Risk and
Regulated Firms

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Foreword

Four decades ago, when the regulation of public utilities was in its early stages, there was widespread interest in the "economics of regulation" on the part of economists and administrators. Issues of valuation, the rate base, fair return on investment—these and a host of topics were under study and analysis. The courts were very much involved, since constitutional problems permeated the entire area of regulation. University courses in Departments of Economics and Schools of Commerce and Business Administration were common. Hundreds of students devoted themselves to the study of the economics of public regulation.

During the 1920s and 1930s, as a result of a series of historical factors, interest in the study and analysis of the regulation process and the economic problems waned. The courses disappeared and the volume of analytical articles declined. Students who formerly "majored" in public utility courses shifted their interest to other directions.

It is clear, of course, that the need to apply the analytical skills of the economist and the social scientist to the problems of public utility regulation has not declined. Hard analysis of the "right" public policies is no less urgent today than when regulation was in its infancy. New problems are constantly arising; the old ones concerning the rate base and the rate of return are no less pressing.

The seminar which led to the papers reproduced in this volume is one of a series held on several campuses of colleges and universities in the State of Michigan during the past ten years. The program is in charge of the Inter-University Committee on Public Utility Economics and is financed by a grant to the University of Michigan from the Michigan Bell Telephone Company. The committee is solely responsible for the format of the program, the choice of topics, and the selection of the speakers. The papers of an earlier seminar, entitled Utility Regulation—New Directions in Theory and Policy, were published by Randon House in 1966 under the editorship of William G. Shepherd and Thomas G. Gies. The present volume contains the
papers delivered at the seminar held in East Lansing in 1971 at Michigan State University. Another volume containing the papers delivered at the seminar held in 1972 at the University of Detroit also will be published, probably during 1973.

William Haber, Chairman
Inter-University Committee
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Introduction

R. Hayden Howard

Regulated industries have received increasing attention from academicians concerned with economic behavior. The impetus probably stems from regulators' desires for aid in performing their tasks better, from managers' desires to respond to pressure from regulators and to improve their performance for stockholders, and from the nature of these industries as good testing grounds for empirical investigation of new hypotheses about economic behavior.

In an oversimplified way, the problem of the regulated firm arises from its immunity to certain market forces. Public utilities are so-called natural monopolies; as such, their services must efficiently can be provided by one firm. Furthermore, consumers are better off if only one firm (or a limited number of firms) provides service, assuming that firm's prices are the same as those that would be set in a competitive situation. Regulation is intended to assure the latter. Its purpose is to protect the firm by allowing it to be the only one providing a particular service (or at least to restrict entry into the area) and to protect consumers by controlling the price of the service. Regulatory commissions must try to set prices such that various classes or types of users of the utility's service are not being discriminated against in favor of some other class. They must try to induce improved performance from the utility's management. Finally, they must set prices at a sufficiently high level that the utility can command the resources needed to provide the service, while not setting prices which force consumers to pay too high a price.

Although regulation removes some of the functions of a market mechanism, public utility firms have many of the same problems as
firms in the so-called unregulated sectors of the economy. Basically, they must compete for scarce resources. They need to be attuned to consumers' desires and must search for better ways of fulfilling them. While public utilities may enjoy a monopoly position in the short run, there have been and probably will continue to be shifts in consumer attitudes and changes in technology that have made and will make any particular type of service obsolete.

Both regulated and nonregulated firms need to understand how they fit into the economy in order to be able to make optimal choices about resource use, pricing, financing, and other economic decisions. Public utility industries have been used as a testing ground for theories that are applicable to nonregulated firms as well. One of the more recent topics to be investigated as it applies to regulated industries is the concept of the cost of capital. Traditionally, the rate of return that the regulated firm was allowed to earn has occupied a good deal of attention of both regulators and managers. In the last several decades there has been an increasing realization that the rate of return should be based on the cost of capital to the firm, or that minimum rate of return specified by suppliers of capital expect as a reward for supplying capital to the firm.

New theoretical relationships have been developed which aid in specifying what the cost of capital should be for a particular firm. Two areas have dominated the discussion and its relevance to the regulation of public utilities. These are the relationships between dividend policy and the cost of capital and the relationship between capital structure and the cost of capital. Regulated industries have been used to test various hypotheses concerning these relationships. The concept of the cost of capital has been used by public utility management in arguing that regulatory commissions should allow higher rates of return to themselves in trying to attain their goal of setting a fair rate of return.

The exploration of the topic has led to a constantly considerable amount of the risk associated with the situation. This has been done by studying the several firms under analysis in the same risk class. This assumption allows exploration of the problems of leverage and dividend policy without having to specify a complete cardinal relationship between risk and returns. For example, consider the relationship between the cost of capital and the degree of leverage in the electric utility industry. Additional risk is borne by the stockholders as more and more debt is used; if there are firms with different degrees of leverage in the same risk class, it may be possible to find out what stockholders demand as increased reward for the increased risk. However, this risk class analysis assumes away (for, at best, treats in an obtuse way) the relationship between the electric utility firm and other firms in the economy. The assumption of a risk class avoids having to specify precisely what risk is, and how that trade-off is between risk and return for a particular firm relative to that trade-off for other firms. This approach has aided in advancing knowledge because it enables some exploration before a complete theoretical structure has been developed satisfactorily, but it is an incomplete way of treating the problem of risk.

One of the major problems of dealing explicitly with risk in trying to explore the cost of capital concept is that there is no commonly accepted definition of risk. This lack of an acceptable definition is a more fundamental problem than the difficulty of distinguishing between risk and uncertainty. Without a definition of risk, no direct relationship can be specified between risk and reward for bearing risk. If regulatory bodies and utility management are to perform at their best, risk must be defined and related to the problems of regulation and management, and tools must be designed which allow the operational application of theoretical structures to the problems. That is the underlying motivation for this book.

The essays in this volume are specifically addressed to the problem of risk as it is related to supplying capital to the firm. The focus is on public utilities, but because of the common problem of having to command capital in the same market, the ideas are applicable to nonregulated firms. Indeed, if one generalizes the idea of regulation beyond the public utility commission context, virtually every firm in the economy is regulated. The public utility case can be viewed as merely a special example of the more general problem. More understanding of risk and the trade-offs between risk and return is needed for all sectors of the economy.

These essays regard risk from several perspectives and explore many different aspects. William F. Sharpe discusses the problem of defining a performance measure to use when trying to evaluate trade-offs. Stephen H. Archer examines risk from the financial analyst's point of view and suggests how the securities of public utilities might be viewed with respect to risk in the coming years. Stewart C. Myers investigates the problem of incorporating risk into the regulatory decision-making process and suggests a basic framework. J. Fred Weston and Michael F. Dunn argue that the capital asset pricing model can be applied operationally to measuring risk for a
particular firm. Kenneth E. Boulding explores the concept of risk in a social setting and discusses the question of the legitimacy of private profit as a reward for risk bearing. Myles S. Delano and R. Hayden Howard consider the segment of risk in a regulatory situation that might be caused by regulation itself.

These contributions do not solve the problems of dealing with risk, but they are a step in that direction. It is hoped that they will stimulate thought and action in dealing with this concept, which is critical to both an understanding of the economic system and for practical decision making.

Risk Adjusted Measures of Security and Portfolio Performance

William F. Sharpe

A common human failing is the desire for simple answers to difficult questions. Evaluation of investment performance is no exception. How well did a security or portfolio do in the past? Most people would like to have such a question answered with a single number. Which security or portfolio did best? Most would like an unambiguous reply.

Faced with this kind of question, finance experts have, until recently, tended to go to one of two extremes. Some provided direct answers using either a measure of average return over some period, or a measure relating terminal value to initial value. Others simply rejected the question on the grounds that performance is far too complicated to measure in any simple way; that every portfolio has its own unique characteristics; and that one simply cannot compare apples with oranges.

There is, of course, much truth in the latter position. Securities and portfolios really are different. Any attempt to measure performance with one number must involve some simplification. On the other hand, simplification is the essence of science. It is impossible to compare everything with everything. Some abstraction is necessary.

Let us take as given the assumption that performance is to be measured with only one number and consider the more interesting question, which number? Only the investigation of the best single measure can provide an adequate basis for answering the question, is one enough?
Consider the problem of measuring the performance of a mutual fund from, for example, 1 January 1965 through 31 December 1970. One traditional approach would be to compute the annual returns for each of the five years, then average them. Another would assume an investment of, for example, $10,000 on 1 January 1965, then compute the terminal value on 31 December 1970, assuming that all interim dividends and capital gains had been reinvested in the fund.

Numbers such as these are far from irrelevant, but they fail to take risk into account. We know that there is risk in the world, and that investors generally dislike it. There is substantial theoretical and empirical support for the assertion that security prices reflect this fact. As a result, there is a trade-off between risk and return. On the average, and over the long run, the best high-risk portfolio provides a greater return than the best low-risk portfolio.

The goal is thus to find a measure of performance that takes risk into account. This paper describes some of the leading candidates. Although all are based on a rather elegant theory of equilibrium capital asset prices, it is instructive to present them simply as useful measures of past performance. No assumptions about market equilibrium, equality of ex post and ex ante values, and so forth, will be invoked. Moreover, the difficult questions concerning the "significance" of differences in past performance will not be considered, since such questions implicitly deal with predictions of future performance.

Throughout, performance will be considered from the investor's point of view. Note, however, that as long as the value of a firm is correctly assessed by the market (an assumption implicit in much of the finance literature), the results will also shed light on the performance of firms.

**Excess Returns**

To begin, decisions must be made about the period to be covered and the differencing interval to be used. No simple prescription is available since the proper choice depends on the purpose for which performance is being measured. For concreteness, we will assume that a period of five years is to be covered, with a quarterly differencing interval. Of course, the procedures to be described also can be applied to other combinations.

The first task is to compute the rate of return for each of the twenty quarters. If great precision seems desirable, the actual dates of the cash flow plus information on interim values can be used to compute the time-weighted rate of return for a quarter. Alternatively, a good approximation can be obtained by computing an internal rate of return. For practical purposes, however, it usually suffices to assume that all cash flows are held until the end of the quarter in which they are received. This leads to the familiar formula

\[ R_t = \frac{P_t + D_t - P_{t+1}}{P_{t-1}}, \]

where

- \( R_t \) = return on security (portfolio) \( i \) in period \( t \);
- \( P_t \) = price of security (value of portfolio) \( i \) at the end of period \( t \);
- \( D_t \) = dividends from security (net cash flow from portfolio) \( i \) during period \( t \); and
- \( P_{t+1} \) = price of security (value of portfolio) \( i \) at the end of period \( t+1 \).

Return measures the performance of a security or portfolio during a particular quarter, but it does not differentiate quarters in which interest rates were generally high from those in which they were generally low. To measure differences on return from prevailing interest rates, one must compute the excess return:

\[ r_t = R_t - \tau, \]

where

- \( r_t \) = excess return on security (portfolio) \( i \) in period \( t \);
- \( R_t \) = return on security (portfolio) \( i \) in period \( t \); and
- \( \tau \) = interest rate on a riskless security in period \( t \).

For a quarterly differencing interval, the return on a ninety-day treasury bill provides an appropriate value for \( \tau \).

All the measures described in this paper will be defined in terms of excess returns. In some cases, definitions proposed in other sources have been modified slightly. When short-term interest rates did not vary significantly, there was little reason to use excess returns. Now, however, it seems desirable to explicitly allow for such variation.

**Reward-to-Variability Ratio**

We consider first a measure designed to assess the performance of a portfolio representing most or all of an investor's capital. It is both
simple and intuitively appealing. The reward provided by a portfolio is measured by its average quarterly excess return. This can be considered the reward obtained for bearing risk. The risk actually borne is measured by the variability, or standard deviation of quarterly excess returns around the average value. Although the standard deviation of excess return may not completely accord with one's interpretation of the term risk, it is generally highly correlated with more appealing measures, and thus provides an adequate surrogate.

The reward-to-variability ratio is simply the ratio of reward (which is good) to variability (which is bad). It indicates the reward per unit of risk borne. The larger the ratio, the better the performance.

This seems an ad hoc argument at best, and it is. Fortunately, a much stronger case may be made. Consider Figure 1. Points i and j plot the average excess return and standard deviation of excess return for portfolios i and j. Point s shows the results for investment solely in ninety-day treasury bills. Since such a strategy results in an excess return of zero in every quarter, the point is located at the origin (that is, both the average excess return and the standard deviation are zero).

Now consider a strategy involving investment in portfolio i and treasury bills. The result would lie somewhere along the straight line connecting points i and s (of course, the location depends on the exact combinations used). Thus portfolio i plus treasury bills could have provided any desired point along line sj.

Similarly, portfolio j plus treasury bills could have provided any desired point along line sj. By recognizing the opportunity to split funds between a portfolio and treasury bills, we can replace the point associated with a portfolio by the line associated with strategies using only that portfolio plus treasury bills.

In the case shown in Figure 1, portfolio j is clearly superior to portfolio i. For any level of variability attainable with portfolio i plus treasury bills, a higher average return could have been obtained with portfolio j plus treasury bills. Moreover, some high variability, high average return alternatives are not even available with portfolio i plus treasury bills. In this case, at least, the portfolio with the steeper line is clearly the better. But note that the slope of such a line is the reward-to-variability ratio. The portfolio with the steeper line has the higher reward-to-variability ratio, and vice-versa.
The portfolio with the higher reward-to-variability ratio may not be better in all cases. Figure 2 provides a counterexample. Here the portfolio with the smaller average excess return has the larger reward-to-variability ratio, but it is not unambiguously better. Consider an investor who wanted an overall standard deviation below \( V_f \). For such a person portfolio \( i \) clearly was better. But what about a more adventurous investor? Note that point \( i \) dominates all points from \( X \) to \( Z \) along line \( \alpha \) since it gives as much average return and less variability. Only in the range above \( V_f \) might portfolio \( j \) provide a more desirable strategy.

If the possibility of borrowing funds is taken into account, the case in favor of portfolio \( i \) is likely to be even stronger. By investing his own funds plus some borrowed money in portfolio \( i \), an investor could have attained a result lying to the right of point \( i \). The actual location would depend on both the amount borrowed and the interest rate paid. If the investor could have borrowed without limit at the rate paid by the U.S. Treasury, points along line \( \alpha \) (the extension of \( \alpha \)) could have been attained, and portfolio \( i \) would clearly have been superior to portfolio \( j \). In fact, of course, interest rates for loans are higher than treasury bill rates; moreover, they increase with the amount borrowed. The result would thus lie along a curve such as \( dB \) or \( BB \). Note that only in the latter case might portfolio \( j \) be a reasonable choice, and only then for adventurous investors.

Despite the rather robust nature of the reward-to-variability ratio, it is wise to avoid comparisons involving portfolios with significantly different variabilities. But over a reasonable range of risk, the reward-to-variability ratio can provide an adequate risk-adjusted measure of portfolio performance.

**Comparisons with the Market**

The reward-to-variability ratio provides an absolute measure of the performance of a portfolio. Subject to the qualifications mentioned earlier, it can be used to compare two or more portfolios. Perhaps more important, the performance of a portfolio can be compared with that of one selected by a so-called naive investor, usually regarded as someone who blindly "buys the averages." A portfolio composed of Dow-Jones 30 Industrial Stocks might be used for the comparison. If broader coverage were desired, one of Standard and Poor's indices could be selected. In any event, some sort of market portfolio is used to represent the results obtained with virtually no investment management or skill.

In Figure 3, point \( M \) represents the market portfolio and point \( i \) the portfolio to be evaluated. In this case the portfolio's excess return was less variable than that of the market, so it is possible to compare portfolio \( i \) directly with a combination of the market portfolio and treasury bills - a combination chosen to have the same variability as portfolio \( i \).

Point \( X \) in Figure 3 represents such a market-based portfolio of comparable variability. In this case, its average excess return was less than that of portfolio \( i \), whose average quarterly differential return (\( \Delta \)) indicates how much better (for positive values) or worse (for negative values) it was on the average than a market-based portfolio of comparable variability.

**FIGURE 3**

The situation is more complex if the portfolio's excess return was more variable than that of the market. A naive investor who desired less variability than that provided by the market could clearly have divided his money between treasury bills and the market portfolio. Neither more nor less than this was assumed in the previous case. But what results would have been obtained by a naive investor interested in more variability than that provided by the market? Would
Variance (standard deviation of excess returns) is an adequate measure of the risk of an entire portfolio. But it is not a satisfactory measure of the risk of a portion of that portfolio—be it a smaller portfolio or a single security—for the variability of the whole does not necessarily equal the sum of the variabilities of the parts. The general relationship between the risk of an overall portfolio and that of its component parts is very complex. However, strong empirical evidence supports the assertion that the most relevant single measure of risk is the volatility of a security or portfolio.

Approximately 30 percent of the variation in the typical stock's rate of returns is attributable to the co-movement of its price with the overall level of the market. For well-diversified portfolios, the proportion is generally more than 90 percent. The responsiveness of rate of return to market swings is clearly the most important single measure of risk. The idea is simple enough. The excess rate of return on a security or portfolio is regressed on the excess rate of return on a market portfolio to obtain a characteristic line. The slope of this line is the volatility. If the value is less than one, the security or portfolio is defensive— it tends to move less than the average security during market swings. If volatility is more than one, the security or portfolio is aggressive—it tends to move more than the average security during market swings. Treasury bills always have a volatility of zero; by definition, the market portfolio always has a volatility of one.

No risk averse investor is likely to invest all his money in a single security. Moreover, many portfolios constitute only a portion of their investor's overall wealth (for example, people combine mutual fund shares with other securities). For evaluating virtually all securities and many portfolios, volatility is thus a more relevant measure of risk than is variability.

It is an easy matter to redefine the performance measures described earlier to account for this. The reward-to-variance ratio is replaced by the reward-to-volatility ratio. All the arguments in its favor and questions regarding its universal applicability are similar to those presented earlier. The average differential return also can be computed, but with the comparison based on a market-based portfolio of equal volatility. The same line of reasoning applies, as do the reservations.

