The application of finance theory to public utility rate cases

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The purpose of this paper is to formulate the implications of finance theory for rate of return regulation. A variety of problems in finance and the law and economics of regulation are reviewed. Also, a regulatory procedure based on finance theory is proposed for practical use.

Finance theory suggests that the "comparable earnings" standard for rate of return regulation ought to be based on utilities' costs of capital. The cost of capital is difficult to measure, since it is defined in terms of investors' expectations. But plausible estimates can be obtained for utilities. The following principle is proposed for use of these estimates: Regulation should assure that the average expected rate of return on desired new utility investment is equal to the cost of capital. This is a definition of "fair return" based on the theory of competitive equilibrium. The principle is consistent with the comparable earnings standard. Only the most obvious, "straightforward" approach to implementing this principle is examined in detail; but this approach is practical and logically sound. It is particularly attractive when combined with conscious use of regulatory lag as an instrument of regulation. There are some difficulties, however, when such a lag is combined with the usual regulatory practice of basing the allowed rate of return on embedded rather than current debt costs.

The problem of determining the appropriate rate base is also discussed. Regulation based on the book value rate base will not generally lead to efficient price, output, or investment decisions. A "competitive market value" rate base would be better from the standpoint of efficiency, since it would lead to long-run marginal cost pricing. However, long-run marginal cost pricing is not generally consistent with the principle that utilities ought to be able to expect to earn their cost of capital on new investment.

1. Introduction

There is little argument in practical circles about the broad purpose of regulating public utilities' rates of return. The accepted legal

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principle is that "the return to the equity owner should be commensurate with returns on investments in other enterprises having corresponding risks." and sufficient to "attract capital" and maintain credit worthiness.[1]

Finance (the study of investments, capital markets, and financial management) seems directly relevant to the regulatory agencies' attempt to determine the rate of return allowed by law. Although relevant, the applications of finance theory in the regulatory field are not easily seen or understood.

The difficulties involved in transferring finance theory to regulatory problems are attested to by the sharp controversies generated by economists who have ventured into rate proceedings. Disagreements have arisen not only between economists and the usual participants in these proceedings but also among the economists themselves. Thus the problem is not simply *explaining* the theory to the regulators; it has not been clear how the theory should be applied.

The purpose of this paper is to formulate the implications of finance theory for public utility regulation. It is an attempt to apply theory to practical affairs. Thus, detailed attention is given not only to the theory per se but to current regulatory procedures, to alternative procedures, and to the controversies associated with recent attempts to apply finance theory in the regulatory arena.

A few caveats are necessary at the start:

(1) The paper's title means just what it says. This is not a general treatment of finance theory or of public utility rate regulation, but of the application of the former in the latter field. The various aspects of finance and regulation are pursued only as far as is necessary for this limited purpose. For example, I treat the practical problems of estimating utilities' costs of capital only superficially, concentrating instead on how an estimated cost of capital should be used. The problem of estimation is at least as hard and important as that of application, but it is substantially the same problem faced by nonregulated firms. Reviewing it in detail would mean reviewing much of finance theory in detail—a task I cannot attempt here.

(2) I will concentrate on one possible method of regulation, namely control of the overall rate of return earned. For the most part, I am taking the existing legal and procedural framework as given. I do not mean to imply that this framework is necessarily the best one.

(3) The paper does not necessarily describe how regulators actually behave, but how they should behave if the legal and procedural framework is taken at face value and the implications of finance and economic theory are recognized. One suspects that various nonfinancial considerations also affect regulatory behavior, and that regulators respond to objectives that are not evident in the legal and procedural framework.[2]

In short, I do not propose to present an optimal regulatory strategy or a complete positive theory of regulatory behavior. The

[1] This is from the Supreme Court Decision on Federal Power Commission et al. v. Hope Natural Gas Company, 320 U. S. 591 (1949) at 603.

[2] For example, see Posner [38] and Stigler [48] for substantially different views of the role of regulation.

objective is to provide an analysis which can be used to improve existing procedures. This is a limited, but important, objective. Existing procedures not only involve Big Money, but they apparently influence the allocation of resources to, and within, a substantial segment of the economy.

The paper begins with a brief review of the mechanics of rate of return regulation and describes the traditional interpretation of the accepted legal standards for a "fair" rate of return. I argue that the traditional interpretation has serious deficiencies, both in logic and in application. A market-based cost of capital is suggested as an alternative basis for establishing a "fair" return.

The middle portion of the paper (Sections 3 through 5) discusses the definition and measurement of the cost of capital, under the simplifying assumption that the firm is all-equity financed. A number of controversies involving definition and measurement for a regulated firm are discussed.

Measuring the cost of capital is one question, using it another. Sections 6 and 7 summarize the aims of regulation and show that these aims cannot be achieved solely by regulating overall rate of return. However, a somewhat limited objective is logical and feasible; that is, regulation should insure that the expected rate of return on desired new investment is equal to the cost of capital. I present an approach to regulation which is consistent with this principle and discuss the real and alleged problems in implementing it.

The penultimate section drops the assumption of all-equity financing, briefly discusses the problem of determining optimal capital structure, and shows how the approach developed in Sections 6 and 7 can be applied to utilities with complicated capital structures.

The last section includes a brief summary of major conclusions.

2. Review of rate regulation

■ **Regulatory procedures.** A utility's prices are set so that the utility covers its costs, including taxes and depreciation, plus a certain return on investment. The return on investment is obtained by multiplying the "rate base" by an allowed rate of return. The rate base is essentially the book value of the utility's capital investment.[3]

For example, suppose Utility X has a rate base of $100 million. It is producing one billion widgets per year. The allowed rate of return is set at 10 percent overall. Costs are $50 million per year, including depreciation and all taxes.[4] Then the average price of widgets is set as follows:[5]

$$\text{Price per widget} = \frac{\text{Revenue requirements}}{\text{No. of widgets}} = \frac{50{,}000{,}000 + 0.10(100{,}000{,}000)}{10^9} = \$0.06\,.$$

Thus widgets are sold for $0.06 until the next regulatory proceeding. This procedure allows the actual return earned to be more or less than

[3] Sometimes "fair value" rate bases are used. They are discussed later in this paper.

[4] That is, costs would be adjusted to cover income taxes associated with a 10-percent return, as well as property taxes, social security contributions, etc.

[5] This paper is concerned with the *level*, not the structure, of utility rates.

TABLE 1

PACIFIC GAS TRANSMISSION CO.–ALLOWED OVERALL RATE OF RETURN

CAPITAL SOURCE	PERCENT OF CAPITALIZATION	RATE OF RETURN IN PERCENT	WEIGHTED RATE
DEBT	79.66	6.13	4.88
EQUITY	20.34	11.64	2.37
TOTAL	100.00		7.25

SOURCE: FPC OPINION NO. 569 [58], P. 15

10 percent, depending on realized cost and revenues during the period of "regulatory lag" between proceedings.

The allowable rate of return is computed in the same fashion as a weighted average cost of capital, but with important differences. Table 1 shows the computation of the overall rate of return allowed Pacific Gas Transmission Company in a 1970 Federal Power Commission decision. The procedure for computing the overall return, 7.25 percent, is clear from the table, but the table does not show where such numbers typically come from.

(1) The figures listed under "percent of capitalization" refer to the respective percentages of debt and equity listed on the company's books at the time of the rate proceeding. They are book, not market, values. Neither do they necessarily refer to the proportions of debt and equity to be employed in future financing.

(2) The 6.13-percent figure is the "embedded" debt cost—that is, total interest payments divided by the book value of outstanding debt. The company's current borrowing rate can be much higher or lower than the "embedded" debt cost shown.

(3) The percentage cost of equity is a figure arrived at by judgment. I discuss the possible bases for this judgment below.

Although there are opportunities for disagreement at each of these three steps, most argument is centered on the return to equity, so I will start there.

☐ **The legal standard for setting the return to equity.** The governing principle is the Supreme Court's statement in the Hope decision:

> The return to the equity owner should be commensurate with returns on investments in other enterprises having corresponding risks. That return, moreover, should be sufficient to assure confidence in the financial integrity of the enterprise, so as to maintain its credit and to attract capital.[6]

The first sentence establishes a standard of "comparable earnings," the second, a standard of "capital attraction." The broad language of the Hope decision allows a variety of specific interpretations of these standards.

It is best to start with the comparable earnings standard. In practice, it has been applied in two ways. The traditional and most widely accepted approach[7] defines "returns" as the book rates of

[6] Note 1 *supra*.

[7] The most complete exposition and defense of this method is Leventhal [22].

return of other firms.[8] Those who advocate the traditional approach read the Hope decision in a particular way, namely:

> The return to the equity owner should be commensurate with [*recent book*] returns on [*past*] investments [*made by*] other enterprises having corresponding risks.

This approach rests on a special notion of opportunity cost—in this context, that a utility should be allowed to earn what it *would have* earned had its capital been invested in other firms of comparable risk.[9]

The alternative suggested by finance theory is to define "commensurate return" as the rate of return investors anticipate when they purchase equity shares of comparable risk. This is a *market* rate of return, defined in terms of anticipated dividends and capital gains relative to stock prices.

☐ **Drawbacks of the traditional interpretation.** The traditional interpretation has clear deficiencies. First, the method does not rest easily on the concept of opportunity cost. Opportunity cost is a marginal and forward-looking concept. Thus, the opportunity cost of investing in a particular asset is usually defined as the anticipated rate of return on an incremental investment in the best alternative. However, observed book rates of return are average returns on past investments.

Granted, average and marginal returns are equal at long-run equilibrium in perfectly competitive markets; but this is in an *ex ante* sense. No one argues that perfect competition requires equality of rates of return after the fact in an uncertain world. In any case, usually no attempt is made in regulatory proceedings to see whether the data examined really are marginal rates of return and whether they stem from perfectly competitive situations.

Second, the traditional interpretation of comparable earnings ignores capital markets. This is serious because the Supreme Court specifies that the variable of interest is "the return to the equity owner." The shareholder is not directly interested in the ratio of book earnings to the book value of a company he invests in. He looks at anticipated dividends and capital gains relative to the stock price he has to pay. Thus, it is more relevant to interpret the opportunity cost of capital as the return on securities with risks similar to the stock of the utility in question.

A third objection is that it is difficult, in practice, to find a suitable class of firms with corresponding risks. Suppose you are looking for a company with risk commensurate with Utility X. The likeliest

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[8] I will use the term "book" to refer to data based on income statements and balance sheets. Thus. the book rate of return to equity is simply the ratio of reported income to net worth as shown on the firm's balance sheet.

[9] The reader may wish to judge for himself whether this characterization of the "traditional interpretation" is accurate. I would suggest starting with two intelligently done examples of this approach. See testimony of Solomon [60] and Friend [37]. Friend concludes: "If regulation is attempting to duplicate competitive results, the rate of return permitted on AT&T equity should be of the same general order of magnitude as on industrials and electric utilities with the same [risk] characteristics. This would require a return in the neighborhood of 12% to be consistent with [book] returns achieved in the last decade by electric companies and even somewhat higher to be consistent with the return achieved by comparable industrials" (p. 17).

candidates are other utilities, whose reported book rates of return reflect past regulatory decisions as well as competitive forces. Basing current regulatory decisions partly on past decisions leads to a dangerously arbitrary standard. One is forced to look elsewhere, to unregulated firms. But such firms presumably are riskier than utilities. Moreover, there is no clear theory about how risk should be related to differences in book rates of return (or even how risk should be defined if the book rate of return is the variable of interest.) In contrast, the relationship of risk and return in capital markets is better understood. This is discussed later in the paper.

