Regulation, the Capital Asset Pricing Model, And the Arbitrage Pricing Theory

By RICHARD W. ROLL and STEPHEN A. ROSS

This article describes the arbitrage pricing theory (APT) and compares it with the capital asset pricing model as a tool for computing the cost of capital in utility regulatory proceedings. The article argues that the APT is a significantly superior method for determining equity costs.

THE capital asset pricing model (CAPM) is rapidly becoming the preferred methodology for the computation of fair rates of return in regulatory proceedings. This is not surprising given the amount of attention the model has received in the academic literature, but what is surprising is its seemingly unqualified acceptance by some regulatory bodies. Paradoxically, as the CAPM has gained favor amongst regulators, it is losing favor among financial scholars.

The major goal of this article is to describe a new scholarly view of how assets are priced in the financial markets and its implications for computing the cost of capital. This alternative approach is known by the acronym APT which stands for the arbitrage pricing theory. We believe that this theory provides a sounder theoretical basis than the CAPM for determining the cost of capital and that it is a more sensible methodology for such computations in rate of return regulation. It has a further advantage that it can be easily understood, particularly by anyone familiar with the CAPM.

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The CAPM — The Current State of Affairs

The popularity of the CAPM is based much less on its theoretical underpinnings than upon the intuitive descriptions that surround it. Central to this intuition is the notion of risk. The common argument goes roughly as follows. In a well-functioning capital market, investors must be rewarded for assuming risks. An investor always has the option of investing in nearly riskless securities, such as Treasury bills. To induce him to invest in equity with its greater risks, he must be promised a higher return than the riskless rate offered by Treasury bills. By the same reasoning, the greater the risk the greater must be the promised return. Of course, the return offered by the equity is just the cost of that capital to the equity issuer.

All of this has a very satisfying Calvinist appeal; if you want to have a higher return then you must bear more risk. The problems really begin when we go beyond this simple perspective and start to ask what is really meant by risk and exactly how it can be measured. The CAPM provides one approach to this question. According to the CAPM, each security has an associated quantity called its "beta" coefficient which is the sole measure of risk. The beta coefficient, b for short, is defined by the theory to be the sensitivity of the return of the security to the return of the "market" portfolio. In theory, the market portfolio is the portfolio composed of all securities and assets existing in the entire world, from simple stocks and bonds to Japanese electronics factories and Nigerian real estate. In practice, there is an enormous simplification to some familiar stock market index such as the Standard & Poor's 500. Given the index, the beta coefficient for an individual security is obtained by any of a variety of statistical techniques all of which essentially involve finding the best measure of b in the following equation:

return on stock = constant + b x (return on S&P 500). (1)
(cost of capital)

In other words, beta is the response of the returns on this stock to the returns on the market index. A beta of one would imply that when the S&P 500 went up or down by 10 per cent the stock would tend to go up or down by the same 10 per cent. A beta higher than one say two, would magnify market movements. Such a stock would move twice as much as the market. Similarly, a beta of less than one would diminish the importance of market movements. For example, if beta was one-half, when the market went up by 10 per cent this stock would on average only go up by 5 per cent. In the extreme, a stock could actually have a negative beta (gold stocks and some lines of the insurance industry exhibit such behavior). Such stocks respond in reverse to market movements, tending to go up when the market goes down and down when it goes up.

Having computed beta, the CAPM then argues that this measure of risk is the sole determinant of return. Any additional variability which might be caused by events peculiar to the individual asset can be "diversified away." In other words, in large diversified portfolios, the type of portfolios held by the investors who determine prices, only the nondiversifiable risk, the systematic risk, is relevant.