The real meaning of such comparisons can best be seen in conjunction with the characteristic line. Assume that portfolio $i$ is to be evaluated. We begin with the quarter-by-quarter excess returns. The problem is to compare them with those of a relevant naive investment strategy. In this context, the relevant strategy should produce the same volatility, which requires the determination of the portfolio's characteristic line, as shown in Figure 4. For concreteness, assume that the slope is $b$. The comparable volatility market-based
portfolio will be based on a strategy of investing 60 percent of the total funds in the market portfolio and 40 percent in treasury bills. Every quarter’s excess return for such a portfolio will fall precisely along a straight line through the origin with a slope of 0.6 (as intended). The two lines are parallel (by construction).

For each quarter, the excess return on portfolio $i$ can be compared with that of the comparison portfolio and the differential return computed. For example, in Figure 4 the differential return is negative ($d_i$) in period 1 and positive ($d_i$) in period 2. By the nature of the least-squares regression procedure the vertical intercept of portfolio $i$’s characteristic line will equal its average differential return ($x$) over a market-based portfolio of comparable volatility. This leads directly to the interpretation of the vertical intercept as a security or portfolio’s characteristic line as a measure of performance. It indicates the percentage per quarter by which the excess return exceeds (for positive values) or falls below (for negative values) that obtainable from a market-based portfolio of comparable volatility.

Needless to say, this measure is subject to all the reservations mentioned earlier. It may thus be unwise to use it to compare the performance of securities and portfolios of markedly different volatilities. But over a reasonable range of variation, it should provide a good risk adjusted measure of performance.

Stock Selection and Diversification

If a portfolio is highly diversified, its performance will be described almost perfectly by its characteristic line. All variation in its rate of return may be attributed to market swings and the portfolio’s volatility. But if a portfolio is not highly diversified, its excess return will vary around its characteristic line, leading to additional overall variability. The average differential return over a market-based portfolio of comparable volatility provides a measure of the manager’s superiority or inferiority vis-à-vis stock selection, disregarding the extent to which the portfolio is diversified. The average differential return over a market-based portfolio of comparable variability provides a measure that takes into account both the manager’s ability to select stocks and his ability to provide diversification. For a perfectly diversified portfolio, the two measures will be the same; for an imperfectly diversified portfolio, the latter generally will be smaller. The difference can be considered the decline in performance due to lack of diversification.

In a real sense, the problem of portfolio management is to achieve an appropriate balance between stock selection and diversification. The answer is clearly not to select the one (supposedly) best stock. On the other hand, to achieve near perfect diversification, a manager would have to select hundreds of stocks—almost certainly condemning him to an average performance. Comparison of the two measures of average differential return can provide at least some insight into the way in which a portfolio manager has performed this delicate balancing act.

Abnormal Periods

In a “normal” period, the average excess return on a market portfolio of risky assets is positive. This is reflected in all the diagrams used thus far. And it accords with the expectations that must be held by the majority of (risk averse) investors. But nature sometimes does the unexpected. It is possible for the average quarterly excess return on the market portfolio over a five-year period to be zero or even negative. In the former case, adjustment for risk would be harmless, at best, since the average excess return of every market-based portfolio would equal zero. But in the latter case, the average excess return...
turn of a market-based portfolio would be smaller (that is, more negative), the larger the portfolio's variability or volatility, leading to somewhat different results.

Figure 3 provides an example. The market portfolio's average excess return was negative, so line $\alpha M$ is downward sloping. The "reward" for bearing the risk of portfolio $M$ was negative; thus, both the reward-to-variability ratio and the reward-to-volatility ratio were negative. Although one can easily explain this (abnormal times give abnormal results), the intuitive meaning of both measures is lost.

Average differential return fares somewhat better, as the figure shows. For example, portfolio $\alpha$'s performance is rated superior to that of a market-based portfolio of comparable variability, as it should be. But closer examination shows at least an apparent anomaly. Consider portfolio $j$, with the same average excess return but with greater variability than that of portfolio $i$. Portfolio $j$'s performance was given a superior rating. Why? Because it was compared with $M$ -- a market-based portfolio of greater variability than that of $M$, with which portfolio $i$ was compared. Is this a reasonable result? Yes. Portfolio $j$ really did outperform a market-based portfolio of comparable variability ($M_l$), while portfolio $i$ was only somewhat better than such a portfolio ($M_i$). Of course, during this abnormal period, one was penalized for taking on risk. But it is still important to assess performance relative to that achieved by a naive investor holding a portfolio of comparable risk. The measures of average differential return do this, even when the market is more perverse than usual.

Conclusions

There is much more to be said about performance measurement. We have only provided an introduction to some of the modern approaches. The hallmark of all such procedures is the explicit consideration of risk. The evidence is, by now, almost overwhelming: Measures that account for risk (although, perhaps, imperfectly) are clearly superior to those that do not. This is widely recognized in the academic community and, increasingly, in the investment community. Several major firms now offer performance measurement services using procedures similar to those described here. Without question, risk adjusted performance measurement is here to stay.

References

This paper draws from the previous work of a number of authors. The interested reader will find more details in the following references:

Risk: The View of the Public Utility Analyst

Stephen H. Archer

"It is not variation per se which constitutes risk; it is the decline in price or value. I believe that we will ultimately find an objective measure of sensitivity to decline which avoids the inherent absurdity of calling a stock risky because in the past it has gone up much faster than the market in some years and only as fast in others, whereas we call a security which never varies in price not risky at all." These are interesting comments for reflection, and here I shall raise some questions concerning the academic position on risk of an individual security or a portfolio as it has progressed since the explosion that began with Markowitz's paper in the Journal of Finance over eighteen years ago. I also will examine its compatibility with the financial analyst's position on risk as well as note that neither the academic nor the analyst was satisfactory in predicting increasing public utility risk.

Academics have continued to explore the application of the Markowitz breakthrough, and as we look over our shoulder to see if the mass of practitioners are close behind, not all are following. Many continue along their merry way as they have for decades, seemingly unaware that we presumably have changed the "name of the game." Certainly most of us could point to certain areas and at...


Stephen H. Archer 19

tempts by practitioners to apply the new rules, but, as a whole, they just have not taken it. Markowitz diversification is nice, but what investor looks for a declining stock in a rising market, everyone is looking for the one running counter to the trend in a bear market.

As most analysts probably were weaned on the 1940, 1951, or 1962 edition of Graham and Dodd, Security Analysis, 4 what do these authors have to say about risk? Essentially their view is that of safety of principal. It may not be inherent in the issue, as they say, for price is frequently the critical factor; in other words, an investment may be risky at a high price-earnings ratio but much less so at a lower ratio. This concept of risk concurs not only with James Lorie, but also with Webster's New World Dictionary, which defines risk as the chance of injury, damage, or loss.

The ratings of investment advisory services relied upon by analysts such as Standard and Poor's and Moody's, which are made to reflect the quality of bonds, largely are determined by the degree of protection of interest and principal, which might be presumed by bond investors to be the prime cause of loss of value. Slightly or wrongly, the ratings are regarded as highly correlated with returns to the investor. Preferred stock quality ratings are based on the relative security of dividends, and common stock quality rankings are rather apologetically made on the basis of the relative stability and growth of earnings and dividends, also prime factors affecting loss of value.

One cannot help wondering if (1) the lag between the discovery and use of a new risk concept is as long as two decades, or (2) is the variability in investor returns an incorrect concept of risk, or (3) is the concept of risk good in theory but not useful in practice? Financial analysts might well say that the length of lag in learning is not the problem, but that our measures of risk to date have been inadequate.

Risk Measures in the Academy

Following the portfolio analysis concept of risk, it is assumed that investors' risk estimates are proportional to the variability of expected returns on a portfolio. Since investors are concerned with possibilities of loss, it is natural that one should have looked first to semivariance as a candidate for the measure of variability of returns. Semivariance concerns itself with the area of the probability distribution to the left...
of the expected value $E(r)$; its square root, standard deviation, is equivalent, and could be more intuitively appealing. However, as many studies seem to suggest, distributions of returns over long periods were symmetric for the most part. The semi was abandoned for the standard deviation, it being superior in computation, convenience, and familiarity, and capable of producing the same efficient portfolios.

A majority of the studies to date have used the standard deviation, which measures the deviations around the arithmetic mean, as the measure of risk. The use of the arithmetic mean, however, may introduce distortions into the analysis. If a stock doubles from $10 to $20 in price one year and then falls by 50 percent to $10 the next, the arithmetic mean return for the two periods is 25 percent ($100 - $50)/$20. Unfortunately, the price simply returned to the starting point. The arithmetic mean has an upward bias which is particularly serious if both good and bad years are included. Therefore, deviations are being scored from an unrealizable first moment. Nevertheless, studies which established a significant association between standard deviation of returns and arithmetical mean have been suggested as support for standard deviation as a measure of risk.4 Perhaps fortunately, many of these studies have been made in a generally rising market. Short periods involving general rising markets might save the arithmetic mean and standard deviation from their biases, but, unfortunately, distributions of returns in such short periods tend more toward being positively skewed. Merton Miller, in an unpublished paper, has indicated that in such cases the mean and standard deviation are positively correlated.5 An observation drawn from the long right tail of such a distribution blows up both the arithmetic mean and standard deviation of the sample. For a simple exponential distribution such as $y = e^{-y^2}$, $2 \alpha > 0$, the correlation coefficient between the arithmetic mean and standard deviation ($R$) is 7 and explained variance is 5. Thus the statistics are suspect, but investors usually are more concerned with the left tail than the right. Yet another measure of risk for the individual security arose out of the development of an extension of portfolio theory development.

This measure was referred to as the covariance of returns with the market. Portfolio theory has demonstrated the benefits to the investor of diversification, but as a practical matter, an investor cannot diversify away all risk. A portion of the risk is the fluctuation "explained" by the fluctuation in the market as a whole; the residual or unsystematic risk is presumably what a rational investor could eliminate through diversification. Not all securities will vary with the market by the same amount. Those with small undiversifiable risk presumably are less risky than those with larger systematic risk regardless of the gross variability. The more a security has that cannot be eliminated by diversification, the more return investors should require to induce them to hold that security in their portfolio. Yet we may find securities or industries with low systematic risk and yet high reward-to-variability ratios. This is an intuitively appealing measure of risk, but less easily understandable by practitioners. Yet the covariance should be afflicted with some of the same statistical qualifications as the standard deviation, for it requires the use of the variance and standard deviation, and there is little empirical support for such a measure of risk. Arithmetic mean returns have been suggested as support for regression mean returns on regression coefficients (obtained by regressing returns on the market index of returns) and obtained mixed results (correlations sometimes positive and sometimes negative).6 To eliminate the bias of the arithmetic mean some have suggested the use of the geometric mean, which may be more reflective of true returns to investors. In addition, the mean absolute deviation is a less erratic estimator than the standard deviation; it contains less sampling errors. Unfortunately, it has not been popular, probably because it is computationally more cumbersome, is an absolute not a relative measure, and is less mathematically tractable. There are many measures that have been suggested or used, such as the semi-quartile deviation, coefficient of variation, adjusted variance, and so on. However, it probably is safe to say that the standard deviation of gross or excess variability has been the most used and generally accepted measure of risk to date.

**Risk: The Standard Deviation of Ex Post Returns**

The standard deviation of ex post returns is the measure of risk

4For example, see F. D. Andlari, "Risk and the Required Return on Equity," *Journal of Finance* 22, no. 1 (March 1967): 10-36.


probably most familiar to financial analysts to date. We already have noted that (1) it measures deviations from a biased first moment, and (2), if the distribution of returns is positively skewed, the standard deviation as well as the mean are distorted. The standard deviation squares deviations, which causes distortions by the large outliers in the right tail of the distribution. (3) The sample standard deviation is a more erratic estimator of the true population value than, for example, the mean absolute deviation, because of point 2 above. Other difficulties with the risk measure seem to exist either statistically or intuitively. (4) It is incompatible with dynamic capital market theory. How can one get from one capital market line to another parallel line without having the fall in asset prices affect standard deviation of ex post returns? Yet, under such parallel shifts, risk premiums remain constant. In other words, if the riskless rate changes (as has happened recently in the market), and if we assume risk premiums remain constant, how are ex post standard deviations of returns going to remain constant? Standard deviation includes changes in the riskless rate into its measure of gross risk even though the risk (risk premium) may not have changed.

In addition (5), if returns to an investor over a period of time are constant, then standard deviation is zero and the return is positive. If, then, the returns increase at an increasing rate, standard deviation increases, as does mean return. Such growth, therefore, increases risk—which would likely not appear compatible with the financial analyst’s view of risk. Finally (6), ex post returns well may be roughly distributed symmetrically. It frequently is argued that the use of ex post returns as a surrogate for ex ante returns introduces a downward bias in the estimation of the correlation between standard deviation and arithmetic mean. But the financial analyst likely views, ex ante, the probability of a 100 percent return as being greater than a total loss (–100 percent return). That is, ex ante returns well may be skewed, making the ex ante standard deviation and its proxy, ex post standard deviation, an inadequate risk measure.

The Financial Analyst’s Beatitude

It is not likely, in the face of these problems of risk measurement, that financial analysts openly would embrace the academician’s new risk. More probably they hold the view of Graham, Dodd, and Dottie: “The relation between different kinds of investments and the risk of loss is entirely too indefinite and too variable with changing con-

ditions to permit [use] of sound mathematical formulation. This is particularly true because investment losses are not distributed fairly evenly in point of time, but tend to be concentrated at intervals, i.e., during periods of marked decline in general business activity.” The financial analyst and academician would like a measure of risk that is quantifiable on a cardinal scale; comparable among all securities; comparable over time; mathematically tractable and statistically clean from bias; independent of the measure of the mean absolute deviation, because of point 2 above. Other difficulties with the risk measure seem to exist either statistically or intuitively. (4) It is incompatible with dynamic capital market theory. How can one get from one capital market line to another parallel line without having the fall in asset prices affect standard deviation of ex post returns? Yet, under such parallel shifts, risk premiums remain constant. In other words, if the riskless rate changes (as has happened recently in the market), and if we assume risk premiums remain constant, how are ex post standard deviations of returns going to remain constant? Standard deviation includes changes in the riskless rate into its measure of gross risk even though the risk (risk premium) may not have changed.

In addition (5), if returns to an investor over a period of time are constant, then standard deviation is zero and the return is positive. If, then, the returns increase at an increasing rate, standard deviation increases, as does mean return. Such growth, therefore, increases risk—which would likely not appear compatible with the financial analyst’s view of risk. Finally (6), ex post returns well may be roughly distributed symmetrically. It frequently is argued that the use of ex post returns as a surrogate for ex ante returns introduces a downward bias in the estimation of the correlation between standard deviation and arithmetic mean. But the financial analyst likely views, ex ante, the probability of a 100 percent return as being greater than a total loss (–100 percent return). That is, ex ante returns well may be skewed, making the ex ante standard deviation and its proxy, ex post standard deviation, an inadequate risk measure.

The Analyst’s Risk

While the analyst waits, he survives on the more familiar and traditional measures of risk such as those the investment rating services offer. He may not be happy, but he believes “that’s all there is.” A survey of 25 public utility financial analysts indicated that a ratio of two to one were satisfied with such rating systems. Yet such ratings were not very discerning of very significant losses suffered by investors in the 1969-1970 bear market for all securities, or in the 1964-1970 bear market for utilities. Standard and Poor’s 55 utilities, including electric, gas, and telephone companies, showed very little change (see Table 1) in the distribution of ratings from 1960-1984 and 1964-1970 for the same companies. This was hardly a forewarning of the potential large capital losses and losses in principal that accrued in this period due primarily to rising interest rates in the securities markets. According to W. B. Hickman’s study of bonds over the period 1900-1945, bond ratings, as indicated below, seemed an effective good measure of default risk.8 Hickman’s findings indicated a “clear-cut, long run relation between bond quality at offering and yields actually obtained by investors. On the average and over long periods, the life span yields realized on high grade bonds were below those on low-grade bonds.” Regardless, we can observe a striking increase in risk premiums of public utility securities over other securities.

---

5Graham, Dodd, and Dottie, Security Analysis, pp. 230-23.
7Ibid., pp. 14-15.
Hickman, of course, was concerned only with bonds. However, financial analysis of individual bonds has tended to consider only the default risk. Over the 1900-1945 study period public utilities defaulted on 103 percent of the issues, whereas industrial bonds had a 14.8 percent default rate. During the 1931-1934 crisis, the industrial rate was 17.2 percent, and public utilities defaulted at the rate of only 8.6 percent.¹¹ Financial analysts and academicians agree that default is not the only relevant aspect of risk, but the practicing analyst still is looking for an improvement. From their 1968 highs to the 1973 lows, prices of newly issued Aa utility bonds declined 31 percent, yields rose 6.1 basis points, and so-called deep discount Aa utility bonds declined 26 percent. These bonds rebounded from the 1970 lows, 34 percent and 22 percent respectively, by January 1971. Thirty-year prime munipalcs dropped 37 percent and rose 33 percent in the same period, while US 4% (1972) dropped 27 percent and then rose 21 percent. The great volatility of these securities was not reflected in bond ratings, which demonstrated stability over the 1900-1970 period. In the period prior to 1968 (see Table 2), we see that bond prices, as a whole, were relatively stable from 1960-1965, at which point they resumed their decline begun in 1946.