The final objection is that accounting rates of return are subject to serious measurement errors and biases, particularly when comparisons are made between firms in different industries. This is also discussed later in the paper.

To summarize, the difficulties with the traditional interpretation of the comparable earnings standard are at very least sufficient to justify examination of alternatives.

3. Finance theory and the cost of capital concept

■ If a utility's allowed rate of return is to be "sufficient . . . to attract capital" and "commensurate with returns on investments in other enterprises having corresponding risks," then it has something in common with the cost of capital as that concept is used in finance. But "the cost of capital" is one of those phrases that can mean a dozen things. Thus, it will be helpful to review the concept briefly.

☐ **Definitions and assumptions.** To simplify matters, we will concentrate for the moment on a firm that is all-equity financed and can ignore market imperfections such as transaction costs and taxes. The logic in developing a cost of capital (i.e., minimum acceptable expected rate of return, or "hurdle rate") for such a firm's investments goes as follows:

(1) The firm is one of a class with similar risk characteristics—call this class j.

(2) At any point in time there is a unique expected rate of return prevailing in capital markets for this degree of risk—call it R_j.

(3) The share price of the firm in question will adjust so that it offers an expected rate of return R_j to investors.

(4) This rate, the shareholders' opportunity cost, should be the minimum acceptable expected rate of return on new investment, assuming the projects under consideration have risk characteristics similar to currently held assets. Otherwise, the firm's shareholders' wealth will not be maximized.

This sequence of logic defines the appropriate discount rate for projects which do not change the firm's risk characteristics. The basic problem is one of estimating the rates prevailing in the market.

The following equilibrium condition will be assumed to define R_j:

$$P_{tj} = \frac{D_{t+1,j} + P_{t+1,j}}{1 + R_j}, \qquad (1)$$

where

$$P_{tj} = \text{ex-dividend price at the end of period } t;$$
$$D_{t+1,j} = \text{dividends}^{10} \text{ expected to be received in } t+1, \text{ and}$$
$$P_{t+1,j} = \text{expected ex-dividend price at the end of } t+1.$$

It is not literally true that everyone has the same expectations of future returns. However, for purposes of analysis I assume that it is permissible to speak of "the market's" expectations.

Also, note that if R_j is assumed constant over time,[11] equation (1) implies

$$P_{0j} = \sum_{t=1}^{\infty} \frac{D_{tj}}{(1+R_j)^t}. \qquad (2)$$

☐ **Additional comments.**

Risk classes

The phrase "risk class" does not strictly imply that risk can be measured in one dimension. Moreover, it is conceivable that equilibrium expected rates of return on securities depend not only on risk but on still other factors, although this has not been established.

Nevertheless, the concept of opportunity cost (relative to an equivalent class of securities) is not made invalid by the fact that it may have to be defined as a function of several variables.[12] It is true, of course, that the more complicated the function, the more difficult is use of the concept.

Evaluating investments in differing risk classes

Most of the analysis in this paper assumes that the firm's risk class is given. However, what happens if it is not?

Suppose the firm acquires or disposes of an asset or liability, and that the transaction changes the firm's risk class from j to w. Assume that the asset or liability considered separately is in class k. Then in perfect markets,

$$P_{wt} = \bar{P}_t + \Delta P_t = \frac{\bar{D}_{t+1} + \bar{P}_{t+1}}{1+R_j} + \frac{\Delta D_{t+1} + \Delta P_{t+1}}{1+R_k}, \qquad (3)$$

where $^-$ indicates initial values and Δ, changes due to adoption of the

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[10] "Dividends" must be broadly interpreted to include all cash flows from the firm to holders of the share in question. Conceivably, D_t might include return of capital or even direct repurchase of shares by the firm.

[11] This assumption avoids consideration of the term "structure of interest rates." It also assumes that the perceived risk of successive future dividends increases at a constant rate as a function of t. See Robichek and Myers [40].

[12] For example, the different tax treatment of capital gains vs. dividends implies, *ceteris paribus*, that equilibrium expected rates of return should be positively correlated with dividend yield. If so, this would add another dimension necessary to define a class of equivalent securities. However, it is not clear whether there is any systematic empirical relationship between dividend yield or payout and equilibrium rates of return. See, for example, Friend and Puckett [15], Miller and Modigliani [30], especially p. 370, and Black and Scholes [6]. Others, notably Gordon, have argued that equilibrium rates of return are negatively related to dividend payout. See [16], for example.

project in class k.[13] Alternatively,

$$\Delta P_t = \sum_{t=1}^{n} \frac{\Delta D_t}{(1 + R_k)^t}, \quad (4)$$

where ΔD_t is the expected incremental cash flow from adoption of the project. Thus, if the asset or liability under consideration has risk characteristics like securities in class k, then the appropriate opportunity cost is R_k, the equilibrium rate of return offered by class k securities.

4. Estimating the cost of capital

■ This paper does not go very deeply into the problem of estimating investors' opportunity costs. However, a brief review will be helpful in two ways. First, it will show the kinds of evidence likely to be relied on in a practical context. Second, it will show some of the implications of the view of security valuation presented in Section 3 above.

The basic proposition underlying the cost of capital concept is that at any point in time securities are so priced that all securities of equivalent risk (i.e., all securities in a "risk class") offer the same expected rate of return. For a given utility the basic problem is to determine the expected rate of return for the class in which the stock falls.

There is no mechanical way to do this. Measurement of expectations is intrinsically difficult. But there are several types of evidence that should be examined before the ultimate judgment is made.

1. Interest rates

Interest rates on corporate bonds and other debt instruments can be readily observed to provide a floor for the estimate. Changes in the basic level of interest rates normally correspond in direction to changes in the cost of equity capital.

2. Ex post rates of return to investors

Averaging of *ex post* rates of return (or better, of *ex post* risk premiums, since interest rates vary over time) give some indication of the relevant range in which expectations lie. These averages are most helpful to the extent that they cover a long period of time and many stocks.[14] One cannot very well rely on five years of history for the utility in question as a guide to investors' expectations for the future.

3. DCF formulas

Examination of interest rates and past rates of return indicates a range for expected rates of return on common stocks. But these measures give insufficient bases for estimating a particular firm's cost of equity capital.

[13] The theorem is proved in a more general form in Myers [36]. There are, of course, degrees of perfection, and there is a residual disagreement about how perfect markets have to be in order for equations (3) and (4) to hold. See Lintner [31, p. 108, and on the other hand, Hamada [19].

[14] There is plenty of evidence available. See, for instance, Fisher and Lorie [13].

One approach is the so-called DCF or discounted cash flow method.[15] Its basic premise is equation (2)—i.e., that stock price is the present value, discounted at R, of the stream of expected dividends.[16] The idea is to infer R from the observed price P_0 and an estimate of what investors expect in the way of future dividends.

In practice a number of simplifications of equation (2) are employed in using the DCF method. Suppose, for example, that the dividend stream is expected to grow indefinitely at some rate g which is less than R. Then equation (1) can be simplified to

$$P_0 = \frac{D_1}{R - g}, \tag{5}$$

$$R = \frac{D_1}{P_0} + g. \tag{5a}$$

For utilities, for which a constant, moderate long-term trend in earnings and dividends is often identifiable, equation (5a) can be a reasonable rule of thumb for estimating R. A danger is that temporary growth trends are apt to be mechanically projected "to infinity." Likewise, it is tempting to assume without checking that expected future growth is constant. Fortunately, there is nothing in equation (2) that requires a single, perpetual growth rate. One can easily assume that different growth rates are anticipated for different future periods.[17]

In general, the DCF model—either equation (5a) or some more complicated variant of equation (2)—has to be fit to the case at hand. The point of the analysis is to answer the question, What would a rational unbiased investor expect from a long-term investment in this stock at the prevailing price? This rate of return is taken to be R on the assumption that the prevailing price is based on the opportunity cost of investment in equivalent-risk securities.

4. Earnings-price ratios

Earnings-price ratios can be used to measure the cost of equity capital in some cases. The formulas

$$P_0 = \frac{\text{EPS}_1}{R}, \tag{6}$$

$$R = \frac{\text{EPS}_1}{P_0} \tag{6a}$$

are actually special cases of equation (2) if certain assumptions hold.

Suppose that earnings per share (EPS) in any one year are "normal" long-run earnings of the firm's business and that all earn-

[15] For examples of the use of the method, see testimony of Brigham [55], Kosh [52], Myers [53, 61], and Roseman [57].

[16] The subscript j has been dropped because the firm's risk class is taken as given.

[17] In [61] I used a simple structural model of the firm to project the dividend stream under different assumptions about the short-term growth, long-term growth, and year-by-year book profitability. The dividend stream and the final estimate of the cost of equity capital were based on these simulations.

ings are paid out as dividends. Then equations (6) and (6a) are simply equations (5) and (5a) but with $g=0$.

Thus it is said that EPS_1/P_0 measures the cost of equity capital for "no-growth" firms. This is possibly misleading, however. Suppose a firm which falls initially into the no-growth category instead reinvests a portion of its earnings in projects which have on the average a present value of exactly zero. Then announcement of these projects makes the firm no more nor less attractive to investors, even though the firm will expand because of the reinvested earnings. The firm's current stock price will not change. Therefore, R is still correctly measured by EPS_1/P_0.

If the projects are on the average more than marginally desirable, however, the price will rise, earnings per share will remain constant, and thus the earnings-price ratio will underestimate R.

Note that equation (2) can be written

$$P_0 = \frac{EPS_1}{R} + \sum_{t=1}^{\infty} \frac{D_t - EPS_1}{(1+R)^t}. \qquad (7)$$

The second term can be interpreted as the net present value of future growth opportunities. Equation (6) follows from equation (7) only if the second term equals zero—i.e., if the firm's future investments yield exactly R on the average.

We see that growth in itself does not invalidate equations (6) and (6a). What does invalidate the formulas is growth that is more or less than minimally profitable.

This result has an interesting practical implication. Suppose it is argued that a utility's earnings-price ratio underestimates R. Then it must also be argued that investors expect the utility to earn more than the cost of equity capital on its future investments.[18]

☐ **Measuring risk.** It is clearly better to estimate R from data from a sample of equivalent-risk companies, rather than from data pertaining to the utility in question. But this requires an operational definition of "equivalent risk."

There is no consensus as to how risk should be defined and measured. Nevertheless, it is possible to obtain, from historical data, one or two statistics that are widely used as proxies.

The risk measures most often used stem from Markowitz's formulation of the individual's portfolio selection problem.[19] The investor is assumed to balance R_p, the expected one-period return on his portfolio, against σ_p^2, the variance of R_p. Let x_i equal the proportion of his investment allocated to security i, one of N candidates. Let σ_{ik} be the covariance of R_i and R_k and let $\sigma_i^2 = \sigma_{ii}$. Then

$$R_p = \sum_{i=1}^{N} x_i R_i , \qquad (8)$$

[18] This assumes that EPS_1 equals expected average earnings from assets held in $t = 1$. EPS_1 may differ from earnings as actually reported.

