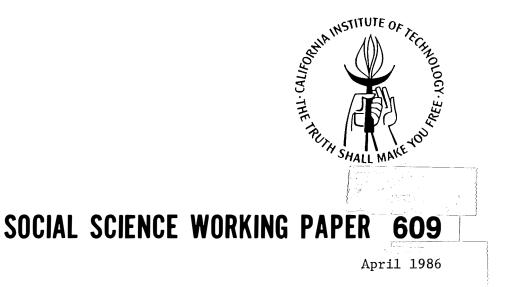DIVISION OF THE HUMANITIES AND SOCIAL SCIENCES

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A NOTE ON ALLOWED AND REALIZED RATES OF RETURN
IN THE ELECTRIC UTILITY INDUSTRY

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ABSTRACT

Most empirical investigations of electric utility behavior use
the realized rate of return as a proxy for the allowed rate of return.
We examine the validity of this assumption and investigate the
relationship of the allowed and realized rates to the cost of capital
between 1973 and 1982. We use two measures of the cost of capital:
one based on returns to book equity, the other derived from a market
price of equity. While realized and allowed rates were generally
higher than the book measure throughout the period, both of the rates
of return were less than the market price of capital after 1979. We
also find firms did not earn their allowed rate of return after 1974.
Therefore, the use of the realized rate as a proxy for the allowed
rate in emprical models will lead to biased parameter estimates. To
help correct this bias, we give data for allowed rates.

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Over two decades after Averch and Johnson published their 1962
article, their thesis is still a source of controversy in economics.
Since 1974, it has undergone extensive empirical testing. These tests
differ in model specification, econometric methods, sample size, and
results. However, almost all the tests have used the realized rate of
return on the rate base as a proxy for the allowed rate of return
under the assumption that the allowed and realized rates are equal in
equilibrium. The single period forms of the model require the allowed
rate of return to be at least as great as the cost of capital. We
examine the validity of these assumptions. We find (1) the allowed

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and realized rates were greater than the cost of capital until the late 1970s and (2) the realized rate of return was less than the allowed rate of return after 1974.

1. THE COST OF CAPITAL AND RATES OF RETURN

There are thirteen regimes defined by the relations among the allowed rate of return (s), the realized rate of return (z), and the cost of capital (r). We portray these in Table 1. One can distinguish the regimes by their satisfaction of two assumptions: (1) The firm must earn its cost of capital, or exit the market in the long run (the financial constraint), i.e., $z \geq r$. (2) The firm earns no more than its allowed rate of return (the regulatory constraint), i.e., $s \geq z$. These assumptions imply: (3) The allowed rate of return is at least as great as the cost of capital, i.e., $s \geq r$. As one can see in Table 1, most regimes are not admissible under the traditional form of the Averch-Johnson model. Any regime consistent with all three assumptions must satisfy $s \geq z \geq r$.

Most empirical tests of the model assume that $s = z > r$ holds for the average firm. As Smithson (1978), p. 569, states, the substitution of the realized rate for the allowed rate, where the allowed rate is greater than the realized rate, results in a biased estimate of overcapitalization.[1] Some authors have been sensitive to this issue. Spann (1974) controls his sample period to assure the firms are in equilibrium. Gollop and Karlson (1980) note the equality of allowed and realized rates is an important assumption, but they do

not need to restrict their dynamic model to regimes where $s \geq z \geq r$.[2] Therefore, to test the Averch-Johnson model, one must first show $s \geq z \geq r$. We test this by examining these variables from 1973 to 1982.

2. DIFFERENCES AMONG RATES

To conduct these tests, we must define the cost of capital. We use two measures: one based on regulatory practices and the other from financial theory. The first is a weighted average cost of capital, c, derived from the capital asset pricing model's definition of the market price of equity. The second is the Allowance for Funds Used During Construction (AFUDC) rate, a, calculated from realized rates of return on the book value of equity. It is the rate at which firms are allowed to capitalize construction expenditures. We describe both measures in the Appendix. Table 2 shows the market cost of capital was greater than AFUDC rate after 1973, and significantly greater in 1974, 1975, and from 1978 to 1980. Hence, it will not be surprising to find our results are sensitive to the measure of the cost of capital.

