THE EARNINGS-PRICE RATIO AS A SURROGATE FOR RISK IN THE PREDICTION OF EQUITY RETURNS

By

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TABLE OF CONTENTS

LIST OF TABLES

KEY TO SYMBOLS

SYMBOL		Page
SML	Security market line	37
T	Index designating time period	87
t	Test statistic based on Student's t distribution	83
$t(\bar{\hat{a}}_i)$	t-statistic for testing the significance of the mean value of $\hat{a}_{iT}$	86
U(R)	Utility of return	57
V_i	Coefficient i associated with quadratic utility function	57
W	Terminal wealth of investor	61
X	Independent variable in simple linear regression	41
x_A	Dollar weight of security A in portfolio j	34
x_B	Dollar weight of security B in portfolio j	34
Y	Earnings per share	22
Z	Zero-beta portfolio	50
z	Test statistic based on normal distribution	115
β	Beta coefficient	37
β_A	Beta of security A	36
β_{Aj}	Beta of security A in relation to portfolio j	61
$\hat{\beta}_{jT}$	Estimated beta of portfolio j in time T	63
γ	Gamma coefficient	62
γ_A	Gamma of security A in relation to portfolio j	61
$\hat{\gamma}_{jT}$	Estimated gamma of portfolio j in time T	63
$\phi_{E(W)}$	Coefficient measuring investor's attitude toward expected wealth	61

KEY TO SYMBOLS--Continued

SYMBOL		Page
σ_j^2	Variance of portfolio j return distribution	34
σ_M^2	Variance of market portfolio return distribution	36
σ_P^2	Variance of security price distribution	22
σ_R^2	Variance of return distribution	57
σ_Y^2	Variance of security earnings distribution	22

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Advocates of classical capital asset pricing theory assert that the risk borne by an investor who holds a well-diversified portfolio of equity securities is fully described by the portfolio's beta, an estimate of the volatility of the portfolio's return relative to the mean return expected from all risky assets during the corresponding investment holding period. Further, these theorists argue that, on average, portfolio volatility and portfolio return are positively and linearly related. While some studies support this theory, others indicate that portfolios comprised of securities typified by higher-than-average earnings-price ratios have consistently yielded returns greater than those predicted by the classical capital asset pricing model. Theorists attribute these latter studies' results to inefficiencies in the market for risky assets.

The purpose of this dissertation was to determine whether skewness in portfolio return distributions, rather than market inefficiencies, might explain the positive relationship between earnings-price ratios and returns adjusted only for volatility risk. The three-moment extension of the capital asset pricing model, developed by Alan Kraus and Robert Litzenberger, was used to evaluate portfolio risk; this model, unlike the classical model, includes as explanatory variables measures of both volatility and skewness. Measures of return, volatility, skewness, and earnings-price ratio were calculated for 1,200 securities in each of the 84 months included in the July 1971-June 1978 period. Twenty portfolios of 60 securities were formed on the criterion of earnings-price ratio rank, and, as a separate set, on the basis of volatility and skewness rank. Cross-sectional regressions of portfolio return on the three explanatory variables were run for each month of the test period; following the procedure set forth by Kraus and Litzenberger in their September 1976 Journal of Finance article, the mean coefficients derived from these regressions were tested for statistical significance.

The test results generally contradicted the expected relationships. It was hypothesized that return and the volatility measure would be positively related; return and the skewness measure, negatively related; and, return and earnings-price ratio, not significantly related when the volatility and skewness measures were included in the test equation. Only the last condition was met; the mean coefficients associated with volatility and skewness were not significantly different from zero. Moreover, the relationship between earnings-price ratio and return unadjusted for risk was itself not significant. Mean regression coefficients were calculated also for four non-overlapping subperiods of 21 months; no significant relationships were found between return and any of the explanatory variables. On the other hand, in all periods tested earnings-price ratio was significantly negatively related to the skewness measure. Since the measure of market returns exhibited positive skewness in all periods tested, this may be interpreted as evidence of high positive skewness in the return distributions of securities having low earnings-price ratios.

It was concluded that the three-moment version of the capital asset pricing model failed to assess correctly investment risk, possibly because of extreme market return instability during the period tested. Similarly, a positive relationship between earnings-price ratio and return did not, on average, exist during the test period. Results reported by other researchers supporting a positive relationship may be attributed to sampling or cumulative reinvestment biases. Further research is necessary to clarify the association between return skewness and earnings-price ratios.

CHAPTER ONE
INTRODUCTION

Statement of the Problem

Modern finance theory is concerned primarily with explaining the process which determines the value of investment assets. The capital asset pricing model (CAPM) represents one approach to the problem.[1] Advocates of this approach assert that investment value is determined by the functional relationship of the return that investors expect from a particular asset, and the risk they associate with their achieving that expected return. It is assumed that investors formulate subjective probability distributions which describe investment risk; further, these distributions are normal or approach normality, and are symmetrical. Thus, the risk of an investment security is expressed in terms of its return volatility.

When securities are combined into efficiently diversified portfolios, the portion of return volatility which is particular to individual securities, the unsystematic risk, tends to approach zero. The remaining portfolio return volatility, the systematic risk, is attributed to fluctuations in return common to all risky assets in the market; it is measured as the slope coefficient of a regression line which relates a given portfolio's expected returns to those of some

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[1]This general discussion of the CAPM is based on the model specified by Sharpe in [131], pp. 94-98.

market return index over the same period. This coefficient is commonly called the beta coefficient, or, more simply, beta. Moreover, beta is a measure of both the volatility and the degree of co-movement of a portfolio's returns in relation to those of the composite market for all risky assets. If a portfolio's beta is greater than 1.0, the portfolio is considered to have greater-than-average risk, and if less than 1.0, the converse. Given that investors are risk averse, they expect, on average, a higher return as compensation for a higher level of portfolio risk, and high-risk investments are priced lower than low-risk investments generating the same income stream. Thus, the classical CAPM expresses a positive relationship between investment expected return and expected investment risk. Furthermore, no variable other than beta is considered relevant in the estimation of portfolio risk.

The capital asset pricing theory described above is well developed, sophisticated, and consonant with economic theory of choice under conditions of uncertainty. However, during the past two decades security analysts have noted a consistent and positive relationship between security returns and security earnings-price ratios (EPRs). Returns of high-EPR portfolios have been, on average, greater than those predicted using the CAPM. The opposite has been true for low-EPR portfolios. Advocates of capital asset pricing theory attribute the EPR-return relationship to an inefficient market: investors do not include in their beta estimations the information conveyed by current EPRs. If corporate reports are disseminated unevenly, some investors are unaware of current EPRs; other investors attribute no significance to the new information. Consequently, they underestimate the betas of high-EPR portfolios, and overestimate those of low-EPR portfolios. Thus, EPRs are superfluous to the theory. If all investors were aware of and used current information to estimate portfolio risk, the EPR-return relationship would not exist. Since no coherent alternative theory explains the relationship, CAPM supporters consider it an empirical phenomenon which is attributable solely to market inefficiencies.

This research represents an attempt to explain the empirical EPR-return relationship within the framework of capital asset pricing theory. Results of studies which suppport a positive association between EPRs and risk-adjusted returns have been misinterpreted. These results are not due to market inefficiencies; rather, they should be attributed to an imperfect adjustment for risk. Recent theoretical developments suggest that investors consider not only portfolio return volatility but also portfolio return skewness when estimating portfolio risk. No prior study of the EPR-return relationship examined either the effect of skewness in the risk-adjustment process or the possibility of a relationship between EPRs and skewness measures. The specific goal of this study is to determine whether or not a positive relationship between portfolio EPRs and portfolio returns exists when returns have been adjusted for both volatility and skewness risk. The most significant conclusion that emerges is that the EPR is an indicator of skewness in portfolio returns. Further, the empirical results are interpreted as evidence for the semi-strong form of the efficient markets hypothesis[2] and against the three-moment specification of the CAPM.[3] In summary, the conclusions derived from this research are of interest to finance theorists, investment analysts, and investors in general.

Research Plan

Thus far it has been determined that an unresolved issue exists, and that its resolution requires research beyond that already performed. A summary of the subsequent chapters points out the differences in philosophy, approach, and method which distinguish this research from that previously published.

The second chapter is a survey of studies published in the finance literature which relate the EPR to both risk and return. First, studies supporting a positive relationship between EPRs and returns unadjusted for risk are noted and criticized. Second, the EPR is defined; its use as a proxy for investment return is reflected on, and rejected. Third, the associations between EPR and fundamental business variables, such as growth and leverage, are examined. Fourth, the connection between EPRs and volatility is explored; the stability of the EPR and its components, price and earnings, is discussed, as is the correlation between EPRs and measures of return volatility. Fifth, published studies confirming a positive relationship between EPRs

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[2]For a detailed discussion of the three forms of the efficient markets hypothesis, see Fama [41], p. 383.

[3]The three moments of a probability distribution of returns are the expected return, the variance about this expected return, and the skewness of the distribution.

and risk-adjusted returns are reviewed. Sixth, the chapter is summarized, and tentative conclusions drawn.

In the third chapter, the process used to adjust returns for risk in the EPR-return studies is examined. The classical CAPM is described in detail. Empirical tests of the model are cited, and the model is criticized in depth. Alternative forms, or extensions, of the CAPM are stated, and their empirical and theoretical validity discussed. Two arguments supporting the proposition that the EPR is a skewness proxy are developed to justify the use of the three-moment version of the CAPM as the appropriate model for risk adjustment.

In Chapter Four the procedures used to test the EPR-return relationship are set forth. Methods used in relevant studies are detailed and evaluated, and an alternative approach suggested. Data sources and sampling procedures are delineated, and the test variables and their measures defined. The method of analysis, linear regression, is described. Tested relationships are expressed as linear equations, and hypothesis acceptance criteria stated. Pitfalls of the method are discussed; alternative approaches are surveyed, and their rejection justified.

Results of the investigation appear in Chapter Five. Inferences are made based on the statistical significance of the averages of the regression coefficients for each linear model tested in each of the 84 months of the test period. First, the EPR-return relationship is tested for returns adjusted for both volatility and skewness risk. Second, results from testing the three-moment version of the CAPM are stated and compared to results attained by other researchers. The model's empirical validity is commented on. Third, the link between EPR and skewness is examined to provide evidence for or against a proxy relationship. Additionally, results of the above tests for various subperiods are presented to provide additional insights into the stability of tested relationships during the experimental period. The chapter concludes with an analysis and discussion of various problems which must be considered when forming conclusions based on the test results, and suggestions for further research.

Distinct Features of This Study

This inquiry differs significantly from other studies of the EPR-return relationship. The thrust of the research is directed toward explaining the relationship within the framework of current theory; previous studies have been limited to testing for the existence of the relationship as an empirical phenomenon attributable to market inefficiencies. In this dissertation it is assumed that the market for securities is efficient, and that the results of previous studies may be ascribed to an incomplete adjustment for risk.

The analytic procedures used in this paper differ from those followed in other studies. For example, the data are sampled from 1,200 securities in every period tested, but not necessarily the same securities in every period. The samples are not limited to companies listed on the New York Stock Exchange or having a fiscal year ending in December. The data are current such that the period tested is, to a large degree, non-overlapping with periods tested by other researchers. Test variables are measured differently in line with new developments in theory and method, and other variable measures, tested in preliminary work but excluded from this research, are noted. Additionally, the method of analysis differs; other researchers have based their analyses on questionable assumptions and methods. In this inquiry the risk-adjustment model is tested for validity, just as the EPR-return relationship itself is tested.

The above changes in approach and experimental design depict an attempt to improve the quality of research dealing with the EPR-return phenomenon. No research is without fault, and obstacles do remain. Inferences are based on the analysis of a limited number of securities tested over a relatively brief period; consequently, conclusions drawn from the analysis cannot be generalized to explain the behavior of all securities' returns in all periods. Similarly, sampling, measurement, and econometric biases could discredit the results. While these biases are present to some degree in all research using linear regression analysis, they cannot be ignored.

CHAPTER TWO
EARNINGS-PRICE RATIO, RETURN, AND RISK

Naive Studies of the EPR-Return Relationship

The early studies of the EPR-return relationship are characterized as naive because they are inconsistent in method and variable measurements, and thus non-comparable; formal hypotheses are neither stated nor tested statistically; and, returns are not adjusted for risk. The first study to suggest that high-EPR securities yield returns higher than those of low-EPR securities was published by Nicholson [117] in 1960.[1] Nicholson examined 11 subperiods during the 1939-1959 interval using a sample of 100 "trust investment quality" common stocks. He found that the 20 highest EPR securities' prices appreciated, on average, more than the prices of the 20 lowest EPR securities. Moreover, he found the securities having the highest price gains concentrated in the high-EPR group, and those having the highest losses in the low-EPR group. Also of interest, the average-EPR group had a price appreciation less than that of both the high- and low-EPR groups. Nicholson speculated that investors may be unaware of the importance of EPRs:

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[1]Many of the naive studies segmented securities into groups on the basis of price-earnings ratio, rather than its reciprocal, the EPR. While this causes no change in grouping of securities, it inverts the relationship with return such that high returns would be associated with low price-earnings ratios.

> High price-earnings multiples typically reflect investor satisfaction with companies of high quality, or with those which have experienced several years of expansion and rising earnings. In such cases, prices have often risen faster than earnings. A resultant increase in price-earnings ratios may be justified in individual instances, but under the impact of public approval, or even glamour, it often runs to extremes. When this occurs, upward price trends are eventually subject to slow-down or reversal. High multiple stocks then develop trends which on the average compare unfavorably with low multiple stocks which have not yet been bid up to vulnerable price levels. [117:45]

Nicholson's study may be criticized on several points: first, he measured prices and price-earnings ratios as annual averages rather than as objective values of these variables at points in time; second, he omitted consideration of dividends; third, his sample was small and selected on the basis of past performance.

Nicholson's results quickly became controversial. Levy and Kripotos [93] and Gould and Buchsbaum [56] concluded that earnings growth measures are superior to EPRs in discriminating high price-appreciation securities. Levy [92] found high-EPR securities as vulnerable to price declines as low-EPR securities in general market declines lasting six months or more. Contrarily, studies performed by Fleugel [47], Breen [25], Nicholson [118], Miller and Widmann [109], Miller and Beach [108], and McWilliams [106] on annual data supported the positive EPR-return relationship. Both Breen and McWilliams included dividend yields in their return measures. Other studies, published by Latané and Tuttle [84], Latané, Tuttle, and Jones [85], Latané, Joy, and Jones [86], Joy and Jones [78], and Joy [77] examined the connection between price appreciation and EPRs. These studies supported Nicholson's results, but attributed the positive EPR-return phenomenon to inefficiencies in the dispersion of quarterly earnings data to investors. The researchers reasoned that most firms announce quarterly earnings figures within two months following a particular quarter, but not all investors become aware of these figures as they are announced. If a particular firm's earnings announcement is perceived by investors as an indicator of higher (lower) growth in annual earnings, then they will bid up (down) the price of the firm's shares. Those investors who first assimilate favorable information contained in quarterly earnings reports therefore have the opportunity to attain large capital gains as other investors become aware of the information and subsequently purchase shares in the firm. Conversely, given an unfavorable quarterly earnings report, those investors first cognizant of the lower earnings growth could either sell their own shares or sell short other shares;[2] other investors, receiving such unfavorable information belatedly, would suffer capital losses as they sold their shares at a lower market price. This explanation is consistent with that of Nicholson previously quoted; the change in earnings growth expectations could be the stimulus for price trend reversals in both the high- and low-EPR security groups. Molodovsky [111], in a critique of the earlier naive studies, speculated that decreases in earnings growth would be more likely to occur in the low-EPR security groups and increases in the high-EPR groups:

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[2]A short sale is one in which an investor sells borrowed shares in the expectation that their price will fall, thus allowing him to replace them at a profit.