[19] See Markowitz [28]. For more extended treatment of the concept and its applications, see Markowitz [29] and Sharpe [45].

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$$\sigma_p^2 = \sum_{i=1}^{N} \sum_{k=1}^{N} x_i x_k \sigma_{ik} \tag{9}$$

with $\sum x_i = 1$.

Consider the special case in which the portfolio is limited to one security. For such an undiversified investor the relevant risk of security i is simply σ_i^2. Thus, if it is believed that demand for utility z's shares stems predominantly from undiversified investors—the proverbial widows or orphans who own stock in at most a few firms—then an estimate of σ_z^2 from past data should be a reasonable risk proxy, and a class of equivalent risk securities could be defined by $\sigma_i^2 \cong \sigma_z^2$.

However, it is hard to believe that the special case of widows and orphans is dominant. In general, the risk of security i is its marginal contribution to σ_p^2. This is

$$\frac{\delta \sigma_p^2}{\delta x_i} = 2x_i\sigma_i^2 + 2 \sum_{k \neq i} x_k \sigma_{ik}$$

$$= 2 \sum_{k=1}^{N} x_k \sigma_{ik} = 2\sigma_{ip} . \tag{10}$$

Thus security i's risk is proportional to σ_{ip}, the covariance of R_i and R_p.

As the number of securities in a portfolio increases, R_p becomes more and more closely correlated with R_M, the return on the "market portfolio" composed of all securities. (In fact, a high correlation of R_p and R_M has been found for randomly selected portfolios consisting of as few as ten stocks.)[20] This suggests σ_{iM} as an indicator of the "systematic" or "undiversifiable" risk of security i—the risk relevant to a diversified investor. σ_{iM} is in turn proportional to the coefficient β_i in the linear regression equation

$$R_i = \alpha_i + \beta_i R_M , \tag{11}$$

since β_i is given by σ_{iM}/σ_M^2.

Now, β_i can be estimated from past data. Thus it is a natural proxy for the effective risk of security to the well-diversified investor.

There is disagreement about the relative importance of β_i and σ_i^2 as determinants of R_i, but one and/or the other capture most of what most economists understand as risk.

☐ **The capital asset pricing model.** The risk measure β_i was just "derived" on a pragmatic basis, in order to show that it is *one* reasonable risk measure even in the absence of a formal theory of how risk affects security prices. Such justification is available, however, in the so-called capital asset pricing model.[21] Suppose we assume:

(1) That investors have identical assessments of securities' expected returns and risk characteristics,

(2) That the Markowitz model describes their portfolio choice, and

(3) That they can borrow or lend at a given risk-free rate, R_F.

[20] See Evans and Archer [11].

[21] The model is due to Sharpe [44], Lintner [24, 25], and Mossin [35].

Then at equilibrium in perfect markets.

$$R_i - R_F = \beta_i(R_M - R_F),$$
$$\beta_i = \frac{\sigma_{iM}}{\sigma_M^2}. \qquad (12)$$

It is not clear that equation (12) provides a *complete* empirical explanation of asset valuation.[22] But it does lend additional support to the use of β_i as a risk measure.[23]

Note also that if equation (12) is accepted it provides a vehicle for estimating R_i. R_F is approximately observable—a Treasury Bill rate, or a prime commercial paper rate, is customarily used. And presumably R_M, or $R_M - R_F$, will be easier to estimate from historical data than R_i or $R_i - R_F$. However, this approach has not yet been used in a regulatory proceeding.

☐ **Further comments on estimation in practice.** It is not my intention to go very deeply into practical problems of estimation. Nevertheless, a few comments may help to put the material just presented in better perspective. The problem is assumed to be estimating the opportunity cost of stockholders in Utility X.

It would be nice if investors' expectations were readily observable. If they were, they would surely be reported in the financial pages; and estimating R for Utility X would be a matter of looking up the currently projected dividends and capital gains, observing X's price, and calculating a rate of return. This would be taken as R_x on the assumption that X's stock is accurately priced relative to alternative equivalent risk investments. A sample of one firm (X) would be sufficient.

This is a never-never land. Suppose, however, we start with a sample of one firm, then postulate that a utility's future growth is relatively stable and predictable, and that it is therefore reasonable to use past trends as proxies for investors' expectations.

1. DCF estimates

Take the case of AT&T.[24] In March 1971 its annual dividend was \$2.60, the share price about \$49, and the dividend yield 0.053. During the 1960s the growth trend in its earnings per share was 4.6 percent. The trend in dividends per share for the same period was 4.5 percent. Suppose equation (5a) applies. If investors expected continued growth at about 4.5 percent per year, then their expected rate of return must have been $0.053 + 0.045 = 0.098$, that is, about 10 percent.

But it is immediately clear that the future need not be like the past. For example, AT&T's total assets may grow at a different rate,

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[22] See Friend and Blume [14] and the several empirical studies in Jensen [20].

[23] Equation (12) also suggests that $R_i - R_F$ and $R_M - R_F$ should be substituted for R_i and R_M in estimating equation (11). Even if equation (12) does not hold exactly, security returns at any point in time depend on R_F, and a more reliable estimate of β_i can be obtained if fluctuations in R_F over time are adjusted for.

[24] The numerical examples following are drawn from my recent testimony [53]. I am not trying to summarize that testimony, nor am I implying that what was done there is necessarily appropriate for other cases. I am using that testimony here as a convenient source of numerical examples.

TABLE 2

COST OF EQUITY CAPITAL ESTIMATES BASED ON SIMULATION MODEL

AVERAGE BOOK RATE OF RETURN ON EQUITY INVESTMENT	LONG-TERM GROWTH RATE OF BELL SYSTEM ASSETS			
	0.07	0.08	0.09	0.10
0.100	0.097	0.098	0.098	a
0.105	0.101	0.102	0.103	0.104
0.110	0.106	0.107	0.108	0.109
0.115	0.110	0.111	0.112	0.113
0.120	0.115	0.116	0.117	0.118
0.125	0.119	0.120	0.121	0.122

[a] NO MEANINGFUL FIGURE EXISTS FOR THIS CASE.

SOURCE: SIMULATION RUNS, DESCRIBED IN [53], APPENDIX B.

and it may be more or less profitable. Since investors took such facts into account in their assessments of expected future earnings and dividends, equation (5a) may not apply.

2. Simulations

The obvious next step is to explore the consequences of alternative assumptions about the future performance of AT&T.

Table 2 shows the long-run rate of return from investments in AT&T stock at $49, under various assumptions about book rate of return on equity (ROI) and long-term asset growth (g_A).[25]

Table 2 should be read in the following way: If investors expect $g_A = 0.08$ and ROI = 0.10, then the cost of capital is 0.098, roughly the same as estimated previously via equation (5a). However, if investors expect $g_A = 0.08$ and ROI = 0.115, then the cost of equity capital must be 0.111; otherwise AT&T's stock would not sell for $49.

Thus, to the extent that it is possible to establish a reasonable range for investors' expectations of asset growth and book profitability, it is possible to specify a range for the cost of capital. For example, if there is no evidence that could justify an expectation of ROI > 0.12 or $g_A > 0.09$, then R must be less than 0.117.

Note that the cost of equity capital estimate increases with the assumed growth in assets. The higher g_A, the greater the present value of growth opportunities (ROI > R in all instances) and the greater the cost of capital needed to explain the observed share price. However, the cost of equity capital estimate is much more sensitive to ROI than g_A, which reflects an interesting problem peculiar to regulated firms. The range of possible variation in ROI is wide partly because of uncertainty about the behavior of AT&T's various regulators. Granted, some of the more extreme values in Table 2 might be rejected as estimates of investors' *expectations*, but the uncertainty persists. This is one more reason why testimony in a regulatory proceeding cannot rest on a sample of one firm. The regulatory process

[25] The table is based on a simulation which is described in detail in [53], Appendix B. The simulation was necessary because of the complexity of the relationship between g_A, ROI, and the projection of dividends and earnings per share. The major complicating element was the necessity for periodic stock issues to finance asset growth at g_A.

introduces an element of uncertainty, which makes it difficult to assess investors' expectations, and thereby makes it difficult to measure the cost of capital. It is obviously necessary to broaden the sample.

3. *Risk classes*

However, broadening the sample requires specification of a risk-equivalent class of stocks. Suppose we make use of the risk proxies described above. Figure 1 plots *ex post* return versus σ and β, respectively, for AT&T and Moody's 24 utilities, a sample of large, well-established electrics. The points shown were calculated from monthly rate of return data covering the 1960–1969 period.[26]

The figure shows that, compared to these utilities, AT&T was a relatively safe investment for the undiversified investor. For a well-diversified investor AT&T's risk was about the same.

Suppose that the 24 electrics are accepted as an "equivalent risk class." The logical next step is to estimate the cost of equity capital for the utilities. There are several ways in which this could be done. We might observe the average dividend yield of the 24 utilities (0.054) and the average of their 1960–1969 trends in earnings per share (0.06). Then using equation (5a),

$$R = \frac{D_1}{P_0} + g$$

$$= 0.054 + 0.06 = 0.114 .$$

4. *The role of judgment*

One can go on to consider other companies, other measures, and other time periods. The only solid generalization is that, at the present state of the art, the final figure for cost of equity capital will be a judgment based on a wide variety of data and techniques. Such judgment is customary in regulatory proceedings; it is not peculiar to estimates of market-based costs of capital. The important point is that judgmental estimates of R do not have to be shots in the dark. One can arrive at rough but plausible estimates of R by using the simple tools I have just described.

5. *Econometric models*

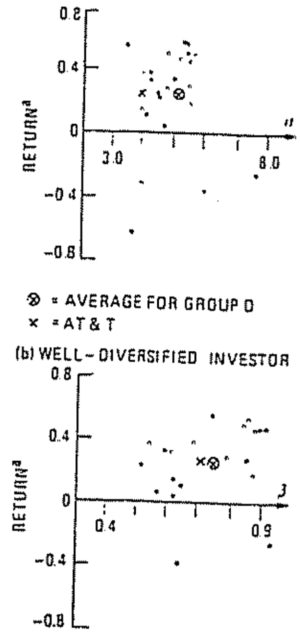
The persuasiveness of "judgmental factors" in cost of capital estimates creates a clear opportunity for effective use of econometric models. Such models may improve the accuracy of the estimates and certainly will make the required judgments more explicit.

There are many recent attempts to estimate the cost of capital via econometric techniques,[27] but the approaches taken are so diverse

FIGURE 1

RETURN VS. RISK FOR AT&T AND STOCKS IN GROUP D

(a) UNDIVERSIFIED INVESTOR



[a]DEFINED AS THE AVERAGE RISK PREMIUM EARNED, 1960-1969, BASED ON MONTHLY DATA. THE TREASURY BILL RATE WAS USED AS THE RISK-FREE RATE OF INTEREST. FOR FULL DETAILS SEE [53], PP. 49-57 AND ATTACHMENTS H THROUGH N

[26] *Ibid.*, pp. 49–57 and Attachments H through N. Since Figures 1(a) and 1(b) are used here only for illustrative purposes, I do not think it necessary to include all of the backup material.

