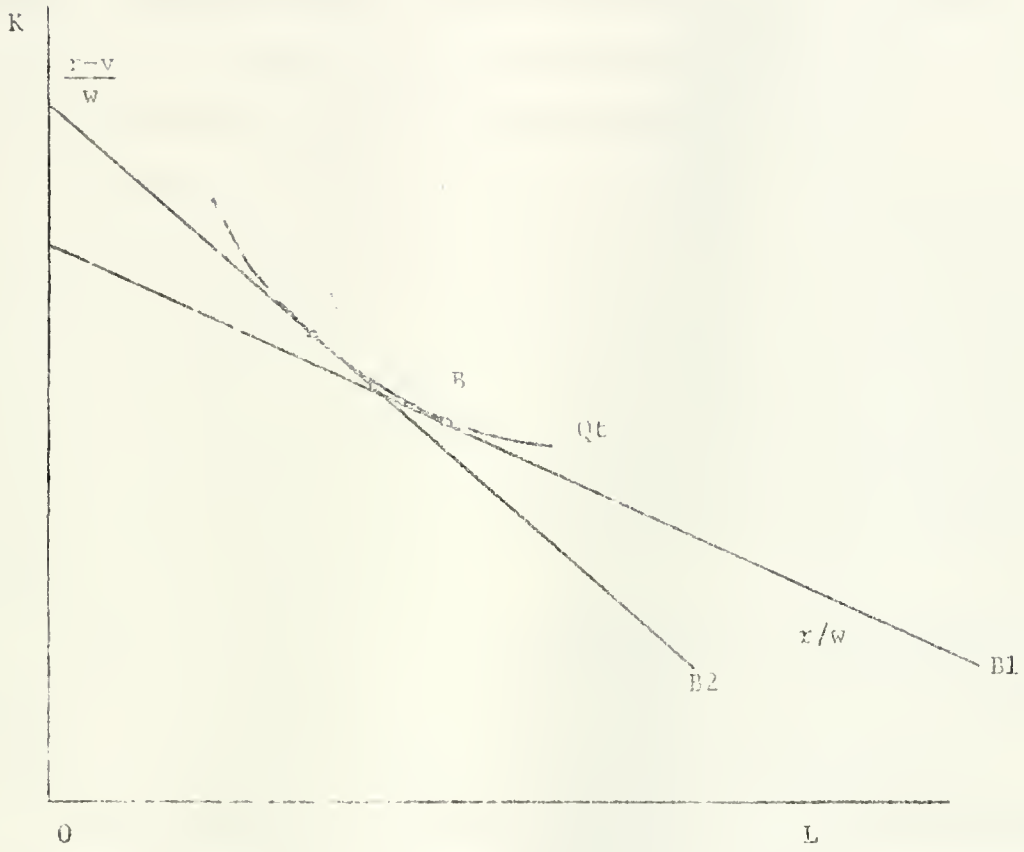
The allowed rate of return,  $s$ , is permitted to exceed the market cost of capital,  $r$ , by some specified percentage,  $v$ . Thus,  $s = r + v$ .

As all firms do, the regulated firm will attempt to maximize profits by choosing the combination of inputs which will minimize production costs. One difference with the regulated firm, however, is that its perceptions of the cost of capital are different, since it is subjected to rate of return regulation. The regulated firm does not perceive its cost of capital to be  $r$  because it "reduces" the cost of capital by the amount it earns from investing that capital. Consider a regulated firm facing capital costs of, say, eight percent; if it is allowed to earn a ten percent rate of return, the firm earns a net two percent. The firm, therefore, would behave for investment purposes as if its cost of capital were not ten percent, but six percent ( $r-v$ ) =  $8-2 = 6$ . It is this behavior which causes the misallocation of capital and labor. ". . . private cost is less than market cost by an amount equal to this difference." Averch-Johnson (1962, p. 1053).

As Averch-Johnson (1962, p. 1053) explain, this effect of regulation is analogous to changing the relative prices of capital and labor. This can be seen from Figure 1. If the output level is  $Q_t$ , costs for the



FIGURE 1





regulated firm would be minimized at point A on the production isoquant where the isocost curve is  $\frac{r-v}{w}$ . The unregulated firm, however, would minimize costs on the same isoquant at point B, where the isocost curve is  $\frac{r}{w}$ . It is very clear, according to Averch-Johnson, that regulated firms use excessive capital intensive production methods.