---

**Risk**

### TABLE 1. Percentage Distribution of Utility Security Ratings, 1964-1968

<table>
<thead>
<tr>
<th></th>
<th>Commona</th>
<th>Preferreda</th>
<th>Bondsa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1964</td>
<td>1968</td>
<td>1964</td>
</tr>
<tr>
<td>A+</td>
<td>16</td>
<td>13</td>
<td>Aaa</td>
</tr>
<tr>
<td>A</td>
<td>53</td>
<td>53</td>
<td>Aa</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>20</td>
<td>A</td>
</tr>
<tr>
<td>B+</td>
<td>9</td>
<td>9</td>
<td>Ba</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>


---

**Bond Experience of the Utilities**

---

### TABLE 2. Bond and Preferred Stock Yields, 1946-1970 (Percent)

<table>
<thead>
<tr>
<th>Year</th>
<th>Long-Term Treasury Bonds*</th>
<th>Aaa Utility Bonds**</th>
<th>High-Yield Utility Preferred Stocks***</th>
</tr>
</thead>
<tbody>
<tr>
<td>1946</td>
<td>2.19</td>
<td>2.51</td>
<td>3.48</td>
</tr>
<tr>
<td>1947-50</td>
<td>2.33</td>
<td>2.67</td>
<td>3.83</td>
</tr>
<tr>
<td>1951-53</td>
<td>2.72</td>
<td>3.40</td>
<td>4.60</td>
</tr>
<tr>
<td>1954-56</td>
<td>3.62</td>
<td>4.94</td>
<td>4.61</td>
</tr>
<tr>
<td>1957</td>
<td>3.99</td>
<td>3.47</td>
<td>4.71</td>
</tr>
<tr>
<td>1958</td>
<td>3.05</td>
<td>4.35</td>
<td>4.52</td>
</tr>
<tr>
<td>1959</td>
<td>4.00</td>
<td>4.27</td>
<td>4.38</td>
</tr>
<tr>
<td>1960</td>
<td>4.15</td>
<td>4.62</td>
<td>4.49</td>
</tr>
<tr>
<td>1961</td>
<td>4.31</td>
<td>4.56</td>
<td>4.53</td>
</tr>
<tr>
<td>1962</td>
<td>4.65</td>
<td>5.13</td>
<td>5.19</td>
</tr>
<tr>
<td>1963</td>
<td>4.83</td>
<td>5.58</td>
<td>5.54</td>
</tr>
<tr>
<td>1964</td>
<td>4.35</td>
<td>6.23</td>
<td>6.07</td>
</tr>
<tr>
<td>1965</td>
<td>6.10</td>
<td>7.12</td>
<td>6.76</td>
</tr>
<tr>
<td>1966</td>
<td>6.99</td>
<td>8.77</td>
<td>7.84</td>
</tr>
<tr>
<td>1967</td>
<td>5.97</td>
<td>7.09</td>
<td></td>
</tr>
</tbody>
</table>


The use of standard deviation of ex post returns from 1900-1965 would have produced a relatively low value, as we approached 1968, the standard deviation would have begun to increase. However, the stability of the 1900-1965 period, as measured by standard deviation of ex post returns, should have led investors to view risk as low and therefore should not have required greater risk premiums for utility bonds on their investment from 1965 on. The increased instability from 1965-1966 might have influenced the utility bond investor to require greater risk premiums from 1966-1970, yet yields fell from their highs in 1970, on the tail of great risk (instability of ex post returns).

The risk premiums of seasoned Aa utility bonds over U.S. governmentse were relatively stable on an absolute yield basis from 1959-1966, at which time they began to increase considerably (see Table 3). The spread is shown below.

Fisher’s cross-sectional study of risk premiums found that the risk premium on a firm’s bonds were a linear function of logarithms of earnings variability, period of solvency, equity-debt ratio, and bonds outstanding. The relationships appeared to be relatively stable at different dates from 1927 through 1953. Together they explained about three-fourths of the variability in risk premiums. These variables generally are regarded by analysts as being of value in appraising the quality of bonds. These results indicated the size vari-
The same tough tests for preferred yields, which increased
only 3.6 percent in 1965 to 4.64 percent in 1966, after which yields
receded again to be as high as 2.34 percent in December 1970. Yet
the results outstandingly, as can be consistently, more highly
Preferred Expenses


<table>
<thead>
<tr>
<th>Year</th>
<th>Market Price</th>
<th>Percentage Change</th>
<th>Earnings Per Share</th>
<th>Percentage Change</th>
<th>Price-Earnings Ratio</th>
<th>Percentage Change</th>
<th>Dividend Yield (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1957</td>
<td>49.42</td>
<td></td>
<td>3.41</td>
<td></td>
<td>14.49</td>
<td></td>
<td>2.43</td>
</tr>
<tr>
<td>1958</td>
<td>57.96</td>
<td>+108%</td>
<td>3.63</td>
<td></td>
<td>15.97</td>
<td></td>
<td>2.50</td>
</tr>
<tr>
<td>1959</td>
<td>66.35</td>
<td></td>
<td>4.62</td>
<td></td>
<td>17.37</td>
<td></td>
<td>2.61</td>
</tr>
<tr>
<td>1960</td>
<td>69.02</td>
<td></td>
<td>4.12</td>
<td>+49%</td>
<td>16.05</td>
<td>-0.25</td>
<td>2.89</td>
</tr>
<tr>
<td>1961</td>
<td>90.55</td>
<td></td>
<td>4.33</td>
<td></td>
<td>20.31</td>
<td></td>
<td>2.81</td>
</tr>
<tr>
<td>1962</td>
<td>91.50</td>
<td></td>
<td>4.73</td>
<td></td>
<td>19.34</td>
<td></td>
<td>2.97</td>
</tr>
<tr>
<td>1963</td>
<td>102.78</td>
<td></td>
<td>4.99</td>
<td></td>
<td>20.00</td>
<td></td>
<td>3.21</td>
</tr>
<tr>
<td>1964</td>
<td>106.76</td>
<td></td>
<td>5.41</td>
<td></td>
<td>20.10</td>
<td></td>
<td>3.43</td>
</tr>
<tr>
<td>1965</td>
<td>117.98</td>
<td></td>
<td>5.92</td>
<td></td>
<td>19.78</td>
<td></td>
<td>3.66</td>
</tr>
<tr>
<td>1966</td>
<td>102.90</td>
<td></td>
<td>6.3%</td>
<td>+39%</td>
<td>16.33</td>
<td>-39%</td>
<td>4.11</td>
</tr>
<tr>
<td>1967</td>
<td>101.87</td>
<td></td>
<td>6.77</td>
<td></td>
<td>15.27</td>
<td></td>
<td>4.34</td>
</tr>
<tr>
<td>1968</td>
<td>93.87</td>
<td></td>
<td>6.99</td>
<td></td>
<td>14.73</td>
<td></td>
<td>4.50</td>
</tr>
<tr>
<td>1969</td>
<td>94.55</td>
<td></td>
<td>6.92</td>
<td></td>
<td>13.00</td>
<td></td>
<td>4.61</td>
</tr>
<tr>
<td>20 Dec. 1971</td>
<td>88.31</td>
<td></td>
<td>7.06</td>
<td></td>
<td>12.50</td>
<td></td>
<td>4.73</td>
</tr>
</tbody>
</table>

obviously much more affects quality. It is appropriately may be added that Standard and Poor's regards such a measure as inadequate for public utility common stocks: "Since earnings and dividends of regulated public utilities characteristic are more stable than those of non-regulated industries, numerous other factors must be considered. Among those are capital structure, amount of depreciation reserves, condition of properties, growth potentials or individual service areas, the regulatory environment, and the rate of return." It is interesting to note that, because of public utility earnings stability, stability measures are inadequate, which is like saying that if you are good, we will find some other way of ranking you so that you are not; you can't win.

The quality ratings remained relatively constant despite a decline that began from a peak P/E multiple of over 20 in the mid-1960s to a low of almost 10 in 1970. Prices fell nearly 40 percent and price-earnings ratios almost 50 percent. However, the rating on Penn Central common did fall from B (speculative) to C (subordinated) after the May 1970 collapse. The increase in the price of public utility common stocks from 1965-1964 exceeded average industrials, yet this growth made public utility stock standard deviations larger. In the mid-1960s, prices and price-earnings ratios stabilized for a period before their large decline in 1970.

### TABLE 5. Patterns of Industrial and Utility Common Stock Performance

<table>
<thead>
<tr>
<th>Year</th>
<th>Price</th>
<th>Earnings</th>
<th>P/E</th>
<th>Div. Yield</th>
<th>Price Earnings</th>
<th>P/E</th>
<th>Div. Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>1957</td>
<td>143.05</td>
<td>10.27</td>
<td>13.99</td>
<td>5.91</td>
<td>4.11</td>
<td>40.42</td>
<td>3.41</td>
</tr>
<tr>
<td>1965</td>
<td>218.24</td>
<td>12.43</td>
<td>17.55</td>
<td>6.98</td>
<td>3.39</td>
<td>103.79</td>
<td>4.99</td>
</tr>
<tr>
<td>1966</td>
<td>284.32</td>
<td>16.42</td>
<td>17.32</td>
<td>8.48</td>
<td>2.38</td>
<td>117.09</td>
<td>5.92</td>
</tr>
<tr>
<td>1967</td>
<td>255.96</td>
<td>17.63</td>
<td>15.92</td>
<td>9.24</td>
<td>3.33</td>
<td>108.77</td>
<td>6.87</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Month</th>
<th>Industrial</th>
<th>Utility</th>
<th>Dividend</th>
<th>Growth Rate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct</td>
<td>3.21%</td>
<td>5.36%</td>
<td>6.11%</td>
<td></td>
<td>2.71%</td>
</tr>
<tr>
<td>Dec</td>
<td>2.98%</td>
<td>3.96%</td>
<td>3.87%</td>
<td></td>
<td>2.63%</td>
</tr>
</tbody>
</table>


---

**Public Utility Risk Premiums: Some Comments**

It was noted when discussing bond risk that the basic point spread between S&L high grade utility bonds and U.S. governments increased substantially from 20 in 1965 to 104 in December 1973, reflecting demands by investors for larger absolute premiums for the risk of holding public utility bonds. On a relative basis the ratio of U.S. government bond yields to utility bond yield increased from 3.05 in 1965 to 3.14 in 1965 and 1.17 in December 1970.

Turning to common stocks, a comparison with industrial common stocks may be useful. The Moody's indices of industrial and utility common stocks are shown in Table 5.

From 1965 to December 1970, the percentage changes were as follows:

<table>
<thead>
<tr>
<th>Industrials</th>
<th>Electric Utilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prices</td>
<td>+5</td>
</tr>
<tr>
<td>Earnings</td>
<td>-3</td>
</tr>
<tr>
<td>P/E</td>
<td>+8</td>
</tr>
<tr>
<td>Dividend</td>
<td>3.21%</td>
</tr>
<tr>
<td>Growth Rate</td>
<td>-11.25%</td>
</tr>
</tbody>
</table>

The traditional method for measuring current yield on common stock is to add dividend or earnings growth to dividend yield. The dividend yield for December 1970 plus the compound annual growth rate in earnings for the previous five years (1965-1970) gives drastically different current yields, as shown.

<table>
<thead>
<tr>
<th>Industrials</th>
<th>Electric Utilities</th>
<th>Natural Gas (Transmission and Distribution)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dividend</td>
<td>2.98%</td>
<td>3.96%</td>
</tr>
<tr>
<td>Growth Rate</td>
<td>4.56%</td>
<td>-6.45%</td>
</tr>
</tbody>
</table>

In 1965 (using the five-year prior period to compute earnings growth) the current yields were:

<table>
<thead>
<tr>
<th>Industrials</th>
<th>Electric Utilities</th>
<th>Natural Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dividend</td>
<td>2.98%</td>
<td>3.96%</td>
</tr>
<tr>
<td>Growth Rate</td>
<td>11.25%</td>
<td>-1.50%</td>
</tr>
</tbody>
</table>

Total 2.71% 5.36% 6.11%
The many popular explanations were: inflation squeezing expected profits; inflation and the resultant tight money policy which restricts growth, high money costs; regulatory atmosphere regarding rate adjustments; and attractiveness of alternative investments. Pollution cost considerations were mentioned but were well down the list. The message is generally that inflation plus tight money and accompanying high interest rates are highly injurious to the outlook for public utility investments; financing, growth, and profits are affected.

It also may be interesting to note that the analysts did regard public utility stocks as defense (defined as investments whose earnings tend to be little affected by declines in business activity) by a ratio of 10 to 1. Analysts also regarded the growth prospects of the electric power and telephone industries as stronger than natural gas. When asked if they considered the following as growth stocks, the results were:

- Electric power: Yes (16), No (8), Undecided (1)
- Natural gas: Yes (11), No (13), Undecided (1)
- Telephone: Yes (15), No (6), Undecided (1)

Summary

In summary, standard deviation of ex post returns may win the favor of academics but not of investors or analysts. We need a measure that concentrates on risk premiums not gross risk, and one which is more reflective of ex ante uncertainties than those presently used. Nor is analysts' reliance upon investment advisory ratings satisfactory. In the face of continued growth, public utility common and other public utility securities commanded greater risk premiums in the past five years, apparently because of inflation uncertainties with the accompanying tight money and high interest rates which restrict profits and growth.
On Public Utility Regulation Under Uncertainty

Stewart C. Myers

It is not new to say that risk is important in regulation. The legal principle guiding rate of return regulation provides that "the return to the equity owner should be commensurate with returns on investments in other enterprises having corresponding risks." This idea, that risk determines allowable return, is incorporated in court and regulatory decisions dating back to before the turn of the century. I doubt there is one regulatory case in which the firm's representatives have not argued that the firm is facing high risks and therefore should be allowed a high return, or in which their opponents have not argued the opposite.

The goals of this paper are, first, to define the role of risk in public utility regulation in a broader and more explicit way, and, second, to illustrate the sort of analysis needed to understand this role.

It may seem a bit late to offer observations on "the problem" of risk in public utility regulation when risk has received countless man-hours of attention in rate proceedings and elsewhere. Actually, the time is ripe, since recent developments in financial economics have made significantly better analytical tools available.

Consider, for example, the perennial problem of defining and meas-
and short on answers. At this time it is difficult to make meaningful prescriptions for optimal regulation under uncertainty or to present a general analysis of utility behavior under uncertainty and regulatory constraints. Nevertheless, it seems worthwhile to attempt to define the problem.

**Regulation and the Allocation of Risk Bearing**

Most utilities are safer than other firms. Are they safe because of the nature of their business, or because they are regulated in a particular way? That is, does the relative safety of investment in utilities reflect a relative absence of risk or its absorption by consumers, the government, or other parties?

Regulatory rules do affect the allocation of risk bearing. The strength of the effect can be appreciated by considering two somewhat extreme regulatory strategies. One tends to allocate risk to investors; the other allocates most of the risk to consumers. For simplicity, it will be assumed that utilities are all-equity financed, that they produce a single homogeneous product, and that taxes can be ignored.

**Strategy I: Revenues Fixed Ex Ante**

The first strategy is designed to allocate to investors all of the risk associated with production and operating costs. Although in each period investors expect to receive a satisfactory return on additional investment made by the utility during that period, investors are not guaranteed that the rate of return actually earned will equal the expected rate.

Let:

- \( I_t \) = gross investment of a utility in period \( t \)
- \( R_t \) = its cost of capital measured at \( t \)
- \( C_{0t} \) = expected incremental operating costs due to \( I_t \)
- \( j = 1, 2, \ldots, H \)
- \( H \) is the maximum life of the asset.

The cost of capital at \( t \) is defined as shareholders' opportunity cost of investment in the utility. That is, \( R_t \) equals the rate of return offered by investments in other securities of similar risk.

The incremental expected revenue requirements over the life of the investment are calculated as

\[
REV_{0j} = C_0 + R_t (I_t - Z_{0j-1}) + Z_{0j}
\]

(1)

where \( Z_{0j-1} \) is the depreciation to be accumulated on \( I_t \) up to the start of the \( j \)th period after installation, \( Z_{0j} \) is the additional depreciation to be charged in the \( j \)th period.

Suppose that the variables \( REV_{0j} \) \( (j-t+1, t+2, \ldots, t+H) \) are determined at time \( t \), when the investment is made, and not changed thereafter even if costs turn out to be different than expected. Then the utility's aggregate revenue requirements at any time \( j \) are

\[
REV_j = \sum_{t=J-H}^{J-1} j \ REV_{0j}
\]

(2)

When period \( J \) is reached prices will be set to generate \( REV_{0J} \) — no more, no less.

This rule is an example of what may be called ex ante regulation, since the basic regulatory decisions are made before the fact. The result is analogous to a series of fixed price contracts between the utility and the public, the public being represented by the regulators. There is a variety of possible ex ante rules. For example, price could be fixed rather than \( REV_0 \), forcing investors to bear the risks associated with future demand. Alternatively, regulators could fix \( REV_0 \) but allow the firm to use more or less capital-intensive technologies, thus allowing the firm to choose the best point in the trade-off of investment versus operating costs.

The point of regulation according to Equations (1) and (2) is that all uncertainty about assets' operating costs is borne by investors once the assets are in place. Naturally, these risks will be reflected in the utility's cost of capital. The advantages of the rule just described are that (1) each period's investment will offer an expected rate of return equal to the cost of capital; (2) the rule is consistent with the law, since the expected return to the firm's investors is equal to the return offered by comparable risk investments; (3) the rate of return shown on the utility's books is not the instrument of regulation. This avoids the very difficult problems associated with ex post measurement of a utility's rate of return; and (4) this rule provides

---

*The assumption is that the utility's risk characteristics do not change as it expands. Then the appropriate cost of capital for its new investment at any point in time is the same rate investors use to evaluate the firm as a whole.*

maximum incentive to improve operating efficiency once assets are in place. There are also substantial disadvantages. There would be difficulties in administration, particularly in estimating expected future costs. (The rule gives management maximum incentive to lie about future costs in negotiations with regulators.) More important, the rule described above ignores the utility’s output and investment decisions. Price in any period \( J \) is set at whatever is necessary to generate REV. This price probably will not lead to the optimal output. Finally, there is no guarantee that the utility will invest the correct amount. These disadvantages are substantial, but the idea of ex ante regulation should not be discarded out of hand. Other rules can be constructed which retain the essential idea of regulating before the fact.

Strategy 2: Equating Actual and Expected Rates of Return Ex Post

Consider the following alternative to the scheme just described. In any period \( J \), prices are set so that

\[
REV = C_J + \Delta Z_J + R_J \sum_{t=J-H}^{J-1} (1 - Z_{J-t-1})
\]

(3)

where

\( J - H \) = the period in which the firm’s oldest assets were acquired; 
\( C_J \) = total operating costs in \( J \); 
\( \Delta Z_J \) = depreciation charged in \( J \); and 
\( R_J \) = the firm’s cost of capital at the start of \( J \).