[27] The list includes Miller and Modigliani [30] and the subsequent comments and elaboration on their approach [8], [17], and [42]; Gordon's work for the FCC [51], of which a new version is in preparation; also, Brigham and Gordon [7], McDonald [27], Litzenburger and Rao [26], and others.

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that it is impossible to review the field here. More of a consensus will probably have to be reached before such models are routinely used. So far, Gordon's model[28] is the only one presented as evidence in a major regulatory proceeding.

5. Market efficiency and market perfection

■ There are two possible reasons for objecting to the use of the shareholders' opportunity costs in regulatory proceedings. The first is that they cannot be estimated with sufficient accuracy to support reasoned judgment by regulators. This objection cannot be answered *a priori*, but only by experience. The second objection is that data derived from stock market behavior are inappropriate for regulatory proceedings because of the market's irrationality or imperfection. This requires an answer.

□ **Efficiency of the stock market.** Some find it difficult to rest regulatory proceedings on something so volatile as the stock market. But this volatility is basically a reflection of the fact that most assets are risky; and to say that assets are risky means that their values will fluctuate. Uncertainty is a fact of life which happens to be more dramatically disrobed in the stock market than elsewhere. Therefore, the question is not whether the stock market is stable or predictable, since part of its function is to act as a locus for risk-bearing in the economy. The question is whether the market performs this function efficiently.

An "efficient" market is one in which at any point in time security prices fully reflect all information available at that point in time, and in which prices react quickly to new information as it becomes available.[29]

Efficiency can be defined more precisely. Rewriting equation (1) with more elaborate notation,

$$P_{jt}|\Phi_t = \frac{E(\tilde{D}_{j,t+1} + \tilde{P}_{j,t+1}|\Phi_t)}{1 + E(R_j|\Phi_t)}, \tag{1a}$$

where Φ_t is defined as a set of information. Equation (1a) defines the market's evaluation of j at t, given Φ_t. The market is efficient with *respect* to Φ_t if there is no way to use Φ_t to choose stocks with $E(\tilde{x}_{jt}) > 0$, where $\tilde{x}_{jt} = \tilde{R}_{jt} - E(\tilde{R}_{jt}|\Phi_t)$. Thus there are degrees of efficiency, depending on the breadth of information assumed included in Φ_t.

A relatively weak test is to define Φ_t as past price data and to predict that there is no superior trading strategy based on this information. Since past prices are certainly "available information," there should be no explainable price trends or cycles in an efficient market. This appears to be the case: no trading rule based on past prices has been shown to give abnormally high profits.

In fact, the evidence so far indicates that the U. S. capital markets are basically efficient with respect to a relatively broad set of information, including all data that would be regarded as publicly available. The evidence is ably summarized by Fama.[30]

[28] See [51].
[29] This discussion follows Fama [12].
[30] *Ibid.*

What relevance does this have for the use of finance theory in public utility regulation?

First, the market's efficiency is consistent with perfect markets—which are assumed here, and are usually built into theoretical models of valuation and the cost of capital.

Second, it indicates that observed prices at any time t approximate the equilibrium values, given Φ_t. Thus, an estimate of R at time t should be based on prices at t, not on an average of these and previous prices. There is no point in "smoothing" stock price series.

Third, market efficiency confirms that observed stock prices are closely coupled to information about the possible risks and returns of alternative investment opportunities. Otherwise a firm's "cost of capital" has little meaning or relevance. The measurement of a firm's cost of capital rests on the assumption that its stock is accurately priced relative to other equivalent-risk investments.

To summarize, there is positive evidence that overall capital market operations are basically efficient, and this efficiency is consistent with the hypothesis that market imperfections are minor.

6. Using the cost of capital as a basis for regulation

■ From this point I will assume that an estimate of Utility X's cost of capital is available. The problem is to determine how this figure should be used. I will continue to assume all-equity financing.

□ **A straightforward approach: application to book value rate base.** I turn first to a simple and somewhat exaggerated example. Imagine a utility with book assets (rate base) of $100 per share. It is all-equity financed. Earnings per share are $16, all paid out as dividends. Earnings per share are expected to remain constant indefinitely.

Under such conditions, the earnings-price ratio (or the dividend yield) will measure shareholders' opportunity cost correctly. Suppose we observe a current price of $200. Then

$$R = \frac{EPS_1}{P_0} = \frac{D_1}{P_0} = \frac{16}{200} = 0.08\,.$$

How should the regulatory commission use this information? What I will call the "straightforward approach" is to allow earnings of 8 percent on the usual book value rate base. The price of a utility's product or service will be set at a level sufficient to yield profits of 0.08 (100) or $8.00 per share.

If investors consider the new earnings level permanent, the utility's stock price will fall to $100:

$$P_0 = \frac{EPS_1}{R} = \frac{8.00}{0.08} = 100\,.$$

In other words, the straightforward application, in this idealized case, will drive share price to book value per share. The stock sold at $200 in the first place only because the firm was then earning, and was expected to earn, twice the cost of capital.

A firm's market value will equal book value if it consistently earns a book rate of return equal to the cost of capital.

This example is not intended as a paradigm of ideal regulation. However, I do wish to respond to Ezra Solomon's contention that it and similar approaches are "inherently contradictory and inconsistent"[31] when there is a gap between the cost of equity capital and the book return actually being earned by the utility in question. Walter Morton has come to a similar conclusion:

> What is wrong with [the cost of capital] is that whenever it is applied to a price above book it must . . . cause a fall in earnings and a fall in the price of the stock.
>
> Any theory which postulates that investors pay above book, with the expectation that earnings will be cut as described by regulatory action, must assume either profound ignorance and ineptitude on the part of the investors, or a spirit of masochism which induces them to destroy their own capital.[32]

Actually, there is nothing inconsistent or illogical about the straightforward approach unless it is assumed that investors' expectations (as observed in the process of measuring the cost of capital) should always be confirmed when regulatory commissions act.

Take the simple example. Suppose that investors do not anticipate the rate reduction which forces earnings per share down to $8. The cost of capital is 8 percent both before and after the regulatory decision, so there can be no error or inconsistency in measurement. Rather, what happens is that the expectations investors hold before the regulatory decision (i.e., earnings per share of $16) turn out to be wrong in the event. But the regulatory commission is not bound to confirm investors' expectations. Therefore, the straightforward approach is logically sound. (Whether or not the regulators *should* force earnings per share down to $8 is, of course, another question.)

This discussion illustrates the dangers of using market value (as measured by share price) as a basis for setting earnings levels. The point is explicitly recognized in the Hope decision:

> The fixing of prices, like other applications of the police power, may reduce the value of the property which is being regulated. But the fact that the value is reduced does not mean that the regulation is invalid. . . . It does, however, indicate that "fair value" is the end product of the process of rate-making not the starting point. . . . The heart of the matter is that the rates cannot be made to depend upon "fair value" when the value of the going enterprise depends upon earnings under whatever rates may be anticipated.[33]

In short, "consistency" does not require that a market-based cost of capital must be applied to market value rate base. Actually, the problem with the straightforward approach is not one of inconsistency but of possible difficulties in measurement.

Suppose that market value is initially above book. The regulators announce that they will use the straightforward approach along with the DCF method of measurement. Share price will fall, since investors will anticipate a lower allowed rate of return after the Commission acts. On the other hand, if share price falls, the Commission will overestimate the cost of capital if they assume that investors expect continuation of past earnings. If investors, recognizing this, expect that the regulators will misread their (investors') expectations,

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[31] Testimony of Solomon [60], transcript p. 1044.
[32] [33], p. 22.
[33] Note 1 *supra*, at 601.

TABLE 3

TEXAS EASTERN TRANSMISSION COMPANY– ACTUAL RATES OF RETURN ON EQUITY VS. RATES IMPLIED BY 6.5 PERCENT OVERALL RETURN

YEAR	RATES IMPLIED BY 6.5 PERCENT OVERALL RETURN	ACTUAL RETURN	DIFFERENCE
1965	11.10	14.03	+2.93
1966	10.65	14.44	+3.79
1967	9.98	15.10	+5.12
1968	9.38	16.25	+5.87

SOURCE: FPC DOCKET RP69–13 (PHASE I). INITIAL BRIEF OF COMMISSION STAFF [59].

then clearly, we have the beginnings of a very complicated game. Moreover, there is no guarantee that the players will arrive at a solution in which R is correctly measured.[34]

The solution to this measurement difficulty is not to rely on a sample of one firm, the utility in question, but on a broader sample of equivalent-risk firms.

☐ **Will share prices be forced to book value?** In our example, straightforward application of the DCF approach forces share price down to book value per share. This is generally true if the utility can actually be expected to earn the rate set for regulatory purposes. However, this is not always a safe assumption in practice.

This can be illustrated by the actual case of Texas Eastern Transmission Company for the 1965–1968 period. The firm's rate settlement in 1965 was on the basis of an overall rate of return of less than 6.5 percent. If Texas Eastern had actually earned 6.5 percent overall from 1965 through 1968, then it would have achieved the rates of return on book equity indicated in the second column of Table 3. The actual rates of return are shown in the third column.

Although it is difficult to infer exact causes, the fact that utilities can earn more or less than is nominally allowed appears due to four factors.

1. Regulatory lag

The existence of a regulatory lag is necessary but not sufficient. That is, if prices were immediately lowered (raised) whenever a

[34] Suppose that there is no growth trend in the utility's sales, profits, etc., and that the regulators measure R by the earnings-price ratio. Let BV be book value per share and ROI be the book rate of return. Let the superscript ° indicate initial values. Thus, in the numerical example used in this section, $BV = BV^{\circ} = 100$, $EPS^{\circ} = 16$, and $ROI^{\circ} = 0.16$. The regulators are assumed to set $ROI = EPS^{\circ}/P$, resulting in a new earnings-per-share of $EPS = ROI(BV^{\circ})$. If investors recognize this, $P = EPS/R$. Thus we have three equations and three unknowns, EPS, ROI, and P. Solving for ROI, we obtain

$$(ROI)^2 = EPS^{\circ} \frac{R}{(BV^{\circ})}$$

or

$$(ROI)^2 = ROI^{\circ}(R).$$

Of course if $ROI^{\circ} = R$ then $ROI = R$, but in this case the "game" will never begin. If the game does begin, then ROI° must differ from R and thus at the "solution" the new allowed ROI will not equal R either. In the numerical example, this solution will lead to $ROI = 0.113$.

utility's realized return rose above (fell below) the allowed return, then the utility would always earn exactly the allowed return (assuming that there is *some* price which will generate the required profits). But the utility has an opportunity to earn more than the allowed return if regulatory surveillance is lax and/or there is delay in instituting new proceedings.

2. Cost trends

The tendency in regulatory proceedings is to estimate future costs per unit of output on the basis of past, or at best current, costs and output. The likely future changes in cost and output levels are not taken into account systematically. If cost trends are favorable—as a result of technological advances, for example, or of market growth when there are economies of scale—then regulatory lag will allow utilities always to stay somewhat ahead of the game.

3. Factors not under regulatory control

Clearly, if a utility has diversified into nonregulated fields, then restricting the profitability of the regulated portion is not sufficient to insure that the firm's book rate of return equals the cost of capital for the firm as a whole. A similar problem arises when different parts of a firm's operations are regulated by different bodies.