As indicated earlier, there has been abundant additions to the economic literature constituting theoretical refinements and empirical tests of the Averch-Johnson thesis. Important theoretical refinements were presented by Klevorick (1966), Kahn (1968), Kafoglis (1969), Takayama (1969), Bailey and Malone (1970), Zajac (1970), Baumol and Klevorick (1970), Klevorick (1971), Stein and Borts (1972), Klevorick (1973), McNicol (1973), and Needy (1975).

Empirical tests of the Averch-Johnson thesis were presented by Boyes (1976), Courville (1974), Spann (1974), and Petersen (1975) and criticisms of the last three studies were presented by McKay (1976).

There have also been many other examinations of the theory; however, only three studies, discussed below, are of particular interest to this paper.

Baumol and Klevorick (1970, pp. 162-163) present a review of the substance of the literature stemming from the Averch-Johnson model and examine a number of propositions of the theory. One important conclusion of this study is "It is at least plausible that other potential sources of difficulty in the regulatory process dwarf the consequences of the distortion in the capital-labor ratio that the model predicts." This analysis is useful and interesting, and the authors are concerned about regulatory matters. However, they do not consider the dependence





of the rate of return on rate base methods or the impact of this dependence on the A-J theory.

In one of the more interesting refinements of the A-J theory, Klevorick (1971, p. 122), instead of considering the allowed rate of return as given, views the fair rate as an endogenous variable. Klevorick's analysis considers this central question: "Given the way in which the A-J regulated firm will respond to different values of the fair rate, at which level should the regulators set this allowed rate of return in order to induce the regulated firm to act in a way most conducive to the overall well-being of society?" Klevorick (1971, p. 122). Although this study does examine the rate of return question, and in particular the manipulation of the rate by the regulatory commission, the interdependence of that rate with the rate base is not considered in the Averch-Johnson formulation.

Petersen (1975, p. 111) attempted to quantify the tightness of regulation in a test of the A-J model. He found that tighter regulation is associated with a greater proportion of cost going to capital. Although Petersen partially recognized the interaction between the rate of return and the method of rate base determination, he did not explicitly incorporate this effect into the A-J model. Instead, in his analysis, the rate base method only reflects a regulatory constraint in his empirical test of the theory.

#### RATE BASE METHODS AND AVERCH-JOHNSON

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. 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. Averch-Johnson (1962, p. 1059).

The above quote clearly confirms the comment mentioned earlier concerning the lack of attention to rate base methods and the accompanying distortions caused by regulation in the original formulation by Averch-Johnson. As mentioned earlier, these effects were also ignored by all of the many authors who have followed up on this seminal research. This section shows that overlooking these aspects of the regulatory process may have affected the empirical research which has been done in a significant way.

The regulatory process for utility firms is rather straightforward. Rates of return are generally determined by the cost of capital. The regulatory process specifies relevant costs and expenses which may be recovered by the utility firm as services are priced to buyers. The revenue requirement, that is the revenue that the utility is authorized to collect, may be defined as follows, following Garfield and Lovejoy (1964, p. 44).

$$(1) \text{ Revenue Requirement} = \text{cost of service}$$

$$(2) \text{ RR} = E + d + T + (V-D)R$$

where: RR = Revenue requirement.

E = Operating expenses.

d = Depreciation expenses.



T = Taxes.

V = Gross valuation of the property serving the public.

D = Accrued depreciation.

R = Rate of return (a percentage).

(V-D) = Rate base (net valuation).

(V-D)R = Return amount, or earnings allowed on the rate base.

For our purposes, R, (V-D), and (V-D)R are the key variables in the regulatory process. The rate of return, R, is an amount determined by the regulatory commission, based on its judgment of the cost of capital, and the amount that the utility firm should be permitted to earn. D is the accumulated depreciation which has accrued through time on the property owned by the utility firm. V is the gross valuation of the property serving the public. The term (V-D) is the rate base of the utility firm and when the rate of return is applied to this amount, the return amount, or earnings allowed to the utility firm are determined.

It is essential to understand that both the rate base (V-D) and the rate of return (R) are variables. That is, both are part of the regulatory process; their values are affected in a very important way by the regulatory regime a firm faces in the state in which it operates. Regulation is not a homogeneous process across states; one important difference is the method of rate base determination used by the regulatory commissions.