> It stands to reason that prices of stocks with characteristically high earnings multipliers are more fragile. Only confidence that earnings growth will be sustained at high compounding rates for an extended period can keep them aloft. When investors lose faith that a high-flying stock will continue to make money at a rapidly growing rate, the same thing happens as when an aircraft loses speed: it starts falling. [111:103]

He further stated:

> The stock of a company enjoying a rapid earnings growth is bound to suffer more from unrealized growth expectations. . . . When confidence begins to wane, the rate of decline of a stock's price will bear a relation to its anticipated rate of earnings growth. . . . A group consisting of the highest P/E ratio stocks will obviously contain within itself a larger proportion of coming disappointments of investment hopes than groups with lower P/E ratios. [111:103-104]

Molodovsky's argument is logical, but empirical insight is provided by Miller and Beach:

> Our evidence indicates that the low P/E concept works not so much because the preponderance of stocks in the high P/E group is "weak," but because the minority, which indeed does prove disappointing from the standpoint of earnings growth, is penalized severely . . . . These disappointments in the high P/E group typically suffer such precipitous price declines that the entire group's performance is materially affected. An opposite situation characteristically occurs in the low P/E group. [108:110]

To recapitulate, the naive studies generally support a positive relationship between investment return and EPR. This relationship is attributed to large price changes in a relatively small number of securities resulting from changes in investors' growth expectations. These changes in expectations result from announced changes in earnings figures; diminished growth, associated with the "more vulnerable" low-EPR securities, causes large price declines in a number of securities classified within a particular low-EPR group and lowers the average return for the group. Increased growth, assumed more likely to be associated with a number of securities in a given high-EPR group, raises the mean return of that group. This explanation is termed the naive rationale.

The EPR as a Proxy for Return

The EPR has been employed as a measure of return in studies performed by Benishay [18], Bower and Bower [24], Beaver, Kettler, and Scholes [16], and others; one possible definition of the EPR, current earnings divided by current price, is generally denoted the "earnings yield." Opinions on the appropriateness of using the EPR to measure return are diverse. Molodovsky [111] considered the price-earnings ratio to be only a quotient of two economic variables, and of little use in the valuation of securities. Levy and Sarnat [90, 91] showed that a firm's EPR is equal to its cost of equity capital if the firm earns this cost of equity on reinvested earnings. Similarly, Beaver and Morse [15] equated the EPR to the riskless rate of return. Both of these definitions of EPR are based on Gordon's valuation model,[3] and require restrictive assumptions rarely, if ever found in reality. Litzenberger and Rao [95] also derived an equivalence relationship between EPR and the required rate of return, where the numerator of the EPR is firm expected earnings and the denominator the market value of equity; as with the Levy-Sarnat and Beaver-Morse derivations, a firm's

[3]Gordon's model is discussed in detail in [91], pp. 302-307.

rate of return on reinvestment is constrained to equal its required return on equity, but the requirement of perfect certainty is relaxed. While Beaver and Morse, and Levy and Sarnat, showed that the EPR is consistent with discounted cash flow methods of security valuation in a certain world, the use of the EPR as a proxy for required or expected return is questionable. Brigham and Pappas [28] used EPRs as estimates of firms' reinvestment rates; Beaver, Kettler, and Scholes used them as return proxies in calculating firms' accounting betas. On the other hand, Murphy and Nelson [115] considered the EPR a doubtful proxy for return; Pringle [122] suggested that it "seriously underestimates the rate of return required by equity holders in all but a few special cases."[4] Morris [112] advocated doubling a firm's EPR to estimate its cost of equity capital. Beaver and Morse summarized the problem, observing that in an uncertain world: the future earnings figure is unknown, and must be estimated as an expected value; future values of a firm's payout ratio and earnings growth rate are also unknown; and, the expected return is no longer the riskless rate of interest, but rather some rate dependent on the firm's risk.

The above discussion points out that expected EPR is equivalent to expected return on equity only under certain ideal conditions. None of the naive studies of the EPR-return relationship tested for an expectational relationship; rather, realized values of EPR and return were analyzed. An EPR-return proxy relationship becomes more dubious when

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[4]See [112], p. 38.

we consider that there are many possible measures of realized EPR which might be used to estimate expected return. Price, the denominator, may be considered an economic variable insofar as it is objectively determined by market forces; it is considered an unbiased estimate of the value of a common share, which theoretically is equal to the present value of the expected income stream associated with the share. While price is objective, it changes with nearly every transaction in the security. Since the numerator of the EPR, earnings, remains constant for approximately one quarter between earnings announcements, the change in EPR during a particular quarter is due solely to changes in price, with every price change defining a new EPR. In the naive studies price was variously defined as: current market price; market price lagged one or three months from the date of investment; or, some historical average.

The case for defining earnings as an economic variable is more tenuous. Bower and Bower [24], and Malkiel and Cragg [102], for example, used firm "normal" earnings as the numerator of their EPR measure. These normalized earnings figures, calculated from a regression equation relating reported earnings to time, must be considered arbitrary since they are dependent on the number of periods used in the regression. It is published earnings figures that investors absorb; however, even if these figures are adjusted for stock dividends and splits and extraordinary earnings and losses, they are still not objective. Good and Meyer [53] suggested that investors have lost confidence in reported earnings figures as a basis for valuation. Emery [37] implied that investors should use other information to estimate correct earnings figures, rather than simply accept those published. Treynor [138] attacked the accounting concept of earnings, stating that:

> No number affected by an accountant's determinations of the value of assets contributing significantly to the investment worth of the firm can be useful to the security analyst--regardless of how the accountant's determinations are made . . . . Accounting earnings are more like estimates of change in the value of the firm over the accounting period--if, indeed, they have any economic meaning at all. [138:667]

Thus, accounting principles to some degree determine the value of a given EPR, however defined. For instance, Beaver and Dukes [14] discovered that firms using straight-line depreciation generally have EPRs greater than those of firms using accelerated methods.

If the quality of published earnings is suspect, then also is the periodicity of the earnings announcements. Miller and Widmann [109] defined earnings as the annual earnings figure announced by a company after the end of its fiscal year. All companies sampled had a fiscal year ending in the September to December period; in all cases, calendar year-end price was used to form the EPR. Thus, earnings for the September fiscal year companies would have been known to investors as much as three months before the assumed investment date, while those of December fiscal year companies would not yet have been announced. McWilliams [106] ranked firms on the basis of their price on the first trading day in April and annual earnings as of the previous December. Latané, Joy, and Jones [86] set an investment date two months after the end of a firm's fiscal quarter; they assumed that the firm's earnings from the previous quarter by then would have been announced.[5] For convenience, they sampled only firms whose fiscal quarters coincided with calendar quarters. Additionally, they used the quarterly earnings figure, as opposed to an annual figure, to calculate the EPR. Latané, Tuttle, and Jones [85] had earlier determined that quarterly earnings data, whether deseasonalized or not, were of more use than annual earnings data in predicting price movements. They reasoned that the information conveyed by quarterly earnings is more current than that conveyed by the sum of the previous four quarters' figures. Jones and Litzenberger [76] found that seasonal price movements do coincide with seasonal earnings patterns, but they discounted the effect as "negligible." These researchers ignored one aspect of the problem; in limiting their samples to December fiscal year companies, they biased their data against industries having seasonal patterns incongruent with the patterns of December fiscal year firms. However, both Breen [25] and Joy [77] found industry EPRs of no use in predicting industry returns and Joy found seasonal effects minimal.

If seasonality does not negate the use of quarterly earnings figures, we must still consider the possibility that they convey a large transitory component, and as such may be less reliable than are annual earnings in measuring a firm's current profitability. Brown and

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[5]Latané and Tuttle [84] and Latané, Tuttle, and Jones [85] tested EPRs defined in terms of current and future announced earnings; neither figure would have been available to investors at the time of investment.

Niederhoffer [29] found first-quarter earnings of value in predicting annual earnings. Green and Segall [57] came to the opposite conclusion. Newell [116] found neither the originally reported nor revised quarterly earnings figures of much value in annual earnings predictions, and Kisor and Messner [79] concluded that "the sum of earnings over four quarters bears a more consistent relationship to price than the figures for individual quarters."[6]

The positive EPR-return relationship, then, does not depend on any particular definition of EPR since many definitions are possible and many have been tested. Unlike investment return, which is defined as the sum of the dividend income and capital gain accruing to a security over some holding period divided by the initial investment, the definition of EPR is subjective. Further, a positive expectational relationship between EPR and return is contradictory. A given EPR may be expected to rise if price falls relative to earnings; a rational investor will expect return to fall, rather than rise, due to the expected capital loss. This, of course, assumes that an increase in dividend will not cancel the capital loss. In any case, for the reasons stated above, the proposition that EPR is a proxy for return must be rejected.

EPRs Related to Firm Fundamental Variables

If the EPR is not a proxy for investment return, it may be a proxy for some other variable related to return. In this section fundamental variables refer to those which describe a firm in terms of

[6]See [79], p. 110.

its business and financial characteristics. First, firm size, as measured by total assets, is considered to be negatively related to risk. Both Benishay [18] and Ofer [119] found firm size negatively related to EPR; smaller, more risky firms appear to have higher EPRs. Benishay found high-EPR firms to be less liquid, and thus more risky; contrary to expectations, he found also a significant negative relationship between EPR and the debt-to-total-assets ratio, a measure of financial leverage. Levy and Sarnat [90, 91] proved that, given a perfect capital market, a firm with debt in its capital structure will, in both a tax and no-tax world, have an EPR greater than that of an all-equity firm having the same growth and operating risk.[7] Ofer's results supported the Levy-Sarnat position, but weakly; in 14 years tested he found a significantly positive relationship in only four instances. Consequently, the relationship between financial leverage and EPR is unclear.

Beaver, Kettler, and Scholes [16] gave evidence that firms having low-dividend payout ratios are more risky than firms which pay a higher proportion of their income as dividends.[8] Benishay [18], Whitbeck and Kisor [143], Ofer [119], and Bower and Bower [24], and Malkiel and Cragg [102] found the relationship negative for both historical and expected payout ratios. From the above results we can infer that high-EPR securities are more risky, as gauged by fundamental risk measures, than are low-EPR securities.

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[7]The proof is given in [90], pp. 170-175.
[8]See [16], p. 669, Table 5.

While the above-discussed fundamental variables may be construed as risk measures, earnings growth is usually considered a nonrisk factor when related to EPR.[9] Ofer [119], Bower and Bower [24], Beaver and Morse [15], Hammel and Hodes [60], and Malkiel and Cragg [102] found no consistent relationship between EPR and historical growth. While correlation coefficients between EPRs and growth were predominantly negative, they were, in all cases, close to zero. On the other hand, Pringle [122] considered EPR a good indicator of expected growth; several theoretical models support his contention. Holt [63] developed a model postulating a positive relation between the price-earnings ratio of a high-growth stock relative to that of an average-growth stock. Conclusions drawn from the model are: the longer the duration of high growth expected by investors, the lower the EPR; and, the higher the growth rate relative to that of an average-growth stock, the lower the EPR. Baylis and Bhirud [13], using Holt's model, found low-EPR securities overpriced in terms of historical growth rates. For example, at the time of their study (1973) Avon's EPR reflected 14 more years of exceptionally high growth; for McDonald's Corporation, an EPR of .015 could be justified only if the corporation's earnings were to grow at the 42 percent historical rate for five years. If the growth rate were to decline to 14 percent, then nearly 17 years of constant growth would be required. The Holt model accordingly is valuable insofar as it explains why large

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[9]Refer to Benishay [18] for an elaboration of the differences between corrective variables and explanatory variables.

changes in EPR can occur with a given change in expected growth; more practically, it can be used to detect unreasonable projections of growth which underlie unjustifiably low EPRs of high-growth securities. Malkiel [100] developed a model, similar to that of Holt, which yields basically the same conclusions. He postulated three growth stock theorems, the most important of which state that the spread between the price-earnings ratios of a growth stock and an average non-growth stock is an increasing function of both the growth rate and the expected growth duration. This, of course, is consistent with Holt's model's predictions. Foster [48], in bringing growth into the EPR-return framework, showed, given his assumptions, why the EPR is consistent with present value methods and why it does not equal the required rate of return. Discounting earnings continuously over an infinite horizon assuming a constant (average) growth rate, he derived an identify in which EPR is equivalent to the required rate of return minus the growth rate. All three of the above-discussed models, then, point to a negative relationship between EPR and earnings growth.

The relationship is better defined in theory than in reality. Hammel and Hodes [60], Malkiel and Cragg [102], and Whitbeck and Kisor [143] empirically confirmed a negative relationship between expected growth and EPR. Murphy and Nelson [115], and Murphy and Stevenson [114], found no relationship. Jahnke [67] confirmed the relationship, but attributed it to the overpricing of growth stocks. Comparing the expected returns of a growth and non-growth portfolio having the same risk, as measured by beta, he determined that the non-growth portfolio's return was

2.5 percent higher; further, he calculated that growth stocks' EPRs would have to increase as much as 100 percent before the returns would be equalized. One might infer from the above that growth stocks are typified by artificially low EPRs.

EPRs and Volatility Measures

In this section measures of the volatility of the EPR and its components, and measures of return volatility, are associated with the EPR. The risk surrogates used most in modern finance theory are measures of the volatility of a given variable about its expected value; the measures used here include standard deviation, range variablity, and in the analysis of return volatility, beta. Hammel and Hodes [60] and Benishay [18] found a positive association between the EPR and the standard deviation of its numerator, earnings. Whitbeck and Kisor [143], using the standard deviation of earnings residuals about their trend line as a volatility measure, discovered the same positive association. On the other hand, evidence published by Benishay [18], Bower and Bower [24], and Heins and Allison [62] indicated a negative relationship between EPR and the volatility of its denominator, price. Haughen [61] found the standard deviation of price higher for high-growth stocks. As noted previously, high growth is associated with a low EPR. Heins and Allison used range variability as a measure of volatility; they defined this measure as the difference between high price and low price divided by average price during the interval examined, so their results are less telling than if they had calculated standard deviations.

The volatility of the EPR itself is our next concern. Molodovsky [111] enumerated ten conditions under which the EPR would change, and noted the three conditions under which it would remain constant, depending on the direction and rate of change of its numerator and denominator relative to each other. The evidence from studies performed by Murphy and Stevenson [114], Murphy and Nelson [115], Murphy [113], Brigham and Pappas [28], and Beaver and Morse [15] indicates that EPRs are relatively stable; especially, portfolios formed on EPR rankings tend to maintain their rank, on average, for as long as a decade or more.[10] While portfolio relative rankings tend to persist, however, the EPRs themselves tend to regress toward their mean.[11] Ofer [119], incorrectly using the standard deviation of the EPR as a measure of earnings stability, did find the EPR positively related to its own volatility.

The apparent stability of the EPR tends to explain its volatility relationships with its components. Assume that earnings varies randomly, and that there exists perfect positive correlation between the random series of earnings and a corresponding series of prices. Then, at any and all points in the time the ratio of earnings to price, by definition the EPR, is constant. Designating Y as earnings, P as price, σ_Y^2 as the variance of earnings, and σ_P^2 as the variance of price, we first define the identity

$$Y/P = EPR \tag{1}$$

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[10] Refer to [15], p. 67, Table 3.
[11] Ibid.