Clearly a utility will tend to be safer (from the investor’s viewpoint) under this scheme of ex post regulation than under ex ante regulation. Fluctuations in operating costs are passed directly to consumers, so are fluctuations in the cost of capital. Risk is introduced only by lags in the regulatory process, which mean that \( REV \) is not adjusted immediately to take account of changed conditions and that it is possible there may be no price which will be the required revenue. This could happen if demand turns out to be (1) low relative to capacity and (2) relatively elastic. Thus, a utility’s cost of capital

would tend to be lower under ex post than under ex ante regulation. If adjustment of \( REV \) to changed conditions is rapid, \( R_J \) should be only slightly higher than the yield on corporate bonds.

The strategy of ex post regulation is easier to administer than the ex ante strategy, but it shares the disadvantage of leaving the utility’s investment decision unregulated. The utility, by controlling investment, in turn controls output, since output is determined by price and capacity. Investment establishes capacity directly, and price indirectly via Equation (5).

The regulatory process in practice falls between the extremes just described, but probably closer to the ex post strategy. To be sure, an element of ex ante regulation is introduced by regulatory lags, but these seem to be more a bureaucratic phenomenon than an attempt to shift risk to utilities and their stockholders.

Comments

These are only two possible strategies for public utility regulation. Doreen could be invented, but the two are sufficient to illustrate how the choice of regulatory strategy can affect the allocation of risk bearing. They also suggest a number of general observations.

The first point stems from the generally accepted principle that the object of regulation is to prevent the utility from behaving like a monopoly—that is, to impose constraints which force the utility to make the same investment, price, and output decisions as would obtain at a competitive equilibrium. In practice, this principle is pursued by regulating the utility’s rate of return. The attempt is primarily to eliminate monopoly profits, not to enforce competitive investment and output decisions.

The condition for eliminating monopoly profits is that the utility’s expected rate of return on new investment is equal to the cost of capital.1 If this condition holds, then by definition the expected rate of return on investment by a utility will be equal to the expected rate of return offered by other investments of similar risk, and utility shareholders will not receive windfall capital gains. This condition is an ex ante concept. It is not violated if the actual rate of return turns out to be more or less than expected. Perfect competition does not require that profit expectations be realized for individual assets, or even on the average for all assets over any given period of time.

1 Elimination of monopoly profit is necessary but not sufficient to achieve the competitive solution.
Both the regulatory rules described in this section -quate expected rate of return on investment to the relevant cost of capital. Thus, both eliminate "monopoly profits." However, risk and the cost of capital depend upon the regulatory strategy chosen.

The second observation is that the regulatory strategy which results in the lowest cost of capital is not necessarily best. The best scheme may entail a high cost of capital, if this leads to a good allocation of risk bearing or to other advantages.

Existing theory about allocation of risk bearing does not offer firm guidance on the design of an optimal regulatory strategy. However, I will offer a conjecture. The relevant principle seems to be that risks should be borne by those economic units specialized in this function. This means investors rather than consumers. Capital markets afford a wide variety of alternatives for diversification and for tailoring portfolios to particular risk preferences. Thus, it can be argued that consumers should be insulated from the risks of utility operations and that this would increase welfare even though utilities' costs of capital would be increased. Of course, the likely behavior of the utility under schemes designed to allocate risk to investors will have to be closely examined to see whether utilities' investment and output decisions would be adversely affected. A tentative discussion of this matter is presented in the last section of this paper.

Third, although it is hard to categorize actual regulatory procedures, they seem closer to the ex post rule presented above than to the ex ante one. This suggests that utilities are relatively safe partly because regulation makes them so.

Finally, it is interesting to note how vague current regulatory procedures are with regard to who bears risk. This can be illustrated by the arguments which arise whenever there is rapid inflation. Is it "fair," for instance, for investors to bear the risks associated with unexpectedly high inflation? Should investors receive a higher rate of return or be allowed to claim a higher rate because of this inflation? Whether or not this is "fair" depends entirely on the regulatory rules. Do they call for consumers or investors to bear the risks associated with unexpectedly high inflation? If it had been clearly decided in 1960 that consumers were to bear the risks, then it would now be clear that investors deserve extra compensation. Unfortunately, the rules were never specified.

The discussion up to this point thus leads to several conclusions about the role of risk in public utility regulation, namely:

1. The risk borne by investors is not a fixed parameter, but a result of the regulatory rules.
2. The impact of existing regulatory rules is probably to make utilities safer than they otherwise would be.
3. Current regulatory procedures probably lead to a relatively low cost of capital for utilities, but there is little ground for arguing that this is the best result.
4. Existing regulatory rules are deficient in that they do not take account of the effects of regulatory constraints on utilities' investment and output decisions.

In order to make further progress it is necessary to investigate how utilities' output and investment decisions are made, given uncertainty and regulatory constraints. A tentative analysis is presented below.

Behavior of Utilities Subject to Uncertainty and Regulatory Constraints

The purposes of this section are: (1) to calculate the equilibrium investment and output decisions of a monopolistic firm acting under uncertainty, (2) to compare this equilibrium result with the one that would be achieved under competitive conditions, and (3) to show how regulatory constraints can affect the behavior of such a firm. The analysis is conducted for an extremely simple case with the help of a numerical example. I believe this case captures the essential elements of the problem. However, I am not at this time attempting to present a general model or to state theorems about optimal regulatory strategies.

The analyst will employ the time-state-preference framework for analysis of behavior under uncertainty. That is, uncertainty is about conditions in a future period is described by specifying a set of possible states of nature, only one of which can actually occur. The realized values of random variables are contingent on which state of nature occurs.

I will analyze a one-period world, in which there are two equally probable future states of nature $t = 1, 2$. Decisions are made now, $t = 0$, without knowing which state will occur at $t = 1$. (The general-
Equilibrium Conditions

Consider a utility which has to invest now (t = 0) in order to build capacity for production in the future (t = 1). Cost and demand conditions for t = 1 are not known. They depend on which of the two possible states of nature occurs.

We will employ the following notation, where s indexes the possible states:

\[ V(s) = \text{present value of $1$ delivered if, and only if, state } s \text{ occurs} \]
\[ Q(s) = \text{utility's output in } s \]
\[ Q_{max} = \text{maximum output, determined by investment at } t = 0 \]
\[ C(s) = \text{cost per unit of output in } s \]
\[ P(s) = \text{price per unit of output in } s \]
\[ F(Q_s) = \text{investment required to build the capacity } Q_{max} \]

The utility's objective is to maximize the net present value of its investment, subject to the constraint that, regardless of the state of nature occurring, it cannot produce more than its capacity. Formally, its problem is to:

\[
\begin{align*}
\max & \sum_{s=1}^{2} V(s)[P(s) - C(s)]Q(s) - F(Q_s) \\
\text{subject to} & \quad \phi(s) = Q(s) - Q_{max} \leq 0,
\end{align*}
\]

Assuming \( Q(1), Q(2), \) and \( Q_{max} \) all are positive, the conditions for the maximum are:

\[
\begin{align*}
Q(1) &= V(1) \left[ P(1) + Q(1) \frac{\partial P(1)}{\partial Q(1)} - C(1) - Q(1) \frac{\partial C(1)}{\partial Q(1)} \right] - \lambda(1) = 0; \\
Q(2) &= V(2) \left[ P(2) + Q(2) \frac{\partial P(2)}{\partial Q(2)} - C(2) - Q(2) \frac{\partial C(2)}{\partial Q(2)} \right] - \lambda(2) = 0; \\
\phi(1) &= -\frac{\partial F}{\partial Q_{max}} + \lambda(1) = 0; \\
\phi(2) &= -\frac{\partial F}{\partial Q_{max}} + \lambda(2) = 0; \\
\phi(s) &= \lambda(s) = 0, \quad s = 1, 2.
\end{align*}
\]
The conditions are easy to interpret. The shadow prices $\lambda_1(1)$ and $\lambda_2(2)$ represent the present value of the difference between marginal revenue and marginal cost. Marginal revenue and marginal cost are not equal unless output is less than capacity, in which case $\phi(s) < 0$ and $\phi(s) = 0$. But the condition for $Q_a$ assures that capacity will limit output in at least one state, since $\Delta F/\Delta Q_a > 0$. Thus the shadow prices $\phi(s)$ also represent the present value of the extra capacity in $s$, and the condition on $Q_a$ simply states that capacity should be expanded until the marginal cost of an extra unit equals the present value of an extra unit available for use in the various states.

The solution for competitive markets is exactly the same except that $Q_a(1) = \frac{\Delta P(s)}{\Delta Q(s)} = 0$ for all $s$, that is, $P(s)$ appears instead of marginal revenue in the conditions for $Q_a(s)$. Also, in competitive markets firms will enter (or exit from) the industry until $\phi = 0$.

There is no reason to expect $\lambda_1(1)$ to equal $\lambda_2(2)$ in either the competitive or monopolistic case. This is important, because the $\lambda$s are an index of the profitability that the utility will enjoy after the fact. Clearly, the attempt by regulators to impose a "reasonable" or "fair" rate of return after the fact may rule out any chance of approximating the competitive solution. This is illustrated in the numerical example presented below.

The impact of various regulatory strategies can be analyzed by adding constraints and observing the changes in $Q_1(1)$, $Q_2(2)$, and $Q_a$. For example, suppose the firm is limited ex post to a maximum rate of return $R_a$. The constraints change to

$$\phi_1(s) = Q(s) - Q_a < 0,$$

$$\phi_2(s) = Q(s) |P(s) - C(s)| - (1 + R_a)F(Q_a) < 0.$$

(4a)

To simplify notation, let $MR(s) = P(s) + Q(s) \frac{\Delta P(s)}{\Delta Q(s)}$ and $MC(s) = C(s)$, then the addition of the constraints $\phi_1(s)$ changes the conditions for the maximum to

$$Q(s): V(s)[MR(s) - MC(s)] - \lambda_1(s) - \lambda_2(s)[P(s) - C(s)] = 0;$$

$$\frac{\Delta F}{\Delta Q_a} = \Delta P(s) + \lambda_1(1) + \lambda_2(2) + \frac{\Delta F}{\Delta Q_a}(1 + R_a)\lambda_1(1) + \lambda_2(2) = 0;$$

Also: $\phi_1(s) = 0; \phi_2(s) = 0$.

A variety of other regulatory strategies can be analyzed by changing the constraints $\phi_1(s)$.

A Numerical Example

The implications of this model of utility behavior can be illustrated by a simple numerical example. We assume that the firm faces the following contingent demand functions:

$$Q(1) = 2500 - 400P(1);$$

$$Q(2) = 5000 - 400P(2).$$

Thus:

$$P(1) = 5.5 - 0.0025Q(1);$$

$$P(2) = 7.5 - 0.0025Q(2).$$

Costs also are contingent on the state occurring. $C(1) = 1$ and $C(2) = 2$. The present investment required per unit of capacity is $1$, that is, $F(Q_a) = (1.0)Q_a$. Present values are obtained via the assumed prices $V(1) = 5$ and $V(2) = 4$, which implies a risk-free rate of interest of about 11 percent. The two states of nature are assumed equally probable.

Using the conditions stated in Equation (5), the optimal solution for $Q_1(1)$, $Q_2(2)$, and $Q_a$ can be calculated. The values for a monopoly are shown in the first columns of Table 1, along with several other characteristics of the solution. These may be compared with the values which would obtain under perfect competition, which are shown in the second column of Table 1. The results for the competitive case were calculated from Equation (5), but with price substituted for marginal revenue in each state.

The differences between the monopoly and competitive solutions are clear from the first two columns of Table 1. Only a few comments are called for. When the utility (s) is free to act as a monopoly it re-
stricts capacity and output, charges high pri-e-es, and earns a whopping profit. The profit is reflected in a high positive net present value. In the competitive case there is no such windfall gain.\(^9\) The monopoly is also safer, from the investor’s point of view. This is reflected in the lower cost of capital.\(^10\) However, the model does not imply that monopolies will always be safer than competitive firms.

The third column of Table 1 shows the results if the utility acts like a monopoly, subject to the regulatory constraint that it earn no more than 20 percent on its investment ex post. It is assumed that this constraint is known ex ante, that it is strictly enforced, and that the firm cannot plan to ration output in either state. The effect of this constraint is to drive the net present value of the utility from 1490 to approximately zero, that is, to eliminate the utility’s monopoly profit, which is presumably a good thing. However, other characteristics of the constrained solution are not so desirable. The firm is led to invest more than it would in the competitive case since the only way to reduce profits in \(s = 2\) is to invest and produce more. This additional capacity is used only in state 2, however. In state 1 the constraint on maximum profit is not binding, and so the firm seeks maximum profit by restricting output and driving up prices. Even at an output of 900, where \(MR(1) = MC(1)\), it can earn only 5 percent on the investment of 1920. In short, the effect of the rate of return constraint is that the utility invests more than a competitive firm would and produces more in state 2. But the firm can act as a pure monopolist in state 1, since the combination of low demand and high capacity need for state 2 makes the rate of return constraint not binding.

\(^9\) Strictly speaking the reason why \(\phi = 0\) in the competitive case is that constant returns to scale are assumed in the numerical example. In the absence of constant returns to scale, windfall gains or losses would be eliminated by entry or exit from the industry.

\(^10\) The cost of capital \(\mu\) is computed by the relation

\[
NPV = \frac{\text{Expected Cash Payoff}}{1 + \mu} - F(Q_m).
\]

Thus, for the monopoly solution,

\[
1490 = \frac{(2000 + 3200)}{1 + \mu} - 812 = 141.\]

\(\mu = 1.141\).

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Variable} & \text{Monopoly Solution} & \text{Competitive Solution} & \text{Constraint on Max. Rate of Return} (\mu = 0.39) \\
\hline
Q(1) & 812 & 1022 & 900 \\
Q(2) & 812 & 1022 & 1020 \\
\mu & 812 & 1022 & 1020 \\
\text{Required Investment} & 1490 & 0 & +1250 \\
\text{Cost of capital in (percent)} & 14.1 & 19.6 & 11.0 \\
\text{Ex post rate of return in } s = 1 \text{ (in percent)} & 14.7 & -55.5 & 8.3 \\
\text{Ex post rate of return in } s = 2 \text{ (in percent)} & 23.7 & 94.5 & 20 \\
F(1) & 3.47 & 1.445 & 3.25 \\
F(2) & 8.47 & 3.445 & 2.7 \\
\hline
\end{array}
\]

It is also interesting that the firm becomes safer from the investors point of view when it operates under the constraint. Its cost of capital is only 12 percent compared to a risk-free rate of 11 percent and costs of capital of 14.5 and 18.4 percent for the monopoly and competitive solutions respectively.

Areas for Further Research

This paper describes the role of risk in public utility regulation and illustrates an approach to analyzing this role. But defining the problem does not solve it, nor does the analysis of a simple example lead to confidently held conclusions. Thus, I will conclude by indicating problems which require further work. The problems are listed roughly in order of difficulty.

- The first item is to generalize the one-period, two-state model to encompass many states of nature, and to identify the exact conditions under which particular sorts of behavior will occur.\(^11\) For example: (1) Under what conditions will a constraint on ex post rate of return lead the utility to invest more than the competitive solution calls for? (2) Under what conditions will such a constraint make the

\(^{11}\) I have explored these questions in another paper written after this paper was presented. See "A Simple Model of Firm Behavior Under Regulation and Uncertainty," Bell Journal of Economics and Management Science, forthcoming. Also see "The Application of Finance Theory to Public Utility Rate Cases," ibid., 3 (Spring 1972), 56-97.
utility a safer investment than under the competitive solution? (3)What will be the impact of allowing the firm to ration output in some states? (4) Is it possible to find a regulatory constraint which will lead the utility to a tolerable approximation of competitive behavior?

- In many ways, the world described in the preceding section is not a very interesting one in which to analyze the allocation of risk bearing. If any firm or consumer can buy or sell dollars delivered contingent on any state of nature, then the problem of allocating risk bearing is completely separable from investment, output, and consumption decisions. There is no risk that cannot be hedged or insured; that is, there are complete markets for risk allocation.15

This happy situation does not exist in real life. However, it should be possible to construct a model for the case of incomplete markets that is very similar to the one described above.16

- Extension of the analysis to more time periods would be beneficial. It is not clear that this can be done, however. But the attempt will at least suggest what errors are introduced by ignoring the sequential nature of utility investment decisions.

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**CAPM and the Measurement of Business Risk**

J. Fred Weston

and

Michael F. Dham

This paper applies the capital asset pricing model (CAPM) to the measurement of business risk. First, previous literature on measurement of business risk will be reviewed. Second, the capital asset pricing model will be briefly summarized. Third, the model will be applied to data for individual firms and industries. Fourth, the implications for public policy applications of the theory will be considered.

**Historical Variance as a Measure of Business Risk**

In the empirical studies to be reviewed, two types of risk measures have been employed. One method, called a spatial measure, has involved the estimation of risk as the variance around an industry average at a given time. A second approach, a temporal measure, has involved estimation of firm risk as the variance of firm returns over time.

**Spatial Risk Measurement**

Conrad and Plotkin. A spatial approach to the measurement of risk has been applied by Gordon Conrad and Irving Plotkin,1 who

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13For a specification of the conditions necessary for complete markets, see Myers, "A Time-State-Preference Model."

define risk as the variance of firm accounting returns around the industry average. Conrad and Plotkin make the following argument for a spatial risk measure. Company units are said to have several drawbacks. They may have badly data; distortions may be introduced by standard financial reporting. Risk situations may be obscured; results may be affected by luck or inertia; the individual enterprise may be too small and too unusual a unit to be the sole focus of measurement; and companies tend to smooth their reported performances over time. Industry units provide the advantage that individual idiosyncrasies are averaged. Conrad and Plotkin hypothesize that the industry with low dispersion can better predict profit performance than one in an industry with high dispersion.