4. Changes in rate base relative to capacity and output

The size of a utility's book value rate base relative to its production capacity and output depends on the average age of its assets—that is, the older the assets the greater the proportion of the initial investment written off as depreciation. Thus, if capacity, output, and operating costs are constant, the utility's book rate of return will increase over time. The same phenomenon will occur if the utility's rate of asset expansion diminishes, other things constant.

Of course, these four factors may work against the utility as well as for it.[35]

In short, a straightforward application of the cost of capital to a book value rate base does not automatically imply that market and book values will be equal. This is an obvious but important point. If straightforward approaches did imply equality of market and book values, then there would be no need to estimate the cost of capital. It would suffice to lower (raise) allowed earnings whenever markets were above (below) book.

☐ **Mixing true and accounting rates of return.** Ezra Solomon has forcefully pointed out one major difficulty in regulatory procedures.[36] As matters stand now, regulation is based on utilities' book rates of return. The trouble is that book rates of return can be poor measures

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[35] What about the "differences" shown for Texas Eastern in Table 3? My understanding is that they are due to favorable cost trends and profitable diversification into nonregulated industries. One "favorable cost trend" was a reduction in the effective income tax rate due to the investment tax credit. Incidentally, the rates of return on equity implied by a 6.5-percent overall return declined because embedded debt costs rose over the 1965–1968 period.

[36] Solomon [46]. See also Solomon and Laya [47].

of true (DCF) rates of return. The error's direction and extent can be an extremely complicated function of the firm's growth, the average maturity of its assets, its depreciation and capitalization policy, and inflation and other factors. Solomon concludes correctly that "the rate of return in conventional book rate units is conceptually and numerically different from the rate of return in DCF units," and that "two companies with similar DCF rates of return may well show widely differing book rates of return."[37]

Clearly, this is a potentially significant problem. How should regulatory decisions respond to possible biases in book rates of return? Do biases make use of cost of capital estimates inferior to rates of return based on traditional interpretations of the comparable earnings standard?

Suppose we accept that the possible biases are very difficult to estimate and adjust for. Then the traditional interpretation has an apparent advantage of consistency, in the sense that a utility's allowed book rate of return is compared to the book returns of other firms. However, consistency would also require that the utility's performance should be compared with the performance of firms whose book rates are subject to similar biases.

This only aggravates the problems in using the traditional interpretation. The firms most likely to have similarly biased book returns are other utilities. But their returns partly reflect past regulatory actions and thus do not provide an independent standard. Book returns of unregulated firms can be used, but such firms are likely to report book returns subject to different and possibly more severe biases than utilities' returns.

The alternative is to rely on the cost of capital concept. In this case regulators are faced with the possibility that the utility's apparent (book) rate of return may be different from the true (DCF) rate of return actually being earned by the utility.[38]

Evidently difficulties exist regardless of the interpretation of comparable earnings. At the present state of the art, the possible biases just discussed above provide no grounds for preferring the traditional interpretation of the comparable earnings standard to the interpretation presented here. The matter is ripe for further research.

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[37] [46], p. 78.

[38] Actually, the difficulties which arise when this concept is relied upon seem to be more tractable—in the long run, at least—than if the traditional approach is used. The bias need be assessed for only one firm rather than for the broad sample of firms required to implement the traditional approach. It also seems likely that the regulatory process itself restricts the bias. If a regulatory commission decides to allow a return *R*, and adjusts the utility's prices frequently enough that the utility always earns *R* on a book basis, then the utility will earn the same true return *R*. It must be granted that regulation does not work this perfectly. There are lags and therefore some fluctuations in book returns with unknown effects on true returns. Allowed rates of return change from time to time. Inflation is a factor. The likely effects of all these items probably cannot be assessed without building a relatively detailed simulation model. Nevertheless, I think we can anticipate the likely results of such a simulation. The biases in the book return are associated with variation in individual assets' book returns over the assets' lives. The regulatory process diminishes this variation. Since its extent is probably much less for utilities than for manufacturing companies or other unregulated firms, the bias in utilities' book returns will probably be relatively small. This argument is made in more detail by Trapnell [49].

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☐ **Inflation.** A book value rate base is the original cost of assets less depreciation. Neither component is adjusted to reflect experienced inflation, which raises two questions:

(1) Does fair play require an "inflation adjustment" to either the rate base or the allowed rate of return?

(2) Is such an adjustment required for efficient allocation of resources?

I consider only the first question here and defer the second until later on in the paper.

The classic formulation of the problems of regulation in inflationary times is Walter Morton's.[39] His answer to question (1) is yes. This answer rests on a value judgment—more precisely on an operational idea of fair treatment for utility investors.[40] Unfortunately, the requirements of "fair treatment" are not clearly defined in practice.

First, note that the cost of capital, as defined here, includes an adjustment for expected inflation. Investors' opportunity costs are estimated in nominal, not real, terms. Further, since "risk" here is related to uncertainty about nominal returns, it reflects uncertainty about future inflation and its possible effects on the regulated firm. (The effects depend in turn on the responses of regulators to various degrees of experienced inflation.)

One might visualize an implicit contract between investors and regulators, specifying the regulators' response to experienced inflation among other things. The question of whether investors are being treated fairly at any point in time depends on whether the implicit contract is being honored by the regulators.

Consider again the numerical example introduced at the start of this section. The cost of capital is 8 percent and the rate base is \$100. Suppose the 8-percent rate of return includes investors' expectation of 2-percent-per-year inflation.

Thus the regulators allow earnings of 0.08(100) = \$8. Price is

$$P_0 = \frac{EPS_1}{R} = \frac{D_1}{R} = \frac{8}{0.08} = \$100 .$$

Now assume that there is actually 10-percent inflation in $t = 1$, 8 percent more than expected. However, by the start of $t = 2$, investors expect inflation to drop to the "normal" 2-percent-per-year rate. Then R is again 0.08 at the start of period 2 and, according to the straightforward approach, no adjustment in the utility's allowed return is necessary. Share price will remain at \$100. The utility's shareholders' wealth is \$108 per share at the start of $t = 2$, including earnings paid out during $t = 1$. Obviously their real rate of return is negative.

Is this fair? It depends entirely on whether the "contract" between regulators and investors calls for investors to absorb the risks of greater-than-expected inflation. In real life, the "contract" is so vague that there is very little ground for calling any regulatory strategy fair or unfair. However, the straightforward application of the cost of capital to the book value rate base is not unfair as long as it is applied consistently.

[39] See [33].

[40] See [34], p. 122 *ff.*

■ In the last section I considered several possible objections to use of utilities' costs of capital as a basis for their regulation. By and large the objections can be answered. But at best this shows that regulation *can* be based on finance theory: it does not show that it *should* be. Thus we must turn to a more fundamental question: What are the goals of rate of return regulation, and to what extent can these goals be met by procedures based on finance theory?

7. Finance theory and the goals of regulation

To some extent the specification of goals is a matter complicated by the necessity for value judgements. An investor who purchases shares of Utility X at $200 in good faith will feel cheated by any regulatory decision which hands him a $100 capital loss. On the other hand, regulators cannot be bound to confirm investors' expectations in all instances.

Finance and economics are not very helpful when the problem of regulation is framed as "consumers vs. investors." Instead I will assume that regulation is intended as a substitute for competition. Thus, a "fair return" will be defined in terms of the competitive standard.

□ **"Fair return" and the competitive standard.** Ideal regulation forces the utility to operate at competitive levels of investment, price, output, and profit.

This is difficult, perhaps impossible, to achieve in practice. Clearly, rate of return regulation can reduce or eliminate "monopoly profits;" but it is not so clear that such regulation produces the investments, outputs, or prices that would occur if a competitive solution could be achieved.

Moreover, in "naturally monopolistic" industries, with systematically decreasing average costs, a fully competitive market is not a realistic alternative. In this case, we might conclude that

> the function of regulation is to preserve for the public, instead of the producer, the benefits arising from legal monopoly without depriving the investor of a competitive profit.[41]

Thus it is natural to begin with the problem of eliminating "monopoly profits"—or, to put it more positively, the problem of providing the "fair" rate of return that would obtain in a competitive market.

What does "monopoly profits" mean? Suppose we observe an unregulated firm that has recently been very successful, one that has been able to earn more than its cost of capital. Are these high returns monopoly profits? Not necessarily: the firm may be in a competitive industry in which very high profits were not expected. (They were perhaps hoped for, but the hopes were balanced by fear of losses.) The rate of return actually being earned may be a pleasant surprise.

A superior rate of return will be a "short-run" phenomenon in competitive markets. Such a return will erode as markets shift towards long-run equilibrium. However, short-run profits or losses are more the rule than the exception. In real life the path of adjustment to long-run equilibrium will not be smooth, because of uncertainty and because the target itself will be continually changing.

In short, the theory of competitive markets provides no grounds for enforcing *ex post* equality of a utility's rate of return on assets

[41] *Ibid.*, p. 94.

and its cost of capital. It is more relevant to consider rates of return *ex ante*.

Long-run equilibrium in competitive markets implies that the average expected rate of return on new capital investment equals the cost of capital.[42] If the average expected rate of return does not equal the cost of capital then there will be entry or exit from the industry. Thus, if the aim is to eliminate monopoly profits, this principle follows:

Regulation should assure that the average expected rate of return on desired new investment is equal to the utility's cost of capital.

This principle follows if "fair return" is understood in terms of the competitive standard. If the principle is accepted, it obviously follows that rate of return regulation should be based on finance theory and the cost of capital concept.

☐ **What "fair return" does and does not imply.** Before considering how to implement the principle, it will help to summarize some other things it does and does not imply.

(1) Note that an opportunity to invest in a project offering more than the cost of capital generates an immediate capital gain for investors. This is a windfall gain, since it is realized *ex ante*.

(2) A firm which can expect to earn its cost of capital on new investment meets the "capital attraction standard." This follows from the very definition of the cost of capital.

(3) Adherence to the principle implies that expected return to the equity owner is "commensurate with returns on investments in other enterprises having corresponding risks." Thus the principle is consistent with the comparable earnings standard established by the Hope case, provided that the standard is interpreted in terms of investors' opportunity costs.

(4) There are several things that the principle does not imply. It does not specify returns *ex post*; it is solely an *ex ante* concept. The existence of competitive markets does not require that expectations be realized for any asset, or even for all assets over any given period of time. Regulators can eliminate unexpectedly high or low rates of return after the fact, but only if they are willing to make the firm a risk-free investment.

(5) The principle says nothing about whether regulation should aim to make utilities safe or risky enterprises.

(6) Finally, it should be reemphasized that adherence to the principle does not guarantee that the utility will operate at competitive levels of price, output, and investment. This can easily be shown; it follows from the absence of any unique relationship between these variables and the *ex ante* rate of return on investment. There are many combinations of price, output, cost, and investment as well as many combinations of the various factors of production which will yield an expected rate of return equal to the cost of

[42] It is always true that the firm will invest up to the point where the marginal expected return on investment equals its cost of capital. This is so for both perfect competitors and monopolists, in both the short or the long run; thus, it provides no guidance for regulation.

capital. Further, there is no reason to suppose that the risk class the firm finally ends up in will be the same class that would prevail in a competitive environment.