Then, solving for earnings, and accounting for the constancy of EPR

$$\sigma_Y^2 = (EPR)^2 \, \sigma_P^2 \qquad (2)$$

Taking the square root of both sides of the equation and solving for EPR yields

$$EPR = \sigma_Y / \sigma_P \qquad (3)$$

Equation (3) is consistent with the empirical evidence; given stable EPRs, one would expect a high-EPR security to be characterized by high earnings volatility relative to its price volatility; similarly, one would expect a low-EPR security to exhibit greater relative price volatility. If EPRs were not reasonably stable, then, a particular EPR's expectation would depend on the product of expected earnings and expected reciprocal of price minus the covariance between these two variables. That covariance would equal zero only if price or earnings were expected to be constant as the other varied, or if they varied independently of each other; these conditions are economically absurd. Yet, EPRs of individual companies do change, and sometimes radically during a short interval. This is probably because they are measured in terms of published data. At any given moment investors' changes in growth and risk expectations affect price, and EPR, immediately. Published earnings remain constant, but expected earnings change; thus, in an expectational sense, the EPR may not change at all even though its published measure does. The moot questions are: Are these changes in expectations systematically associated with the level of published EPRs? And, are these changed expectations ultimately realized?

While an examination of the volatility of the EPR and its components is instructive, it is the relationship between EPRs and return volatility measures that is critical to our analysis, for this relationship appears to be inconstant. Malkiel [100, 101], for one, suggested that growth firms paying no dividend have very volatile returns. We might infer from his analysis that low-EPR securities have higher return standard deviations than do high-EPR securities. Litzenberger and Rao [95], however, from an analysis of public utility data, concluded the contrary. Miller and Widmann [109] found the return distributions of high- and low-EPR security portfolios to be very similar. McWilliams [106] noted that, on average, both the highest and lowest EPR portfolios in his sample exhibited return standard deviations higher than those of the average EPR portfolios. However, if one converts these measures to coefficients of variation,[12] one notes a nearly monotonic increase in the measure as EPR decreases. Only the highest EPR portfolio is the exception; its coefficient is 1.48, compared to 1.18 for the next highest EPR portfolio, and 1.94 for the portfolio consisting of the lowest EPR securities. The above-mentioned average standard deviations represent the dispersion of security returns around their average (portfolio) return at a point in time. It is also of interest to examine the standard deviations of the ranked portfolios' return over time.[13] The highest EPR portfolio, over the 12 years tested (1953-1964),

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[12]The coefficient of variation is equal to the standard deviation of the return distribution divided by the distribution's expected value; it may be interpreted as a measure of volatility per unit of return.

[13]The data needed to perform the necessary calculations are in [106], p. 138, Table I.

had a mean return of 23.3 percent, a return standard deviation of 21.3 percent, and a resulting coefficient of variation of .92. Corresponding figures for the lowest EPR portfolio are: 15.5 percent; 21.4 percent; and 1.38. If risk is defined as volatility and measured by return standard deviation, then the high-EPR portfolio, on average, returned nearly 6 percent more for the same risk. If one averages the highest and three lowest EPR portfolio's returns and duplicates the above calculations on these average returns, the results are substantially the same.

The second volatility measure we relate to EPR is beta, the risk measure associated with the classical CAPM. Bower and Bower [24] found a positive relationship between EPR and the natural logarithm of the covariance between securities' returns and returns of the Dow Jones Industrial Average. Since this covariance is the numerator of beta, their result is consistent with a positive risk-return relationship. Beaver, Kettler, and Scholes [16] observed a highly significant positive relationship between betas calculated from EPRs and from market returns; remembering that the standard deviation of EPR would appear in the numerator of the EPR beta, and that Ofer [119] found a positive relationship between EPR and its standard deviation, we can tentatively assert a positive relationship between EPR and beta. This assertion is tenuous, however, as we are implicitly holding constant the correlation between security EPR and sample average EPR, which Beaver, Kettler, and Scholes used as a surrogate for the earnings yield of the market.[14] In any case, our assertion becomes even less valid if we recognize, with Gonedes [52], that the Beaver, Kettler, and Scholes results may be attributable to spurious correlation; the researchers used the same price as the denominator for both earnings yield and market return, and they failed to exclude a particular firm's EPRs from the average of EPRs it was regressed against.

Other researchers' results are less definite. Malkiel and Cragg [102] found EPR significantly positively related to beta in only two of five years; the relationship was negative, but not significant, in two other years. Similarly, Ofer's [119] results showed a significantly positive relationship in only five of 14 years. Beaver and Morse [15], testing the EPR-beta relationship over a 15-year period (1956-1970) found it significant and positive in six years, but significant and negative in four. They explained their results in terms of the level of market-wide EPRs, which vary with economic conditions:

> The expected sign of the correlation between P/E and beta may be either positive or negative. . . . Stocks' earnings move together because of economy-wide factors. In years of transitorily low earnings, the market-wide P/E will tend to be high, but stocks with high betas will tend to have even higher P/E ratios because their earnings are most sensitive to economy-wide events. Conversely in years of transitorily high earnings, high beta stocks will have even lower P/E ratios than most. Therefore, we expect a positive correlation in "high" P/E years and a negative correlation in low years. [15:70]

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[14] Recall that the classical CAPM framework requires the specification of some measure of the average return on all risky assets in the market for each period used to calculate beta.

Beaver and Morse did find the expected relationship. Generally, in years when the market-wide EPR was low, beta and EPR were negatively correlated; when it was higher than average, they were positively related. Given the above evidence, it is concluded that the relationship between EPRs and measures of return volatility is dependent on market conditions, and therefore is not stable.

EPRs and Returns Adjusted for Volatility

The sophisticated studies of the EPR-return phenomenon may be distinguished from the naive studies in two respects: first, they are more current, having been published since 1970; and second, they all test the relationship with returns adjusted for volatility. Litzenberger, Joy, and Jones [96] sampled 25 high-EPR securities, then split the sample into two groups of the highest 10 and lowest 10 securities ranked on EPR. Using Sharpe's [131] measures,[15] they found both groups about equal in return-total risk characteristics; measures for the top ten, bottom ten, and Standard and Poor's 425 Index were .72, .74, and .28, respectively. Using the same securities and technique but ranking on beta rather than EPR, they found that the lowest beta securities yielded returns higher than those of the highest beta securities in eight of the 11 periods tested. Jones [75] replicated the study using different data. Basing his conclusions on both

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[15]Sharpe's measure relates the risky portion of portfolio return to portfolio total risk. It is calculated by subtracting the risk-free rate of interest from average portfolio return and dividing this difference by the return standard deviation. For a discussion of the measure, see Sharpe [131], pp. 152-159.

Sharpe's [130, 131, 132] and Treynor's performance measures,[16] he affirmed the Litzenberger, Joy, and Jones [96] results. Dreman [35] found significantly higher returns associated with high-EPR securities. Equally important, he noted that the betas of the high-EPR portfolios were lower than those of the low-EPR, low-return, portfolios. He attributed his results to investors' psychology: investors are more emotionally involved with low-EPR, high-growth stocks, and more prone to sell these stocks if their returns are lower than expected, thereby causing a large price decline. Investors view high-EPR securities with less optimism, however, and expect such securities to exhibit return fluctuations. Given a setback, they are more likely to view it as transitory, and less likely to sell the security. This explanation is congruent with the evidence supporting the tendency for low-EPR securities to exhibit high standard deviations of price. Also, note that the explanation is but an embellishment of the naive rationale previously discussed.

The most extensive, and most sophisticated, studies of the EPR-return phenomenon are those published by Basu [11, 12] and interpreted as tests of the efficient markets hypothesis. The two studies differ only in method, so we will concentrate on the second, more current, analysis. Basu's stated aim, to analyze the EPR-return relationship after adjusting for the biases present in the naive studies, was mostly accomplished. By adding a file of delisted companies to his sample,

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[16]Treynor's measure relates portfolio excess return to beta, rather than to standard deviation. For a comparison with Sharpe's measure see [131], pp. 154-159.

he increased it so as to include failed, negative growth, and merged firms which investors might have invested in at the starting dates of past investment periods, but which would be excluded from current data bases. He adjusted returns for taxes, transactions costs, and information search costs. Additionally, he tested differently defined EPRs, and tested the effect of including or excluding negative-EPR firms from the low-EPR portfolios. Most importantly, Basu [11, 12] tested EPR-ranked portfolios' returns adjusted for systematic risk using both the traditional and the zero-beta versions of the CAPM.[17]

Basu's [11, 12] results supported a positive relationship between EPRs and risk-adjusted returns for the 1957-1971 period. On average, the highest EPR portfolio's return was 7.0 percent higher than the lowest EPR portfolio's, and 4.5 percent higher than its expected risk-adjusted return. Consistent with our previously discussed analysis of McWilliams' [106] data, the Sharpe [130, 131, 132] and Treynor [138] performance measures increased directly with portfolio EPR. Further, Basu compared the EPR-ranked portfolio returns against those of randomly selected portfolios having statistically equivalent betas. The highest EPR portfolio yielded a significantly higher return than its randomly selected counterpart, while the two lowest EPR portfolios yielded significantly lower returns when compared to their corresponding randomly generated portfolios. Even more disturbing to the CAPM adherents, the high-EPR, high-return portfolios had betas less than those of the lower yielding, low-EPR portfolios.

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[17]The zero-beta model developed by Black [19] and Vasicek [140] is discussed in Chapter Three.

These results cannot be attributed to the presence of only survived firms in the samples; neither can they be explained by the omission of taxes and transactions costs from the analysis, nor by the inclusion of negative-earnings securities. Basu further noted that:

> None of the portfolios has significantly more outliers. In short, the performance of the various P/E portfolios is not dominated by the related performance of a few securities. [12:675]

This finding tends to contradict the Miller and Beach [108] argument used to support the naive rationale discussed previously. Admitting that he, in reality, tested a joint hypothesis, Basu stated the first alternative:

> It seems that the asset pricing models do not completely characterize the equilibrium risk-return relationship during the period studied, and that, perhaps, these models are mis-specified because of the omission of other relevant factors. However, this line of reasoning, when combined with our results, suggests that P/E ratios seem to be a proxy for some omitted risk variable. [12:672]

Basu, however, rejected this possibility, opting for the alternative that "lags and frictions" in the dissemination of information are responsible for the EPR-return relationship:

> We therefore assume that the asset pricing models are valid. . . . Results reported in this paper are consistent with the view that P/E ratio information was not "fully reflected" in security prices in as rapid a manner as postulated by the semi-strong form of the efficient market hypothesis . . . . A market inefficiency seems to have existed. [12:680]

Basu's assumption of CAPM validity is examined in Chapter Three, and his method criticized in Chapter Four.

Discussion and Critique

Certain relationships which appear to exist between the EPR and variables other than return might, with further research, prove illusory. For example, Malkiel [101] criticized Ofer's [119] results on the basis of probable collinearity among the explanatory variables.[18] Additionally, Malkiel suggested that the regression residuals used by Ofer to measure growth expectations might just as soundly be interpreted as measures of risk not captured by the risk variables included in Ofer's equation.[19] Weston and Dunn [142] asserted that the inclusion of fundamental risk variables in any equation including beta as an explanatory variable is redundant, since these fundamental variables contribute to return volatility. In a similar sense, Holt [63] put forth the possibility that historical growth might be partially attributed to a firm's use of financial leverage; thus, including both variables in a regression explaining EPR would result in collinearity. In any case, Malkiel and Cragg [102] found that relationships between the EPR and various fundamental variables are unstable from period to period, while Beaver and Morse [15] indicated that beta does not explain the behavior of EPRs. Considering all of the evidence presented to this point, two tentative conclusions are advanced. First, the EPR is related to certain fundamental risk variables, and therefore may

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[18]This econometric problem arises when the independent variables in a multiple regression are linearly related to each other. Its effects are discussed in Chapter Four.

[19]Residuals are defined as the distance separating an observed value from its predicted value, as determined by a linear regression equation.

itself be a proxy for some theoretically sound risk variable. Second, the models used for risk adjustment in the studies discussed heretofore have not captured the risk information conveyed by EPRs After examining the theoretical and empirical validity of the CAPM approach to risk and return, these two provisional judgments will be further investigated.

CHAPTER THREE
A REVIEW OF RISK-ADJUSTMENT THEORY

The Classical Capital Asset Pricing Model

Studies indicating a positive relationship between EPRs and risk-adjusted returns are dependent on the validity of the classical capital asset pricing model. Earnings-price ratios, however, seem to represent some part of risk not captured by the model's risk measure, beta. If the CAPM does not fully measure risk, then the risk-adjustment procedures followed in the EPR-return studies are invalid, and the conclusions derived from these studies are tenuous.

The foundation of modern capital asset pricing theory lies in the portfolio theory developed by Markowitz [103] during the 1950s. Markowitz defined risk as return volatility, and measured it as the standard deviation of the return distribution of a security or portfolio.[1] He noted that when securities whose returns were less than perfectly positively correlated were combined into a portfolio, the volatility of the portfolio's return decreased as the correlation between securities decreased. For example, in a two-security portfolio, the portfolio's return variance is equal to the sum of the securities' return variances, each weighted by the square of its percentage of the

[1]The standard deviation of a distribution is the square root of its variance. For a definition of these dispersion measures, see Chou [31], p. 60.

total dollar investment, and the covariance between the securities' returns weighted by twice the product of the two securities' investment percentages. Given two securities, A and B, the relationship is expressed symbolically:

$$\sigma_J^2 = x_A^2 \sigma_A^2 + x_B^2 \sigma_B^2 + 2x_A x_B \rho_{AB} \sigma_A \sigma_B \tag{4}$$

where σ_J^2 is the variance of portfolio j; x_A and x_B are the percentage of investment dollars invested in security A and security B, such that $x_B = 1 - x_A$; σ_A^2 and σ_B^2 are the security return variances, and σ_A and σ_B the respective standard deviations; and ρ_{AB} is the correlation coefficient between A's and B's returns. Note that the covariance is equal to $\rho_{AB}\sigma_A\sigma_B$; other things equal, as the correlation coefficient decreases, so does the covariance and the portfolio variance.

Given the above, it follows that investors should diversify their portfolios to lower their overall risk for a given expected return; efficient diversification occurs when an investor holds a portfolio such that no other portfolio is expected to return more for the same risk, and no other portfolio is expected to return the same for less risk. Given this principle of portfolio dominance, rational investors should hold only efficient portfolios based on their individual risk propensities.

The above portfolio theory is impractical in that it requires the computation of the covariance between every pair of securities considered by an investor; for example, nearly 500,000 covariances would be necessary to analyze a 1,000-security universe. Additionally, the theory is normative; while it prescribes the investment policy investors should follow, it does not describe investors' behavior. Portfolio theory, then, cannot be tested. Sharpe [130], following a suggestion by Markowitz [103], solved both of the above problems in developing an embryonic CAPM. The model was refined by Lintner [94], who showed that, given a riskless asset, only one efficient portfolio of risky assets exists, and by Fama [40], who proved that this risky asset portfolio is composed of all risky assets on the market in proportion to their market value. This capital market model is defined

$$E(R_j) = R_F + \frac{E(R_M) - R_F}{\sigma_M} \sigma_j \qquad (5)$$

where $E(R_j)$ is the expected return on some portfolio designated as j; R_F is the single and constant rate of return on a riskless security; $E(R_M)$ and σ_M are the expected return and standard deviation associated with the market portfolio, and σ_j is the standard deviation associated with portfolio j. The relationship between expected return and risk for a portfolio, as shown, is linear. The slope, which Sharpe [131] called the price of risk reduction for efficient portfolios, represents the excess return of the market portfolio over the risk-free rate divided by the risk of the market portfolio.[2] The model thus defines a line, the capital market line, on which, in equilibrium, all efficient portfolios will lie. Only one portfolio composed solely of risky assets, the market portfolio, is efficient; all other efficient portfolios

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[2]See Sharpe [131], p. 85.

consist of either some combination of the risk-free security and the market portfolio, or a leveraged holding of the market portfolio.