To find the cost of capital for a given stock we need only recognize that it must offer a return premium over and above that offered by a riskless asset. By the theory this premium will be proportional to the beta of the stock. Furthermore, since we can measure the average return on the S&P 500 we can use this to figure out the constant of proportionality. If, for the sake of illustration, the S&P 500 has an average return of 9.5 per cent while Treasury bills have averaged 5 per cent, then we would conclude that it has had an average return premium of 9.5% − 5% = 4.5%. Since the S&P 500 clearly has a beta of one with itself it follows that the constant of proportionality is 4.5 per cent. All of this is summarized in the following equation which is the cornerstone of the CAPM:

return on stock (cost of capital)	=	riskless return
		+ (2)
		beta x (S&P 500 − riskless return)
		= Treasury bill rate + 4.5% x beta.

But is beta really all that there is to the story? More precisely, does beta really capture all that is systematic in the risk of a security, and is it a sufficient measure of this risk for an adequate determination of the cost of capital?

In recent years these questions have become central to the academic debate of capital asset pricing. The doubts that have been raised concerning the practical significance of the CAPM and its use in the determination of the fair rate of return, have their counterparts in the theoretical and academic discussions as well. There is a lengthy literature on this debate. By way of a quick summary, the major points of contention have centered on the somewhat artificial nature of the theory and on the inability to test the theory statistically. To date there is yet to be an adequate test of the CAPM. Those tests that have been conducted, if accepted at face value, have not been generally supportive. The theory says that a particular portfolio, the market portfolio of all the assets in the world, is the proper benchmark against which to measure risk. In the parlance of the theory, it is a mean-variance efficient portfolio. The theory does not say that the S&P 500 is such an efficient portfolio, and, in fact, current evidence suggests that neither this index nor any other familiar single index will suffice.

Given this unfortunate state of affairs, why then is the CAPM so popular? It is our view that this popularity stems not from the theory itself, but rather from the intuition which the theory attempts to embody. There is nothing wrong with the general idea. Somehow it all sounds plausible, but the final results just do not make much sense.

A newer alternative model has been developed in the academic literature which captures all of the fine intuitions of the CAPM, seems more sensible, and produces much more reasonable results. This model is called the arbitrage pricing theory. Like the CAPM, the APT determines the cost of capital from the systematic risk of the security, but unlike the CAPM, it allows assets to be subject to more than a single source of systematic risk.

The Arbitrage Pricing Theory, APT

The APT begins with a simple description of the way in which uncertain and unpredictable events influence asset returns. The returns on an individual stock in, say, the coming year will depend upon a variety of anticipated and unanticipated changes in the economy over that period of time. These changes in the overall economic environment affect all stocks in systematic ways, and the response of any particular stock depends upon its sensitivity to the general economic environment. Those changes that are anticipated will be incorporated by investors into their expectations of returns on individual stocks, and the market prices will reflect such expectations. Generally, though, well over half of the return actually realized will be the result of unanticipated changes. Of

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course, change itself is anticipated and investors know that the most unlikely occurrence of all would be for them to get exactly what they now expect to be the most probable future scenario. But, even though they know that the economy will change in some currently unforeseen ways, they do not know either the direction or magnitude of these changes. What they can know is the sensitivity of stock returns to these events.

Asset returns are also affected by factors that are not systematic to the economy as a whole. These factors are the amalgam of all of those forces which influence individual firms or particular industries, but are not directly related to overall economic conditions. We call these forces idiosyncratic to distinguish them from the systematic forces which describe the major movements in market returns.

Large portfolios will have their returns influenced by changes in the major systematic factors and, through the process of diversification, they will be nearly immune to the idiosyncratic effects on individual assets. As a consequence, the systematic factors alone determine the returns on large portfolios, and the actual return on any given portfolio depends upon the sensitivity of that portfolio to unanticipated movements in the common factors. Since the factors are the major sources of risk in large portfolios, a portfolio that is so hedged as to be insensitive to the common factors and sufficiently large and well proportioned so as to diversify away idiosyncratic risk, is essentially riskless. It follows that exposure to the unpredictable movements in the common factors is the risk that the capital market is most concerned about in the determination of the cost of capital.