First, we test the null hypothesis: $z \geq r$, i.e., whether the financial constraint is binding. Let $w = z - c$ and $ww = z - a$. The alternative hypothesis becomes $0 > w$ or ww. Given our allowed rate of return data are confined to observations on regulatory jurisdictions, we average z, c, and a for each state. We calculate t-statistics for paired observations assuming z, c, and a are approximately normal.

Table 3 presents the sample means and test statistics.[3] The AFUDC rate is less than the realized rate for 1973-80 and 1982, and insignificantly greater in 1981. But we find the market measure of the cost of capital less than or equal to z from 1973 to 1978, and greater than z from 1979 to 1982. This result has serious implications for the applicability of the Averch-Johnson model in the late 1970s and early 1980s.

Second, consider whether $s \geq z$, i.e., if the allowed rate of return constraint was binding. Let $u = s - z$. See Table 4. Except for 1973, the realized rate was less than that allowed by regulators. It was significantly less after 1974. While firms were allowed to earn more than they did earn, other factors, such as AFUDC regulation, restricted returns.[4]

Finally, we test whether $s \geq r$, or alternatively, whether $s - r < 0$. Let $v = s - c$ and $vv = s - a$. See Table 5. The allowed rate was always greater than the AFUDC rate. And between 1973 and 1978, it was significantly greater than the market cost of capital. However, in 1979 and 1982 the allowed rate and the market cost of capital were almost equal, and in 1980 and 1981 the allowed rate was less than the cost of capital. If we use the market cost of capital, we can conclude regulators were not allowing sufficient returns in 1980 and 1981.

3. SUMMARY

Different measures of the cost of capital yield different conclusions about the appropriateness of using the Averch-Johnson model to describe electric utility behavior in the latter part of the 1970s. The realized rate of return was greater than the cost of capital given by the AFUDC rate for all years. However, when we use a market price of the cost of capital, the realized rate of return was less than the cost of capital from 1979 to 1982. This finding violates the financial constraint of the Averch-Johnson model, suggesting the model is an inappropriate description of electric utility behavior in the late 1970s and early 1980s. Also, we found the allowed rate of return was greater than the realized rate after 1974. Using the realized rate as a proxy for the allowed rate will thus bias estimates of overcapitalization toward accepting the Averch-Johnson thesis. Instead of the traditional focus on allowed rate of return regulation, we suggest future research concentrate on practices that have restricted realized returns, such as the role of AFUDC regulation.

APPENDIX: DATA

A Market Cost of Capital (c)

We derived a market-based, weighted average cost of capital
from the capital asset pricing model. Let

$$c = i \cdot (1 - T) \cdot (1 - EC) + [r_f + \beta \cdot (r_m - r_f)] \cdot EC,$$

where i is the interest rate on debt, T is the corporate tax rate (set
equal to 0.50), EC is the equity to total capitalization ratio, r_f is
the risk-free rate of return, β is the covariance of the rate of
return on firm equity with the rate of return on a market portfolio,
divided by the variance of the return on the portfolio, and $(r_m - f_f)$
is the expected difference between the market return and the risk-free
rate. We determined interest rates by comparing bond ratings with
average bond yields. Bond ratings for each firm between 1973 and 1975
were from "Securities Offered," Moody's Public Utility Manual, 1973-
75. Ratings from 1976 to 1980 can be found in Moody's Corporate
Credit Report (November 9, 1983). We compared these ratings to
"Moody's Bond Yields by Rating Groups," Moody's Public Utility Manual,
1983. The equity to capitalization ratios were found in U.S. DOE or
U.S. FPC, "Capitalization Ratio of Common Equity," Statistics of
Privately Owned Utilities. We assumed the risk-free rate to be equal
to the rate on three-month U.S. Treasury securities. See Economic
Report of the President (1985), p. 310. Calculated betas are

available in Value Line Investment Survey. The expected difference on
a market portfolio and the risk-free rate was taken from Ibbotson and
Sinquefield (1977). We assumed the expected premium to 1976 holds
after 1976.