While standard deviation is the appropriate risk measure for an efficient portfolio, it is not for an individual security. Rather, a security's risk is represented as its contribution to the total risk of an efficient portfolio if the security is added to that portfolio. Considering that the market portfolio is the only risky portfolio that is efficient, the measure of risk for a single asset is its covariance with the market portfolio.[3] The relationship between the expected return of a security, A, and its covariance with the market return, Cov(M:A), is

$$E(R_A) = R_F + \frac{E(R_M) - R_F}{\sigma_M^2} \text{Cov}(M:A) \tag{6}$$

This equation is very similar to that defining the capital market line; however, the slope, the price of risk reduction for securities, has as its denominator the variance rather than the standard deviation of the market portfolio's expected return. Recalling that Cov(M:A) is equal to $\rho_{MA}\sigma_M\sigma_A$, the equation can be transformed to the more prevalent definition of the classical CAPM

$$E(R_A) = R_F + [E(R_M) - R_F]\,\beta_A \tag{7}$$

where

$$\beta_A = \frac{\rho_{MA}\sigma_M\sigma_A}{\sigma_M^2} \tag{8}$$

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[3]For the proof of this relationship refer to Sharpe [131, pp. 86-91, or Jensen [72], pp. 359-363.

Note that the term on the right-hand side of equation (8) is by definition the slope of the regression line relating the returns of security A to those of the market portfolio; this is beta (β), the CAPM risk measure. In equilibrium every risky asset lies on the security market line (SML) defined by equation (8). Its expected return is determined solely by the magnitude of its beta, which represents the systematic, or non-diversifiable, portion of its risk. Further, recollecting from Chapter One that unsystematic risk tends toward zero when securities and portfolios are combined, an investor may hold some combination of the risk-free asset and a well-diversified portfolio of risky securities; such a portfolio would approach the efficiency of the market portfolio. Sharpe [132] estimated that the unsystematic risk of a portfolio containing 60 securities would be reduced by approximately 90 percent. He pointed out, however, that portfolios must be balanced. That is, they must not be composed of similar securities. Mokkelbost [110] concluded that combining a small number of securities into a portfolio eliminates most of the unsystematic risk; he qualified this conclusion, however, noting that the reduction is not dependent only on the number of securities combined. Fama and Miller [43] showed algebraically that unsystematic risk is eliminated when securities are equally weighted in a portfolio and their returns are independent.

Assuming efficient diversification, then, the classical CAPM describes how investors act in an uncertain world. If the market is efficient, all investors have the same information, and impound this information into their estimates of security return and beta. They hold efficient portfolios, selected on the basis of their risk tolerance. Both portfolio beta and portfolio expected return are equal to a weighted average of those of the securities included in the given portfolio.[4] Prices of risky assets are set in the market based on their risk and return, and the capital market is in equilibrium. Finally, those investors who assume more risk will expect, on average, a higher return. Whether or not they achieve this higher return is discussed in the next section.

A Critique of the Classical CAPM

Early studies of the CAPM, performed by Sharpe [130, 131, 132] and Jensen [71] on mutual fund data, tended to confirm a positive linear relationship between portfolio returns and covariances.[5] Douglas, however, found securities' returns related to their variances, but not to their covariances.[6] Douglas also cited unpublished results of linear regressions performed by Lintner [94] which indicated the existence of a significant relationship between securities' returns and unsystematic risk. Lintner's intercept term was greater than the risk-free rate of interest, and his slope coefficient less than the market return in excess of the risk-free rate. Miller and Scholes [107] verified Lintner's findings on data sampled from a later period.

There are many possible explanations for these results. The above researchers used as their tool of analysis the ordinary least

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[4]Both beta and return are additive, and thus may be averaged. See Sharpe [131], pp. 90-95.

[5]Sharpe's results are discussed in [131], pp. 160-174.

[6]Douglas's findings are discussed in Miller and Scholes [107], pp. 47-52.

squares technique of linear regression. One assumption of the ordinary least squares model is that the variance of residuals about the estimated line is constant. The condition of a changing variance, heteroscedasticity, could flatten the characteristic line relating risky securities' returns to market returns if the residual variance were to increase directly with return. Beta, the slope of the characteristic line, would then be underestimated, and the more risky securities' betas could give a lower slope to the SML. Martin and Klemonsky [104], however, found heteroscedasticity present in less than 15 percent of their regressions of the returns of 335 New York Stock Exchange securities on a market return proxy. Heteroscedasticity also could account for an empirically flat SML if the residual variance about the SML itself were to increase with return and beta. Miller and Scholes [107], nonetheless, determined that the effect of heteroscedasticity in their regressions of return on beta was not severe enough to explain the less-than-expected slope of the SML. From these studies we conclude that the flat SML is not due to the presence of heteroscedasticity in either the market model used to estimate beta or the CAPM itself.

The flat SML could be attributed to a non-linear relationship between beta and return; this would, perhaps, be detected by noting the presence of spatial autocorrelation,[7] or patterns, in the residuals

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[7]Spatial autocorrelation occurs when successive observations, in this case returns ranked by their associated betas, are correlated. Such correlation violates the assumption of a zero covariance between regression residuals. See Gujarati [58], chapter 11.

of cross-sectional regressions.[8] Miller and Scholes [107], in testing for a quadratic beta return relationship, found the regression coefficient associated with beta-squared positive; a negative coefficient would be necessary to explain the flat SML. Fama and MacBeth [42] found, on average, a zero coefficient attached to an average of individual securities' squared betas; Blume and Friend [23] discerned a significant negative relationship between return and beta-squared for the 1955-1959 period. The relationship was positive and insignificant during the 1960-1964 period, and negative and insignificant for the 1965-1968 interval. The low slope of the SML, thus, cannot be attributed to a quadratic risk-return relationship.

Miller and Scholes [107] pointed out a third possible explanation: the SML's slope would be depressed if, over time, the proxy used to measure the risk-free rate were negatively correlated with the measure of the market portfolio's return, and if the risk-free rate were not considered in the calculation of security beta.[9] While they did find this negative correlation, it could not have caused the flattened SML since the risk-free rate varied negligibly during the period tested. Further, they found no significant difference in betas calculated on raw returns or on excess returns, where the latter equal raw returns minus the risk-free rate.

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[8]Cross-sectional observations are observations of different categories at the same point in time. On the other hand, time series observations are those on the same category at different points in time.

[9]See Miller and Scholes [107], pp. 54-57.

Miller and Scholes [107] suggested also that errors in the measurement of beta could bias downward the CAPM slope coefficient. They attributed this bias to an inflation of the coefficient's denominator, the variance of the estimated betas, which includes both the variance of the true betas and the variance of the measurement errors due to sampling. Using their own data, they found that the slope coefficient "might well have been reduced by the force of the measurement error bias to something less than two-thirds of its true value."[10] More recently, Lee and Jen [88] concluded:

> Our analysis indicated that both the cross-sectional tests and the time series test of the CAPM are affected by . . . the sample variation of the systematic risk. Hence, interpretation of the empirical results of CAPM should be done with extreme care. [88:309]

The measurement of beta is less of a problem when dealing with portfolios, for the use of portfolio average return in its calculation eliminates much of the sampling error associated with individual securities. Malinvaud [99] noted that means of grouped security returns give unbiased linear estimators with little loss of information if at least ten groups are formed from the data based on a ranking of the independent variable. Kmenta [80] further pointed out that each group must contain the same number of observations; otherwise, heteroscedasticity would invalidate the regressions. Johnston [74] recommended the selection of a grouping procedure "which will maximize the between-group variation of X in relation to the within-group variation."[11]

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[10] Ibid., p. 61.

[11] See Johnston [74], p. 231.

In testing the CAPM, Black, Jensen, and Scholes [20] grouped security data as suggested above and tested betas calculated on portfolio, rather than security, returns. Malinvaud [99] had previously indicated that inconsistent estimates would arise from the use of group means if the observations were correlated with their errors, and had suggested classifying observations using rankings based on some variable other than the independent variable but highly correlated with it.[12] To overcome the possibility of positive errors clustering in high-beta portfolios and negative errors in low-beta portfolios, Black, Jensen, and Scholes grouped securities on betas calculated over a period prior to that tested. Using 35 years of monthly return data and samples ranging from 582 to 1,094 securities, they ran time series regressions for each of ten portfolios formed annually on the basis of securities' prior-period beta. Their results supported the Miller-Scholes [107] finding of a relatively flat SML:

> Thus, the high-risk securities earned less on average over this 35-year period than the amount predicted by the traditional form of the asset pricing model. At the same time, the low-risk securities earned more than predicted by the model. [20:89]

Sampling errors in beta cannot, then, explain fully the CAPM's failure to generate returns commensurate with risky assets' theoretical risk levels.

Such security aggregation procedures as followed above depend on the stability of beta; if beta were to change between periods, then grouping on a prior-period beta would violate the group variation

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[12]See Malinvaud [99], pp. 408-409.

conditions set forth by Johnston [74] and discussed previously. Black, Jensen, and Scholes [20] used as few as 24 months of returns to calculate prior-period betas, but calculated portfolio betas over the complete 35-year period. Blume [21, 22] and Sharpe and Cooper [133] found that portfolio betas tend to remain stable over time for portfolios containing 50 or more securities. Blume noted, however, that portfolio betas tend to regress toward unity when calculated over two contiguous seven-year periods. The use of betas calculated from historical data to estimate future risk, therefore, yields an overestimate of the risk of more risky portfolios, and the opposite for less risky portfolios. Roenfeldt, Griepentrog, and Pflaum [124] noticed a "tendency for individual security betas to remain in the same or adjacent quintile especially for the highest and lowest quintiles."[13] They found instability in security betas when calculated over different intervals; for example, betas calculated over a 48-month period were poor estimates of betas calculated over the succeeding 12 months, but good estimates of those computed over the subsequent 48 months. Contrarily, Gooding and O'Malley [55] found portfolio betas instable at the extreme values, and advocated using different betas to reflect market conditions. Fabozzi and Francis [38], in testing betas over both bull and bear markets, determined that market vicissitudes do not cause beta instability. Rather, in agreement with Lee and Jen [88], they blamed beta instability on random errors in measurement. Lee and Jen, and Brenner

[13]See Roenfeldt, Griepentrog, and Pflaum [124], p. 118.

and Smidt [27], summarized the controversy: betas are instable because the market model is mis-specified.

The problem of beta stability leads to the more general problem involving the stationarity of the distributions underlying the CAPM framework. Fielitz [45] characterized a stationary distribution as one whose mean and variance do not change significantly over time when measured at short intervals. Fama [39], in examining daily price changes of securities, found their distributions non-normal; too many values were clustered near the mean, and too many were concentrated in the distributions' tails. He hypothesized that price change distributions follow a stable Paretian process which is characterized by an infinite variance. Such a distribution is defined by four parameters, but the one of most interest for test purposes, the characteristic exponent, is a measure of the height of the distribution's tails; a population's mean exists only if the characteristic exponent is equal to or greater than 1.0, and its variance exists only if the exponent is equal to 2.0. Fama cited three studies which indicated the exponent lies in the 1.78 to 1.94 range. Thus, while samples of security returns always give a finite variance, over time the variances may fluctuate erratically in magnitude. Nevertheless, if security returns do follow a stable Paretian process, Sharpe [131] has shown that the beta of a well-diversified portfolio "may provide a perfectly adequate measure of risk."[14]

[14] See Sharpe [131], pp. 175-179.

It is important not only to realize that return sample distributions may change their characteristics, but also to understand why these changes might occur. As Roll [126] indicated, stationarity is the condition in which the return distributions and covariances on which investment decisions are based remain constant. In a multiperiod world, this supposition is tenuous. Barry [10] pointed out that the uncertainty attached to future returns and covariances may be dichotomized: first, there is uncertainty given all available information; second, there is uncertainty inherent in the information itself, for it changes with time. If historical information is equally weighted without regard to its currency, then predicted returns and covariances will be misestimated. Further, not accounting for the risk intrinsic to information change results in an underestimation of the market price of risk. Landskroner [83] affirmed this conclusion, observing that in a multiperiod context investors' consumption and investment opportunities change, thus changing the market price of risk. Changes in the structure of the economy also affect the slope of the SML. Hong [64] pointed out that with inflation firms' market values increase less than proportionally with increases in the price level; firms having a high percentage of fixed assets in their total asset structure have lower returns due to the understatement of depreciation relative to nominal asset replacement cost. Hagerman and Kim [59] attributed the flat SML slope found by Black, Jensen, and Scholes [20] to their use of nominal return measures. They suggested that the CAPM should include a term which reflects the covariance between nominal returns and price level changes.

Finally, Lee [87] demonstrated that the CAPM intercept and slope are correlated, and depend on market conditions; they are independent only if the risk-free rate is equal to the expected market return. Recall that Miller and Scholes [107] found measures of these returns negatively correlated. One implication is that the CAPM, when tested in nominal terms, has empirical validity only when measures of the risk-free rate are relatively low and the economy's price level is stable. The seeming indetermination of the classical CAPM might then be attributed to instability in its parameters and secular shifts in its constants.

The responsiveness of individual securities' betas to structural changes in the economy must also be considered. Betas are generally estimated from historical data. The use of security betas, calculated for a period prior to that tested, for grouping securities into portfolios is based on the assumption of beta stability, which, in turn, requires stationarity in the return distributions of individual securities. Economic changes, however, might result in securities' ex ante, or expected, return distributions differing from their historical distributions.[15] Thus, betas calculated from only historical data may measure risk incorrectly. Since the classical CAPM is based on investors' expectations of risk and return for a single investment period, historical returns represent only a fraction of all available information.

Moreover, this information is fixed as of the beginning of the investment period. In an efficient market all investors are cognizant of all information material to their estimations of risk and return.

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[15]Ex ante refers to an expected outcome, while ex post refers to the outcome after its occurrence.

Assuming they are rational, they agree in their predictions, and the risky-asset market remains in equilibrium. If investors disagree, however, the CAPM is undefined.[16] Disagreement could arise from two sources; first, information lags might exist such that some investors have current information others are not cognizant of; and second, investors might weight the significance of a given datum differently. Moreover, Roll [125] affirmed that individual investors calculate different historical betas for the same asset, since they use different measures of past market returns. Sharpe [130, 131, 132] pointed out that betas vary depending on the duration of the past period over which they are calculated. Given all of the above, the existence of a unique beta for any risky asset becomes dubious. Even such a beta could be calculated, if investors failed to recognize its relation to expected return the CAPM would not explain investors' behavior. Blume and Friend [23], in a survey of investors' risk assessment methods, found that only 17 percent of the respondents used beta to measure risk; rather, 45 percent emphasized earnings volatility, and 30 percent price volatility.[17] If these results are generalized, then five-sixths of all American stockholders ignore, or possibly do not understand, the concept of return covariance. Gooding [54] reported that even professional portfolio managers include measures of firm risk variables, namely financial leverage and earnings volatility, in their risk assessments. Rosenberg and Guy [127] asserted that historical betas are biased, and should be modified to account for current changes in

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[16]See Sharpe [131], chapter 6.