The logic behind this reasoning is not simply the usual economic argument that if you want more return you must be prepared to bear more risk. While this line of reasoning certainly captures an important truth, there is a far simpler reason why the expected return on a portfolio is related to its sensitivity to factor movements. The argument is the same as that which leads to the conclusion that two three-month Treasury bills or two shares of the same stock must sell for the same price. Two assets which are very close substitutes must sell for about the same price, and nowhere in the entire economy are there any items which are closer substitutes than two financial assets which offer the same returns.

Two diversified portfolios with identical sensitivities to systematic economic forces are very close substitutes. In effect, they differ only in the limited amount of idiosyncratic, or residual risk that they might still bear. Consequently, they must offer the investor very nearly identical expected returns, just as the two Treasury bills or the two shares of the same stock offer identical expected returns.

At this point a bit of mathematics is probably desirable if not inevitable. We will use the Greek letter b to stand for the sensitivity to factor movements. We will let a capital R denote the actual return on a portfolio or stock, and we use a capital E to stand for the expected return on the portfolio or the stock. Since E denotes the expected return to the investor, it is also simply the cost of capital. The whole thrust of this theory is to relate E to the systematic risk. A lower case f will stand for the actual unpredictable return on the systematic economic factors and a lower case e will denote the return on the unsystematic, idiosyncratic factor. Armed with this notation we can break the actual return on any asset, be it a stock, a bond, real estate, or even a portfolio, into its three constituent parts:

$$R = E + bf + e. \quad (3)$$

In words, this equation reads,

Actual return = Expected return
\+
Factor sensitivity x Factor movement
\+
Idiosyncratic risk.

As we have been stressing, though, there is not simply a single systematic factor; rather empirical research has found that there are at least three or four important ones, so

$$R = E + (b1)(f1) + (b2)(f2) + (b3)(f3) + (b4)(f4) + e. \quad (4)$$

where each systematic economic factor has been explicitly broken out. Each of the four middle terms in the above equation is the product of the unanticipated returns on a particular economic factor and the given asset's sensitivity to that factor.

What are these factors? They are the underlying economic forces which are the primary influences on the asset market. Our research has suggested that three of the most important factors are unanticipated movements in inflation, in industrial production, and in the general cost of risk bearing. For the determination of the cost of capital using the APT it is not necessary to identify which economic forces actually are the most important influences on market returns, but doing so does aid the intuition and is further confirmation that the cost of capital has been correctly measured.

Since we have already argued that the expected returns on large portfolios are influenced almost exclusively by these systematic factors and not by the idiosyncratic terms, if we carefully choose four different portfolios in just such a way that they each have different sensitivities to the systematic factors, then these portfolios can be indices for the factors. The easiest way to illustrate this argument is to assume, for the moment, that there are two completely unknown and unidentifiable factors which influence returns. Even though we have no idea what these factors are and may, in fact, disagree strongly about them, nevertheless we can still compute the cost of capital for an individual stock in an unequivocal manner. To do so we need only find two large, well-diversified portfolios whose returns regularly differ from each other; i.e., are not very well correlated. This assures us that one of the portfolios is more heavily weighted towards one of the unknown factors than is the other portfolio; if they had the same weights then they would tend to have nearly identical returns. Now we can simply compute the sensitivity of the given stock to each of these "mimicking" portfolios and use these sensitivities to determine the cost of capital for the stock. In what follows, then, we will simply interpret the four factors in equation (4) as four portfolios of assets, since identifying them more carefully will not influence the determination of the cost of capital.

Equation (4) is the basic description of how the returns on a given security are related to the overall returns on the four portfolios which mimic the economic factors. We use this model of the capital market to determine the cost of capital, E, by proving that there must be a particular relationship between the cost of capital, E, and the systematic risk measures for the stock; i.e., b(1), b(2), b(3), and b(4).