Since the regulatory powers are concerned with the level of earnings generated by the firm, it is reasonable that considerable attention should be directed to the method of rate base determination as well as the



allowed rate of return. The rate base is at the heart of the rate making process.<sup>1</sup> Indeed, it has developed through time that, depending upon the state in which a utility firm operates, its rate base is generally determined by one of three basic methods; original cost, fair value, and reproduction costs. State statutes prescribe which of the three methods will be used in a given state.

Original cost refers to a method where the utility property is valued at a value equal to that when the property was first employed in a public utility application. Reproduction cost valuation considers the appropriate value to be what it would cost to install the same equipment today. This value will exceed original cost if there has been inflation since the time of installation. Fair value is effectively an average of original and reproduction cost.

The significance of the above discussion is that three essentially different procedures are used for computing the rate base and they yield significantly different values. Original cost valuation methods generally yield the lowest valuation, while reproduction cost generally yield the highest, and fair value yields a value in between.

It is generally considered, therefore, that original cost represents a less liberal method of rate base determination than either fair value or reproduction cost. Reproduction cost represents the most liberal of the three methods. Note that these assessments of liberality refer to (V-D), the size of the rate base alone, assuming an equal rate of return, R, to a rate base, once its value has been determined. Empirical evidence does not necessarily support that inference.





Primeaux (1978) reported using standardized rate bases, eliminating interstate differences concerning what should be included in the rate base, and found no difference in realized rates of return between firms controlled by original cost, fair value, and reproduction cost regulatory regimes. One explanation presented for this result is that regulators tend to adjust the rate of return downward when the rate base method is upward bias. Eiteman (1962, p. 39) supports this conclusion in his empirical study:

. . . commissions which regulate on original cost, a comparatively low valuation during the last decade, permit, on the average, relatively higher percentage rates of return. Conversely, commissions which regulate on higher fair-value or reproduction-cost rate bases offset the effect of the higher rate base by granting, on the average, somewhat lower rates of return. These differences in the mean rate of return allowed can be interpreted as evidence that, although rate of return is supposedly determined autonomously, its magnitude is in fact influenced by the type of rate base adopted.

It is this interdependence of the rate of return and the rate base method which is at the heart of this analysis. Since rate of return is a key element in the Averch-Johnson hypothesis it is obvious that the rate base method must also be considered in that analysis.

#### THE IMPACT OF RATE BASE METHOD ON THE A-J EFFECT

##### The Effect of Different Rates of Return for Different Rate Bases--Partial Effect

To assess the impact of rate base methods on the Averch-Johnson effect consider three identical firms. Everything about the firms and their external environment is identical except that one operates in a state regulated by original cost rate base methods, one operates in a state with fair-value rate base methods, and the third operates in a reproduction



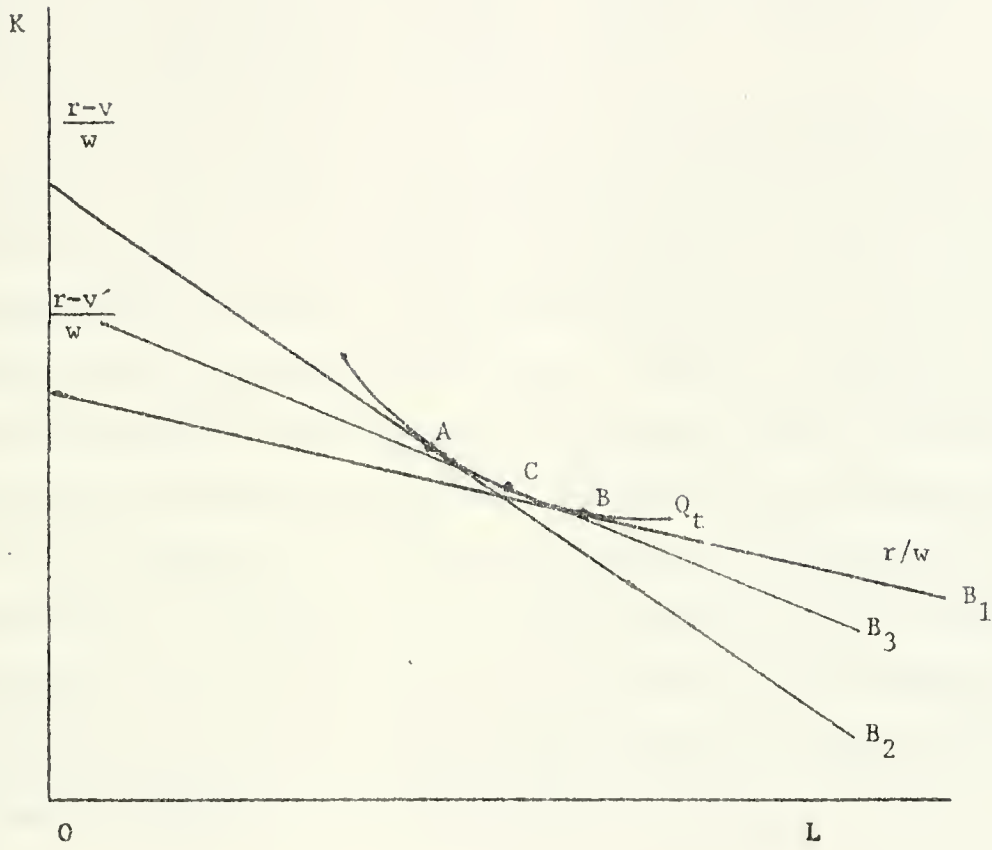
cost jurisdiction. According to Averch-Johnson, each firm would be affected in the same way and their decision to move toward a more capital intensive process would be reflected in a diagram such as in Figure 1. The isocost-curve and isoquants would be identical for each firm, even though rate base methods are different.