☐ **Implementing the idea of fair return.** The principle that utilities ought to expect to earn the cost of capital on new investment is general enough to be compatible with a wide variety of regulatory schemes. Which one should be used? It is not yet possible to answer this question definitively. Nevertheless, a good deal can be said about the pros and cons of the most obvious alternatives.

In many ways the simplest approach is the "straightforward" approach with no regulatory lag. That is, the utility's product is priced at the start of each period t so that

$$REV_t = C_t + Z_t + R_t BV_t, \qquad (13)$$

where

REV_t = anticipated revenues in t,

C_t = anticipated operating costs in t,

Z_t = depreciation to be charged in t,

BV_t = the rate base at the start of t—i.e., the book value of the utility's assets at that time, and

R_t = the utility's cost of capital measured at the start of t.

"No regulatory lag" means that the time from t to $t + 1$ is short enough so that deviations of actual, from anticipated, revenue and cost are not significant. Of course, it may not be easy to find a price such that equation (13) holds; both REV_t and C_t depend on output, which is in turn a function of price. But I will assume that regulators solve this problem somehow. Now consider the pros and cons of such a proposal.

Pros

First, the cost of capital will be relatively easy to measure, since a utility operating under the scheme just described will tend to be a very safe investment. The only uncertainties involve:

(1) Future changes in the cost of capital, and

(2) The possibility that there may be no price which will generate the required revenue.

It is hard to believe that an established utility facing only these uncertainties would have a cost of capital much greater than corporate bond yields. (Note that holders of corporate bonds also face the first source of uncertainty.)

Second, such a scheme would be easy to administer. The rate cases would be frequent, but routine.

Cons

There are, however, serious disadvantages. For one thing, a low cost of capital is not necessarily a good thing. There is no basis for assuming that, in a competitive market, uncertainty about operating costs would be borne almost entirely by consumers, as would be the case under this rule. Consequently, this is not likely to be an optimum allocation of risk bearing.

But the most serious item is that there is very little incentive for the utility to be efficient in choice of factor proportions, capacity, price and output, or technology. If the utility can expect to earn no more nor less than its cost of capital, then it has no incentive to seek efficiency along any of these dimensions.

It might be thought that a slight compromise of the principle—i.e., allowing the utility to expect to earn a rate R^* which is a bit greater than R—would establish the proper incentives. However, Averch and Johnson[43] have shown that the condition $R^* > R$ creates an incentive for firms to use more than the efficient amount of capital relative to other factors of production. Moreover, it is possible for the inefficiency in factor proportions to increase as the difference between R^* and R decreases.[44] Thus the compromise does not seem helpful, assuming use of the straightforward approach with no lag.

The charge of inefficiency is reinforced by Irwin Friend's argument,[45] which goes as follows. Suppose the utility is regulated by the straightforward approach, with no lag. Nevertheless, it is acting in good faith and trying to be efficient. The utility finds itself faced with a wide range of investment opportunities, some "good"—i.e., offering a rate of return greater than R—and some "bad." Efficiency would seem to call for taking only "good" projects. But this would lead to an average rate of return higher than R. Thus the utility might just as well forgo the good projects or balance them with bad ones.

In short, the straightforward approach sans lag has little to recommend it. It meets the standard of "fair return" but it accomplishes little else. In particular, it removes any incentive for efficient operating or capital budgeting procedures.

☐ **Conscious use of regulatory lag.** As I have now emphasized several times, firms in a competitive industry will not earn the cost of capital at all points in time. *Ex post* returns can deviate substantially from the cost of capital in the short run. The duration of the deviations will be limited by the time required by firms to invest (or dis-invest) and enter (or leave) the industry. A regulatory lag provides a short run in which utilities can earn unexpectedly high or low profits, and the rate proceeding at the end of the lag can play a role analogous to the forces which drive competitive industries towards long-run equilibrium.

Consider, then, regulation according to the straightforward approach but with *conscious* use of regulatory lag. I emphasize "conscious:" although there is inevitably a lag in practice, this does not necessarily imply a tolerance for surprisingly high or low rates of return. Rather, it seems to reflect a willingness to put off the next rate proceeding until profits get out of line.

With conscious use of regulatory lag, prices would be set and then left unchanged for several periods. Equation (13) would remain the starting point for determining the appropriate price. However, there are some additional complications. Suppose it turns out that trends in cost, technology, demand, etc. consistently favor the utility. Then

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[43] See [1].

[44] See Baumol and Klevorick on this point [18], pp. 175–76. The Baumol-Klevorick article reviews the extensive literature on the Averch-Johnson thesis.

[45] See Friend [50] and [37], p. 4.

in principle the regulators should take account of the trends. That is, revenues allowed in t would have to be lower than REV_t as given by equation (13), so that

$$\sum_{\tau=t-1}^{t+L} \frac{REV_\tau - \overline{REV}_\tau}{(1 + R_t)^{\tau-t}} = 0 \,, \qquad (14)$$

where

$\overline{REV}_\tau$ = revenues expected in τ, given the price set at t;
REV_τ = revenues expected to satisfy equation (13) in τ, and
L = anticipated length of the lag.

This condition is necessary for the utility to expect to earn the cost of capital on investments undertaken in t and subsequently.

Practical difficulties

The necessity for equation (14) means that the longer the lag, the greater the administrative difficulty. To some extent there must be regulation *ex ante*, which provides for endless argument. Moreover, the utility now has the incentive to overestimate future costs. These difficulties can be ignored, but only at the expense of possibly violating the principle that utilities ought to expect to earn the cost of capital on new investment.

Another disadvantage is the difficulty in determining the appropriate duration of the lag. This cannot be left entirely to the utility, because then the lag would be short when profits are low and long when they are high. Further, it makes sense to accept unexpectedly high profits for a relatively long time if they are due to unusual managerial efficiency, but to cut the lag short if the high profits stem from the exploitation of the utility's monopoly position. At best, the straightforward approach *cum* lag could not be a formula for regulation but only an approach to it.

Effects of the regulatory lag on efficiency

The existence of a regulatory lag clearly provides the utility with an incentive to improve efficiency. The incentive appears along several dimensions:

(1) Suppose the allowed rate of return equals the cost of capital. Bailey and Coleman[46] have shown that existence of a regulatory lag will induce the utility (a) to use factors of production in efficient porportions and (b) to produce more than would an unconstrained monopoly.
(2) Existence of a lag allows the utility to capture some of the rewards of managerial efficiency and of cost-reducing innovation.[47]
(3) The lag encourages efficient capital budgeting procedures. There is a positive incentive to avoid "bad" projects offering returns less than the cost of capital, and an incentive to disengage from "bad" projects previously undertaken.

[46] In [2] Bailey and Coleman also show that the Averch-Johnson effects persist when there is a lag and the allowed rate of return is *above* the cost of capital.

[47] See Baumol and Klevorick [4], pp. 182–89.

Thus, although we cannot guarantee that a straightforward approach *cum* lag will lead exactly to the competitive solution, it does move the utility in the right directions. The inclusion of a lag does not make this strategy any more or less fair, but it makes the utility more efficient.

☐ **A tentative proposal.** The implications of the discussion so far can be summarized by offering a tentative proposal. Regulators should:

(1) Determine a price for the utility's product or service such that it can expect to earn its cost of capital, given the current cost and demand functions, rate base, and scheduled depreciation.
(2) Check to see whether the utility can be expected to earn more (less) than the cost of capital in subsequent periods, given the price set at $t = 1$. If so, lower (raise) the price so that the utility can expect to earn its cost of capital over the period of the anticipated lag.
(3) Tolerate unusually high or low profits during the period of regulatory lag. The length of the lag should roughly correspond to what the short run would be if there were a competitive market—that is, the length of time necessary to adjust the amount of fixed factors of production in response to changed conditions.

Admittedly, there would be compromises in practice. Because of administrative difficulties, step (2) would probably have to be skipped except in very clear-cut cases, and any adjustment would probably be based on judgment rather than explicit use of equation (14).

This proposal differs from current procedures primarily in the conscious use of regulatory lag. It is probably not the best strategy in any ultimate sense. There are many other strategies that are consistent with the principle that utilities ought to expect to earn their cost of capital on new investment; and it will be surprising if none among these turn out to be better, at least in theory, than the straightforward approach *cum* lag. Nevertheless, this proposed approach seems attractive pending rigorous examination of alternatives.

The search for alternative regulatory strategies might proceed in any one of several directions. One open question is whether use of a book value rate base leads to the best attainable regulatory decisions. This matter is briefly reviewed in the next section.

8. Determining the appropriate rate base

■ There are basically three different concepts of rate base that could be employed. They will be abbreviated as follows:

- BV Book value, based on the usual accounting principles.
- SMV Stock market value, i.e., number of shares outstanding times price per share.
- CMV Competitive market value, i.e., whatever the utility's assets would be worth at long-run equilibrium in a competitive market.

CMV can also be defined as the original cost of the firm's assets less economic depreciation. Similarly, BV equals original cost less accounting depreciation.

Some state commissions employ a fourth concept, the "fair value" rate base: but this need not delay us. In practice, fair value seems to be defined as book value plus a modest *ad hoc* adjustment.

Thus far, all I have said is that SMV is not useful in defining a utility's rate base. There are several reasons why. First, since SMV depends on how investors expect the regulators to act, it should be the "end result . . . not the starting point."[48] Second, adopting SMV as a rate base amounts to a commitment to confirm investors' expectations regardless of what they are based on. Third, if SMV is maintained consistently above (below) BV then the utility will expect to earn a rate of return on its new investment which is greater than (less than) the cost of capital.

But what about CMV as an alternative to BV?

☐ **Determinants of CMV relative to BV.** The concept of a CMV rate base originates in the standard theory of competitive markets. It will help to review the determinants of CMV according to this theory.

Long-run equilibrium requires that the expected rate of return on a firm's CMV be R, its cost of capital. This must be true both in an average and a marginal sense. If the marginal return on the CMV of new assets is not R, then the firm's investment decision can be improved. If the average return on the CMV of all assets is greater than R, then there will be entry of new firms; if it is less than R, capital will be withdrawn from the industry.

There are several ways to state this formally, but the most useful starts with an analogue to equation (13):

$$REV_t = \pi_t Q_t = C_t + \hat{Z}_t + R_t \text{CMV}_t , \qquad (15)$$

where

$\pi_t Q_t$ = equilibrium price times quantity to be produced during the period from t to $t + 1$,

$\hat{Z}_t$ = expected economic depreciation from t to $t + 1$,

C_t = expected out-of-pocket cost of producing Q_t, and

R_t = cost of capital measured at t.

Long-run competitive equilibrium requires that equation (15) holds when $\pi_t = \text{LRMC}_t$, where LRMC represents long-run marginal cost. For simplicity, let us omit the t's. Then the following equation may be regarded as an implicit definition of the CMV of the firm's assets:

$$\frac{R(\text{CMV}) + \hat{Z} + C}{Q} = \pi = \text{LRMC} . \qquad (16)$$

That is, given the equilibrium price π, each firm's CMV will adjust so that equation (16) holds. Of course competitive equilibrium also requires that π = LRAC, long-run average cost.

Under these conditions, the CMV of any new asset is simply its purchase price. Suppose a firm invests $100 in new assets during a given year. The firm is in a competitive industry which is at long-run equilibrium. We know that the expected rate of return on the 100th dollar must be R; consequently, this marginal dollar must contribute exactly $1 to both CMV and BV. However, the average expected rate

[48] Note 1 *supra*, at 601.