[17]These results are reported in Friend, Westerfield, and Granito [51], p. 904.

fundamental variables; specifically, they recommended the addition to, or subtraction from, historical beta of weighted factors representing current earnings growth and volatility, financial leverage, and other firm-related variables. Hence, the notion of beta as a unique and complete risk measure is further obscured.

The classical CAPM is dependent on the assumption that investors know the identify and quantity of every risky asset on the market. Otherwise, they would be unable either to define the market portfolio or to estimate its return. Roll [125] criticized all tests of the CAPM and its variations, asserting that the model's only testable preposition is that the market portfolio is mean-variance efficient; Roll demonstrated that the Black, Jensen, and Scholes [20] results would have supported the validity of the classical CAPM if those researchers had used as their market portfolio an efficient portfolio correlated 90 percent with the equal-weighted index which they used to measure market returns. Friend, Westerfield, and Granito [51], however, rebutted the Roll criticism primarily on the grounds that the efficient portfolio used in his example is of unknown composition.

Recall that the market portfolio consists of all risky assets weighted in proportion to their market value.[18] Nevertheless, Fama and MacBeth [42] measured market returns using the Arithmetic Index devised by Fisher [46]; similarly, Friend and Blume [50] used Fisher's Combination Link Relative Index. Both of these indexes give equal weight

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[18]This was pointed out in the first section of this chapter. See Fama [40].

to the returns of included securities. In addition to their theoretical inappropriateness, they are more volatile than value-weighted indexes, and they give different turning points.[19] Alexander [1, 2] found multiple-index models and equal-weighted single-index models inferior to value-weighted single-index models in generating Markowitz-efficient frontiers. Elton and Gruber [36], comparing the Standard and Poors' Industrial Index to an index constructed from their sample of securities, determined that:

> The correlation between stocks is better estimated on the basis of broad merket influences rather than influences which are specific to a sample of stocks. [36:1215]

Both Black, Jensen, and Scholes [20] and Kraus and Litzenberger [82] used sample-generated indexes in their tests of the CAPM. Expanding an index to include bonds semmingly would enhance its validity as a market return proxy; Miller and Scholes [107], however, found the innovation frivolous, and not explanatory of their CAPM test results. Thus, no perfect measure of market returns exists; it is possible that this problem is responsible for the failure of the CAPM to explain the structure of investment returns, but the issue remains unresolved.

Another assumption on which the classical CAPM is based is that of a single risk-free rate of interest at which investors may either borrow or lend without limit. A multiplicity of risk-free rates would result in the same number of SMLs, and a consequently undefined CAPM. Practically, few investors, if any, are able to borrow and lend at the same rate; Friend and Blume [50] suggested that the returns of high beta portfolios might be biased downward because investors holding these

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[19]See Lorie and Hamilton [98], p. 68.

leveraged portfolios would have to borrow at a rate higher than their lending rate. This would tend to decrease the SML's slope at higher risk levels, and thus explain the flat SML found by Miller and Scholes [107]. A more rigorous explanation was developed by Black [19] and Vasicek.[20] Black's alternative to the classical CAPM conforms to a world having no riskless asset, but allowing unlimited short sales. The model's SML is defined by two points: the expected return of the market portfolio, and the expected return of the minimum variance risky-asset portfolio whose returns are uncorrelated with those of the market. This latter portfolio is commonly designated the zero-beta portfolio. The model is expressed formally

$$E(R_A) = (1 - \beta_A)E(R_Z) + \beta_A E(R_M) \tag{9}$$

where $E(R_A)$, $E(R_Z)$, and $E(R_M)$ are the expected returns on security A, the zero-beta portfolio, and the market portfolio, and β_A is security A's beta. With simple algebraic manipulation equation (9) reduces to equation (7), except that the random variable, $E(R_Z)$, replaces R_F, the constant risk-free rate.

Vasicek [140] extended the model to include the case of riskless lending; the SML in this instance is kinked for efficient portfolios--its low-risk segment is a line connecting the market portfolio's return to the risk-free rate. Individual assets appear on the straight line defined by the zero-beta and market portfolio returns. Given that

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[20]For summaries of Vasicek's work see Vasicek and McQuown [140] and Jensen [72].

the expected return on the zero-beta portfolio is greater than the risk-free rate, the resulting expected returns for inefficient portfolios and individual assets are higher than predicted by the classical CAPM; expected return and risk combinations above are those of the market portfolio, then, are generated by selling the zero-beta portfolio short and investing the proceeds in the market portfolio. Hence, the model explains the comparatively low slope of the classical CAPM. Tests of the model, however, are inconclusive. Brennan [26] determined that the zero-beta return should equal the weighted average risk-free return of all borrowers and lenders in the risk-free asset. Empirical studies performed by Black, Jensen, and Scholes [20], and Fama and MacBeth [42], found the average zero-beta return greater than the average risk-free borrowing rate for the 1926-1968 period.[21] While the above researchers interpreted their results as supportive of the zero-beta version of the CAPM, Blume and Friend [23] found, in three five-year subperiods covering the 1955-1968 period, an extremely erratic zero-beta return; further, the regression coefficient associated with beta was negative and significant during the 1960-1964 subperiod.[22] In any case, the model is less robust than the classical CAPM because the zero-beta return is random and must be predicted for each period; and, while some researchers have inferred that the zero-beta model yields superior predictions, the overall empirical results remain ambiguous.

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[21] See Black, Jensen, and Scholes [20], and Fama and Macbeth [42].
[22] See Blume and Friend [23].

Recall that the classical CAPM is based on the assumption that investors hold efficiently diversified portfolios. Miller and Scholes [107] showed that errors in beta measurement could be responsible for the positive association between return and unsystematic risk noted by Lintner [94]. These errors would tend to be positive for high-beta and negative for low-beta securities, thus violating the ordinarly least squares assumption of a zero covariance between regression residuals and the independent variable, beta. The Black-Jensen-Scholes [20] grouping techniques supposedly eliminated this problem, which is one of proper diversification. Using efficient grouping methods, Fama and MacBeth [42] and Foster [49] found measures of unsystematic risk insignificant when added to the classical CAPM. Friend, Westerfield, and Granito [50], noting that investors in general do not hold efficiently diversified portfolios,[23] added an unsystematic risk measure to their CAPM test equation. They found, using expectational data for individual stocks in the years 1974, 1976, and 1977, that the regression constants were much higher than the risk-free rates for the same years. Further, beta was not significant in most of their regressions. The coefficients associated with the unsystematic risk measure were positive, but significant in only one year. Using expectational data, it appears that unsystematic risk is at least as important as systematic risk in the generation of returns; using ex post returns, however, the researchers found neither measure as important as a measure of the heterogeneity of expectations concerning a particular stock's return.

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[23]See Friend, Westerfield, and Granito [50], pp. 903-904.

Therefore, tests of the CAPM performed by different researchers have yielded inconclusive results as to the importance of unsystematic risk measures.

Unsystematic risk may be a significant factor not only at the security level, but also at the portfolio level. Farrell [44] and Martin and Klemonsky [105] furnished strong evidence that grouping securities on the basis of any common characteristic violates the ordinary least squares assumption of zero covariance in the regression residuals. That is, such securities' returns tend to move together in time, but do not move with the returns of other groups. Martin and Klemonsky found that the unsystematic risk of a randomly selected portfolio of 10 securities accounted for only 9 percent of the portfolio's total risk; a similar portfolio composed of oil stocks, however, had 53 percent of its total risk attributed to unsystematic risk. The failure of the CAPM to measure correctly the risk of these homogeneous stock groupings may be attributed to its exclusion of the effect of large residual variances resulting from inefficient diversification.

The EPR Revisited

The above section has pointed out the theoretical and practical considerations one must account for when using the CAPM as a risk-adjustment mechanism. We now reconsider those studies which found a positive relationship between EPRs and risk-adjusted returns. Four assumptions underlying the CAPM include: all assets are perfectly divisible; all investors are price takers; all assets are marketable;

there exist no taxes or transfer costs. The first is intuitively apparent; portfolios are highly divisible into their component securities. The second is somewhat questionable. Possibly, legal constraints on the specific securities that institutions are permitted to own could distort EPR relationships; legally acceptable securities are limited in supply, and a bidding up of their prices by institutions could artificially lower their EPRs. Since "legal lists" of securities are compiled on the basis of past performance,[24] many of the permitted securities would likely represent companies in the latter stages of their life cycles. This must, however, be considered an unsupported speculation.

The third of the above assumptions also may be questioned. While all securities are marketable, it is the degree of marketability that must be considered. For example, betas calculated on weekly returns for two securities are non-comparable if one security has been involved in many more transactions during the weekly intervals, as might be the case with low-EPR securities vis-a-vis high-EPR securities. Again, this is only conjecture. The last assumption may be discounted; Basu [12] found that the EPR-return relationship existed even when returns were adjusted for both taxes and transfer costs.[25] Therefore, relaxation of this assumption is not critical to our analysis.

Our critique of the CAPM's risk-adjustment potential focuses mostly on the general case. Of primary interest, however, is the

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[24]For example, the list of securities published by the New York State Insurance Commission is based largely on historical data.

[25]The New York state tax on security transactions is considered to be a transfer cost.

specific assessment of risk of portfolios having different EPRs. Several of the general criticisms might apply. First, even though EPRs of portfolios tend to be fairly stable, EPRs of individual securities may change very rapidly as new fundamental information becomes available to investors. A beta calculated on historical data does not reflect a change in investors' expectations. For example, betas of energy-related companies calculated on data antecedent to the raising of crude oil prices by OPEC countries in 1973 would not reflect current realities. If EPRs of energy-using companies had been low on the assumption of a continued low cost of energy inputs, it is likely that these companies' returns would have fallen, and their EPRs risen, in a relatively short time. Historical betas would have changed little. To the degree that beta is based on economic stationarity, it will not express the probability of catastrophic shocks.

A second area of concern is the effect of inefficient diversification. Quite possibly, different EPR classes of securities form homogeneous groups, and, when these securities are aggregated into portfolios, the resulting portfolios are inefficient; the CAPM then underestimates the risk of the resultant portfolios, and they appear to have higher returns than justified by their risk. This explanation, while intuitively appealing, sheds no light on the question of why the CAPM also underestimates the risk of efficient portfolios. The zero-beta model appears to explain theoretically why the SML of the classical CAPM is depressed; yet, Basu found the EPR-return relationship to exist even after returns were adjusted using the zero-beta model.[26] A closer examination of Basu's [12] test results is therefore warranted.

Basu [12] divided his sample into six portfolios: five included all securities selected as to EPR rank, with portfolio A including the lowest EPR securities and portfolio E the highest; the sixth, portfolio A*, included the lowest EPR securities but excluded those having negative earnings figures. Unfortunately, he did not test a measure of unsystematic risk, but the variances of the portfolios' residuals can be calculated from the figures he did report.[27] Recall that Sharpe's [130, 131, 132] performance measure is equal to the portfolio average return in excess of the risk-free rate divided by the standard deviation of the excess return. Multiplying the excess return times the measure and squaring this product gives the total variance of the excess return. Since this variance is equal to the sum of systematic and unsystematic risk, we can subtract from it the product of the square of portfolio beta and the variance of the market return to derive portfolio unsystematic risk. Symbolically, this is expressed

$$\sigma_e^2 = \sigma_j^2 - \beta_j^2 \, \sigma_M^2 \qquad (10)$$

If unsystematic risk is responsible for an underestimation of high-EPR portfolios' risk, then we would expect these portfolios to have a relatively high residual variance. Such is not the case. The residual variances for portfolios A, A*, and E are respectively .0271, .0279, and

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[26] Ibid.

[27] Ibid., Table I, p. 667.

.0226. In the same order, portfolio betas are 1.11, 1.06, and .99. In comparison with portfolio E, the high-EPR portfolios, A and A*, yielded, over the period tested, a lower return for assuming both higher systematic and higher unsystematic risk levels. Thus, the EPR-return relationship cannot be attributed to an underestimation of high-EPR portfolios' risk resulting from homogeneous group effects.

The Effect of Skewness on Risk Adjustment

One assumption underlying the classical CAPM approach has not yet been dealt with: returns are symmetrically distributed. The classical CAPM is based on a normally distributed return distribution fully described by its first two moments, the expected return and its variance. Given normality in returns, investors can be described as having quadratic utility functions of the form[28]

$$U(R) = V_0 + V_1 R - V_2 R^2 \tag{11}$$

where U(R) is the investors' utility in terms of return, V_0 is a constant, and V_1 and V_2 are positive constants. Taking the expectation of utility yields

$$E[U(R)] = V_0 + V_1 E(R) - V_2 E(R^2) \tag{12}$$

Since

$$E(R^2) = \sigma_R^2 + [E(R)]^2 \tag{13}$$

[28]Utility is an abstract measure of the degree of preference an investor has for a particular investment relative to his other investment opportunities.

equation (12) may be restated:

$$E[U(R)] = V_0 + V_1 E(R) - V_2 [E(R)]^2 - V_2 \sigma_R^2 \qquad (14)$$

Investors' expected utility, thus, is shown to be positively related to expected return and negatively related to risk, as measured by the variance of the expected return.[29] Given such a utility curve in expected return-variance space, a risk-averse investor selects his portfolio based on his highest feasible indifference curve's tangency with the capital market line.

While the above theory is elegant, it excludes the possibility of skewness entering into the investor's portfolio selection. Fama [39] found price-change distributions positively skewed, and Miller and Scholes [107] determined that return skewness could account for the positive relationship between unsystematic risk and return reported by Lintner [94].[30] Arditti [4] supplied the theoretical rationale for a negative relationship between return and skewness; assuming initial wealth and return constant, he approximated an investor's expected utility function using the first three terms of a Taylor Series to represent the first three moments of the investor's end-of-period wealth distribution. Given that an investor is risk averse and that his risk aversion decreases with wealth, Arditti proved that the investor "will therefore accept a lower expected return from an investment with a higher positive skewness of returns and the same variance."[31]

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[29]This derivation is found in Sharpe [131], chapter 8.
[30]See Fama [39] for a description of specific tests for skewness.
[31]See Arditti [4], p. 21.

Levy [89] criticized Arditti's approach, implying that it requires a cubic utility function which would, at higher levels of wealth, yield increasing marginal utility for wealth. Arditti [5], however, pointed out that he had assumed a general utility function in which the higher moments are simply ignored. In any case, Arditti's empirical results supported his hypothesis of a negative return-skewness relationship.

Jean [68] provided the first attempt to extend portfolio theory to three-moment analysis. The resultant capital market model was subsequently criticized by Arditti and Levy [6], who noted several theoretical problems. The model, as first stated, was consistent with a positive expected return-skewness relationship. Further, the optimal investment policy appeared to involve borrowing an infinite amount and investing in any efficient portfolio; it was not clear whether a unique and efficient market portfolio could even be identified. Jean [69, 70] extended and clarified his analysis, showing geometrically that efficient portfolios would appear on a surface in three-dimensional space; investors would then select their portfolios based on their expected return, variance, and skewness preferences. Jean's model was further developed by Simonson [135], who applied it to an analysis of mutual fund returns. However, it was Kraus and Litzenberger [81, 82] who developed the positive theory necessary for a three-moment market equilibrium model.