A Book Cost of Capital (a)

In regulating electric utility investment the Federal Power
Commission (1977) defined the Allowance for Funds Used During
Construction (AFUDC) rate as a weighted cost of debt and equity.
Following this measure of the cost of capital, let

$$a = i \cdot (1 - T) \cdot (1 - EC) + e \cdot EC,$$

where i, T, and EC are defined above, and e is an average of the
realized rates on common equity in the periods t, t-1, and t-2.
(Although the FPC suggested averaging the three previous periods, we
use t, t-1, and t-2 to compensate for the slight downward bias of not
including preferred equity and short-term debt.) The rates of return
on common equity were taken from U.S. DOE or U.S. FPC, "Selected
Financial Ratios," Statistics of Privately Owned Utilities.

The Realized Rate of Return (z)

Realized rates of return on the rate base are available in
U.S. DOE, "Selected Financial Ratios," Statistics of Privately Owned
Utilities. They equal electric utility operating income divided by

the rate base. The rate base equals net plant plus an allowance for working capital. We aggregated across utilities in each state, while making some modifications. Utilities with extremely high or low equity to total capitalization (EC) ratios tend to report realized rates of return that deviate greatly from the state norm. Thus, we excluded nineteen utilities with EC ratios greater than 90% or less than 10%. See Eastman (1985), p. 16, for a list of these.

The Allowed Rate of Return (s)

The National Association of Regulatory Utility Commissioners (NARUC) publish rates of return allowed by state commissions in their annual report (1973-82): "Section F: Basis of Rate of Return." This source was supplemented by U.S. FPC (1973). Several adjustments were required. We assumed the rate was in effect from the first day of the month of the date given and remained effective until a different rate was reported. In certain years some regulatory agencies did not furnish the allowed rate of return to NARUC. For missing values, we substituted a regional average, based on the ten federal regions as defined by the DOE. At times more than one rate was reported. Where a range was given, we averaged the reported values. The procedure presented no problems where the specified range was small (less than 0.5%). This was true for every state except Kansas from 1974 to 1978. There, the highest value of the allowed rate was most consistent with the values reported for 1979 to 1982. We made no attempt to distinguish between electric utilities and electric/gas combination

firms. We calculated the geometric mean across months for a yearly average. We report the allowed rate of return in Table 6. Values for other variables are available from the authors.

TABLE 1: Possible Combinations of S, Z, and R

Group 1: Regimes violating z ⟩ r

    (1)*   r ⟩ s ⟩ z

    (2)   r = s ⟩ z

    (3)*   r ⟩ s = z

    (4)*   r ⟩ z ⟩ s

    (5)   s ⟩ r ⟩ z

Group 2: Regimes violating s ⟩ z

    (4)*   r ⟩ z ⟩ s

    (6)*   z ⟩ r ⟩ s

    (7)*   z = r ⟩ s

    (8)   z ⟩ r = s

    (9)   z ⟩ s ⟩ r

*Regimes also violating s ⟩ r

Group 3: Regimes not violating any assumptions

    (10)   s ⟩ z = r

    (11)   s = z ⟩ r

    (12)   s ⟩ z ⟩ r

    (13)   s = z = r

TABLE 2: UU = A - C

Sample Size = 42

	Sample Mean	t Statistic
uu73	0.31	2.66**
uu74	-0.73	-7.22**
uu75	-0.22	-2.45**
uu76	-0.08	-0.90
uu77	-0.12	-1.34
uu78	-0.78	-8.49**
uu79	-1.73	-17.21**
uu80	-2.22	-21.94**
uu81	-2.77	-28.49**
uu82	-1.43	-13.25**

TABLE 3: W = Z - C AND WW = Z - A

Sample Size = 42

	Sample Mean	t Statistic		Sample Mean	t Statistic
w73	1.53	9.49**	ww73	1.21	10.97**
w74	0.01	0.03	ww74	0.73	4.28**
w75	0.93	5.42**	ww75	1.14	8.21**
w76	1.57	10.80**	ww76	1.65	12.79**
w77	1.61	11.07**	ww77	1.73	13.25**
w78	0.86	4.43**	ww78	1.64	9.88**
w79	-0.60	-2.78**	ww79	1.12	6.11**
w80	-1.59	-8.52**	ww80	0.64	3.88**
w81	-3.03	-13.89**	ww81	-0.26	-1.35
w82	-0.57	-2.38**	ww82	0.86	3.90**

* Significant at 5% (10%) level for a one (two)-tailed test.
**Significant at 2.5% (5%) level for a one (two)-tailed test.