Suppose that there are two stocks, A and B, with identical factor sensitivities, but whose costs of capital, E, differ. Let us look at this situation from the point of view of an investor with a large portfolio. For such an investor contemplating purchasing or retaining shares in these two companies, the only relevant measures of the risk are the factor sensitivities, and these are the same for the two companies. The respective idiosyncratic risks of A and B do not matter since these will be diversified away in the large portfolio. But if, for example, the expected return on asset A, denoted by EA is larger than that for asset B, EB, then all such investors would want to hold the stock of company A and none of them would want company B. Since there would be no demand for company B's stock, its price must fall. If company B is to retain its stockholders, it must pay just as much as A in order to attract capital. In other words, two companies with the same systematic sensitivities must have the same costs of capital; the cost of capital is determined by the b's.

To show exactly how the b's and E are related, a simple example will be sufficient. We will refer to the factor sensitivities, the b's, as factor betas or just betas for short. For illustrative simplicity, assume that the assets being considered have identical sensitivities to all but, say, the third factor portfolio, f3. The accompanying figure plots the costs of capital and the third factor betas of two stocks and a riskless bond. The characteristics of the three assets are displayed in Table 1.

Notice that the riskless asset, the bond, offers a yield that (we assume) is unaffected by the systematic factor that influences the other two assets. Suppose that we form a portfolio that is evenly divided between the bond and the stock B. Such a portfolio will have a return that is a simple average of the returns of the two constituent assets. Hence the expected return on such a portfolio will be given by

$$E = 1/2 \times 15\% + 1/2 \times 35\% = 25\%.$$

TABLE 1

	Bond	*Stock A*	*Stock B*
E (Expected return, cost of capital)	15%	20%	35%
b3 (Factor sensitivity)	0	1	2

Similarly, the sensitivity of this portfolio, its b3, will also be halfway between the sensitivities of the bond and B,

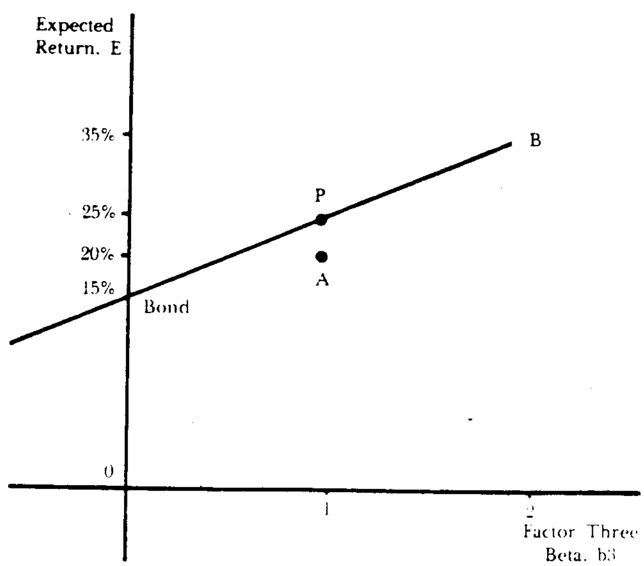
$$b3 = 1/2 \times 0 \quad + \quad 1/2 \times 2 = 1.$$

This portfolio is plotted as point, P, in the accompanying figure. Notice that P lies directly above stock A. Consider what this means. By forming a portfolio of the bond and the higher risk stock, B, we have exposed our investment to the same systematic factor risk as we would have by investing in stock A. While stock B is twice as sensitive as stock A, only half of our investment is at risk and the remainder has gone into the bond. The combination therefore has exactly the same sensitivity to the third factor as asset A.

But, with this same sensitivity we have obtained a higher expected return! The expected return on the portfolio is 25 per cent while that on asset A is only 20 per cent. It does not matter whether investors like the systematic risk or not, what is essential is that the portfolio P is exactly like stock A in all relevant features except for one: It has a higher expected return, 25 per cent versus 20 per cent. No matter what happens with unforeseeable economic forces, the portfolio P will have a higher rate of return.