Kraus and Litzenberger [81, 82] first surveyed alternative utility functions. The quadratic, appropriate for the two-moment analysis of the classical CAPM, has a third moment equal to zero; it is not useful in skewness analysis. We noted previously that a cubic function exhibits properties inconsistent with the behavior of a risk-averse investor. Pratt [121] defined in general terms the properties of utility functions which characterize risk-averse investors. First, absolute risk aversion, measured by the negative of the ratio of an investor's utility function's second derivative to its first derivative in terms of wealth, refers to changes in an investor's attitude toward risk as the level of his wealth changes. A rational investor is typified by constant or decreasing absolute risk aversion. That is, he does not become more risk averse as his wealth increases. Relative risk aversion, measured by the product of the absolute risk aversion measure and wealth, is less determinate in interpretation. Tsiang [139] considered investors to be typified by increasing relative risk aversion; from their empirical work, however, Cohn, Lewellen, Lease, and Schlarbaum [33] concluded that investors tend to invest proportionally more in risky assets as their wealth increases, thus exhibiting decreasing relative risk aversion. Both Rubinstein [129] and Kraus and Litzenberger [81] developed multiperiod models based on logarithmic utility functions, which are representative of constant relative risk aversion. Comparing their model to the classical CAPM, Kraus and Litzenberger concluded:

> Empirically, the measures of market risk for the two models are close to perfectly correlated for common stocks. The logarithmic utility model and the mean-variance model should be viewed as complementary approaches that yield empirically indistinguishable predictions concerning observable rates of return on common stocks. [81:1224]

In deriving the three-moment CAPM, then, Kraus and Litzenberger [81, 82] followed a logarithmic utility approach consistent with investors' having an "aversion to standard deviation and preference for (positive) skewness."[32]

A positive economic model must be empirically verifiable. Further, the coefficients associated with its parameters must have an economic interpretation. Kraus and Litzenberger [81, 82] first determined the three-moment relationship between individual risky assets and an investor's optimal portfolio. Maximizing an investor's constrained utility function, they derived the equilibrium relationship

$$E(R_A) - R_F = -(\phi_{\sigma_W}/\phi_{E(W)})\ \beta_{Aj}\ \sigma_j$$

$$-(\phi_{m_W}/\phi_{E(W)})\ \gamma_{Aj}\ m_j \qquad (15)$$

where $E(R_A) - R_F$ is the excess return on asset (or security) A, $\phi_{\sigma_W}/\phi_{E(W)}$ and $\phi_{m_W}/\phi_{E(W)}$ are the marginal rates of substitution between expected wealth and risk measured in terms of the second and third moments of the terminal wealth distribution, where W represents wealth, and σ_j and m_j are the portfolio's second and third moments. Asset beta, β_{Aj}, has been defined earlier in this paper, but in this case measures the covariance of an individual security's returns with those of the investor's portfolio standardized by the variance of portfolio, rather than market, returns. Gamma, γ_{Aj}, is defined

$$\gamma_{Aj} = \{E[R_A - E(R_A)]\ [R_j - E(R_j)]^2\}/E[R_j - E(R_j)]^3 \qquad (16)$$

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[32] See Kraus and Litzenberger [82], p. 1087.

Gamma thus measures an asset's skewness in relation to portfolio skewness; its denominator is equivalent to m_j cubed.

Equation (15) can be extended to represent market equilibrium. Kraus and Litzenberger [81, 82] noted that two assumptions are required: first, all investors must be in agreement on the probability distributions of all assets' returns; second, all investors must exhibit the same degree of caution in selecting their optimal risk portfolio. Given these conditions, all investors hold the market portfolio, and equation (15) can be redefined

$$E(R_A) - R_F = b_1 \beta_A + b_2 \gamma_A \tag{17}$$

where β_A is defined as in equation (8), and γ_A as in equation (16) except that the systematic skewness is measured in terms of the market portfolio, which is the efficient portfolio for all investors. The coefficient attached to β_A, b_1, is equal to the marginal rate of substitution between expected wealth and its standard deviation multiplied by the standard deviation of the market portfolio's returns; it "may be interpreted as the market price of beta reduction."[33] The b_2 coefficient is similarly defined and interpreted; it is expected to be negative if the market portfolio exhibits positive skewness,and vice versa. Further, given logarithmic utility and proportional stochastic growth, wherein the higher moments of the wealth distribution change in direct proportion to the change in expected wealth, the ratio of b_1 to the market return

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[33]Ibid., p. 1088.

standard deviation, and the ratio of b_2 to the market skewness measure, m, are constant over time. Rubinstein [128] had previously shown that with constant relative risk aversion the distributions of securities' excess returns would not be stationary over time if the risk-free rate were to vary between periods. Deflating the excess returns by one plus the risk-free rate, however, yields a stationary distribution, and the return measures used to generate betas and gammas would be viewed as emerging from the same distribution. Further, Kraus and Litzenberger [81,82] showed that b_1 and b_2, when deflated by one plus the risk-free rate, may be considered "to be intertemporal constants in cross-sectional empirical tests."[34]

In testing the above model Kraus and Litzenberger [81, 82] examined portfolio ex post returns, betas, and gammas over the 414 months included in the January 1936 to June 1970 period. Cross-sectional regressions were run in each month, and the resulting coefficients averaged. The mean coefficients were then tested for significance. The model is here restated to allow the addition of a constant term and to define the variables as realized, rather than expected values:

$$R_{jT} = \hat{b}_{0T} + \hat{b}_{1T}\,\hat{\beta}_{jT} + \hat{b}_{2T}\,\hat{\gamma}_{jT} \qquad (18)$$

The results were highly supportative of the model's validity. The constant term, $\hat{b}_{0T}$, was not significantly different from zero, consistent

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[34]Ibid., p. 1090.

with the prediction of the classical CAPM. Further, $\hat{b}_{1T}$ was large, positive, and significant; moreover, it was, in magnitude, much greater than when the model was tested excluding skewness. Finally, $\hat{b}_{2T}$ was negative and significant, as expected.

The Kraus-Litzenberger [81, 82] results appear to explain the flatness of the SML noted in most earlier studies of the CAPM. Additionally, as pointed out by Lee, the exclusion of skewness from CAPM performance measures, such as Sharpe's [130, 131, 132] and Treynor's [138], would bias these measures, and thus render spurious conclusions derived from their use.[35] Recall that Basu's [11, 12] finding of a positive EPR-risk-adjusted return relationship was based on the employment of these measures.

The Kraus-Litzenberger [81, 82] results are not absolutely conclusive, however. The researchers formed their 20 test portfolios by sorting sampled securities first on beta and forming ten portfolios based on the rank of securities' betas, and then sorting the same securities on gamma to give ten other portfolios. Since their own results show high collinearity between beta and gamma, the cross-sectional independence of the portfolio variable averages is questionable. Additionally, betas and gammas were calculated using an equal-weighted, sample-specific, index. Their use of one-month intervals for measuring return skewness may be questioned, also. Arditti and Levy [7], in developing a multiperiod equilibrium model for three-moment portfolio analysis, concluded:

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[35]See Lee [87].

> Skewness is clearly a function of the investment horizon which is, in turn, determined by investors' behavior. For those investors with short investment horizons, skewness of portfolio returns can be ignored since existing empirical evidence indicates that these distributions are symmetric; however, for investors with longer horizons, the distribution's skewness may be significant. [7:799]

The Arditti-Levy model is based on each period's skewness equaling zero, with a period equal to one month. Smith [136], however, found a high degree of positive skewness characteristic of monthly returns. Resolution of the conflicting findings might lie in a consideration of portfolio efficiency. Simkowitz and Beedles [134] found portfolio skewness to diminish rapidly as portfolios were further diversified. It is not the number of securities in a portfolio that matters as much as the types of securities combined. Grouping securities on the basis of skewness rank does not result in a zero systematic skewness if security returns are skewed in monthly intervals. Simkowitz and Beedles combined securities randomly, however, in deriving their conclusion.

The most damaging testimony against the three-moment model was presented by Friend, Westerfield, and Granito [51].[36] The researchers substantially replicated the Kraus-Litzenberger [81, 82] test for the periods 1964-1968 and 1968-1973. In the first of the two periods they found beta's regression coefficient positive and gamma's coefficient negative, as did Kraus and Litzenberger. However, the coefficients were not significantly different from zero, as the t-statistics were both much less than one. In the second period, not only

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[36]Refer to Friend, Westerfield, and Granito [51], p. 914, footnote 31.

were the coefficients not significant, but also their signs were opposite what the theory predicts. It is possible that multicollinearity is responsible for the poor results; a third explanatory variable, residual standard deviation, was included in the regressions.

The Skewness-EPR Rationale

The naive rationale for a positive relationship between EPR and return is based on the premise that the higher-than-average returns associated with high-EPR securities result from atypically large returns which accrue to some number of securities in the high-EPR category; contrarily, a number of securities in the low-EPR group suffer unusually large losses, thus depressing the mean return for that category. Further, these larger-than-average returns and losses occur during the periods following the announcement, by the pertinent companies, of earnings figures that differ from those expected by investors. Two implications are apparent. First, the market is inefficient: not only are changes in earnings growth, as suggested by published earnings reports, unanticipated, but also the reported earnings information reaches investors with varying lags. Second, the return distributions of low-EPR securities are negatively skewed, while those of high-EPR securities are positively skewed.

Consider first the market efficiency argument. Ball and Brown [8], Beidleman [17], Murphy [113], and Ofer [119] found large price changes occurring in the same period as large earnings increases. This means that the large capital gains associated with an increase in earnings growth occur before the announcement of increased earnings; thus, it appears that investors do anticipate correctly the information conveyed by earnings announcements. Malkiel [100, 101] noted that the EPR is a good predictor of a security's subsequent earnings growth; this is consistent with an efficient market, as investors' revisions of expected earnings growth are expressed almost immediately in a price change. One cannot take the extreme view, however; a recent study published by Watts [141] indicated that not all information in quarterly earnings reports is discounted before publication, and abnormal returns may, in the short run, be earned by investors who purchase securities of companies having higher-than-expected published earnings. Nevertheless, the market appears to adjust rapidly to this unforeseen information, and, since Watts's study focuses only on the earnings variable, any connection to EPRs is unclear.

The second implication of the naive rational betrays an economic irrationality. If high-EPR securities exhibit positive return skewness, then they should be characterized as yielding relatively low risk-adjusted returns; a positively skewed distribution limits investors' potential losses while affording the chance of large gains. The converse would apply to negatively skewed distributions. Securities characterized by such distributions would be expected to return more to compensate for the higher risk. Thus, if skewness is of any importance in valuation, and if high-EPR securities actually yield higher returns, then, other factors equal, high-EPR securities' returns must be negatively skewed. For example, assume that investors revise upward the expected earnings growth rate of a particular security. Its price rises during the period, giving an abnormally large return; at the end of the period it is characterized by a positively skewed distribution and a lower EPR, and investors expect relatively lower future returns consistent with the lower risk they ascribe to the security. Contrarily, if the security's expected growth rate is lowered in the market, then it suffers a large decline in price and return. Its higher EPR at the end of the period is associated with negative skewness, and investors require a higher rate of return to compensate for the additional risk.

The above scenario is speculative, as must be any explanation based on conjecture. We cannot determine investors' beliefs as to the expected skewness they associate with high- or low-EPR returns. If, as Ofer [119] indicated, investors' expectations are met in the structure of ex post returns, then we would expect to see a negative relationship between EPRs and skewness; the high returns associated with high EPRs would be explained in terms of skewness risk. Our skewness rationale is meant only as an alternative to the naive rationale. While we could reject the latter if a negative EPR-skewness relationships exists, we could not accept the former. Rather, we can state categorically only that rationality requires a positive EPR-return relationship to be associated with a negative EPR-skewness relationships, given that all other risk factors are constant.

CHAPTER FOUR
EMPIRICAL TESTING OF THE
EPR-RETURN RELATIONSHIP

Data Sources and Sampling Procedure

Since this study involves a synthesis of two concepts, the EPR-return relationship and three-moment risk adjustment, we compare the analytic methods followed in this research to those followed in the Basu [12][1] and Kraus and Litzenberger [82][2] studies. The first datum of concern is the proxy for the risk-free rate. Kraus and Litzenberger used the 90-day Treasury Bill lending rate; while this provides a single discount rate, it is not compatible with the one-month investment horizon over which they determined returns. Basu used a 30-day Treasury Bill rate, but did not define his data source. For this study the monthly risk-free rate was estimated by dividing by 12 the annualized one-month-to-maturity "asked" rate on Treasury Bills. The figures were collected from microfilm editions of the Wall Street Journal published on the last business day of the month for every month in the June 1966-May 1978 period.[3] Since maturity periods vary in relation to the last business day, the rates are not all 30-day rates, but they fall in the range of 27 to 34 days.

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[1]See Basu [12] for EPR-return test method.
[2]See Kraus and Litzenberger [82] for three-moment model test method.
[3]Published in column entitled "Government Agency and Miscellaneous Securities."

Our second datum of interest is the measure of market return. Kraus and Litzenberger [82] estimated market returns, while Basu [12] used Fisher's Arithmetic Performance Index. We have noted that neither of these is a theoretically sound measure. The market return proxy used in this study was calculated from monthly price and dividend figures for the value-weighted Standard and Poor's 500 Index.[4] A potential bias exists in that the dividend index is reported only on a calendar quarter basis; adding the dividend yield to the price yield only every third month somewhat distorts the resulting market return series. Two intuitive alternatives, adding one-third of the dividend yield in each of three months, or excluding the dividend yield, are undesirable, as inspection of the total return figures showed any resultant bias to be negligible.

Kraus and Litzenberger [81, 82] collected their security return data from magnetic tape files maintained by the Center for Research in Security Prices, selecting all New York Stock Exchange listed securities for which complete data were available during each 120-month period, starting in 1926, and incrementing by 12 months, through June 1970.[5] They gave no figures for sample sizes over time, but one could predict larger samples in the later years due to the availability of data. Basu's [12] security data were picked from a tape file comprised of New York Stock Exchange industrial securities; included were

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[4]Trade and Securities Statistics, published by Standard and Poor's Corporation, Publishers (1978) in Orange, Connecticut.

[5]The Center for Research in Security Prices is affiliated with the University of Chicago.

securities delisted during the April 1956-March 1971 test period. From this universe, Basu selected securities having complete data for at least one 12-month subperiod in the test period, and a December 31 fiscal year. His samples averaged approximately 500, but included as many as 753 securities. Security data for this study, on the other hand, were gathered from the Compustat Price-Dividends-Earnings tape file compiled by Standard and Poor's Corporation.[6] Initially, securities having complete monthly price and dividend data for the 73-month period beginning in June 1966 were selected. The procedure was repeated for each June through 1972, giving seven sets of securities based on an annual selection. Securities of firms having other than a March, June, September, or December fiscal year were eliminated. Securities not listed on the New York Stock Exchange were included, as were firms having negative earnings in quarters for which EPRs would be calculated. Twelve hundred securities were subsequently selected from the first-stage samples for each of the seven sets. An IBM scientific subroutine, RANDU,[7] was used to generate the necessary uniformly distributed random numbers. In comparison with Basu's average sample, our data base contained more than twice as many securities.

The use of any security data file for empirical research requires the assumption that the data are reliable; no data base, however, is perfect, and reference to the appropriate Compustat manuals shows this to have applied in our case.[8] First, complete data are available for

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[6]The specific tape file used in this study was created on September 21, 1978.

[7]This FORTRAN subroutine is defined in [137], p. 77.