TABLE 4: U = S - Z

Sample Size = 50

	Sample Mean	t Statistic
u73	-0.16	-1.02
u74	0.24	1.35
u75	0.24	1.68*
u76	0.21	1.69*
u77	0.54	3.34**
u78	0.34	1.90*
u79	0.79	4.10**
u80	0.94	4.51**
u81	1.43	6.88**
u82	0.70	3.02**

TABLE 5: V = S - C AND VV = S - A

Sample Size = 42

	Sample Mean	t Statistic		Sample Mean	t Statistic
v73	1.38	12.97**	vv73	1.07	6.70**
v74	0.36	3.05**	vv74	1.08	7.48**
v75	1.09	8.46**	vv75	1.30	8.89**
v76	1.66	12.68**	vv76	1.74	12.19**
v77	1.95	13.85**	vv77	2.07	13.34**
v78	1.18	8.32**	vv78	1.96	13.21**
v79	0.12	0.83	vv79	1.84	12.23**
v80	-0.76	-4.20**	vv80	1.47	8.09**
v81	-1.77	-10.56**	vv81	1.01	5.97**
v82	-0.04	-0.22	vv82	1.39	6.76**

* Significant at 5% (10%) level for a one (two)-tailed test.
**Significant at 2.5% (5%) level for a one (two)-tailed test.

TABLE 6: ALLOWED RATES OF RETURN

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AL	7.92	8.08	8.59	7.59	7.33	7.33	8.01	9.33	9.97	10.59
AK	9.24	9.24	6.77	12.16	12.16	7.76	6.90	7.42	13.36	13.36
AZ	6.75	6.75	7.03	8.43	8.49	8.32	8.32	8.74	9.03	9.28
AR	7.78	8.08	8.15	8.81	9.40	9.31	9.00	9.00	10.00	10.51
CA	8.00	8.20	8.20	8.25	8.86	9.51	9.65	10.22	10.38	12.20
CO	7.46	7.83	8.67	8.85	8.83	8.88	9.16	9.90	10.24	10.75
CT	8.01	8.01	8.13	8.30	8.52	9.21	9.55	9.82	10.56	12.16
DE	7.86	8.37	8.67	8.72	9.03	9.03	9.23	9.83	10.28	11.19
DC	7.22	8.50	8.50	8.55	9.06	9.06	9.06	9.27	9.44	10.14
FL	7.93	7.93	8.77	8.35	8.04	8.13	8.33	9.16	9.59	10.44
GA	7.95	8.18	9.49	9.68	9.57	9.36	9.40	9.89	10.00	11.21
HI	8.25	8.25	8.25	9.21	9.46	9.74	10.33	10.29	10.25	11.77
ID	6.90	6.90	8.40	8.23	8.71	9.68	8.83	9.29	10.72	11.19
IL	7.64	7.82	8.36	8.55	8.93	8.93	9.08	9.30	8.50	8.62
IN	6.60	6.95	6.99	7.11	7.27	7.35	7.35	7.35	7.40	7.50
IA	7.17	7.22	7.95	8.59	8.53	8.79	9.09	9.33	9.42	9.42
KS	7.60	8.56	8.75	8.75	10.00	9.00	9.36	9.00	9.98	9.99
KY	7.92	8.08	8.59	8.52	8.47	8.81	9.03	9.33	11.03	11.44
LA	8.29	8.49	8.22	8.13	9.06	9.15	9.26	10.53	11.44	11.78
ME	7.71	7.71	8.73	9.19	9.33	9.37	9.48	9.80	10.78	10.78
MD	8.20	8.20	8.90	8.92	9.11	9.11	9.11	9.45	9.55	10.84
MA	7.91	7.91	9.12	8.81	8.81	8.81	8.81	8.81	10.84	11.11
MI	7.49	7.62	8.54	8.44	8.90	9.08	9.04	9.21	9.28	9.31
MN	7.06	7.22	7.77	7.82	8.36	9.00	9.05	9.05	9.77	9.73
MS	8.45	8.43	8.18	8.28	8.28	8.28	8.28	8.55	9.88	9.88