Following the earlier analysis,  $s$ , is the allowed rate of return, the market cost of capital is  $r$ , and  $v$  is the specified percentage by which  $s$  is permitted to exceed the cost of capital; thus,  $s = r + v$ . From Eiteman (1962) and Primeaux (1978) one observes that the allowed rate of return is highest in original cost jurisdictions, lowest in reproduction cost jurisdictions, and fair value jurisdictions allowed rates of return in between these extremes.

The impact of the above differences in rates of return is clearly reflected in the decision process involved in the A-J model. This is seen in Figure 2. Points A and B are identical to those in Figure 1 and the isoquant,  $Q_t$ , and the isocost-curves,  $B_1$  and  $B_2$  are also identical. In addition to the basic diagram presented for Figure 1, Figure 2 presents an important modification. For this analysis, assume that this firm is regulated by a fair value regulatory procedure while the basic diagram in Figure 1, carried forward to Figure 2 represents an original cost situation. The allowed rate of return, as was mentioned earlier, would be lower (according to Eiteman and Primeaux) for the fair value firm than in the original cost case. This means that for a fair value situation, at a given cost of capital, the specified percentage by which the allowed rate of return, ( $s$ ), exceeds the cost of capital, ( $r$ ), is lower than in the original cost case. That is in the expression  $s = r + v$ , both  $s$  and



FIGURE 2





v decrease in the fair value case. When this happens, the isocost-curve,  $B_1$  is tangent at  $B_3$  instead of at  $B_2$  and the firm employes more capital than at point B (where rate of return regulation does not exist) but less than in the original cost rate making process.

The allowed rate of return for reproduction cost would be the lowest of the three methods. The isocost-curves in this case would become even flatter than  $B_3$  and the firm would use even less capital than in the fair value and original cost cases, but more than in the case where rate of return regulation does not exist. The above discussion is based upon the assumption that the value of the capital stock is the same in each rate base method and this is not the case; indeed, different values for the same physical plants are characteristic of differences in rate base methods. Consequently, the complete analysis must also consider differences in the size of the rate base as well as the accompanying adjustments to the rate of return; this analysis is presented in the following section.

The Effect of Different Rates of Return  
and Different Sized Rate Bases--Total Effect

The relationship discussed thus far may be illustrated within the framework of the original A-J model. The firm is assumed to produce one output, employing two inputs, both of which are available at a constant cost regardless of the quantities purchased. The firm is assumed to maximize profits subject to a rate of return constraint imposed upon it by the regulatory authorities.