[8]See Compustat [34] and PDE Compustat [120].

fewer companies the farther back one goes in time. A potential bias exists in that companies selected for the earlier periods' testing are probably larger and older firms for which historical data are more readily available. Thus, the qualitative composition of the samples may vary temporally. Second, earnings figures on the tape file have been restated in the cases of a major change in accounting procedures; a change in the month in which a company's fiscal year ends; or, in periods in which a company has been involved in a major merger or acquisition. The annualized earnings figures used to calculate EPRs in this study might then be somewhat different from those originally calculated by investors using reported earnings. Litzenberger, Joy, and Jones [96] concluded, however, that the bias attendant to the use of Compustat earnings figures, rather than originally reported earnings, is negligible.[9] Third, Litzenberger, Joy, and Jones found that the fourth-quarter earnings figures of approximately 90 percent of their sampled companies were reported within two months of the quarter's end. Since this study assumed a July 1 portfolio formation date, it is not clear that the first-quarter earnings figures would have been reported as quickly as fourth-quarter figures generally are; the latter are, in effect, a residuum of December fiscal year companies' annual earnings. Additionally, Compustat reports only the month in which a company's fiscal year ends. The earnings figure for a company ending its fiscal year on the first day of a particular month would likely be published before that of another company ending its fiscal year on

[9]See Litzenberger, Joy, and Jones [96].

the last day of the same month. Fourth, Compustat does not include stock prices for the first day of the month; prices used in this study to calculate security returns were those existing at the end of the last business day of the previous month. Hence, they may apply, given weekends and holidays, to as many as four days prior to the beginning of the assumed investment periods. This should present no great bias, however, as the market returns and risk-free rates also are based on the last business day of the month.

The fifth problem, retroactive selection bias, deserves some discussion. Molodovsky [111] attributed the results of the naive EPR-return studies at least partially to the exclusion of failed firms from the samples tested.[10] He reasoned that failed firms would tend to have high EPRs prior to failure, and that their exclusion would bias upward the returns of high-EPR portfolios. There is, however, no assurance that failed firms would tend to cluster in the high-EPR portfolios. Rather, it is likely that some firms would have had zero or negative earnings prior to failure, and, in an arithmetic sort, be ranked in the lowest EPR portfolio. The exclusion of failed firms from one's data base will explain the positive EPR-return relationship only if failed firms tend to have positive earnings high in relation to firm market value just prior to failure; there is not a priori reason to support this proposition.

Basu [11, 12] did add failed firms to his data base. However, he assumed all proceeds from liquidation to be reinvested in Fisher's

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[10]Molodovsky [111] did not consider merged firms.

Arithmetic Performance Index, thus biasing the returns of portfolios containing failed firms toward the market return, and thereby changing their risk level. Basu also added firms which had, during his test period, been merged into other firms; he assumed the proceeds resulting from such mergers to be reinvested in the acquiring companies' securities. This is more realistic, but it still involves a change in portfolio risk. Moreover, it is inconsistent with his handling of failed firms' proceeds. To eliminate retroactive selection bias, one also would be required to exclude those companies added to his data base during the experimental period. Such companies would likely represent survivors from high-risk, high-technology industries, and would not have been available for sampling prior to their addition. These securities could be retained only if other similar, but liquidated, firms were included in the data base.

The above discussion has pointed out that adjusting for retroactive selection is somewhat arbitrary. In the context of this experiment, an examination of the Compustat file of delisted firms shows that approximately 70 firms failed during the test period. We would then expect ten failed firms to be available for sampling in each of the seven portfolio formation periods. If all of thse firms were selected in the first stage sampling on the basis of their having complete data and the correct fiscal year, then, probabilitically, fewer failed firms would appear in the more recently formed portfolios, as the number of survived firms available is much greater than in the earlier portfolio formation periods. Moreover, one would have to determine how to reinvest the proceeds from the failures while still holding constant the relative risks of the different portfolios. If these problems could be easily solved, it can be shown that, assuming an extreme, the effect of including the failed firms would be negligible. If we assume that: all of these failed firms would have been selected for analysis; one firm would have failed in each of 70 of the 84 months studied; all of the failed firms would have been included in the highest EPR portfolio; and, the return for each would have been a negative 100 percent in the month of failure, then the average return of the highest EPR portfolio would be only 1.4 percent lower. To illustrate, an average return of 12 percent would be reduced to 11.83 percent. This decline is not large enough to explain the differential return between high- and low-EPR securities found by Basu [11, 12], for example. Additionally, Ball and Watts [9] compared a fifty-year time series of earnings of a 25-security sample of firms, none of which failed during the period, to two other samples not requiring firm survival. They concluded that "there is little survivorshop bias in that the results appear quite similar among the samples."[11] Moreover, Basu found that the inclusion of failed and merged firms in his portfolios did not alter the basic EPR-risk adjusted return relationship that existed without their inclusion. Retroactive selection bias, given the above discussion, is not so important as Molodovsky [111] believed, and, as shown, the effect of omitting failed firms from the samples used in this study is insignificant. On

[11]See Ball and Watts [9], p. 198.

the positive side, our sample was not limited to December fiscal year and New York Stock Exchange listed securities, as was Basu's.

Portfolio Formation and Variable Measurement

In the foregoing section the experimental security data collection procedure was described. Twelve-hundred securities were selected for analysis in each of the seven years in the study. Security records consisted of 73 months of price, dividend, and earnings information. The first 61 months of price and dividend data were used to calculate 60 one-month returns for each of the 8,400 securities, with each return equal to the sum of the dividend paid during the month and the price change during the month divided by the price at the end of the preceding month. These 60 returns were then converted to deflated excess returns, which were used to calculate beta and gamma for each security.[12] The security records were then sorted on the basis of their EPRs in each of the seven annual subperiods. For testing the EPR-return relationship, twenty portfolios of sixty securities each were formed on the basis of EPR rank for each of the 84 months in the test period. For example, the 60 highest EPR securities in the first of the seven years included in the study had their betas and gammas calculated over the 60 months included in the July 1966 to June 1971 interval. The first 12 months of portfolio returns were then calculated as the average monthly return of the 60 securities in the portfolio for each of the 12 months included in the July 1971 to June

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[12]A deflated excess return is equal to the difference of security return and the risk-free rate divided by one plus the risk-free rate.

1972 period. The same procedure, applied to the other 1,140 securities in the first year's sample, yielded a total of 20 portfolios, each characterized by 12 returns and one EPR applicable to the first test year. Replication of the procedure for the following six test years resulted in a matrix of 84 portfolio montly returns for each of the 20 portfolios rebalanced annually on the basis of EPR. The 84 monthly returns for each porfolio were subsequently converted into deflated excess returns. Beta and gamma were then calculated for each portfolio in each month.[13] Their denominators were computed over the full 84-month period using deflated excess returns derived from Standard and Poor's 500 Indexes of stock prices and dividends. The numerators, however, were calculated over 83 months so as to exclude the portfolio deflated excess return for the month in which it would appear as the dependent variable in the cross-sectional regressions relating it to beta and gamma. Including this return would introduce a dependency between it and these measures, thus violating an assumption of the ordinary least squares model. The resulting betas and gammas were then corrected for the inequality of the number of returns in their numerators and denominators.[14]

This procedure produced 20 portfolios, ranked on portfolio EPR, for each of the 84 months included in the July 1971 to June 1978 period. The deflated excess returns, betas, gammas, and EPRs associated with

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[13]These measures were defined in Chapter Three. Refer to equations (8) and (16).

[14]For a description of this correction procedure, see Kraus and Litzenberger [82], p. 1094, footnote 12.

each of the 1,680 portfolios represent the data used to test the EPR-return relationship. A second set of portfolio data was produced to test the validity of the three-moment model. The same sample of securities, previously sorted on EPR, was divided into two subsamples. To ensure EPR homogeneity between the two subsamples, every other security was selected into the second subsample relevant to each of the seven sample years. The first subsample was sorted on the basis of the prior-period beta previously calculated for each security; ten portfolios of 60 securities were then formed. The same procedure was followed for the second subsample, except that the 10 portfolios were formed sorting on the prior-period gammas. Betas and gammas were then computed for each of the 20 portfolios in each of the 84 months in the test period using the same method as was used in developing the EPR-return test variables.

The procedures used to compute the measures of return, beta, and gamma have been described, and are essentially the same as those used by Kraus and Litzenberger [81, 82]. The measure of security EPR was defined as the sum of the quarterly earnings per share reported by Compustat for the four contiguous quarters ending with the first calendar quarter of the year of portfolio formation divided by the price per share on the last business day of the first calendar quarter. For example, the EPR applicable to a portfolio assumed formed on July 1, 1971, would have as its numerator the sum of the quarterly earnings per share reported by a company for the quarters ending in June, September, and December 1970 and March 1971. Its denominator would be the security's price at the end of the last business day of March 1971. The portfolio EPRs tested in this study were arithmetic averages of the EPRs of the 60 securities included in each portfolio. Further, portfolio EPRs were calculated only once for each 12-month investment holding period. Consider the highest EPR portfolio. Its EPR, calculated as described above, was used as a predictive variable in analyzing the monthly deflated excess returns in each month included in the July 1971-June 1972 period. The portfolio was rebalanced as of the end of June 1972, and a new EPR, calculated from March 1972 data, was used for the months included in the July 1972-June 1973 period. This procedure was repeated for every portfolio in each of the seven years included in the study.

Annual rebalancing of portfolios was followed also by Kraus and Litzenberger [81, 82], and Basu [11, 12], and is justified by four considerations. First, in testing the three-moment model and the EPR-return relationship, it is desirable that the test methods be similar to those used by these researchers. Otherwise, any comparison of their results to those derived from this study would be pointless. Second, Basu's study indicated that the EPR-return relationship is significant only after several months have passed after the deate of portfolio formation. Rebalancing portfolios on a monthly basis, besides being prohibitively expensive, would not yield a true test of the relationship. Third, annual rebalancing permitted the use of an annual earnings figure in calculating EPR for each security. A shorter rebalancing interval would have resulted in the use of an earnings figure for a shorter interval, thus introducing seasonality and non-comparability; or, an overlapping of periods used to calculate annual earnings for the same security at different points in time; or, a much smaller sample, since the avoidance of overlapping and the attendant loss of independence between interperiod EPRs would have required the exclusion of a security selected in one period from the samples representing the preceding and subsequent investment periods. Finally, rebalancing portfolios less frequently than annually would have given too much weight to economic factors prevalent at the time of rebalancing; results could be attributed to starting investment holding periods at particular times. In any case, the longer the holding period, the more likely it is that changes in portfolio EPRs would confound the original rankings, since these EPRs, over the longer term, tend to regress to the mean EPR. Therefore, annual rebalancing involves a compromise; a shorter or longer rebalancing interval potentially would have changed our research results.

Rejected Alternative Approaches

The procedures used to collect the experimental data and to prepare them for analysis have been defined and justified. In general, these procedures reflect an attempt to maintain consistency with those followed by Kraus and Litzenberger [81, 82], and Basu [11, 12]. In some cases, the results of previous research were used to justify the approach taken here. For example, the data were not adjusted for taxes, transfer costs, or retroactive selection; Basu found these factors non-explanatory of the EPR-return phenomenon. On the other hand, Basu continuously compounded his portfolio excess returns over a 14-year period, thus subjecting his analysis to the cumulative reinvestment criticism used by Molodovsky [111] to discredit certain of the naive EPR studies.[15] Neither did Basu deflate his excess returns to adjust for a changing risk-free rate over the period. This study accounted for both of the above potential biases.

Several alternative grouping procedures might have been followed in this study. For example, the data used to test the three-moment model were grouped into 20 portfolios. Johnston suggested that groups formed by sorting on only one independent variable would result in biased coefficients in a regression including two independent variables.[16] Kraus and Litzenberger [81, 82] accounted for the problem by forming ten portfolios based on the beta rank and ten portfolios based on the gamma rank of all the sampled securities. Every security in a given period appeared in two portfolios, and since gamma and beta are highly correlated, it is likely that many of the same securities in the beta ranked portfolios appeared also in the corresponding gamma ranked portfolios. Foster [49], on the other hand, divided his sample into four subsamples based on beta rank, and formed four portfolios from each subsample based on an unsystematic risk measure.[17] The resultant 16 portfolio excess returns were then regressed on both the systematic and unsystematic risk measures. The approach taken in this research

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[15]See Molodovsky [111], pp. 104-105.

[16]See Johnston [74].

[17]Foster [49] first ranked on beta for theoretical reasons.

represents a compromise between the above methods. No security appeared in more than one portfolio; by splitting the sample evenly, equal weight was given to beta and gamma in the portfolio formation process, and any loss of information attributable to the grouping procedure should be comparable to that which would have occurred using either of the above alternative grouping procedures.

Alternatives existed also in the specification of the equations to be tested and in the definition of variables. Here the results of preliminary regressions performed by this writer will be surveyed. It must be emphasized that this preliminary work was useful only insofar as it assisted in the discarding of certain possibilities suggested by previous research. Since testing was informal and of an ad hoc nature, the results are preseented in this discussion of method. As Rao and Miller [123] stated:

> When a researcher is on a "fishing expedition" he should not forget that the usual statistical properties of his estimates need not be valid at all stages of the operation. Lack of validity in such a case is not a serious limitation, because the researcher is now interested simply in "feeling out the data" and not necessarily in obtaining an estimate of a parameter. This approach is somewhat of an economic necessity; from insights thus obtained a researcher can minimize the cost of investigation by eliminating some alternative theoretical possibilities from his list of models. [123:81]

The data analyzed in these preliminary regressions were collected from a Compustat Price-Dividends-Earnings file which had been created in August, 1977; following procedures similar to those used in this research, 20 portfolios of 26 securities each were formed. Quarterly geometric mean returns were calculated for each portfolio for one, two, three, and four-quarter investment holding periods. Fourteen periods, starting with the second calendar quarter, 1973, were available for study, with the final geometric mean portfolio returns calculated over the four quarters included in the July 1976-June 1977 period. In all cases, two-tailed t-tests at the .05 level were used to determine the significance of regression coefficients. The first question addressed was: Does the EPR-return relationship change if the EPR is calculated using a price existing after quarterly earnings have been announced as opposed to the price existing at the end of the related quarter before the announcement of that quarter's earnings? Recall that Basu [11, 12] formed his portfolios, assumed purchased in April, using EPRs calculated as of the previous December. Latané, Joy, and Jones [86] on the other hand, defined EPRs in terms of earnings as of the previous December divided by price at the end of the following February. A third alternative, using even more current information, would involve the same earnings figure divided by price at the end of March, the time of investment. Given these three possibilities, three sets of portfolios were formed based on the differently defined EPRs. Portfolio geometric mean returns were then regressed on the associated EPRs, and the significant regressions enumerated and compared. Results for the three sets of regressions were substantially identical. Of the 56 regressions performed on each set of portfolios, the total number of significant positive relationships associated with EPRs formed using a security price lagged three months (set 1), lagged one month (set 2), and unlagged (set 3) were 30, 27, and 29, respectively. Moreover, given a significant regression in set 1, the probabilities of a corresponding significant regression in set 2 and set 3 were .83 and .87. These results indicate that it is irrelevant whether portfolios are formed based on EPRs calculated before or after earnings are announced. Of the three EPRs defined above, the one using the least current information yielded the most significant regressions; using a one-quarter investment holding period, EPR was significantly and positively related to return in six of 14 periods. Contrary to the EPR-return hypothesis, however, it was significantly and negatively related in two periods, and not significantly related in six. Since results for the two-, three-, and four-quarter holding periods are subject to both the cumulative reinvestment bias and the overlapping bias, they are not reported here.[18]

The second question addressed in the preliminary work served to eliminate the possibility of a quadratic EPR-return relationship. Both Nicholson [117, 118] and McWilliams [106] had noticed that in some periods both high- and low-EPR portfolios had yielded returns higher than those of average-EPR portfolios. To test for a curvilinear EPR-return relationship, regressions of portfolio return on EPR and EPR-squared were run; the required conditions, a significant negative coefficient associated with EPR and a significant positive coefficient with EPR-squared, were noted in only three of the 14 periods tested. On the speculation that negative-EPR portfolios might be responsible for the phenomenon, the regressions were replicated using only positive-EPR portfolios. The same three regressions again showed a significant

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[18]For a discussion of the "overlapping" bias, see Cheng and Deets [30].

curvilinear relationship between quarterly return and EPR. These results suggest the third question addressed in the preliminary work: Is the inclusion of negative-EPR securities in the low-EPR category responsible for the positive EPR-return relationship? To decide this regressions were run using the same portfolios that previously had yielded a significant relationship in six of the 14 periods examined. Dropping the negative-EPR portfolios from these regressions changed only one of the six coefficients from significant to not significant. Thus, five of the 14 periods still showed a positive and significant relationship between EPR and quarterly return.