TABLE 2:   ALLOWED RATES OF RETURN, continued

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
MO	8.10	8.10	8.10	8.10	9.04	9.11	9.11	9.11	9.89	11.19
MT	7.37	7.82	8.36	9.02	8.36	8.30	8.84	8.84	9.10	10.71
NV	8.13	9.14	9.14	9.36	9.36	9.86	9.81	9.92	11.16	12.41
NH	8.50	8.50	9.70	9.70	9.70	10.03	10.19	11.53	12.49	14.26
NJ	7.85	8.26	8.71	9.09	8.92	9.27	8.83	9.30	9.86	10.67
NM	7.99	8.74	8.74	8.84	9.90	9.90	9.60	9.85	10.66	11.36
NY	8.05	8.23	8.51	9.35	9.03	9.22	9.44	13.61	10.76	10.12
NC	7.82	7.78	7.93	8.71	9.15	9.68	10.00	10.27	10.97	11.92
ND	6.97	6.97	7.59	8.47	8.58	8.70	8.70	8.79	9.75	10.71
OH	6.49	6.49	7.20	7.20	8.33	9.57	10.14	10.49	11.07	11.56
OK	8.14	8.62	8.48	8.48	9.01	9.02	9.33	9.85	10.68	11.17
OR	8.05	8.80	8.80	8.80	9.41	9.41	10.53	11.15	12.27	12.80
PA	7.25	8.00	8.48	8.66	8.81	8.79	9.02	10.16	11.27	12.67
RI	7.25	7.25	9.35	9.02	8.39	8.55	8.90	9.60	9.60	11.14
SC	7.45	8.09	8.59	8.52	8.47	8.66	9.37	9.83	10.51	10.86
SD	7.37	7.82	8.36	8.75	8.77	8.83	9.34	9.88	10.45	10.60
TN	7.92	8.08	8.59	8.52	8.47	9.08	10.64	11.51	12.28	12.57
TX	8.14	8.62	8.48	8.48	7.73	7.73	9.46	10.04	10.51	12.00
UT	7.90	8.20	8.63	10.36	10.52	10.25	10.25	11.29	11.81	11.98
VT	8.25	8.56	9.68	9.77	9.77	9.84	10.60	10.80	10.80	10.80
VA	8.80	8.80	8.80	8.72	9.03	9.03	9.44	9.66	10.15	10.75
WA	7.70	7.88	8.77	8.91	9.17	9.02	9.65	11.39	11.71	12.58
WV	7.86	8.37	8.67	8.76	9.15	9.15	9.52	10.60	11.00	11.57
WI	7.06	7.22	7.77	7.82	8.36	8.78	8.93	11.13	11.11	11.28
WY	7.15	8.27	8.57	8.69	8.83	9.27	9.71	9.71	10.00	10.57

FOOTNOTES

1. Only Perrakis and Zerbinis (1981) used allowed rates of return. Their data were gathered by the National Association of Regulatory Utility Commissioners (NARUC) and were published jointly by the NARUC, the FPC, and the FCC. See U.S. FPC (1973). The following studies used the realized rate of return as a proxy for the allowed rate: Nelson (1984), Nelson and Wohar (1983), Cowing (1982), Gollop and Karlson (1980), Cowing (1978), Peterson (1975), and Spann (1974). For others, see Rothwell (1985), Table 2.1, pp. 53-55.

2. Differences between the allowed and realized rates of return may result from (1) lags in reporting the allowed rate of return, or (2) problems in aggregating across different regulatory jurisdictions. We examined the relationship between allowed rates and regulatory characteristics, such as fair value and original cost accounting and the inclusion in the rate base of (1) construction work in progress, (2) the AFUDC account, (3) payments for land held for future use, (4) contributions in aid of construction, (5) research and development expenditures, (6) allowances for working capital, (7) accumulated tax deferrals, and (8) pollution control equipment. None of these factors systematically explained differences across states in every year.