The authors concede that their risk measure is invalid if single company returns or the company rankings within industries do not vary over time. An industry with diversity among firms but stability over time would be judged risky by a spatial measure, but not by most investors. No attempt to test these conditions was reported. Conrad and Plotkin also argue for their risk measure on the basis that their statistics results are more significant than those using temporal measures of risk. It is dangerous to justify a model on the basis that it yields centrist statistical results. The fact that the spatial risk variable is more significantly related to return statistically than the temporal measure of risk is not useful in evaluating one measure versus the other. After all, the purpose of the study is to measure the risk-return relationship. One set of results is not better than another; the alternative models must be evaluated on a conceptual basis.

Conrad and Plotkin have no real theoretical framework. They merely assert that the spatial is better than the temporal as a measure of risk. It is not clear that the problems with the latter measure are solved by the former. Differences in return between firms may occur because of internal peculiarities rather than as a result of industry factors. The spatial (or temporal) variance is apparently intended as a measure of the probability distribution of returns. If investors do not diversify, the firm variance is a reasonable measure of risk. However, if investors are risk averse, they will diversify as shown by H. M. Markowitz and others. The variance then may

be separated into systematic and nonsystematic components. The actual risk exposure which investors face is dependent only on the systematic component, and nonsystematic risk may be diversified away. (The studies of Benjamin King indicate that almost half of the variance of stock market returns is not related to the overall market.)

A firm which has a low correlation with the overall economy may require less of a risk premium than one with a lower variance but a higher correlation.

The Little Report. Irving Plotkin and Janet Cappers applied the spatial definition of risk in a study of rates of return of the property and liability insurance industry for Arthur D. Little, Inc. in 1967. This report was criticized by Alfred Hollander and R. Hal Mason and by J. D. Hammond and N. Shilling on the basis of conceptual difficulties with the spatial risk measure and its technical defects in the report. A revised report on the same subject was issued in 1969 using the temporal risk measure, apparently in answer to criticism of the spatial approach. The study still may be lauded for use of the variance of firm returns as the measure of risk rather than a systematic concept of risk.

Temporal Risk Measurement

Annuity. After establishing the relationship between the mean, variance, and skewness of the probability distribution of returns, F. D. Arditi applies this framework to ex post stock return data. He uses a temporal approach. His return variable is the geometric average return for a firm over time. Variance and skewness are calculated over time and around the arithmetic temporal average. Arditi also brings in several other factors which are related to risk in one context or another.

He includes the correlation coefficient between each firm and the market as a risk variable on the argument that the lower the correlation, the more valuable is the asset for diversification and the lower return investors will require. Two objections may be raised to its inclusion here. The use of the variance and the correlation coefficients is inconsistent. The variance alone is appropriate if no diversification is permitted. If diversification is allowed, then the covariance is the appropriate measure of risk. This brings us to the second objection. Ardititi’s work was published after William Sharpe’s 1966 article, which shows that the appropriate measure of risk is one that is linearly related to required returns in the context of the capital asset pricing model. Covariance of the asset with the market and

\[ \text{COV}(R_i, \mu_t) = \text{COV}(R_i, \mu) \]

The correlation will not be linearly related to required return because \( \beta_i \) will vary with each asset. Therefore, the correlation coefficient is not an appropriate variable for inclusion in a multiple or simple linear regression study.

Arditi includes two other variables which may affect risk: the debt to equity ratio and the dividend to earnings ratio. The inclusion of the financial variables is inconsistent with either of the above approaches because their effects are included in the variance and in the correlation coefficient. The inclusions of these variables is redundant, and they also are inadequate if considered without the distribution variables because of Ardititi’s failure to consider other factors influencing risk. For example, the possession of a risk (variability or volatility of sales plus operating leverage) which is magnified through financial leverage. With no business risk, financial leverage would involve no additional risk. To summarize, Ardititi constructs the following model:

\[ k = \text{avg. over time}_i + \text{avg. over time}_e + \text{avg. over time}_v + \text{correlation}_c + \text{debt/equity}_d + \text{dividend/earnings}_e \]

where:
- \( k \) = geometric average return over time;
- \( a_i \) = variance around the arithmetic average over time;
- \( s_i \) = skewness around the arithmetic average over time;
- \( c_i \) = correlation coefficient;
- \( d_i \) = debt/equity;
- \( e_i \) = dividend/earnings.

Arditi regresses every possible combination of his five variables against return. His results are not generally significant statistically. Variance and skewness are appropriate risk variables only if the possibility of investor diversification is eliminated. The correlation coefficient is a risk variable only if investor diversification is assumed. In any case, it will not be linearly related to required return. The financial variables are redundant and even if considered without the previous variables they must be considered in the context of a properly specified model that includes the other relevant risk variables. Therefore, Ardititi’s model is not supported by economic logic, and none of his variables considered individually may be expected to be linearly related to return if investor diversification is recognized.

Fisher and Hall: The objective of the study by Irving Fisher and George Hall was to estimate risk and adjusted rates of return to allow profit comparability. It involves two steps: the concept of risk premium is examined and then measured over firms in eleven industries, and risk adjusted profit rates then are calculated for each firm and are summarized by industry. (The return variable is accounting net income divided by net worth.)

In developing the a priori model, Fisher and Hall treat the firm as if it has a utility function for wealth in a manner similar to that of Ardititi. In this framework, the expectation, variance, skewness, and higher moments of the probability distribution of wealth all enter into the utility function. (The higher moments are ignored in the empirical section.) Fisher and Hall argue for an ex post temporal variance rather than a spatial one. That is, they feel it is better measured by deviations of the firm’s rates of return about its own mean over time rather than about the mean of the industry for a given time. They also argue that stability is more important than dispersion. An industry with firms whose rates of return are stable but different would be considered risky by the spatial measure, but safe by the temporal measure and by most investors.

Fisher and Hall question the concept of a homogeneous industry, claiming that intrasindustry dispersion represents risk only in the situation of a broad industry where no knowledge exists about the reason for interfirm differences. New entrants may view intrasindustry dispersion as risk. (However, even here, successful entrepreneurs al...
Fisher and Hall introduce several empirical refinements. It is argued that a trend may be forecasted and should be considered to avoid the overstated risk. They compute the standard deviation about the trend rather than about the temporal average. A firm's earnings may be correlated from year to year so that the standard deviation over a number of years overstates the year-to-year perceived variability. Firms with significant serial correlation were removed from the sample to avoid overstated risk. In order to characterize industry risk and risk premiums, Fisher and Hall employ a series of dummy variables in their regression studies. In effect, the constant term for each industry is revealed using this method.

The model estimated is expressed in Fisher and Hall's notation:

$$\hat{r}_t = b_0 + b_S_i + C_j$$

where:

- $\hat{r}_t$: arithmetic average rate of return for firm $i$ in industry group $j$;
- $\sigma_i$: standard deviation of rate of return about the trend for firm $i$ in industry group $j$;
- $S_i$: measure of skewness of rates of return about the trend for firm $i$ in industry group $j$;
- $C_j$: shift variable for industry group, $j = 1, \ldots, 11$, and firms with substantial earnings autocorrelation removed from the sample.

The results as summarized by Fisher and Hall are presented in Tables 1a and 1b.


tion. Only people (investors) consume. The relevant measure of risk for an investor is the variance of the probability distribution of returns to him. The variance of returns to the firm will not, in general, represent investor risk. Sharpe has extended this logic to show that investors may diversify by holding various assets whose returns are less than perfectly correlated.21 Sharpe has extended this logic to show that an equilibrium relationship between investor risk and return will imply a measure of risk for the individual firm (asset) which is not the variance.22 Studies which use an expected estimate of variance therefore may be criticized as ignoring the potential of investor diversification for eliminating nonsystematic risk.

A Criticism of Historical Variance

Walter A. Morton claims that there are two aspects to the nature of risk: Instability and risk may coexist in some cases, but risk ultimately consists of future fluctuations in earnings but of the chance or possibility that the firm may not be able to earn the opportunity cost of capital and thus lose all or part of its invested capital.23 He notes another view, namely, that risk is variability, either for a given firm over time or over firms in an industry at a given time. He mentions Conrad and Ploemkin in particular. However, this may not represent another view at all, but merely may be an attempt to measure risk as Morton defined it. Probability distributions are not available from market data; empirical studies must rely on some type of historical variation to measure risk. Morton actually rejects all attempts to measure the cost of capital and relate it to risk based on subjective data. He says judgments must be subjective: "The cost of capital requires the informed judgment of those familiar with the firm or industry, and is made either explicitly or implicitly by the management."24 This may not be operationally useful for regulatory agencies since management's actions will tend to claim a high rate of return is warranted by risk.

Morton argues that the measure of risk, the historical variance, is dependent on the assumption that the historical return actually is anticipated by the market. Unfortunately, he does not stop there. He also says that although individuals may be risk averse, ex post returns on risky assets will not be higher on the average than for less risky assets because investors consistently will fail to achieve their ex ante expectations. He argues that achieving would prevent ex post returns on risky assets from averaging more than those on less risky assets. This is a misunderstanding of risk and risk aversion which could be extended to a logical conclusion that common stocks may return no more on the average ex post than federally insured bank savings deposits.

In the light of this criticism, however, it would be appropriate to mention that the measure of systematic risk is not dependent on an assumption that ex ante and ex post returns were identical. It is dependent on the assumption of a relationship between firm and market returns which is stable over time. This assumption may and will be tested empirically.

Morton does not indicate familiarity with the capital asset pricing model and the concept of systematic risk. An understanding of these ideas even without quantitative data might prove valuable. Consider the following direct quote from the Morton article:

Looking at the matter from a rate making or ex ante viewpoint, the Staff of the Federal Power Commission argues that a fair rate of return for gas producers is affected by risk. However, they claim the risks and the fair rate of return to be substantially the same for producers and integrated companies. Professor Ezra Solomon, a producer witness, also claims that the cost of capital and therefore implicitly the risks for producers and integrated companies to be substantially the same for use in his Discount Cash Flow study. The Federal Power Commission in the Permian Basin rate case found a greater risk in oil and gas exploration and production than in the integrated operations of petroleum companies and awarded a higher rate of return for gas production than would presumably have been appropriate for integrated operations. The Supreme Court concurred. I agree with the finding that production is the more risky of the two because of the unique risk inherent in production due to the uncertain and unpredictable relation between physical inputs and outputs.25

Morton appears to be thinking of risk as the variance of the probability distribution of returns. Suppose that a systematic definition of risk were adopted. The variance of returns in oil and gas exploration may be high, but it is not related systematically to the economy as a whole and therefore may be diversified away by firms or by individual
investors. This might imply that producers are not, in fact, more risky than integrated companies and, in that case, would support the results found by Professor Solomon.

Combining the Spatial and Temporal Measures

In a recent article, Paul Cooner and Daniel Holloway summarize an earlier unpublished study. The empirical measures employ a definition of industry risk as standard deviation of firm rates of return around the industry average. Rate of return is defined as net income (after taxes) plus interest payments divided by total capital. Industry rate of return is related to this spatial standard deviation by a linear regression analysis.

In order to estimate firm risk, the authors relate firm rate of return to several risk variables in a multiple regression analysis. The analysis includes temporal variables, the standard deviation and skewness around each firm's average over time, as well as the standard deviation of annual changes in rate of return around the average annual change.

### TABLE 2. Industry Rate of Return Regression Equations

<table>
<thead>
<tr>
<th>Year</th>
<th>Regression Equation</th>
<th>Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Years*</td>
<td>$I = 0.903 I_1 + 8.18$</td>
<td>$R = 0.550$</td>
</tr>
<tr>
<td>1946</td>
<td>$I = 0.153 I_1 + 11.44$</td>
<td>$R = 0.887$</td>
</tr>
<tr>
<td>1947</td>
<td>$I = 0.661 I_1 + 11.35$</td>
<td>$R = 0.327$</td>
</tr>
<tr>
<td>1948*</td>
<td>$I = 0.789 I_1 + 10.35$</td>
<td>$R = 0.476$</td>
</tr>
<tr>
<td>1949*</td>
<td>$I = 0.578 I_1 + 5.91$</td>
<td>$R = 0.485$</td>
</tr>
<tr>
<td>1950*</td>
<td>$I = 1.005 I_1 + 9.41$</td>
<td>$R = 0.718$</td>
</tr>
<tr>
<td>1951*</td>
<td>$I = 0.736 I_1 + 8.53$</td>
<td>$R = 0.499$</td>
</tr>
<tr>
<td>1953</td>
<td>$I = 0.325 I_1 + 8.69$</td>
<td>$R = 0.310$</td>
</tr>
<tr>
<td>1955*</td>
<td>$I = 0.682 I_1 + 7.63$</td>
<td>$R = 0.424$</td>
</tr>
<tr>
<td>1954</td>
<td>$I = 0.244 I_1 + 8.59$</td>
<td>$R = 0.149$</td>
</tr>
<tr>
<td>1955*</td>
<td>$I = 1.282 I_1 + 8.23$</td>
<td>$R = 0.771$</td>
</tr>
<tr>
<td>1956*</td>
<td>$I = 0.744 I_1 + 7.70$</td>
<td>$R = 0.503$</td>
</tr>
<tr>
<td>1957</td>
<td>$I = 0.276 I_1 + 7.59$</td>
<td>$R = 0.372$</td>
</tr>
<tr>
<td>1958</td>
<td>$I = 0.491 I_1 + 7.12$</td>
<td>$R = 0.278$</td>
</tr>
<tr>
<td>1959</td>
<td>$I = 0.534 I_1 + 9.13$</td>
<td>$R = 0.196$</td>
</tr>
<tr>
<td>1960</td>
<td>$I = 0.278 I_1 + 8.87$</td>
<td>$R = 0.309$</td>
</tr>
</tbody>
</table>

*Indicates a statistically significant regression coefficient at the 1 percent level. For testing significance 38 is the degree of freedom for each equation. $I_1$ = Unweighted average of company rates of return for each industry.

### TABLE 3. Company Rate of Return Regression Equations

| (a) | $Y = 0.905 I_1 + 8.20$ | $R = 0.380$ |
| (b) | $Y = 0.789 I_1 + 5.91$ | $R = 0.551$ |
| (c) | $Y = 0.736 I_1 + 8.53$ | $R = 0.499$ |
| (d) | $Y = 0.682 I_1 + 7.63$ | $R = 0.424$ |
| (e) | $Y = 0.244 I_1 + 8.59$ | $R = 0.149$ |

Note: The numbers in parentheses are the standard errors of the estimated values of the regression coefficients.

Y = The average rate of return on capitalization for a company for the post-war period, 1946-1960.

*$x_1$ = The standard deviation of the company's rates of return over the post-war period around the mean of the industry to which the company belongs for the same period.

*$x_2$ = The standard deviation of the annual rates of return for the company around its post-war average.

*$x_3$ = The skewness of the company's annual rates of return.

*$x_4$ = The standard deviation of annual changes in the company's rate of return around the mean post-war change.

The spatial variable which they introduce is the standard deviation of the firm’s rate of return around the industry average. Their results are summarized for spatial measures of industry risk in Table 2 and for various measures of firm risk in Table 3.

Of Coonter and Holland’s sixteen measurements of industry risk, the results are statistically significant in half the cases; in the result for common rate of return regressions, the individual regression coefficients generally are highly significant. The percentage of variation explained is slightly over 25 percent in three of the five equations, but only 9 percent when the authors’ spatial measure of variance alone is employed.

The weakness of using an eclectic approach to the measurement of risk is that attention may be diverted from the importance of a sound theoretical basis in favor of statistical association. This criticism of the Condl and Plotkin study, which we set forth above, is applicable to the Coonter and Holland study, which was used as a model by Conrad and Plotkin.

Our argument that the capital asset pricing model provides a theoretical framework for correctly approaching the problem of measuring risk also is applicable. Coonter and Holland do consider the newer theories:

We both now agree that in perfectly organized rational markets those theorems [of Sharpe et al.] should describe the required trade-offs between return and risk. Furthermore, since we feel that capital markets are close to perfect, these predicted trade-offs should be close to the relationship actually demanded in the market place. In point of fact, however, the empirical evidence is not as unequivocal as it might be, and since the question is, essentially, an empirical one, there is still interest in these hypotheses on business risk. Despite our appreciation of the beautiful results of the recent theory of financial risk, we do not feel especially apologetic about our older results. Within the class of risk measures utilizing accounting data we consider our measures superior to their competitors.29

While we do not concur that the matter is entirely an empirical one, we have employed the capital asset pricing model in our empirical study, utilizing both accounting and market measures. We therefore proceed to a presentation of our results after a brief recapitulation of the relevant theory.

29 Ibid.
framework which is not appropriate. The potential for investor diversification to reduce nonsystematic risk was not recognized by these studies. They incorrectly treated each firm as if the firm itself had a utility function for wealth, while it is people (investors) who consume and gain utility, not firms. The pressure for adjustment of return to an equilibrium level comes from the stock market and is reflected by accounting measurements.

Ray Ball and Philip Brown have addressed a problem which also is investigated in this paper. If accounting reports can assist the capital market in forming estimates of covariances of returns from assets then they will provide useful information concerning risk. Ball and Brown developed a number of different measures of returns: income, operating and net; income divided by the market value of common stock; and first differences of each of the above. They used a market index defined to be consistent with the appropriate definition of return as the independent variable in a simple linear regression relating each accounting measure and the market index for 261 firms. The results of these regressions were compared with the results of a regression of a stock's market value relative on a market index for the same firms. To the extent that a measure approximated the stock market relationship it was judged to measure volatility. Statistical results were interpreted as indicating that 35-40 percent of volatility could be statistically predicted from accounting data.

We now will estimate a characteristic line for each firm from accounting and stock market data. The slope of this line is an estimate of volatility for each firm. Volatility and average return will be related over all firms in an attempt to examine the equilibrium relationship. A number of assumptions underlie this work and will be tested insofar as is possible.