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of return on the \$100 invested must also be R; otherwise there would be an incentive for capital to enter or exit from the industry. Thus the other \$99 invested must contribute exactly \$99 to BV and CMV. The total CMV of the firm's "old" and "new" assets is determined by equation (16).[49]

Now let us carry equation (16) over into the regulatory arena as the definition of the CMV rate base. Under what conditions will a utility's CMV and BV rate bases differ?

The answer is clearest when we consider a utility that is started "from scratch." The utility's initial rate base is its gross investment outlay. For simplicity, assume scheduled book depreciation equals expected economic depreciation $\hat{Z}$. Then

$$\text{LRAC} = \frac{C + \hat{Z} + R(\text{BV})}{Q}. \tag{17}$$

Comparing equations (16) and (17), it is clear that CMV $\gtreqless$ BV as LRMC $\gtreqless$ LRAC.

This argument reflects the essential equivalence between use of a CMV rate base and LRMC pricing. That is, one way to test whether a firm's CMV differs from its existing BV rate base is to see whether there is a difference between (1) the price derived from straightforward application of the cost of capital to BV and (2) long-run marginal cost of new capacity, based on the most efficient available technology. If price is greater than LRMC, then BV is greater than CMV, and conversely. Thus, the straightforward approach based on CMV is exactly equivalent to (long-run) marginal cost pricing.[50]

☐ **Effects of using a CMV rate base.** It is obvious that regulation by the straightforward approach, under which the utility expects to earn the cost of capital on BV, cannot be expected to lead to the competitive solution unless BV = CMV—that is, unless accumulated book depreciation approximates economic depreciation.

There are no procedural difficulties in applying the straightforward approach *cum* lag to a CMV rate base, assuming that CMV can be estimated. (The estimation of CMV is difficult, particularly for utilities, but probably not impossible.)[51] Use of CMV would call for (1) an attempt to reflect expected economic depreciation in book depreciation schedules and (2) periodic write-ups or write-downs of the

[49] It is *not* determined by the reproduction cost of the old assets. If "reproduction cost" is used to define rate base, it must be in the sense of providing equivalent capacity with the latest equipment and procedures. But reproduction cost so defined is simply the CMV of the old assets.

[50] Here I ignore complications introduced by regulatory lag.

[51] The special complicating factors for regulated firms include the following:

(1) If a CMV rate base is used, the utility has an incentive to overdepreciate, thereby raising its price and increasing the immediate cash return. The excess depreciation could always be made up later by an *ad hoc* write-up of assets.

(2) A CMV rate base dilutes the utility's incentive to embrace technological change. Investment in radically more efficient assets, for example, would lead to a write-down of the value of old assets.

(3) In the case of unregulated firms, SMV may be a reasonable proxy for CMV. Unfortunately, the existence of regulation breaks the link between SMV and CMV.

rate base in response to unexpected developments.[32] However, strict use of a CMV rate base is *not* always consistent with the comparable earnings standard—that is, not always consistent with the proposition that the utility ought to expect to earn its cost of capital on new investment.

Consider again the case of the utility started from scratch. Suppose it is regulated according to a "straightforward approach" but with a CMV rate base. Then if LRMC is less than LRAC (the usual condition for a "natural monopoly") the utility can expect to earn less than R on its investment, since there will be an immediate write-down of the BV of this investment to CMV. Conversely, if LRMC > LRAC, then the utility's shareholders will receive an immediate capital gain due to a write-up of BV. Only in the case of LRMC = LRAC will this regulatory scheme adhere to the principle emphasized above, namely that a utility ought to expect to earn the cost of capital on its new investment.

It is interesting to compare this discussion with Klevorick's.[33] He found that maximization of social welfare will sometimes require that the firm be allowed to earn an average rate of return on investment that is different from the cost of capital. We have arrived at an essentially equivalent result by a somewhat more direct route. The result is that LRMC pricing (the usual condition for welfare maximization and efficient allocation of resources) will not yield an average return on investment equal to the cost of capital unless LRMC = LRAC.

☐ **Conclusions.** In one sense, this is a moot result, since plausible estimates of economic depreciation or LRMC have not yet been obtained. It is not clear whether a switch to CMV rate base would require a write-up or write-down of existing BV rate bases. It may turn out that average and marginal costs are roughly equal.

The immediate implication is that more thought is required on a variety of questions. For example:

(1) Can LRMC be measured in a practical context? That is, are there administratively feasible ways to construct economic depreciation schedules or CMV rate bases?

(2) Does LRMC in fact differ from LRAC? Does application of the cost of capital to utilities' actual BV rate bases result in prices substantially different from long-run marginal costs?

(3) If the answers to question (2) are yes, might it not be possible to have your cake and eat it too (i.e., to reconcile the conflict of marginal cost pricing with the comparable earnings principle) by adopting a two-part tariff? The "use" charge would be set equal to LRMC and the "capacity" charge then adjusted so that the utility expects to earn the cost of capital on its new investment.

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[32] The write-ups and -downs of CMV would presumably lead to corresponding changes in SMV. However, stockholders could be insulated from these changes. If they were included in ordinary income, for example, about 50 percent of the effect would be offset by extra taxes or tax shields. Alternatively, the changes could be passed on to consumers via a one-time credit or charge. It makes little difference, from an economic standpoint, which scheme is used.

[33] See [21].

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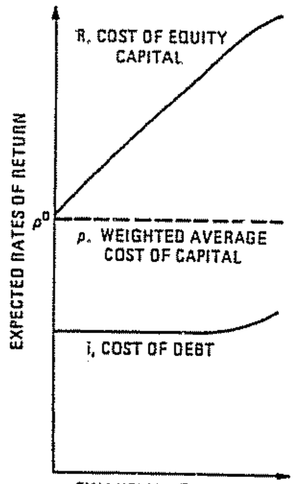
9. Regulating the overall rate of return

Implications of finance theory. The paper up to this point is an attempt to analyze—and to resolve, if possible—all the evident problems in applying finance theory to rate of return regulation. However, the analysis assumes that utilities are all-equity financed, which is of course not so. Thus it remains to be considered how a mixture of debt and equity financing alters the analysis. The first item is to review the theory and measurement of the cost of capital when capital structures include securities other than common stocks.

Measurement

FIGURE 2

EFFECTS OF FINANCIAL LEVERAGE ON COSTS OF DEBT AND EQUITY FINANCING AND THE WEIGHTED AVERAGE COST OF CAPITAL



Suppose we begin with a utility that is all-equity financed. If the utility now revises its capital structure to include some debt, the cost of equity capital (R) will rise, because financial leverage makes the firm's stock riskier. The interest rate, i, on the firm's borrowing will, of course, be less than the cost of equity capital. Figure 2 shows how R and i vary as a function of financial leverage. It should be intuitively clear that the utility's overall cost of capital, ρ, can be measured as a weighted average of R and i. It is not necessarily true that ρ will be constant, however.

Assume first that the firm's debt-equity mix is not expected to change. To get an exact measurement of ρ, given R and i, we can apply the same logic used to develop the cost of capital concept for the case of all-equity financing. Regardless of the degree of financial leverage, it is still possible to invest in the firm as a whole—i.e., in its assets, as distinct from any particular security. Investors can do this simply by purchasing each of the utility's financing instruments in appropriate proportions. Thus, suppose that the utility had \$100 million debt outstanding (market value) and outstanding stock with a market value of \$150 million. Then it would suffice to invest 40 percent of the portfolio in the utility's bonds and 60 percent in its stock.

Consider the opportunity cost of investors holding such a portfolio. The portfolio falls into a class of equivalent-risk securities and portfolios. If the expected rate of return for this class is, say, 10 percent, then the utility's stock price will adjust so that the portfolio of the utility's stocks and bonds will likewise offer an expected return of 10 percent. This 10-percent opportunity cost is the firm's overall, or "weighted average," cost of capital.

Thus, the overall cost of capital can be measured by the expected return on a portfolio of the firm's financing instruments:

$$\rho = i(D/V) + R(E/V), \qquad (18)$$

where

i = current average yield to maturity of the firm's outstanding debt,

R = expected rate of return offered by the firm's stock—i.e., its cost of equity capital,

D = market value of the firm's outstanding debt,

E = aggregate market value of outstanding stock, and

$V = D + E$.

This assumes there are only two kinds of financing instruments, debt and common equity. But the weighting principle remains the same if there are others, such as preferred stock, subordinate debentures, convertible securities, etc. Of the variables used to compute the weighted-average cost of capital, only R, the cost of equity capital, is not directly observable. I have already discussed how it can be estimated.

Use of ρ as a rate of return standard

The overall cost of capital ρ is here defined as the opportunity cost of investing in a firm's *assets*. Therefore the concept and definition of ρ is the same regardless of whether the firm is financed entirely by equity or by debt and equity. The actual financing package must be taken into account in measuring ρ, but the firm's use of debt does not make measurement more difficult. Thus the conclusions reached in earlier sections of this paper are not at all dependent on the assumption of all-equity financing, provided the financing mix is taken as given. However, we face a whole new class of problems if the debt-equity ratio is expected to change. Clearly there will be a change not only in D and E, but also in R and possibly i and ρ.

Effects of changes in debt-equity ratios

The starting point in the analysis of changes in the financing mix is Modigliani and Miller's (MM's) famous Proposition I,[54] which states simply that V and ρ are constants, independent of leverage. The proposition depends on three assumptions:

(1) The existence of perfect markets;

(2) That changes in financial leverage do not affect the firm's assets, future investments, or the size and risk characteristics of its income stream; and

(3) The absence of corporate income taxes—or, alternatively, that interest charges are not tax deductable.

Figure 2 is drawn to conform with MM's Proposition I.

Let us consider the assumptions in the order stated. First, capital markets are not strictly perfect. It can thus be argued that imperfections are sufficient to negate Proposition I as an acceptable generalization. Durand's comment on MM[55] is a cogent presentation of this point of view, which is usually taken to imply that ρ is a shallow, U-shaped function of financial leverage, rather than the flat line drawn in Figure 2.

I will not discuss assumption (2) here.[56] It is not likely to be important except for firms that are levered to the point where there is a noticable probability of financial embarrassment. This is not the usual case for regulated utilities.

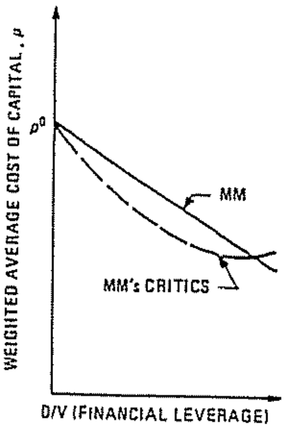
The tax effects are clearly substantial, however. In order to isolate them, we will assume that assumptions (1) and (2) are satisfied. Then MM's Proposition I implies, in general, that[57]

$$V = V^0 + \text{PVTS}, \qquad (19)$$

[54] Modigliani and Miller [32].
[55] See [9].
[56] The role of factors covered by this assumption is treated in Robichek and Myers [41], especially p. 16, and Baxter [5].
[57] See Robichek and Myers [41], pp. 13–15.