By our previous argument, though, any two assets with the same returns must have the same cost of capital. In other words, the expected return on portfolio P cannot differ from the expected return on stock A. In symbols, EP = EA. In well-functioning capital markets

FIGURE: PORTFOLIO SENSITIVITY



such opportunities cannot persist; they are quickly eliminated by astute traders. This arbitrage takes place, by investors reducing their holdings of stock A and purchasing portfolio P, causing the price of A to fall. Since B is in the heavily demanded portfolio, the price of B will rise. At a lower price, stock A will become more attractive and at a higher price B will be less attractive. The process stops when stock A offers the same return as portfolio P.

Such arbitrage opportunities will cease to exist only when all three of the assets in the figure lie on the same line. Otherwise, we would be able to find another portfolio that beat or was beaten by one of the two stocks. This implies, then, that there is a line relating each of the b's and the cost of capital.

More generally, it follows from the same argument that the cost of capital is given by the risk-free interest rate, r, plus a weighted average of the factor sensitivities,

$$E = r + (k1)(b1) + (k2)(b2) + (k3)(b3) + (k4)(b4). \quad (5)$$

The weights, k1, k2, k3, and k4, are the return premiums (in excess of the riskless return) earned by each of the four portfolios, f1, f2, f3, and f4. By way of illustration, suppose, for example, that f3 had an average return of 8 per cent. Using the previous average of 5 per cent for the risk-free rate would produce a return premium of

$$\begin{aligned} k3 &= \text{return on f3} - \text{risk-free interest rate} \\ &= 8\% - 5\% \qquad (6) \\ &= 3\%. \end{aligned}$$

Comparing the APT and the CAPM

The CAPM and the APT have quite different implications for the determination of the cost of capital for regulated utilities. Table 2, column 1, displays the alphas for a sample of regulated utility companies. (No attempt has been made to examine the companies in the sample individually. For example, the reported results are for the entire company and not just for the regulated subsidiaries.) The alpha reported is simply the difference between the historical average past return on equity; i.e. the past average cost of equity capital, and the cost of capital obtained by the CAPM theory described in the first section of this article, and using equation (2). The consistently positive alphas indicate that the CAPM theory has consistently underestimated the cost of capital for these firms relative to their historic capital costs.

Table 2, column 2, displays the alphas for the same sample of firms using the APT. The differences between the CAPM alphas and the APT alphas are reported in Table 2, column 3. These differences are the additional cost of capital implied by the APT. As can be seen in Table 2, column 3, the estimated costs of capital are, on average, significantly greater for the APT than for the CAPM. No attempt has been made here to do anything more than compute simple long-run average estimates. We have argued that the resulting APT estimates for the cost of capital are much more realistic than those obtained from the CAPM. By including the additional forces which influence the systematic risk of equity, the APT theory can better explain the cost of capital than the CAPM. In effect, the APT can explain, significantly lessen, and remove the biases in the CAPM's alphas.

In particular, regulated utilities differ substantially in the pattern of their factor sensitivities from the pattern exhibited by a broad stock market index such as the S&P 500 (which is dominated by nonregulated manufacturing and service companies). Regulated utilities have a much greater sensitivity to the second factor portfolio, the portfolio that mimics unanticipated inflation. This is hardly surprising. Regulated utilities are interest rate sensitive and interest rates respond dramatically to inflation. This sensitivity to inflation is a risk for which investors in regulated utilities require compensation; it is a risk that increases the cost of capital.

The CAPM, unlike the APT, cannot portray this risk properly. The single CAPM beta of a regulated utility merely measures how sensitive the utility is to that particular mix of factors in the S&P 500. For example, suppose that the S&P 500 had b's, sensitivities to the underlying economic forces, of

$$b1s = .8, \text{ industrial production,}$$

and

$$b2s = .2, \text{ inflation,}$$

and suppose also, that the return premiums for the factor sensitivities were

$$k1 = 9\%,$$

and

$$k2 = 7\%,$$

with a riskless rate of 15 per cent.