Measurement of Return

ACCOUNTING DEFINITION. Several alternative definitions of rate of return were considered. The numerator could include some combination of net income, before or after taxes. The denominator could be total assets, net worth, or market value of equity. The definition chosen, net income after taxes divided by net worth, was reached by a process of elimination. Taxes are a fact of life and affect risk and return, so the variable must be after taxes. The cost of capital is not independent of the financial structure because of the tax status of debt and possibly for other reasons. This implies that the capital markets will tend to bring into equilibrium returns on equity rather than returns on total assets. The market definition of equity was rejected because it would obscure continuing economic factors which already have been discounted by the market. It also would hinder comparison of accounting and market data. Therefore, for firm i,

\[ R_P = \left( \frac{\text{earnings available to common, year } j}{\text{net worth as of beginning of year } j + 1} \right). \]

Rate of return is expressed in terms of a value relative in order that negative profits may be included in a geometric average.

STOCK MARKET DEFINITION. For each firm i,

\[ R_S = \left( \frac{\text{value of stock at end of year } j + \text{dividends of year } j}{\text{value of stock at beginning of year } j} \right). \]

TEMPORAL AVERAGE. Historical volatility for each firm is measured over time. The measure of return based on accounting or stock market data also will be measured as a temporal average of the yearly return figures. Fisher and Hall used an arithmetic average as their basic return variable, but they were incorrect for two reasons. They were regressing arithmetic mean against variance. However, these two variables have a correlation proportional to the third moment (skewness) which has nothing to do with risk-return equilibrium. Our study uses an estimate of volatility rather than variance as the risk measure for the individual firm. The use of an arithmetic average of return still would be misleading since greater weight is given to positive than to negative returns.

Market Index

Volatility, the measure of risk used here, is estimated for each firm by regressing yearly firm returns against a market index. Of the many indices of market performance and of the economy, which best will approximate the concept of the market portfolio? Michael Jensen used the Standard and Poor's 500 composite index, which is a value weighted index of 500 of the largest companies on the New York
62 CAFM and Measurement of Risk

Stock Exchange. (However, prior to 1 March 1957 it was based on
only 90 securities.)

The problem of choice of an appropriate index is complicated by
the fact that accounting data are used in this study. Consistency of
accounting definition is important. To the extent that an index is
imperfect the effect of systematic risk will be understated. As a solu-
tion to these problems, weighted indices of accounting and stock
market return were calculated over the sample of firms available on
the Computstat tape. They should be as representative as others avail-
able, and their use eliminates a problem of definitional consistency.
These market indices were calculated as follows for each year $j$
over the $N$ firms.

**Accounting Data.**

$$RP_{wi} = \frac{1}{N} \sum_{i=1}^{N} WP_{i} W_{i}$$

where $W_{i} = \frac{\text{net worth, firm } i, \text{ beginning of year } j}{\text{total net worth, all companies, beginning of year } j}$

The average return of the index based on accounting data is

$$\bar{RP}_{w} = \frac{1}{T} \sum_{j=1}^{T} RP_{w_{j}}$$

where $T$ is the number of years.

**Stock Market.**

$$RS_{i} = \frac{1}{N} \sum_{i=1}^{N} KS_{i} X_{i}$$

where $X_{i} = \frac{\text{value of stock, firm } i, \text{ beginning of year } j}{\text{value of stock, all firms, beginning of year } j}$

and the average stock return is

$$\bar{RS}_{w} = \frac{1}{T} \sum_{j=1}^{T} RS_{w_{j}}$$

Table 4 presents the values of the market index defined in terms of

J. Fred Weston and Michael F. Dunn 63 accounting data and stock return data for each of the ten years. The
stock return index clearly has varied more during the ten-year period.
The variance of stock market return is 6.1 percent as opposed to 1.4
percent for the accounting return index. Because of the relative
lack of variation the accounting index mean return is the same as the
geometric average return. In the case of the stock return index with
more variation, the arithmetic mean is almost 2 percent above the
geometric return, which indicates that the use of the geometric mean
is significant and of more than theoretical interest.

**TABLE 4. The Market Index, Annually Compounded**

<table>
<thead>
<tr>
<th>Year</th>
<th>Accounting Definition</th>
<th>Stock Return Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1957</td>
<td>1.123</td>
<td>0.879</td>
</tr>
<tr>
<td>1958</td>
<td>1.152</td>
<td>1.629</td>
</tr>
<tr>
<td>1959</td>
<td>1.102</td>
<td>1.237</td>
</tr>
<tr>
<td>1960</td>
<td>1.100</td>
<td>0.987</td>
</tr>
<tr>
<td>1961</td>
<td>1.092</td>
<td>1.311</td>
</tr>
<tr>
<td>1962</td>
<td>1.080</td>
<td>0.838</td>
</tr>
<tr>
<td>1963</td>
<td>1.104</td>
<td>1.183</td>
</tr>
<tr>
<td>1964</td>
<td>1.114</td>
<td>1.183</td>
</tr>
<tr>
<td>1965</td>
<td>1.129</td>
<td>1.380</td>
</tr>
<tr>
<td>1966</td>
<td>1.133</td>
<td>0.907</td>
</tr>
</tbody>
</table>

**Mean**

1.110 1.147

**Variance**

0.014 0.061

**Geometric average**

1.110 1.128

Measurement of Volatility

**Accounting Definition.** The estimate of volatility is the regres-
sion coefficient of the firm’s compounded return on net worth re-
gressed against the market index over time.25

$$\beta_{p_{i}} = \frac{1}{T} \sum_{j=1}^{T} (RP_{w_{j}} - \bar{RP}_{w})(RP_{i_{j}} - \bar{RP}_{i_{j}})$$

$$\sum_{j=1}^{T} (RP_{w_{j}} - \bar{RP}_{w})^2$$

where $T$ equals ten years. The intercept term is also calculated as

$$\alpha_{p} = \bar{RP} - \beta_{p} \bar{RP}_{w}$$

The use of an historical measure of systematic risk implies that investors correctly forecasted the relationship between each firm and the market. The most obvious way in which they may have done this is by expecting past relationships to continue into the future. Jensen has found that the historical systematic risk measure based on stock market returns is stable over time for mutual funds. Is the same true of individual firms using profit data? To answer this question the slope coefficient between each firm and the market was calculated over the two five-year time periods used in the study. \( \hat{\beta}_1 \) refers to the systematic risk coefficient calculated over the years 1957-1961; \( \hat{\beta}_2 \) stands for the coefficient for years 1962-1966. These measures are calculated at \( \hat{\beta}_1 \) and \( \hat{\beta}_2 \) and differ only in the time period covered. \( \hat{R}_f \) and \( \hat{R}_{mf} \) are, of course, recomputed over these five-year sub-periods.

**Stock Market Definition.** Systematic risk is measured in a manner similar to that already discussed for accounting data,

\[
\hat{\beta}_s = \frac{\sum_{t=1}^{T} (R_{S,t} - \hat{R}_{S}) (R_{S,t} - \hat{R}_{S})}{\sum_{t=1}^{T} (R_{S,t} - \hat{R}_{S})^2}
\]

\( T \) equals ten years. The intercept term is

\( \hat{a}_s = \hat{R}_{S} - \hat{\beta}_s \hat{R}_{S} \).

\( \hat{\beta}_s \) covers the ten-year period 1957-1966. \( \hat{\beta}_1 \) and \( \hat{\beta}_2 \) cover the component five-year periods. The respective characteristic models for each firm for accounting and stock return are:

\( \hat{R}_f = \hat{a}_f + \hat{\beta}_f \hat{R}_{mf} \); and

\( \hat{R}_s = \hat{a}_s + \hat{\beta}_s \hat{R}_{S} \).

**The Market Line**

The ex ante relationships of the CAPM may be restated:

\[
E(r_s) - \hat{R}_s = \left( \frac{E(R_m) - \hat{R}_s}{\sigma^2(R_m)} \right) \text{ Cov}(R_s, R_m),
\]

or

\[
E(R_s) = \hat{R}_s + \hat{\beta}_s \hat{R}_f.
\]

The market line is the locus of points \((E(R_s), \hat{\beta}_s)\) described by (4).

This may be estimated ex post. The yield to maturity on ten-year government bonds as of January 1957 was about 3.4 percent. This may represent the risk free rate. Let \( \hat{R}_m \) be the geometric average annual return of the market index. The market line will pass through the risk free rate and the average market return which is associated with a volatility of 1, by definition. The slope of the market line then will be:

\[
\lambda = \hat{R}_m - \hat{R}_f.
\]

\[\text{Figure 1}\]

**The Market Line**

A primary factor in selection of the ten-year period 1957-1966 was data availability. What would be the implications of a shorter or longer time period? Jensen has proved that the expected value of the estimate of volatility is independent of the length of the time period if it is assumed that the market horizon is instantaneous.\(^\text{29}\) This condition is adequately met if there are large numbers of investors and if the market is continually in equilibrium. Sampling error could be reduced if more data points were available over the same time period, for example, if monthly data were available. However, no bias is introduced by use of the annual data.

**Empirical Results**

**ACCOUNTING Definition of Return.** Characteristic coefficients, \( \hat{\mu}_s \) and \( \hat{\mu}_m \), were estimated for all firms in the sample. The average value of \( \hat{\mu}_m \) was 3.4, which is very close to 3.0. Since return of the market index is a weighted average of individual firm returns,
this is reasonable. The geometric average return for each firm, \( \bar{R}_g \), also was estimated over the ten-year period. The average geometric average annual return is 1.110 or 11.0 percent for all firms. The standard deviation of geometric return over the sample of firms was 6.5 percent.

Figure 2 plots return against risk over the 630 firms. The market line was constructed by drawing a straight line through the risk-free rate, \( r_f \), and the market combination. The market line joins the risk-free rate of 1.034 and the market combination, which has a return of 1.110. Before discussing the implications and possible application of these results, the underlying empirical assumptions should be examined. If the estimate of volatility over the ten-year period is to be accepted, then it must have temporal stability. Ball and Brown assumed this, but did not test it. In our study, volatility was estimated over both halves of the ten-year period; \( \hat{\sigma} \) is the estimate for 1957–1961, \( \sigma_d \) represents volatility for 1962–1966. The two slope coefficients have a correlation of 0.9, which may be compared to Jensen’s test of stability for mutual funds. The slope coefficients of the two subperiods had a correlation of 0.9 in Jensen’s study.27

An additional test was made to aid judgment of the adequacy of the model as specified. It will be remembered that an index model was assumed above, and it will be carried over into the empirical work:

\[
R_i = \alpha + \beta R_m + \epsilon_i \quad i = 1, 2, \ldots, N. \tag{2}
\]

The following assumptions are necessary for inclusion of the index model into the CAPM:

\[
E(\epsilon_i) = 0 \quad i = 1, 2, \ldots, N; \]
\[
\text{Cov}(\epsilon_i, \epsilon_j) = 0 \quad i, j = 1, 2, \ldots, N; \text{ and}
\]
\[
\text{Cov}(\epsilon_i, R_m) = 0 \quad i = 1, 2, \ldots, N.
\]

It is desirable to test whether the data are consistent with this set of assumptions. If the sample size were much smaller it would be practical to plot the residuals against time and the market. Several problems could be detected by this, should they be present. The variance of the residuals may not be constant over time or over \( R_m \).

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27Ibid., p. 216.
If this were true, ordinary least squares should be replaced by weighted least squares. Linear or quadratic terms in time or other variables possibly should be included if the model is to be well specified.

This project involves the estimation of 1,540 separate regressions over the ten-year period, and 2,480 regressions over the five-year periods. A detailed individual analysis of the residuals is not practical. Rather than neglect potential problems of specification completely, the Durbin-Watson statistic has been calculated for the ten-year regressions for each firm. It will indicate a significant first order autoregressive relationship among the residuals, should one exist.

\[
\text{DWS} = \frac{10}{10} \sum_{t=2}^{10} (\epsilon_t - \epsilon_{t-1})^2 - \sum_{t=1}^{10} \epsilon_t^2
\]

An economic interpretation of autocorrelation is that firm returns are not linearly related to the market. When reported for the regression using profit data this statistic will be called DWSP. For a sample size of 10 with one independent variable, a DWS of less than 1.06 implies autocorrelation significant at the .05 level. The value of DWS at the .01 significance level is .75. To summarize the incidence of autocorrelation, using accounting data of 630 firms, 288 have average values of DWSP less than 1.06, indicating widespread autocorrelation of the residuals, and 28 firms have values of DWSP significant at the .01 level.

**Stock Market Returns.** The results of this study as discussed to this point create some reservations about the specification of the capital asset pricing model as applied to accounting data. To enable comparison, similar tests have been performed using stock market returns in wealth relative form as the basic return variable. A comparison of the results obtained using accounting and stock market data may indicate the usefulness of accounting data for evaluating risk-return relationships. If it is found that volatility as measured on accounting data is closely related to volatility based on stock return.

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data. Then it may be concluded that accounting data are accurately reflecting risk. A poor relationship between the two measures of volatility would lead to the rejection of accounting-based risk measures.

Before comparing accounting and stock market variables directly, risk and return based on the stock market variables will be discussed. Specification of the capital asset pricing model will be examined over this sample, and the relationships between alternative definitions of each of the relevant variables then will be examined.

Geometric average return to stockholders was 1.125 or 12.5 percent for the ten-year period when measured at an annually compounded rate. The standard deviation of the annually compounded rate over all firms was 10.2 percent. Figure 3 is a computer plot of the relationship between $\bar{R}_S$ and $\beta_S$. It is not surprising that Figure 3 reveals somewhat more dispersion around the market line than Jensen found in his mutual fund study. Investors may make nonsystematic errors in the evaluation of individual firms; the law of large numbers would imply that portfolios would be less prone to these errors.

As in the case of return measured on accounting data, the specification of the model in terms of stock market data will now be examined. An assumption of stability of systematic risk over time is necessary to measure it over time, is an empirical study must. Jensen found a correlation between volatility of $\bar{R}_S$ over two periods. This study, using accounting profit data, found a correlation of .99; $\beta_S$ and $\beta_A$ have a correlation of .96, virtually identical with what Jensen found.

The Durbin-Watson statistic indicates much less autocorrelation of the residuals around the estimates of the characteristic line when stock market returns are used than when the accounting definition is followed. Of the 630 firms, 55 have average values of DWSW which indicate autocorrelation at a significance level of .05. Only 22 firms have values of DWSS which indicate significant autocorrelation at the .01 level. Even should no autoregressive process be at work, we could expect this test to incorrectly indicate autocorrelation in 5 percent of the firms, or 31 for a sample of 630.

In general, the capital asset pricing model appears to be much

\footnote{The regression equation estimated over these data was: \( \bar{R}_S = 1.009 + 0.01\beta_S \).}

\footnote{Jensen, "Risk," p. 229.}
better specified over stock return data than over accounting data. In order to further evaluate the usefulness of accounting data, the accounting based variables are related to the stock return variables over all firms. $\beta_A$ and $\beta_P$ have a correlation of .125, indicating a high degree of independence between stock return volatility and accounting return volatility. With respect to statistical tests of the relationship of $\beta_A$ to $\beta_P$, if the correlation coefficient is very small, the significance of the relationship is not important. The question is not whether there is any significant relationship between the two, but whether $\beta_P$ adequately reflects $\beta_A$. The low correlation implies it does not. Since stock return volatility is highly stable over time and profit return volatility is moderately stable, a systematic distortion appears to be introduced by the accounting process.

The average return variables are much more closely related – the correlation is .42. The stock return figures are generally higher than accounting return. Risting expectations in the stock market and increasing investment with accelerated depreciation reducing reported income are two possible reasons for the results.

The observed persistent differences between the estimates of volatility suggest further consideration of the rationale behind the accounting model. The results indicate that firm profit-earnings ratios are not even approximately stable over time, if they were, one would expect the two estimates of volatility to be more similar because of the relationship:

market price = earnings per share \( \cdot \) price earnings ratio.

Earnings are the volatile part of the accounting return variable. Perhaps the interpretation of the basis of volatility as the elasticity of product demand with respect to GNP changes is incorrect. The real source of firm volatility is probably the elasticity of a firm’s expected return with respect to changes in expectations for the economy as a whole.

Industry Risk and Return

There are several reasons why industry data are relevant. Many policy decisions by government agencies involve analysis of industry risk and return. The purpose of the Fisher and Hall study was to compare aerospace risk and return to other industries as an aid to formulation of government procurement policies.\(^{31}\) Conrad and Plotkin and

\(^{31}\)Fisher and Hall, Risk.

Cappers were interested in the risk and return of the drug and insurance industries relative to others.\(^{32}\) Much work has been done investigating the cost of capital to public utilities with and without a formal treatment of risk. It would be useful for regulatory purposes to be able to compare utility risk and return to averages in other industries.

Conrad and Plotkin have argued that the individual firm is too small a unit to use as a basis for a risk return study. They say results may be affected by luck or inertia. Companies may tend to smooth their reported performances over time. Expressed another way, in light of the capital asset pricing model, data for individual companies will include both systematic and nonsystematic components, and the consideration of industry portfolios will tend to indicate the systematic industry relationship with the market index with nonsystematic disturbances tending to cancel each other. This might mean, for example, that industry volatility may have greater temporal stability than that of individual firms.

Choice of Industries

To reflect the portfolio possibilities of industries, only industries which contain some minimum number of firms are arbitrary. The total number of industries is 101. Some of these consist of only one or two firms. Use of ten firms as a cutoff provided fifteen industries. Use of six or more firms gave forty. We compiled data on both groups.