Let:  $\pi$  = total profit of the firm

$Y$  = the quantity of the firm's output





$K$  = the quantity of the capital input

$L$  = the quantity of the labor input

$w$  = the wage rate

$r$  = the unit cost of capital

$Y = F(K,L)$  = the production function

$$F_K, F_L > 0, F_{KK}, F_{LL} < 0, F_{KL}, F_{LK} > 0$$

$P = P(Y)$  = the inverse demand function

The rate of return constraint may be expressed as

1)  $P(Y)Y - wL = s(g)gK$ , where

$g$  = the rate base multiplier

$s(g)$  = the maximum allowed rate of return

$$s'(g) < 0$$

As discussed above, in determining the firm's allowed profit level the regulatory authorities must decide how to value the firm's rate base, or capital stock. The rate base multiplier,  $g$ , is the factor by which the regulatory authorities adjust the firm's rate base to reflect an original cost, fair value, or reproduction cost valuation. The firm's maximum allowed rate of return,  $s$ , is assumed here to be a function of the rate base valuation procedure, or the value of  $g$ . As mentioned earlier, jurisdictions employing either fair value or reproduction cost methods of valuation of the rate base are assumed to adjust the firm's allowed rate of return downward to compensate for the higher value placed on the capital stock compared with those in original cost jurisdictions. The model thus accommodates the effect of the actual institutional procedures and adjustments employed by regulatory commissions which were discussed previously.



The firm is assumed to maximize profits subject to (1). This yields the following lagrangian and the necessary first-order conditions for a maximum.

$$2) \quad Z = PY - rK - wL - \lambda(PY - wL - s(g)gK).$$

$$3a) \quad (1 - \lambda) \text{MRF}_L^2 = (1 - \lambda)w$$

$$3b) \quad (1 - \lambda) \text{MRF}_K - r = -\lambda s(g)g$$

Adding  $\lambda r$  to each side and dividing by  $(1 - \lambda)$  yields:

$$3b') \quad \text{MRF}_K = \frac{\lambda}{1-\lambda} (r - s(g)g) + r$$

$$3c) \quad PY - wL - s(g)gK = 0$$

To explore the effect of a change in  $g$  upon the firm's equilibrium quantity of capital totally differentiate (3c) and simplify to obtain

$$4) \quad \frac{dk}{dg} = \frac{(s'(g)g + s(g))K}{(\text{MRF}_K - s(g)g)}$$

subtract  $s(g)g$  from both sides of (3b') and multiply through by  $(1-\lambda)$ .

Substitute this expression into the denominator of (4) to obtain

$$5) \quad \frac{dk}{dg} = \frac{(1 - \lambda)K (s'(g)g + s(g))}{r - s(g)g}$$

This may be written as

$$6) \quad \frac{dk}{dg} = \frac{(1-\lambda)K}{r-s(g)g} [s(g) (1 - \frac{1}{E})]$$

where  $E = \frac{-s}{s'(g)g}$  = the elasticity of the rate base multiplier with respect to the rate of return

Therefore

$$7) \quad \frac{dk}{dg} \begin{matrix} > \\ < \end{matrix} 0 \text{ as } |E| \begin{matrix} < \\ > \end{matrix} 1$$



Expression (7) clearly indicates the effect of a change in the rate base valuation procedure upon the firm's equilibrium stock of capital. If the rate base multiplier is increased by a given percentage without a corresponding downward adjustment of the allowed rate of return the firm will choose to employ more capital. The opposite result holds when the percentage change in the rate base multiplier is met with a more than offsetting change in the allowed rate of return. Only when the percentage change in the rate base multiplier and the allowed rate of return are equal and offsetting will the firm have no incentive to adjust its equilibrium stock of capital. Consequently, the use of the variable  $s$ , the allowed rate of return, to serve as a proxy for the degree of regulatory "tightness" is not justified. The rate of return constraint may be loosened by increasing the rate base multiplier, while holding the allowed rate of return constant. This result has serious implications for many of the previous studies of the A-J effect that have relied upon the allowed rate of return for a measure of regulatory tightness.

#### CONCLUSIONS

In the history of public utility economics, few theories have attracted so much attention and generated so much research as the seminal piece by Averch-Johnson. Although their theoretical work has been followed by a large quantity of theoretical and empirical analyses, that work has neglected the important interaction between the rate of return and the method of rate base determination. This analysis has shown that the interaction between the rate base method and the rate of return cannot



be ignored in the Averch-Johnson theory. Indeed, previous empirical studies suggest that the rate of return is not independent of the method of rate base determination; and this fact suggests important implications for the Averch-Johnson theory.