Suppose that a particular regulated utility had a different pattern of sensitivities, say,

$$b1u = .2,$$

and

$$b2u = .8.$$

In other words, the utility is more sensitive to inflation and less sensitive to industrial production than is the typical manufacturing stock in the S&P 500. The true expected returns — i.e., the costs of capital — for the S&P 500 and the utility are, as calculated from equation (5),

$$Es = 15\% + (.8)(9\%) + (.2)(7\%) = 13.6\%,$$

and

$$Eu = 15\% + (.2)(9\%) + (.8)(7\%) = 12.4\%.$$

TABLE 2

Regulated Utilities	CAPM Alphas (Per Cent – Per Year)	APT Alphas (Per Cent – Per Year)	APT Cost of Capital – CAPM Cost of Capital
Alagasco Inc	1.602	0.496	1.106
Allegheny Pwr. Sys. Inc	2.457	−0.104	2.561
American Elec. Pwr. Inc	1.160	0.479	0.681
American Na. Res. Co	2.471	1.240	1.231
American Teleph. & Teleg	0.713	−0.146	0.859
Arizona Pub. Svc. Co	−1.046	−3.288	−0.758
Atlantic City Elec. Co	1.509	−0.191	1.7
Baltimore Gas & Elec	0.084	−0.647	0.731
Bay St. Gas Co.	7.685	6.378	1.307
Boston Edison Co.	0.337	−1.158	1.495
Brooklyn Un. Gas Co.	3.270	1.046	2.224
CP Natl. Corp.	2.394	3.268	0.874
Carolina Pwr. & Lt. Co.	0.756	0.214	.542
Cascade Nat. Gas Corp.	1.546	3.424	−1.878
Central & South West	1.820	0.147	1.673
Central Hudson Gas & Elec.	1.344	0.075	1.269
Central Ill. Lt. Co.	−0.173	−1.592	1.419
Central Ill. Pub. Svc.	1.102	−0.936	2.038
Central Me. Pwr. Co.	−1.055	−1.793	0.738
Cincinnati Bell Inc	1.259	1.145	.114
Cincinnati Gas & Elec	2.166	0.638	1.528
Cleveland Elec. Illum.	1.567	0.074	1.493
Columbia Gas Sys. Inc.	4.659	2.853	1.806
Columbus & Southern Oh.	1.090	−0.507	1.597
Commonwealth Edison	−0.347	−2.382	2.035
Consolidated Edison	1.725	−0.490	2.215
Consolidated Nat. Gas	3.328	1.837	1.491
Consumers Pwr. Co.	−0.464	−1.129	−0.665
Continental Teleph. Corp.	−3.951	−4.440	0.489
Dayton Pwr. & Lt. Co.	−0.416	−1.944	1.528
Delmarva Pwr. & Lt. Co.	0.565	−0.625	1.19
Detroit Edison Co.	0.058	−1.464	1.522
Duke Pwr. Co.	−1.753	−0.419	−1.334
Duquesne Lt. Co.	−0.452	−1.716	1.264
Eastern Utils. Associates	−2.279	−1.928	− .351
El Paso Co.	2.633	1.387	1.246
Empire Dist. Elec. Co.	2.536	0.624	1.912
Enserch Corp.	4.270	2.599	1.671
Equitable Gas Co.	3.841	1.800	2.041
Florida Pwr. & Lt. Co.	3.274	2.394	.880
Florida Pwr. Corp.	2.879	2.119	.760
Gas Svc. Co.	−3.156	−3.925	.769
General Pub. Utils. Co.	−2.709	−4.096	1.387
General Teleph. & Elec.	2.226	1.611	.615
Gulf Sts. Utils. Co.	1.911	0.058	1.853
Hawaiian Elec. Inc.	−1.718	−2.067	.349
Houston Inds. Inc.	2.115	0.150	1.965
Idaho Pwr. Co.	1.225	−0.654	1.879
Illinois Pwr. Co.	1.684	−0.172	1.856
Indiana Gas Inc.	−0.951	−3.259	2.308
Indianapolis Pwr. & Lt.	1.685	−0.533	2.218
Interstate Pwr. Co.	1.311	−0.602	1.913
Iowa Elec Lt. & Pwr. Co.	−1.204	R2.538	1.334
Iowa-Ill. Gas & Elec.	1.060	−0.663	1.723
Iowa Pub. Svc. Co.	−1.150	−1.460	.310
Kansas City Pwr. Co.	0.500	−0.985	1.485
Kansas Gas & Elec. Co.	0.054	−2.189	2.243