Accounting Definition of Return

Table 5 and Figure 4 present ex post accounting returns related to the estimates of systematic risk. The dispersion around the market line has been greatly reduced. The range of industry average systematic risk is from –1.104 for cosmetics to 4.023 for air transport. Table 5 includes industry risk and return figures for the forty industries based on accounting data with rate of return in annually compounded form. The range of return is from about 0.45 for canned foods to about 1.80 for drugs. A comparison of these values with those for individual firms implies that many of the firms with extreme risk and return figures were not representative of systematic industry factors. No inference is drawn from the fact that in Figure 4 eleven of the fifteen industries are above the market line; the distribution of

\(^{32}\)Conrad and Plotkin, "Risk/Return", Prices and Profits.
The measures of volatility over the five-year periods for the forty industries have a correlation of .41 as compared to a coefficient of .59 over individual firms. For the fifteen industries the correlation between the two five-year estimates of volatility is only .35. Judging by results alone and ignoring autocorrelation, stationarity, and the relationship to stock return volatility, the results are not inconsistent with reasonable expectations. Food, beverage, tobacco, textiles, and retail industries all show volatility estimates of less than 1.0, which is the average of all firms. Home furnishings, various machinery areas, radio and television, and other durable goods have higher than average volatility except for specialty machinery, which is dominated by the results of one company, Brunswick Corporation. The industry figures for accounting volatility do not appear to be unreasonable.

Stock Market Definition of Return

Table 6 and Figure 5 present industry risk and return estimates. The dispersion of industry risk and return is much reduced from that of individual firms. Figure 6 shows that temporal stability is much higher when volatility is measured over stock returns for the forty industries than when the accounting definition is used. The correlation coefficient is .56 over individual firms using stock market returns. This is improved to .59 for industry averages. As in the case of data over individual firms, industry risk appears to be much more stable over time when it is measured as volatility of stock returns. The fifteen-industry subset shows similar results.

The capital asset pricing model appears to be well specified over stock return data. It has been observed that the accounting return estimates of volatility presented in Table 5 appear to be reasonable. How comparable are the accounting and stock return results for industries? Our data indicate that volatility estimates for the ten years and each of the five-year subperiods are closely related. Consequently, and because of the autocorrelation present in the accounting returns of individual firms, and the high temporal stability of industry stock return volatility, an estimate of industry risk based on volatility of accounting returns cannot be accepted.
TABLE 6. Industry Average Risk and Return for Stock Return Data

<table>
<thead>
<tr>
<th>Industries</th>
<th>Code</th>
<th>Exp R</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Six to Nine Firms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metals, miscellaneous</td>
<td>2000</td>
<td>1.356</td>
<td>1.2</td>
</tr>
<tr>
<td>Oil, crude</td>
<td>1311</td>
<td>1.176</td>
<td>0.94</td>
</tr>
<tr>
<td>Packaged foods</td>
<td>2000</td>
<td>1.284</td>
<td>1.276</td>
</tr>
<tr>
<td>Canned foods</td>
<td>3030</td>
<td>1.308</td>
<td>1.411</td>
</tr>
<tr>
<td>Beverages, beverages</td>
<td>2082</td>
<td>1.520</td>
<td>0.445</td>
</tr>
<tr>
<td>Fabrics, slubbers</td>
<td>1095</td>
<td>1.317</td>
<td>1.334</td>
</tr>
<tr>
<td>Tobacco, cigarette</td>
<td>9111</td>
<td>1.114</td>
<td>0.744</td>
</tr>
<tr>
<td>House furnishings</td>
<td>2210</td>
<td>1.116</td>
<td>1.278</td>
</tr>
<tr>
<td>Cosmetics</td>
<td>8444</td>
<td>1.200</td>
<td>0.857</td>
</tr>
<tr>
<td>Oil, integrated international</td>
<td>2913</td>
<td>1.380</td>
<td>0.356</td>
</tr>
<tr>
<td>Building materials, openings</td>
<td>2900</td>
<td>1.093</td>
<td>0.973</td>
</tr>
<tr>
<td>Tires and rubber goods</td>
<td>3000</td>
<td>1.138</td>
<td>1.281</td>
</tr>
<tr>
<td>Tires</td>
<td>3141</td>
<td>1.067</td>
<td>0.630</td>
</tr>
<tr>
<td>Containers</td>
<td>3321</td>
<td>1.116</td>
<td>0.869</td>
</tr>
<tr>
<td>Building materials, cement</td>
<td>3231</td>
<td>0.957</td>
<td>0.949</td>
</tr>
<tr>
<td>Copper</td>
<td>3431</td>
<td>1.069</td>
<td>1.235</td>
</tr>
<tr>
<td>Machinery, metal fabricated</td>
<td>3400</td>
<td>1.172</td>
<td>1.213</td>
</tr>
<tr>
<td>Building materials, brick</td>
<td>3420</td>
<td>1.314</td>
<td>1.024</td>
</tr>
<tr>
<td>Machinery, construction</td>
<td>3531</td>
<td>1.079</td>
<td>1.415</td>
</tr>
<tr>
<td>Machine tools</td>
<td>3540</td>
<td>1.004</td>
<td>1.297</td>
</tr>
<tr>
<td>Electrical equipment</td>
<td>3610</td>
<td>1.149</td>
<td>0.754</td>
</tr>
<tr>
<td>Radio and TV</td>
<td>3650</td>
<td>1.264</td>
<td>1.703</td>
</tr>
<tr>
<td>Electronics</td>
<td>4070</td>
<td>1.278</td>
<td>1.450</td>
</tr>
<tr>
<td>Railroad equipment</td>
<td>3740</td>
<td>1.118</td>
<td>0.990</td>
</tr>
<tr>
<td>Retail, variety</td>
<td>5331</td>
<td>1.126</td>
<td>1.041</td>
</tr>
</tbody>
</table>

Ten to More Firms

Textile products                 | 2280 | 1.165 | 1.097 |
| Paper                          | 2600 | 1.094 | 0.973 |
| Printing, publishing           | 2700 | 1.286 | 0.944 |
| Chemicals                      | 2660 | 1.032 | 0.910 |
| Drugs                          | 2820 | 1.323 | 0.912 |
| Oil, integrated domestic       | 4912 | 1.106 | 0.938 |
| Steel                          | 3310 | 1.030 | 1.436 |
| Machinery, office equipment    | 3290 | 1.217 | 1.275 |
| Machinery, industrial          | 3250 | 1.098 | 1.243 |
| Office and business equipment  | 3570 | 1.240 | 0.963 |
| Auto parts and accessories     | 3714 | 1.095 | 0.958 |
| Aerospace                      | 3721 | 1.395 | 0.998 |
| Air transport                  | 4511 | 1.311 | 1.171 |
| Retail, department stores      | 5341 | 1.196 | 1.041 |
| Retail, food chains            | 5411 | 1.085 | 0.792 |

Summary and Implications

This paper has sought to investigate the nature of business risk and its relationship to rate of return within the framework of the capital asset pricing model. Previous studies have been based on an inadequate conceptual framework. The variance of return, either spatially or temporally estimated, is not the appropriate measure of firm risk. Previous studies failed to recognize that a firm’s variance is only in part reflected in investor risk. Investors may diversify and eliminate the portion of firm variance not systematically related to variance of the overall market portfolio. Firm risk is therefore systematic risk.

However, the first challenge which the model might face from an empirical standpoint is the question of the considerable dispersion of individual firm and industry results around the market line. We should expect such deviations. Neither firms nor industries would be expected to be in theory efficient portfolios. Inefficient portfolios are not perfectly correlated with the market; hence, deviations from the market line would be expected to occur. This is reflected by the error term in equation (2). While the capital markets are moving continuously toward equilibrium, the adjustment process for achieving equilibrium in the factor and product markets is of long duration.

In general, unexpected performance, either superior or inferior, by individual firms could result in deviations around the market line. This is because both anticipated returns and betas could have been incorrectly forecasted. Although the market is in general moving toward equilibrium, at any point in time there could be considerable departures from equilibrium. The fact that a given firm or industry is above or below the market line at any point provides no basis for predicting that it will continue to be above or below the line in the future. Whatever the forces that caused the individual firm or industry to be above or below the line historically, if systematic in their influence, they may be taken into account in the expectations of investors. If incorrectly anticipated for the future, then for future time periods theory would predict movement toward the market line.

When applied to a proxy model of the CAPM, a number of questions arise in connection with the applicability of the CAPM. These are (1) bankruptcy costs, (2) managerial preferences, (3) necessary level of returns for resource flows, and (4) rewards for efficiency. If the costs of bankruptcy are substantial, will this affect the measurement of business risk? It might be argued that if the costs of bankruptcy are substantial, the measurement of risks of individual
firms should take variance into account as well as systematic risk as defined by the CAPM. However, the more basic question is whether investors would require a premium for holding the shares of a high variance firm because of the risk of bankruptcy. The Sharpe model implies that they would not. High variance investments which are not systematically related to the market portfolio may be held by the individual investor as part of an efficiently diversified portfolio. These high variance investments will contribute little to the variance of the investor's portfolio. The cost of bankruptcy would be reflected by its effect on expected return should the probability of failure be high. Given limited liability for common stockholders, the most an equity investor can lose is the value of his common shares. From the standpoint of the equity markets, resources would continue to be attracted to a firm, regardless of variance of returns, if the expected return-beta combination was on or above the market line.

A second consideration is managerial attitudes toward risk. Managerial reputations are damaged by bankruptcy. Managers, other things being equal, would prefer to avoid situations in which their performance record is tarnished. Should such managerial preferences affect the operation of the CAPM? There are many factors which make managerial positions more or less desirable. These all are reflected in the market clearing wage necessary to adjust the supply and demand for managerial positions. Factors which represent negative utilities to managers will shift their supply function and affect their compensation. But this does not require that investors receive a higher return, nor does it suggest that investors will require a premium for variance that can be eliminated by diversification. Hence, managerial preferences should not affect either the capital market line nor systematic risk.

Third, suppose that the characteristic line for a firm indicates a low beta and therefore the capital market line implies a low rate of return. We postulate further that this indicated return does not cover the marginal value productivity of capital in such activities. If this were true in any point of time, it would indicate disequilibrium in the factor and product markets, which would imply that resources would and should leave the firm. Consumers have higher values, alternatives elsewhere. The fundamental consideration here is that it is the financial markets that determine the flow of financial resources. If there existed betas close to zero (or in fact less than zero indicating low or negative returns) there would be other securities whose betas and returns were sufficiently higher to result in the observed return on the market portfolio.

With regard to the application of the CAPM to regulated industries, a potential objection is that the CAPM would be inapplicable because it utilizes market data. It has been generally recognized that regulation cannot directly use stock market data because stock prices would reflect returns set by regulatory decisions. We have found that accounting data do not convey risk information well and have concluded that they should not be used in the measurement of risk and its relationship to capital cost. How may this conflict be resolved? The apparent answer is that the CAPM has strong implications for regulatory rate setting but that it has not reduced that process to a purely mechanistic one.

Regulators should estimate an ex ante market line, that is, estimate the risk free rate and the expected market return for the period under consideration. We have found that \( \beta \), the estimate of systematic risk, has been stable over time for firms on the average. If an historical estimate of beta is substituted into the ex ante market line, an estimate of capital cost may be obtained. This estimate provides only a first approximation to a determination. For example, the treatment of managerial efficiency is an important consideration. Since the CAPM analyzes the relationship between return and risk, it does not explicitly deal with efficiency. How differential efficiency might be taken into account in the application of the CAPM by regulators is not readily indicated by the present stages of development of the theory.

The index model implies that individual firm returns will vary around the market line due to nonsystematic risk. The rate of return implied by the market line is therefore only a target rate. Also, the product and factor markets adjust much more slowly than the capital markets. Disequilibrium returns play an essential role in the allocation of resources, which regulators also must consider.
Social Risk, Political Uncertainty, and the Legitimacy of Private Profit

Kenneth E. Boulding

The question of legitimacy of private profit is part of the larger problem of the legitimacy of what in general might be called nonlabor income, a problem which has haunted economists from the very beginning of economic thought. We find it, for example, in medieval doctrines of usury, which go back, of course, to the very ancient prohibitions of the Pentateuch. Upon the distinction made in Deut. 23:20, "Unto a strange: thou mayest lend upon usury; but unto thy brother thou shalt not lend upon usury," was founded an important part of the medieval economy. The general doctrine of the Church was that a Christian could not lend at interest to another Christian, but it was acceptable for a Jew to do so. Indeed, few institutions other than prostitution seem to be so universally useful and yet so extraordinarily hard to legitimate.

Adam Smith, perhaps quite incidentally, laid a foundation for the Marxist rejection of the legitimacy of nonlabor income when he conceived of labor as the originator of all product, and regarded, in effect, nonlabor income = rent, interest, and profit — as deductions from the total product, necessitated by the institutions of society, especially, of course, the institution of property. It is a short step from this to Marx's theory of surplus value, which can be put very simply in a single sentence: Labor produces everything, but labor receives only its subsistence, which is only a proportion of the total product. Hence, nonlabor income must be a result of exploitation. This doctrine has exercised an enormous influence on the imagination of mankind, for good or ill, and we still have by no means seen the end of it. The stock exchange building in Leningrad is now a Palace of Culture and Rest, or something like it; and although there may be some signs that the socialist and capitalist worlds are gingerly approaching each other, there is a marked difference between these two kinds of societies, resting primarily on the degree of legitimacy which is given to the private ownership of capital and to private nonlabor income.

The "labor produces everything" tradition is so strong in economies that most efforts to provide for the legitimation of nonlabor income try to relate it to some form of human activity. Thus property income is justified as the reward of saving or "abstinence," as Nassau Senior called it. The activity, if such it can be called, is that of consuming less than one produces so that there is an addition to the total stock of goods. This idea certainly goes as far back as John Locke in modern thought.

There actually is very little discussion of this problem in either Adam Smith or David Ricardo, neither of whom seriously questioned the institution of private property, either in land or in other goods. It would not be difficult, however, to infer a justification of private property from Adam Smith, although he has a certain prejudice in favor of labor income; of the three "ranks" of society, he likes the capitalists least. Adam Smith's greatest contribution was to show how society developed through exchange rather than through threats and coercion, and exchange, of course, would be impossible unless there were property in the things exchanged. Of course, the property does not have to be private. Nevertheless, the whole principle of natural liberty and the "Invisible Hand" suggests that, unless property is largely private, the reward structure in society will not permit efficient allocation of resources and rapid development. There is, furthermore, a very interesting passage in *The Theory of Moral Sentiments*, which is the first use of the term "Invisible Hand," in which the Invisible Hand itself is regarded mainly as an agency for distributing income much more equally than political power or private property are distributed. Thus, Smith points out, although a powerful chief may, in theory, own all the produce of his society, he has to distribute this produce moderately equally among the members of the society simply to keep them alive and to keep the society from falling apart.

The Marxist criticism of nonlabor income has a sufficient emotional and political appeal so that after Marx objective study of this problem became very difficult. The Marxists and the non-Marxists
deal of stress on the difference between risk, which was in principle insurable, and uncertainty, which was not. He also argued that there was a function or activity in society of uncertainty bearing, which could only be borne by the owners of capital simply because it was the value of capital that we were uncertain about. Hence, profit was necessary as a reward or inducement to persuade people to carry out this function, just as interest is supposed to be a reward or inducement to persuade people to carry out the function of saving, wages the reward of labor, and so on.

We perhaps should note here the peculiar position in economic theory of rent, which really is a kind of reward for good luck. The luck is that of owning a specific factor of production which is responsible for, or at least permits a veto upon, some activity in the fortunate position of having a lower cost per unit than the supply price. Rent always has been the least defensible form of unearned income, and it is not surprising that the Ricardian theory of rent eventually produced Henry George, who advocated the expropriation of all economic rent. Most economists are agreed that economic rent is an ideal subject for taxation and that the state can capture it, if it can find it, without doing any damage to the productive activity of the society. The snag, of course, lies in the phrase "if it can find it," for, unfortunately, economic rents are by no means easy to identify, especially in a complicated legal structure.

The two notions of profit as related to uncertainty and rent as related to luck are more closely related than most economists have observed. The rewards of uncertainty are not wholly dissimilar from those of gambling; those investors with the good luck to make the right investments receive high profits, and those with the bad luck to make bad investments receive low or frequently negative profits. The question as to whether there is a "supply price" of uncertainty is very interesting, but is also very hard to answer. There seems to be a certain paradox in the gambling industry this supply price is clearly negative, that is, gamblers obviously find uncertainty a positive pleasure and are willing to make long-run sacrifices in order to enjoy this uncertainty. The principal product of the gambling industry is hope, which evidently is an experience pleasant enough to induce people to pay more than the expected value of a lottery ticket or other chance in order to indulge themselves in agreeable daydreaming. On the other hand, in the case of more sober investments of an uncertain nature, we usually assume that investors are negative gamblers and that, unless the average reward is in some sense greater
than the expected value of the activity, the activity will not be performed.

The puzzle is quite a real one, and I know of no serious attempt to resolve it. If we look at the British case in the nineteenth century, for example, the average rate of return on foreign investment does seem to have been very slightly larger than the rate of return on domestic investment, which presumably was less risky, suggesting indeed that there is an uncertainty premium. This can be visualized as a kind of uncertainty discount, similar to the time discount involved in pure interest, although in any actual case the separation between these two is somewhat arbitrary. At a seminar at the Standard Oil Company, I do recall discovering a very simple rule of thumb which revealed the preferences of the top decision makers of the company. Projects were evaluated mainly on their expected rate of return, and I deduced both from the financial expertise and from certain questions to members of the board of directors that a project which proposes to pay 6 percent in Texas had a fair chance of being accepted. The project, however, would have to have an expected return of over 30 percent in Venezuela and about 85 percent in Indonesia. My discovery was made fifteen or twenty years ago, and I am not sure what the corresponding rates would be now, but I would be surprised if they were very different. The unwillingness of investors to invest in uncertain ventures unless they bear a high anticipated rate of return reflects in part, of course, a kind of insurance premium, that is, risk in the Knightian sense, but it also may reflect an uncertainty discount which is in a way a payment for worry. We could, with Adam Smith, regard the payment for worry as a payment for the labor of the capitalist (tall and troubled) rather than for the employment of the capital itself, but this may not be a very important distinction.