This analysis does not show that the Averch-Johnson theory is not valid. It does show however, that a very important dimension must be added to the analysis. Moreover, the omission of that important element raises serious questions concerning the validity of some of the empirical studies which have followed the landmark work by Averch-Johnson.





FOOTNOTES

1. This point is made in a number of previous studies including: Garfield and Lovejoy (1964), Primeaux (1978), Phillips (1969).
2.  $MRF_i$  = the marginal revenue product of the  $i$ th factor.
3. Baumol and Klevorick (1970) have shown  $0 < \lambda < 1$ , so  $(1-\lambda)K > 0$ .  $s(g)g$ , the allowed rate of return, must be greater than  $r$ , the cost of capital, so  $(r-s(g)g) < 0$ .



REFERENCES

1. H. Averch and L. Johnson, "Behavior of the Firm Under Regulatory Constraint," American Economic Review, Vol. 52, December 1962.
2. E. E. Bailey and J. C. Malone, "Resource Allocation and the Regulated Firm," The Bell Journal of Economics and Management Science, Vol. 1, Spring 1970.
3. W. J. Baumol and A. K. Klevorick, "Input Choices and Rate-of-Return Regulation: An Overview of the Discussion," The Bell Journal of Economics and Management Science, Vol. 1, Autumn 1970.
4. W. J. Boyes, "An Empirical Examination of the Averch-Johnson Effect," Economic Inquiry, Vol. XIV, March 1976.
5. L. Courville, "Regulation and Efficiency in the Electric Utility Industry," The Bell Journal of Economics and Management Science, Vol. 5, Spring 1974.
6. D. K. Eiteman, "Interdependency of Utility Rate-Base Type, Permitted Rate of Return, and Utility Earnings," Journal of Finance, Vol. 17, March 1962.
7. P. J. Garfield and W. F. Lovejoy, Public Utility Economics, Prentice-Hall, Englewood Cliffs, NJ, 1964.
8. M. Z. Kafoglis, "Output of the Restrained Firm," American Economic Review, Vol. LIX, September 1969.
9. A. E. Kahn, "The Graduated Fair Return: Comment," American Economic Review, Vol. LVIII, March 1968.
10. A. K. Klevorick, "The Graduated Fair Return: A Regulatory Proposal," American Economic Review, Vol. LVI, June 1966.
11. A. K. Klevorick, "The Optimal Fair Rate of Return," The Bell Journal of Economics and Management Science, Vol. 2, Spring 1971.
12. A. K. Klevorick, "The Behavior of a Firm Subject to Stochastic Regulatory Review," The Bell Journal of Economics and Management Science, Vol. 4, Spring 1973.
13. D. J. McKay, "Has the Averch-Johnson Effect Been Empirically Verified," Social Science Working Paper No. 132, California Institute of Technology, October 1976.
14. D. L. McNicol, "The Comparative Static Properties of the Theory of the Regulated Firm," The Bell Journal of Economics and Management Science, Vol. 4, Autumn 1973.



15. Charles W. Needy, Regulation-Induced Distortions, Toronto, Heath, 1975.
16. H. C. Petersen, "An Empirical Test of Regulatory Effects," The Bell Journal of Economics and Management Science, Vol. 6, Spring 1975.
17. C. F. Phillips, The Economics of Regulation, revised ed., Irwin, Homewood, IL, 1969.
18. Walter J. Primeaux, Jr., "Rate Base Methods and Realized Rates of Return," Economic Inquiry, Vol. XVI, January 1978.
19. R. M. Spann, "Rate of Return Regulation and Efficiency in Production: An Empirical Test of the Averch-Johnson Thesis," The Bell Journal of Economics and Management Science, Vol. 5, Spring 1974.
20. J. L. Stein and G. H. Borts, "Behavior of the Firm Under Regulatory Constraint," American Economic Review, Vol. LXII, December 1972.
21. A. Takayama, "Behavior of the Firm Under Regulatory Constraint," The American Economic Review, Vol. LIX, June 1969.
22. E. E. Zajac, "A Geometric Treatment of Averch-Johnson Behavior of the Firm Model," American Economic Review, Vol. LX, March, 1970.
23. E. E. Zajac, "Note on 'Gold Plating' or 'Rate Base Padding'," The Bell Journal of Economics and Management Science, Vol. 3, Spring 1972.















UNIVERSITY OF ILLINOIS-URBANA



3 0112 060296461