3. The lack of bond ratings on utilities in 8 states reduced the
   sample size to 42. Compare Table 3 with Table 4. These are
   Alaska, Hawaii, Idaho, Nebraska, Rhode Island, South Dakota,
   Tennessee, Washington, and Wyoming. There is no commission
   regulation of electricity in Nebraska. Instead, the District of
   Columbia brings the sample size to 50.

4. Averaging the realized rate over a three year period, as done in
   Spann (1974) and Gollop and Karlson (1980), gave similar results.

REFERENCES

Averch, Harvey and Leland Johnson. "Behavior of the Firm under
   Regulatory Constraint," American Economic Review 52 (December
   1962): 1052-69.

Cowing, Thomas. "The Effectiveness of Rate-of-Return Regulation: An
   Empirical Test Using Profit Functions," in Fuss and McFadden,
   editors, Production Economics: A Dual Approach to Theory and
   Applications (Amsterdam: North-Holland Publishing Company, 1978):
   215-46.

_____ . "Duality and the Estimation of a Restricted Technology,"
   in Smith, editor, Advances in Applied Micro-Economics (JAI Press:
   1982): 191-211.

Eastman, Kelly A. "The Difference between Allowed and Actual Rates of
   Return and Its Effect on Empirical Tests of the Averch-Johnson
   Thesis," unpublished B.A. honors thesis, University of
   California, Berkeley, 1985.

Gollop, Frank M. and Stephen H. Karlson. "The Electric Power
   Industry: An Econometric Model of Intertemporal Behavior," Land
   Economics 56, 3 (August 1980): 299-314.

Ibbotson, R.G. and R.A. Sinquefield. _Stocks, Bonds, Bills, and Inflation: The Past (1926-1976)_ and the Future (1977-2000) (Charlottesville, Va.: Financial Analysts Research Foundation, 1977).

Moody's Investors Service, Inc. _Moody's Public Utility Manual_ (various years).

Moody's Investors Service, Inc. _Moody's Corporate Credit Report_ (November 9, 1983).

National Association of Regulatory Utility Commissioners. _Annual Report on Utility and Carrier Regulation_ (various years).

Nelson, Randy A. "Regulation, Capital Vintage, and Technical Change in the Electric Utility Industry," _Review of Economics and Statistics_ 66, 1 (1984): 59-69.

_____ and Mark E. Wohar. "Regulation, Scale Economies, and Productivity in Steam-Electric Generation," _International Economic Review_ 24, 1 (February 1983): 57-79.

Perrakis, Stylianos and John Zerbinis. "An Empirical Analysis of Monopoly Regulation under Uncertainty," _Applied Economics_ 13 (1981): 109-25.

Petersen, H. Craig. "An Empirical Test of Regulatory Effects," _The Bell Journal of Economics_ 6,1 (Spring 1975): 111-26.

Rothwell, Geoffrey. "Electric Utility Power Plant Choice Under Investment Regulation," unpublished Ph.D. dissertation, University of California, Berkeley, 1985.

Smithson, Charles W. "The Degree of Regulation and the Monopoly Firm: Further Empirical Evidence," _Southern Economics Journal_ 44, 3 (1978): 568-80.

Spann, Robert M. "Rate of Return Regulation and Efficiency in Production: An Empirical Test of the Averch-Johnson Thesis," _The Bell Journal of Economics_ 5, 1 (Spring 1974): 38-52.

U.S. Council of Economic Advisors. _Economic Report of the President_ (February 1985): 310.

U.S. Department of Energy. _Statistics of Privately Owned Utilities in the United States_ (various years, previously published by the U.S. Federal Power Commission).

U.S. Federal Power Commission. "Uniform System of Accounts for Public Utilities Funds Used During Construction and Revisions of Certain Schedule Pages of FPC Reports," Order No. 561, _Federal Register_ 42 (February 2, 1977): 9161.

U.S. Federal Power Commission. _Federal and State Commission Jurisdiction and Regulation of_ Electric, Gas, and Telephone Utilities (1973).