The socialist controversy may resolve a good deal more than is usually recognized around how much luck there should be in a society. The pressure of equality is also a pressure against randomness. In a society with unequal incomes, the rich, on the whole, are those who are lucky; the poor are those who are unlucky, even if the luck merely involves the accident of having rich parents. In an egalitarian society, everyone knows more or less what his fate is going to be. In a nonegalitarian society a man's position, whether of wealth or of power, depends on a mixture of merit and luck, which may have variable proportions in different societies. The legitimacy of the different types of societies may depend in no small measure on the degree to which people evaluate these two components. A society in which everyone receives what he deserves surely would be unspeakably horrible; similarly, a society in which rewards are completely random would be equally unacceptable. If there is a mix of the two, at least we can blame our low rewards on bad luck and attribute our high rewards to superior merits!

A somewhat different set of considerations, which is highly relevant to the problem of the legitimacy of noninhor income and the whole controversy between public and private enterprise, relates to the role of the price structure in decision making and allocation, a complex range of problems surrounding externalities of all kinds, and the distinction between public goods and private goods. This phase of the argument begins, perhaps, with the famous controversy which originated with Enrico Barone and Ludwig von Mises, with Oscar Lange later on the other side. The question was whether socialist societies would find it impossible to develop a rational price structure, and hence would run into severe misallocations of resources.

This particular controversy has resulted in something of a draw. It is clear that socialist societies experience severe problems of this kind, but so do capitalist societies. There certainly is a nonexistence theorem about centrally planned economies, for they do exist, regardless of how clumsy and heavy-footed they may be. Nevertheless, the problems raised by this controversy are extremely important, and they have gained new life and taken a somewhat new turn because of the enormous interest which has been aroused recently regarding pollution, deterioration of environments, and exhaustion of resources. We seemed to have realized quite suddenly, with rather peculiar intensity, that processes of production produce "bads" as well as goods, and that the pricing system in all societies, whether capitalist or socialist, is prone to the underpricing of goods, that is, negative commodities. Consequently, the processes of production are distorted toward those which produce too large a proportion of goods per good.

A general conclusion seems to be emerging: There is an important distinction between public goods and goods on the one hand and private goods and bads on the other. Furthermore, private goods and bads, in the absence of externalities, are supplied and rewarded, or reduced and penalized, very effectively by private property in private markets. However, these need to be supplemented and constrained by public organization and provision of public goods, the diminution of public bads, such as pollution, and the development of a public reward system, positive or negative, especially through
It is hard to evaluate the effect of these certainty substitutes, as we might call them. In some cases, they may be beneficial in cheering people up and giving them the capacity to make any kind of decisions at all. One of the real dangers of uncertainty is that, if it is too extreme, it may produce a kind of inertia, withdrawal, and an unwillingness to make any commitments and decisions, which may be just as disastrous as overcommitment. On the other hand, in certain illusions, as we have seen, may lead to quite disastrous decisions through overconfidence, and a lack of liquidity and flexibility. The more distant the future, of course, the more uncertain it is; plans and policies which relate to the distant future are peculiarly subject to the diseases of uncertainty. We see this particularly in current discussions about policy toward pollution and exhaustion of resources. How far should present policy, for example, be directed toward possible future exhaustion of fuels and ores? This is an extremely difficult question because the amount of unused resources at the moment is a function of the past accumulation of knowledge. In the last two hundred years we probably have been creating resources faster than we have been using them up, simply through the processes of increased knowledge and continued discovery. It is clear, however, that the earth is ultimately a limited spaceship and that we cannot go on burning it up indefinitely. At some time in the future we will have to fall back on the recycling of all materials and on the input of energy from the sun. Just how far we should anticipate the transition into a fuelless and oreless earth, or even how far, is one of the difficult questions, simply because the future of knowledge, which is the crucial variable, cannot be predicted. In this case, to predict is to anticipate; if we could predict what we are going to know in the future we would know it now.

The reader may be wondering whether these rambling considerations have to do with public utilities. Perhaps the answer is "not very much," but there are at least some common concerns which may not be immediately apparent. Public utilities are a rather odd sector of the economy, certainly not as peculiar as political as defense, education, or health, but still an area with substantial peculiarities and problems. It is a segment in which the risks of enterprise have been to a substantial extent diminished by social organization, so that random price fluctuations have been largely eliminated and rates of return therefore are relatively stable and rather low. This condition is reflected in Figure 1, which shows the remarkable stability of the prices of public utility stocks by comparison with others. Here we
have an interesting case of the social diminution of risk, with consequent apparent diminution in profit.

Agriculture, incidentally, is another interesting segment of the economy in which the risks of price fluctuation have been diminished substantially by public intervention through price supports, an intervention apparently motivated by a desire to increase returns in an industry in which they were regarded as too low. The resulting diminution in uncertainty, however, enormously stimulated investment and technical change. What started off as a program for social justice has, in fact, squeezed the poor farmer out of agriculture into the urban ghettos and has subordinated the rich, it also has produced, in consequence, an unprecedented rate of technological development and improvement in productivity. I suspect that this has not happened to public utilities to the same extent, although even here the productivity gains are far from negligible and certainly very much more than they are in education, where they may well be negative.

The utility industry is interesting as a field in which the old debate between public and private ownership has not so much been resolved as it has simply died of boredom. I would like to see a time series showing the proportion of output produced by publicly owned versus privately owned companies, and I suspect that this has not changed spectacularly in forty years. Presumably the voters of this country have not seen any great advantages in a shift one way or the other, once the initial enthusiasm for publicly owned utilities resulted in a certain amount of experience. Nevertheless, the problem of the legitimacy of private ownership of utilities is by no means a closed question, and opinion could shift one way or the other at almost any time.

In the title of this paper I suggested that risk was social and that uncertainty was political. I am not sure that I would want to carry this distinction too far, but it does have implications which are not without interest. Risk to a considerable extent is a "private bad," and it can be alleviated by private insurance. The case for public insurance involves not only economies of scale, which may be considerable in the age of computers, but also a suggestion that uninsured risks are in some sense a "public bad": when something bad happens to an uninsured person the whole society feels some kind of sympathy and compassion. The welfare of the fortunate is in some degree diminished by their contemplation of the misfortunes of the sufferers. We see this particularly in disaster, which usually evokes a collective
effort to relieve the suffering which has been caused by it. Public insurance is a kind of formalization of this sense of the external disconveniences of misfortune.

I have called uncertainty political, partly because it deals with those elements of good or bad fortune in society which are not insurable, either because they are so irregular that no probabilities can be derived from experience, or because the act of insurance so changes the risks that previous calculations of probabilities are no longer valid. Any attempt to constrain uncertainty, then, must require collective, nonprivate, that is, political, action. It is the political and collective action, however, which are frequently the greatest sources of uncertainty. A political organization tends to concentrate power in the hands of a few individuals; the impact of either random selection of these individuals or random elements in their behavior may be very substantial, and are not only unpredictable but insurable.

On the other side of the coin, political organization easily may reduce private uncertainty, as we have seen in the case of regulated industries and controlled prices. A great deal of the uncertainties of the capital market, for example, could be eliminated by setting up a stock exchange equalization fund which would offer to buy and sell a given market basket of stocks at a fixed price. This would permit the functioning of the market in the establishment of the relative prices of stocks, which is essentially what it is for, but would largely eliminate the meaningless and rather random fluctuations of the general level, which are a result of speculation and self-justified expectations. The whole problem of the use of political organizations for the elimination of private uncertainty has received surprisingly little attention, yet it is potentially one of the greatest benefits—and dangers—of political organization.

As long as we are looking at the place of public utilities in this picture, we should mention technological uncertainty, which may have a peculiar significance for public utilities. We already have seen a good deal of this in the substitution of electricity for gas, for example, and in the decay of public transportation with the rise in use of the automobile. A really efficient small-scale electric generator, still more so one which operated on solar energy, might create an enormous revolution in the electric supply industry, causing the disappearance of centralized power stations and the establishment of self-sufficient households. In the unlikely event of the development of an antigravity machine, the whole technological structure of the present day would be rendered obsolete almost overnight. These technological possibilities are uncertain in their very nature because knowledge cannot be forecast. Perhaps because of this unpredictability they seem to have very little impact on rates of return. A good many old-gilt-edged investments, such as railroads, have had the gilt knocked off them with remarkable rapidity once technological innovation has rendered them obsolete. Yet there seems to be little recognition of this development either in rates of return established in the market or by public commissions.

The question of the legitimacy of private profit, which may seem dormant in the United States except for a radical fringe, is highly pertinent in the Third World. The question, as we have seen earlier, is essentially a function of political uncertainty, so that we may get quite unstable dynamic systems. A rise in political uncertainty leads to a rise in private profit simply because people are not willing to invest under the uncertain conditions in return for what the general public may think of as reasonable profits. Hence, as uncertainty increases, profit increases, which itself diminishes its legitimacy and increases its uncertainty and increases profit. A great deal of the uncertainties of the market, for example, could be eliminated by setting up a stock exchange equalization fund which would offer to buy and sell a given market basket of stocks at a fixed price. This would permit the functioning of the market in the establishment of the relative prices of stocks, which is essentially what it is for, but would largely eliminate the meaningless and rather random fluctuations of the general level, which are a result of speculation and self-justified expectations. The whole problem of the use of political organizations for the elimination of private uncertainty has received surprisingly little attention, yet it is potentially one of the greatest benefits—and dangers—of political organization.

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Regulatory Risk and Public Utilities

Myles S. Delano and R. Hayden Howard

The problem of regulatory climate or strictness is scrutinized frequently in the financial literature, both in textbooks and journal dealing with investments in public utilities. The statement below from Haye's Investment: Analysis and Management provides a typical example: "First, there is the question of whether the company operates within a favorable jurisdiction. However, although an unfavorable regulatory climate would have unsatisfactory implications, the relations of most state commissions and the utilities have 'been good since World War II.' A quotation from a recent article in the Financial Analysts Journal also shows cognizance of regulatory climate. "There is no doubt that some commissions have recognized the need for higher returns. . . . There is, on the other hand, no doubt that other commissions have [not]." Such discussions, however, proceed in a rather vague manner. The fact that the regulatory climate is important is (un)warranted; possible effects are mentioned in general terms, and after the investor is told that the topic is important, little is said about how an unfavorable regulatory climate is defined.

The purpose of this paper is to attempt a definition of the problem of regulatory risk and to undertake some preliminary research into the effect of regulatory climate upon investor performance and the cost of equity capital for a sample of public utility companies. Such an approach considers only two of several interesting problems posed by regulation. The concept of regulatory risk and the effects of regulatory climate can exist in several contexts.

Another point of view to take in exploring regulatory climate and regulatory risk would be to examine the effect of regulation with respect to the efficiency of resource allocation. Regulation might restrict activities by establishing prices at such a low level that the regulated firm could not compete effectively for resources. The result from a social point of view would be too few resources in the regulated sector. The transportation sector might be an example of this. Alternatively, another result might be a misallocation of resources in the sense that the price structure would allow too many resources in the regulated sector.

Regulatory performance could be examined from the point of view of the consumer, an aspect of the process which is currently of great interest. One of the problems in this regard is the possibility of cross-subsidization among consumer-users. For example, residential users of a utility company's service might be subsidizing the industrial users because of the rate structure. Another problem might be that of poor service being allowed to exist even when there is no practical alternative service available which consumers would be willing to buy. Still another problem regulation might sanction that would be detrimental to consumers would be the destruction of various alternative services through pricing practices.

From the company or management point of view, regulation can cause severe problems. The regulatory body might restrict the freedom of management to make decisions or to act in such a fashion that management could not predict the direction of reaction from the regulators to a particular action by the firm.

This paper does not deal with these important problems, but examines the effect of regulatory climate or regulatory risk on investors in the common stock of public utility companies and upon the cost of equity capital for these companies. This area has received little attention, as evidenced in the applications of modern finance theory to the regulation of utilities and in the general literature. This attention was brought into sharp focus in the testimony of Professor Myron Gordon before the Federal Communications Commission in
connection with the American Telephone and Telegraph Company. Gordon attempted to explain the price of AT&T stock using dividends, growth of dividends, the degree of leverage, the rate of new stock financing, and business risk as independent variables. In testing the model with sample data from electric utility companies, the variable for business risk was dropped because its value was approximately zero. Subsequently, Gordon adjusted the values of the remaining coefficients and cited as one of the reasons for the adjustment the fact that investors expected a lower rate of return to be the result of the hearings. If Gordon was correct, regulatory risk was present even if business risk was not.

The problem of defining regulatory risk is a difficult one. The underlying assumption in the literature is that regulatory risk is positively associated with the degree to which the regulatory climate is unfavorable, that is, regulatory risk rises as the regulatory attitudes become less favorable and investors might be expected to avoid states with an unfavorable climate. For example: "Commissions that demonstrate an awareness of the problems and provide fair returns will obviously reduce the risk associated with utility stock, and thus directly reduce capital costs. . . . Since regulation is of prime importance in selecting utility investments in the current environment, those states should obviously be avoided by investors." 6

Regulatory risk does exist in the conceptual sense. If regulatory bodies require low rates for service, the rate of return to stockholders may fail. If regulation is capricious or simply inconsistent, the investors face greater uncertainty. To the extent that actions are predictable they can be anticipated by investors, but if they are not predictable investors may demand a premium for supplying capital to the firm under the jurisdiction of such regulatory bodies.

For the empirical research in this paper, a rather general definition is adopted; regulatory risk is assumed to be a direct result of an unfavorable regulatory climate. This definition raises some interesting questions. From the investors' point of view, the important question is: "What is favorable to investors?" If regulatory risk is defined in terms of certainty (consistency) of regulation, states which provide a favorable investment climate in the sense that they generally allow a "fair" return, might provide (create) high regulatory risk if

9Testimony of Myron T. Gordon, FOC Docket No. 16258, FOC Staff Exhibit No. 17.
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<tr>
<th>State and Companies</th>
<th>Regulatory Chosen</th>
<th>Inventor Performance</th>
<th>Cost of Capital I</th>
<th>Cost of Capital II</th>
<th>Rate of Return on Net Plant</th>
<th>Rate of Return on Book Equity</th>
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Spearman Rank Correlation Coefficient: -.3212, -.3727, -.3630, -.5758, .6

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Spearman Rank Correlation Coefficient: .01838, -.3212, -.7242, -.7576, -.7212
permissive regulation. Wider divergence, then, was assumed to indicate a more favorable climate. This procedure ranks states only to the extent that the companies chosen are representative of the overall regulatory climate in the states; rankings might change if different companies were selected.

The companies then were ranked by investor performance, rate of return on net plant, two measures of the cost of equity, and rate of return on the book value of equity. Each of these rankings was then compared with those of regulatory climate and divergence between book and market value of equity. The Spearman rank correlation coefficient was used to test for relationships. The results are presented in Tables 1 and 2.

Interpretation of Results

A common injunction to investors is to avoid states with unfavorable regulatory climates and to buy companies in states where the opposite is true. No support for this rule is evidenced by the results. In fact, the results tend in the other direction. Investor performance is positively correlated with regulatory climate in both cases, but the results are not significant at the 5 percent level.

The cost of equity capital was positively correlated for both measures when compared with the ranking by expert opinion, and negatively correlated in both cases when compared to ranking by book and market divergence. Neither result was significant at the 5 percent level. The usual presumption that strict regulation should reduce the cost of capital is not borne out in the results.

Both measures of the rate of return were negatively correlated with each of the two methods used to rank states by regulatory climate. The results were significant only when compared with the divergence of book and market value ranking, and just below the level of significance when compared to the expert opinion ranking. These results support what would be expected from the methods used to rank companies and states by regulatory climate. Favorable regulation would tend to imply a high rate of return in the states considered, when specific companies are ranked by the divergence of book and market value there is a strong presumption that wide divergence implies a high return on book equity and net plant.

The results are interesting in that they challenge two basic and widely held assumptions regarding the effect of regulation. While the evidence is limited and subject to the many faults inherent in any such investigation, indications are that further investigation is warranted. More specific hypotheses might be advanced and tested by more powerful statistical procedures. The problem of research design and choice of technique would be difficult, but perhaps no more so than many other areas already studied in the field of public utility regulation. A more specific definition of risk would be useful in further investigation. For example, if the earnings variability resulting from regulation could be identified, a measure of variability might be used directly for the problem.

There are some basic difficulties in constructing hypotheses for research on the problem of regulatory risk. For example, conflicting hypotheses are possible regarding the effect of strict regulation on the cost of equity capital for public utilities. The regulatory body may reduce the cost by the very act of regulation. Certainly for capital already committed to the business the return may be effectively lowered by regulation. The prescription required, successively lowering the allowable rate of return, would amount to a slaughtering of committed capital as stock price fell to adjust the return to general market rates. Such a procedure would not encourage investors to supply new funds for the utility and might increase the cost of new equity capital. A third possibility is that the market would anticipate regulatory action and hence it would have very little effect on the cost of equity capital.

Essentially the same argument could be made for investor performance. To the extent investors are able to discount the effect of any type of regulation, differences in regulatory climate would not affect investor performance.

APPENDIX

Selection of Companies

Companies classified by the Value Line Investment Survey as members of the electric utility industry constituted the population of companies used for the study. Selection criteria to obtain companies from this population required two tests: First, 90 percent or more of the
Brum's business had to be conducted in one state. This rule ensured that the companies used would not be subject to conflicting regulatory climates. Second, 75 percent or more of the firm's gross revenues had to be derived from the sale of electricity. This rule was used to ensure that the firms selected were basically electric utility companies.

In the states selected on the basis of rankings by export opinion, the largest firm operating in the state with respect to revenues and meeting the above two tests was selected. One exception to this procedure was the elimination of Consolidated Edison of New York.

Source of Data

All financial data were taken from Value Line Investment Survey.

Definition of Attributes

Investor performance: (Average high-low market price of common stock in 1989 plus dividends for 1980 through 1989 compounded at 8 percent)/Average high-low market price of common stock for 1980. The rate for compounding dividends was chosen as a reasonable approximation of what investors could obtain by reinvesting in common stock. No consideration was given to the preferential treatment of capital gains over dividend income.


Rate of return on net plant: Rate for 1989 as taken from Value Line.

Rate of return on book equity: Rate for 1989 as taken from Value Line.

Book value per share of common stock/market price of common: Value computed for 1989 from Value Line data.

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