FIGURE 3

EFFECTS OF FINANCIAL LEVERAGE ON THE WEIGHTED AVERAGE COST OF CAPITAL WHEN CORPORATE INCOME IS TAXED



where the superscript ^{0} indicates what the value of V would be if the firm were all-equity financed, and PVTS stands for the present value of tax savings due to the deductability of interest on the firm's debt. More specifically, suppose that the firm has no growth opportunities, so that equation (6) applies. Then

$$V = \frac{X(1 + T_c)}{\rho^0} + T_c D \,, \tag{19a}$$

where

T_c = the corporate tax rate,

ρ^0 = the firm's cost of equity capital if it were all-equity financed, and

X = the firm's expected income before interest and taxes.

This implies that ρ, as defined via equation (18), is also given by[58]

$$\rho = \rho^0 - T_c(\rho^0 - i)D/V \,. \tag{20}$$

The implied behavior of ρ vs. D/V is shown in Figure 3 by the downward-sloping solid line. To repeat, this assumes that MM's proposition I holds exactly except for tax effects—i.e., that the line would be horizontal in the absence of such effects.

If MM's critics are right, the true relationship is like the dashed line in Figure 3. Unfortunately, there is no theory for this case specifying an exact functional relationship comparable to equation (20). Therefore I will continue to use MM's equations for purposes of discussion.

Equation (20) applies regardless of whether the firm is regulated or not. This may seem surprising in view of the treatment of taxes in regulatory proceedings. The usual procedure is to treat a utility's tax bill as an operating cost. If taxes change, the price of the utility's product or service is adjusted to provide an offsetting change in revenue. Thus, if a utility issues more debt, thereby reducing taxes relative to equity financing, the tax savings will be passed on to consumers in the form of lower prices. However, this does not change either equation (19) or (20); but it does make X, earnings before interest and taxes, a function of D. Specifically, for a regulated firm,[59]

$$X = X^0 - T_c i D \,, \tag{21}$$

where X^0 equals earnings before interest and taxes if the utility is all-equity financed. For an unregulated firm, $X = X^0$.

To put it another way, both regulated and nonregulated firms benefit from debt via a lower cost of capital, ρ. But unregulated firms benefit further in that X is *not* decreased to offset tax savings, as is (presumably) the case for regulated firms.

☐ **Practical implications of possible changes in financial leverage.** The implications of all this can be summed up in Figure 3, in which the solid line represents equation (20) and the dashed line incorporates the effects of the market imperfections which MM's critics think are

[58] See Modigliani and Miller [31], p. 439.

[59] See Elton and Gruber [10] for a more detailed discussion of taxes and the regulated firm's cost of capital.

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important.[60] However, there are implications for regulation regardless of which view is correct. One point is that a measurement of ρ on the basis of an observed capital structure will be in error if investors expect capital structure to change.

What is the possible magnitude of the error? Suppose equation (20) is right, and that a utility announces that it will shift D/V by 10 percent. Suppose that $T_c = 0.5$ and $\rho^0 - i = 0.05$. Then ρ will change by $T_c(\rho^0 - i)\Delta D/V = 0.5(0.05)0.1 = 0.0025$, or 0.25 percent. In a practical context this is not a very large number, for several reasons:

(1) If MM's critics are right, and the utility's D/V ratio puts it in the trough of the dashed U-shaped curve in Figure 3, then ρ will change by less than equation (20) would indicate.

(2) It could easily take several years for a firm to shift its capital structure by 10 percent.[61]

(3) Any error in measuring ρ will persist only during the regulatory lag.

(4) To be sure, ± 0.25 percent may amount to a lot of dollars. But it would explain only a fraction of the differences in the proposed costs of capital presented by the various parties in an actual regulatory proceeding.

To summarize, it does not seem too dangerous to estimate a utility's cost of capital on the assumption of a constant debt-equity ratio. Although a planned, major, rapid shift in capital structure should be taken into account, such shifts are presumably more the exception than the rule.

□ **Regulation of capital structure.** Now we may turn to a different problem: Should utilities' capital structures be regulated? At first glance, the objective of regulating capital structure would seem to be minimization of the weighted-average cost of capital. However, it is not at all clear that this is a good thing.

Suppose MM are right, so that equation (20) holds. Then ρ will decline with financial leverage, but only because the effect of the tax subsidy to debt financing is to reduce the risk of a portfolio of the firm's stocks and bonds. However, the firm's assets are no more nor less risky: It is simply that a part of the risk is absorbed by "we the people" via fluctuations in the corporate income tax revenues. Why should this be an objective of national economic policy?

If MM's critics are right, then ρ may also decline because of market imperfections. That is, the market imperfections will lead investors to prefer corporate debt to debt undertaken on personal account, and investors will therefore require, *ceteris paribus*, a lower expected rate of return on investments in levered firms. If this is the

[60] The following is a sampling of recent empirical studies, which contain references to earlier studies: Miller and Modigliani [30]; the "comments" on this piece [8], [17], and [42]; and Brigham and Gordon [7]; but see also Elton and Gruber [10], Sarma and Rao [43], and Litzenberger and Rao [26].

[61] For example, AT&T relied almost exclusively on debt for new external financing during the period 1967–1971. The effect was to shift its ratio of debt to total (book) capitalization from 33 to 45 percent. This was during a period of very heavy requirements for external finance. See Scanlon [54].

case, it is desirable for utilities to provide corporate leverage, since investors will thereby consider themselves better off. The trouble is that we do not know how strong investors' preference for corporate vs. personal leverage really is, if indeed this preference exists at all.

Thus, on purely economic grounds, the argument for regulating capital structure seems weak at best. About all that can be said is that utilities ought not to borrow so much that their solvency is endangered.

☐ **Some additional considerations.** The alert reader will have noticed two important differences between the overall cost of capital, as given by equation (18), and the procedure actually used by regulatory bodies in arriving at an overall rate of return allowance.[62] The differences are that

(1) Market value weights are used in equation (18), whereas book value weights are used in practice, and

(2) Embedded debt costs are used in practice.

What does finance theory say about the effects of these practices?

Clearly, the fact that the cost of capital can be applied to a book value rate base does not mean that book weights should be used in measuring it. The definition of the cost of capital in terms of investors' opportunity costs definitely implies that market value weights should be used.

This is not the whole story, however. Suppose Utility X is partly debt financed. Its regulators estimate ρ as 10 percent and therefore set X's prices so that the firm can expect to earn 10 percent on its book value rate base. X's stock sells for $100 per share after all this is done. Now suppose that interest rates rise by 2 percent, and the firm's overall cost of capital rises from 10 to 12 percent. This leads to another rate hearing in which the utility is allowed 12 percent rather than 10.

Given the regulators' response, the increase in interest rates will not affect the total market value of the firm, $V = D + E$. However, bondholders will suffer a capital loss, which implies that shareholders will receive a capital gain. The rise in interest rates will lead to a capital gain on the initial share price of $100. Conversely, if interest rates fall, bondholders will gain at the expense of stockholders.

Now, suppose that regulators wish to prevent stockholders from gaining when interest rates rise, and also wish to protect them from loss when interest rates fall. The way to do this is by allowing the firm to earn

(1) Its actual embedded interest cost, plus

(2) Equity earnings equal to the cost of equity capital times the book value of equity.

Under this procedure the overall rate of return will be a weighted average of embedded debt costs and the cost of equity capital, using book weights.

[62] See p. 61 *infra*.

To summarize, a regulatory strategy based on current debt costs requires market weights to compute the overall cost of capital. A strategy based on embedded debt costs requires use of book weights to determine the desired rate of return allowance. In general, the desired rate of return allowance in the latter case will not equal the overall cost of capital: that is, it will not generally reflect the current opportunity cost of investing in the firm's assets.

It is probably simpler, conceptually, to forget about embedded debt costs and simply use current borrowing costs. However, it is not necessarily illogical to use embedded costs. In fact, if there is no regulatory lag the use of embedded costs is generally consistent with the principle that utilities ought to expect to earn the cost of capital on new investment.[63] If utilities could change their rates automatically any time their embedded debt cost changed, then the rate of return earned on new investment would always reflect the actual current cost of any debt financing associated with the new investment.

But suppose there is a lag. Then if interest costs rise above embedded costs, a utility's rate of return on new investment will tend to be less than the cost of capital. The converse occurs when interest rates fall.

Conclusions

The use of embedded debt costs and book weights is not the most logical procedure. It seems simpler to rely on market weights and current interest costs, particularly when there is conscious use of regulatory lag. However, the straightforward approach *cum* lag is not necessarily incompatible with embedded debt costs and book weights, since the approach can be restricted to the equity component of utility capitalization. However, if the difference between current and embedded costs leads to a substantial violation of the principle that utilities ought to expect to earn the cost of capital in new investment, then an *ex ante* adjustment should be made.

10. Conclusions

■ This paper was motivated by dissatisfaction with the traditional interpretation of the comparable earnings standard, and by the hope that regulation could be made more effective by greater reliance on finance theory. Specifically, finance theory suggests that the comparable earnings standard should be defined in terms of investors' opportunity costs—i.e., in terms of utilities' costs of capital. Thus the paper is addressed to the question of whether regulation can or should be based on finance theory and the cost of capital concept. As we have seen, the search for an answer to this question requires consideration of a wide variety of topics in finance and the law and economics of regulation.

Is it in fact reasonable to base rate of return regulation on finance theory? It seems to me that the answer is a tentative yes. It is

[63] The timing of the change to current interest rates and market weights is a delicate matter. As this is written, current interest costs are substantially (1.5 percent or more) above embedded costs. A switch at this time would lead to a substantial capital gain for utility investors, financed by a one-time price increase. This raises problems of equity (to say nothing of politics), because it results from a change in the rules and is not a consequence of the regulatory process as consumers or investors have understood it.

tentative because there are difficulties (though the difficulties are often shared by other approaches to regulation) and because it is always possible that this paper will be made moot or obsolete by future developments in law, economics, or the conditions facing regulated firms.

Nevertheless there is a strong positive case to be made. I will close by summarizing it briefly:

(1) Regulation is usually regarded as a substitute for competition. If the definition of "fair return" is based on the theory of competitive markets, then regulation should assure that the average expected rate of return on new utility investment is equal to the utility's cost of capital. This is the ultimate justification for basing rate of return regulation on finance theory.

(2) This principle is consistent with the comparable earnings standard—in fact, more directly consistent than the traditional interpretation.

(3) There are many ways in which the principle can be implemented. Only the most obvious, "straightforward" approach was investigated here. But this approach is logically sound and practical. By and large, the objections to straightforward approaches can be answered satisfactorily.

(4) The straightforward approach is amenable to conscious use of regulatory lag. This does not make the approach more or less fair, but it does create stronger incentives for efficiency.

(5) The cost of capital is not directly observable, since it is defined in terms of investors' expected rates of return. At the present state of the art any estimate is part judgment. However, plausible estimates can be obtained, and the need for judgment is not evidently greater when regulation is based on finance theory rather than on traditional procedures.

The straightforward approach *cum* lag is not the final answer. It is only one of many ways to implement the principle that a utility ought to be able to expect to earn its cost of capital on new investment. Probably some of the other ways are better; it is hard to believe that the usual book value rate base could not be improved upon, for example. As a matter of fact, the whole existing framework of rate of return regulation, which was taken as given for purposes of this paper, may not be best. But all of this awaits further work.

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