Kansas Pwr. & Lt. Co.	1.865	0.688	1.177
Kentucky Utils. Co.	−2.937	−2.184	− .753
Laclede Gas Co.	2.153	0.454	1.699
Long Island Ltg. Co.	2.291	0.687	1.604
Louisville Gas & Elec.	1.498	−0.213	1.711
Mid-Continent Teleph. Co.	−2.010	−2.350	.340
Middle South Utils. Inc.	0.964	−0.149	1.113
Minnesota Pwr. & Lt. Co.	1.651	0.303	1.348
Missouri Pub. Svc. Co.	−0.964	−1.811	.847
Montana-Dakota Utils.	2.720	1.058	1.662
Montana Pwr. Co.	2.357	0.443	1.914
Mountain Fuel Supply	5.986	4.175	1.811
National Fuel Gas Co	1.821	−0.011	1.832
Nevada Pwr. Co.	−0.146	−0.318	.172
New England Elec. Sys.	1.282	−0.275	1.557
New England Gas & Elec.	1.496	4.085	−2.589
New York St. Elec. & Gas	0.592	−0.482	1.074
Niagara Mohawk Pwr. Corp.	−0.436	R1.649	−2.521
Nicor Inc.	3.351	2.045	1.306
Northeast Utils.	−2.631	−2.866	.235
Northern Ind. Pub. Svc.	−3.631	−3.393	− .238
Northern Sts. Pwr. Co.	1.906	0.337	1.569
Ohio Edison Co.	0.641	−0.791	1.432
Oklahoma Gas & Elec.	1.226	−0.892	2.118
Orange & Rockland Utils.	−2.006	−1.695	− .311
Pacific Gas & Elec. Co.	0.235	−1.450	1.685
Pacific Ltg. Corp.	1.466	0.097	1.369
Pacific Pwr. & Lt. Co.	0.695	0.246	.449
Pacific Teleph. & Teleg.	0.104	−0.762	.866
Panhandle Eastern Pipe	6.165	3.792	2.373
Pennsylvania Pwr. & Lt.	0.444	−1.077	1.521
Philadelphia Elec. Co.	−0.504	−1.945	1.441
Piedmont Nat. Gas Inc.	2.879	4.739	−1.860
Portland Gen. Elec. Co.	−1.999	−1.467	− .532
Potomac Elec. Pwr. Co.	1.743	0.367	1.376
Public Svc. Co. Colo.	1.856	0.497	1.359
Public Svc. Co. Ind. Inc.	0.808	−0.443	1.251
Public Svc. Co. N. H.	−2.645	−0.321	−2.324
Public Svc. Co. N. Mex.	−0.042	4.158	−4.200
Public Svc. Elec. & Gas	0.005	−1.455	1.460
Puget Sound Pwr. & Lt.	−0.221	−1.843	1.622
Rochester Gas & Elec.	0.918	−0.595	1.513
Rochester Teleph. Corp.	4.286	2.986	1.300
St. Joseph Lt. & Pwr. Co.	1.046	0.156	.890
San Diego Gas & Elec.	1.001	−0.448	1.449
Savannah Elec. & Pwr.	−4.336	−4.148	− .188
Sierra Pacific Pwr. Co.	−2.635	−1.641	− .994
South Carolina Elec.	1.639	−0.165	1.804
South Jersey Inds. Inc.	2.179	1.017	1.162
Southern Calif. Edison	0.849	−0.837	1.686
Southern Co.	5.474	3.887	1.587
Southern Ind. Gas & Elec.	2.673	1.711	.962
Southern New England	1.249	2.566	−1.317
Southwestern Pub. Svc.	1.030	−0.234	1.264
Tampa Elec. Co.	−2.262	−0.513	−1.749
Texas Eastern Corp.	7.022	3.186	3.836
Texas Gas Transmis.	4.976	3.401	1.575
Texas Utils. Co.	3.014	1.476	1.538
Toledo Edison Co.	0.516	−1.722	2.238
Tucson Elec. Pwr. Co.	0.845	4.441	−3.596
UGI Corp.	4.067	1.968	2.099
Union Elec. Co.	−0.550	−1.963	1.413
United Illum. Co.	−1.685	0.379	−2.064
United Telecom.	−1.388	−0.928	− .460
Utah Pwr. & Lt. Co.	1.504	−2.088	1.792
Virginia Elec. & Pwr.	0.335	−1.242	1.577
Washington Gas Lt. Co.	2.696	1.023	1.673
Washington Wtr. Pwr. Co.	0.407	−0.881	1.288
Westcoast Transmission	4.122	1.915	2.207
Western Un. Corp.	−1.896	−1.463	− .433
Wisconsin Elec. Pwr. Co.	2.458	0.285	2.173
Wisconsin Pub. Svc. Co.	1.992	0.652	1.340
Mean Alpha	.974	.0126	.961

This table contains the results for a sample of regulated utility companies with publicly traded equity. The sample period runs from December, 1925, to December, 1980. Thirteen companies were eliminated from the sample because they had unusually high abnormal returns which were associated with their holdings of significant natural resources. (Many of these companies were specifically engaged in oil and gas explorations.)

But, the CAPM beta of the utility will be the sensitivity of the utility's return to the S&P 500 return, not to the true factors. If, for simplicity, we assume that the factors are not correlated and are equally variable, then

$$\begin{aligned} \text{CAPM b} &= ((.2)(.8) + (.8)(.2))/((.8)(.8) = (.2)(.2)) \\ &= .32/.68 \\ &= .47 \end{aligned}$$

The CAPM would therefore predict that the utility's cost of capital would be, using equation (2),

$$\text{CAPM Eu} = 15\% + (.47)(23.6\% - 15\%) = 19\%.$$

There is a shortfall of 22.4% − 19% = 3.4%, between the true (APT) cost of capital and the CAPM cost of capital and this appears as the "alpha" in the CAPM. Note the magnitude of this shortfall; simply because the utility has a different pattern of sensitivities to underlying economic forces than that of the typical company in the S&P 500 index, the CAPM underestimates the cost of capital by nearly 20 per cent (3.4%/19% = 18%).

One way to view the alphas of the CAPM and the APT is to recognize that they are the result of two distinct forces. Since they capture the differences between historical costs and what the respective theories predict, they are the consequence of both errors in the theories and any actual differences between current and historical equity costs. The striking feature of the alphas in Table 2 from the CAPM is that they do not look at all like random statistical errors. On the contrary, they are predominately positive, indicating that the CAPM consistently predicts lower capital costs (risk premia) for the regulated utilities than their historical costs. Aside from the incongruity of predicting lowered costs in an era of unprecedented inflation, this is prima facie evidence of a missing factor which influences returns in this industrial sector.

The APT, on the other hand, produces a much more reasonable pattern of alphas (see Table 2, column 2); some are negative and some are positive. This is precisely what we should expect from ordinary statistical errors rather than the theoretical errors of the CAPM with its systematic underprediction of capital costs.

Summary and Conclusions

In the foregoing article we have described the arbitrage pricing theory, APT for short, and have compared this alternative theory to the CAPM. We have argued that it provides a superior method, from both a theoretical and a pragmatic perspective, for computing the cost of equity capital. Furthermore, we have demonstrated its application to a sample of utilities and derived much more sensible estimates of the costs of equity capital than those produced by the CAPM.

Bibliography

The first reference cited below provides a legal critique of the application of the capital asset pricing model in rate making, and the remaining references provide the academic papers which underly the authors' economic critique of the CAPM and the development and testing of the APT.

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