In this section we examined alternative approaches to testing the EPR-return relationship. Some potential biases were discussed and deemed unimportant to this study. The portfolio formation process was compared to those followed by other researchers. Several alternative definitions of EPR were compared and found essentially equivalent relative to return prediction; additionally, it was determined that the EPR-return relationship cannot be attributed to the inclusion of negative-EPR securities in low-EPR portfolios. Finally, it was found that the relationship is not stable; in different periods examined it was curvilinear, insignificant, and even, at times, negative. Given these tentative results and conclusions, the means by which the relationship was formally tested is now defined.

Method of Analysis

The procedure followed in testing both the EPR-return relationship and the three-moment risk adjustment process is basically the same as was followed by Kraus and Litzenberger [81, 82] in their tests of the three-moment CAPM. First, the EPR-return tests are discussed. Recall that the originally selected securities' data were used to calculate four measures applicable to each of the 20 portfolios in each of the 84 months included in the study. These measures included portfolio deflated excess return, beta, gamma, and EPR. Initially, 84 cross-sectional regressions of the return measure on EPR were run; the intent was to confirm the existence, on average, of a positive relationship during the July 1971-June 1978 period. Since a positive relationship was postulated, the significance of the slope coefficients for the individual regressions was determined using the one-tail t-test at the .05 level. The significant regressions were then enumerated. The mean constant term and mean slope coefficient were then calculated over the total 84 periods, and tested for significance using, again, a one-tail t-test.[19] The t-statistics were calculated by dividing the mean of the estimated regression coefficients by its estimated standard deviation. Symbolically,

$$t(\bar{\hat{a}}_i) = \frac{\bar{\hat{a}}_i}{(\sigma^2_{\bar{\hat{a}}_i})^{\frac{1}{2}}} \qquad (18)$$

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[19]This procedure, used by Kraus and Litzenberger [81, 82] in testing the three-moment model, is valid only if the cross-sectional regression coefficients are independent over time. The coefficients are not independent, however, since the betas and gammas used as explanatory variables are, due to sampling, not constant over time, and are calculated from overlapped return data. Despite the potential for error inherent in this test procedure, it was used in this study to maintain consistency with the method followed by Kraus and Litzenberger.

where

$$\sigma^2_{\bar{\hat{a}}_i} = \frac{\sum_{T=1}^{84} (\hat{a}_{iT} - \bar{\hat{a}}_i)^2}{84(83)} \qquad (19)$$

In this illustration $\bar{\hat{a}}_i$ is the mean of the regression coefficients, $\hat{a}_{iT}$, calculated over 84 months with months indexed by the subscript, T.[20] Since theoretical signs had been postulated for all of the mean coefficients, one-tail t-tests at the .05 level were used to test all mean coefficients derived from the various cross-sectional regressions. The applicable degrees of freedom varied from 18 for the simple deflated excess return on EPR specification, to 16 for the regressions which included EPR, beta, and gamma as regressors. This same technique then was used to test the validity of the risk-adjustment process. That is, the cross-sectional regression coefficients associated with the betas and gammas of the portfolios formed on the basis of these measures were averaged, and the mean values tested for significance. This represented a substantial replication of the tests performed by Kraus and Litzenberger [81, 82] on data from a period prior to that examined in this study.

The validity of the above method is dependent on the non-violation of the assumptions underlying the ordinary least squares regression model. These assumptions apply to a population regression

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[20]The subscript, T, used to represent time period, should not be confused with the t-statistic defined in equation (18).

function, or that regression equation which would be derived if all possible observations were included in a given regression. Consider a two-variable regression equation, where the dependent variable is related linearly to only one independent, or explanatory, variable. Defining an error term as the difference between an observed value of the dependent variable and the value predicted by the regression line for a given value of the independent variable, the first assumption is that the error terms are distributed about a mean of zero. That is, the regression line passes through the mean values of the distributions of the dependent variable corresponding to each value of the independent variable. Second, the error terms at different values of the independent variable are uncorrelated. Third, the variance of the error terms at any value of the independent variable is constant. Fourth, the error terms are uncorrelated with the independent variable. Given these assumptions, and further assuming that the error terms are distributed normally, several qualities associated with sample regression coefficients may be stated. First, the coefficients are unbiased; in successive regressions, based on repeated sampling from the population, the expected value of a coefficient will equal the population value. Second, the estimated coefficients exhibit minimum variance. When these two conditions are met, the coefficients are said to be efficient. Third, the estimated coefficients are consistent. As sample sizes are increased, they converge in probability to their population values. Given the above characteristics of the estimated coefficients, we are interested also in their precision. An estimate is reliable only if the estimated coefficient is large relative to its standard error.

Now the consequences of three violations of the ordinary least squares assumptions are examined. First, multicollinearity, or linear correlation between independent variables, could destroy the precision of these variables' associated estimated coefficients. Multicollinearity is generally considered a sample phenomenon; variables which are uncorrelated in the population sense may be correlated in a particular sample, and as this correlation increases, the covariances between the estimated coefficients, and their individual standard errors, also increase. The high covariances obfuscate the effect of the individual correlated variables on the dependent, or predicted, variable. Further, the resultant inflated standard errors depress the t-statistic values. Thus, variables that are significant in a population regression may appear insignificant if multicollinearity is present in the particular sample data analyzed. At the same time, the regression coefficient of determination could be high and significant.[21] The most obvious solution to the problem involves dropping one of the correlated independent variables from the particular equation being tested. However, Rao and Miller [123] caution that dropping a variable will result in a specification bias if the signs and magnitudes of the remaining independent variables change.[22] Further, Cohen and Gujarati

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[21]The coefficient of determination is a measure of the percentage of the variance of a dependent variable that is explained by the independent variables.

[22]See Rao and Miller [123], p. 38.

[32] noted that "the conventional t-tests are valid for anything short of perfect collinearity between the explanatory variables."[23]

A second econometric problem which must be considered is heteroscedasticity; its presence results in unbiased and consistent, but inefficient, estimates of population coefficients. If, for example, the variance of error terms increases directly with a given independent variable, then the ordinary least squares estimate of the associated coefficient's standard error will be downward biased, thereby inflating its t-statistic and increasing the probability of accepting a false hypothesis. The regressions performed in this study were inspected for heteroscedasticity initially by examining plots of the residuals; in a few cases Spearman's rank correlation test was performed to determine whether or not significant heteroscedasticity was present in particular cross-sectional regressions.[24] In most regressions, however, inspection showed heteroscedasticity to not be a problem.

A third area of concern bears on the presence of spatial serial correlation in the cross-sectional regressions. The ordinary least squares model, as noted previously, is based on a zero correlation between the error terms of successive observations. If, however, the sample regression residuals are correlated, the resulting estimated regression coefficients will be unbaised and consistent, but not efficient. As with positive heteroscedasticity, the standard errors of

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[23]See Cohen and Gujarati [32], p. 346.

[24]For particulars of Spearman's test procedure, see Gujarati [58], pp. 205-206.

estimated coefficients are depressed downward, thereby inflating the t-statistics and making the acceptance of a false hypothesis more likely. Serial correlation may be due to either the omission of a significant variable from the test equation, or to a misspecification of the form of the equation. Regressions performed as part of this research were checked for autocorrelation by examining plots of the residuals for regular patterns, and by noting the frequency of significant Durbin-Watson statistics. Rao and Miller [123], however, caution that the Durbin-Watson test may falsely indicate the presence of serial correlation if outlier residuals have large values. Further, patterns in the residuals may not indicate the omission of a relevant variable unless the variable is uncorrelated with the independent variables included in the regression equation.

Additionally, the method of averaging estimated cross-sectional coefficients is questionable. There is no assurance that the coefficients' distributions remained stable or followed a normal process over the period tested. This problem was partially dealt with by examining the average coefficients over various subperiods included in the period studied, and relating the mean coefficients to market fundamentals prevalent during the subperiods.

Statement of Hypotheses

The primary hypothesis tested in this research, stated verbally, is: Portfolio EPR is not linearly related to risk-adjusted portfolio deflated excess return. This statement may be interpreted as a joint hypothesis. First, it was hypothesized that risk is fully described by beta, the measure of volatility, and gamma, the measure of skewness, and that the three-moment model, as developed by Kraus and Litzenberger [81, 82], correctly specifies the relationship of these two measures to deflated excess return. Second, it was hypothesized that the capital market is efficient; any risk information conveyed by EPR and not embodied in beta is captured by gamma. The specific equation used to test the hypothesis is:

$$R_{jT} = \hat{a}_{0T} + \hat{a}_{1T}\,\hat{\beta}_{jT} + \hat{a}_{2T}\,\hat{\gamma}_{jT} + \hat{a}_{3T}\,EPR_{jT} \qquad (21)$$

Note that equation (21) is identical to equation (18), except that EPR is included as a third explanatory variable. R_{jT} is the deflated excess return of portfolio j in month T. The $\hat{a}_{iT}$ represent the estimated regression coefficients resulting from the cross-sectional regression performed using month T data. The three explanatory variables, $\hat{\beta}_{jT}$, $\hat{\gamma}_{jT}$, and EPR_{jT} were defined previously.

Hypothesis testing proceeded as follows: Two series of cross-sectional regressions were run for each of the 84 months included in the study. The required calculations were executed using Econometric Software Package, a regression program, on the portfolio data, which were stored in a direct access data set. In the initial series, the regressions were run using only portfolio beta and gamma as explanatory variables. In the second regression series, EPR was added to the equation. The average coefficients derived from each series were then calculated and tested for significance using the method previously described. Confirmation of the hypothesis required the following results:

$\bar{\hat{a}}_0$ statistically not significant in both series of regressions; $\bar{\hat{a}}_1$ positive and statistically significant in both series, $\bar{\hat{a}}_2$ negative and significant in both series; and $\bar{\hat{a}}_3$ statistically not significant in the second series of regressions.

Three secondary hypotheses were formulated to aid in interpreting the test results. First, the validity of the three-moment risk-adjustment process was tested using data from the portfolios formed on the basis of beta and gamma, rather than EPR. The intent was to determine whether the alternative grouping criteria resulted in significantly different regression results. Second, the EPR-deflated excess return relationship was examined to determine its average direction and significance during the test period:

$$R_{jT} = \hat{a}_{0T} + \hat{a}_{3T}\ EPR_{jT} \qquad (22)$$

The coefficients were averaged and tested in the same manner as were those resulting from the previously discussed regressions. Third, the relationship between EPR and gamma was explored. This served two purposes: to show the degree of collinearity between the two variables, and to determine the direction of the relationship. Although regressions were run for each of the 84 months tested, only those coefficients derived from the regressions applicable to one particular month in each of the seven years were averaged and tested for significance. With annual rebalancing, the regressions of gamma on EPR would be substantially identical for each 12 months of that period. Thus, only the estimated coefficients applicable to the first month (July) of the holding period, and, in a separate test, those applicable to the last month (June), were tested. The regression equation which provided the estimated coefficients, $\hat{d}_{iT}$, is

$$\hat{\gamma}_{jT} = \hat{d}_{0T} + \hat{d}_{1T}\, EPR_{jT} \tag{23}$$

A negative and significant $\bar{\hat{d}}_1$ would be supportive of the skewness rationale for the high EPR-high return phenomenon.

Coefficients from the above regressions were tested also for average significance during four non-overlapping subperiods of 21 months each. Market conditions for the same subperiods were examined and related to the test results. The gamma-EPR regressions were excluded from subperiod testing; such testing would have proved superfluous. Over-all, testing of subperiod relationships was valuable mostly insofar as it allowed an estimate of the stability of the hypothesized relationships during the whole seven-year period.

CHAPTER FIVE
EMPIRICAL RESULTS AND THEIR IMPLICATIONS

Returns and EPRs with Three-Moment Risk Adjustment

Direct testing of the primary hypothesis was conducted following the procedure outlined in the previous chapter. Eighty-four cross-sectional regressions of the form defined by equation (21) were run; the average regression coefficients were then tested for significance. Recall that in this complete model $\hat{a}_{0T}$ represents the constant term, and $\hat{a}_{1T}$, $\hat{a}_{2T}$, and $\hat{a}_{3T}$ are coefficients associated respectively with portfolio beta, gamma, and EPR in each month T. The regressions were then replicated using the same data, but including only beta and gamma as explanatory variables. The same testing procedure was applied to the coefficients resulting from this reduced model. Mean coefficients, their t-statistics, and the average coefficient of determination ($\bar{r}^2$) associated with each model specification are presented in Table 1. The critical t-statistic for a one-tail test at the .05 level applicable to the reduced model is 1.740, and for the complete model, 1.746.[1] Given our criterion for hypothesis acceptance, none of the null hypotheses can be rejected. Contrary to theory, the constant term in both models is relatively large; if we had tested at the .10 rather than the .05 level, both would be significantly greater than zero. Moreover, the

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[1]See Chou [31], p. 864.

coefficient relating beta to deflated excess return has the wrong sign in both specifications of the model. The mean coefficients associated with gamma have the correct sign in the sense that the deflated excess returns of the market proxy exhibited positive skewness during the test period.[2] Neither, however, is significant. The only average coefficient to emerge as expected is that attached to EPR; its lack of significance, nevertheless, cannot be attributed to three-moment risk adjustment.

TABLE 1

RESULTS OF REGRESSIONS OF DEFLATED EXCESS RETURNS ON BETA, GAMMA, AND EPR

Coefficient Mean	Reduced Model	Complete Model
$\bar{\hat{a}}_0$	.0158 (1.65)[b]	.0251 (1.71)
$\bar{\hat{a}}_1$	-.0073 (-.66)	-.0139 (-1.17)
$\bar{\hat{a}}_2$	-.0009 (-.26)	-.0023 (-.65)
$\bar{\hat{a}}_3$		-.0157 (-.84)
$\bar{r}^2$[a]	.243	.321

[a]Average coefficient of determination of 84 cross-sectional regressions.

[b]The t-statistics appear in parentheses below the associated regression coefficients.

[2]The cube root of the third moment of the market return proxy used in this study was, over the whole 84-month period, +.035.

Now some possible reasons for these generally negative results will be discussed, focusing on the complete model. First, serial correlation in the cross-sectional regression residuals represents a possible problem. A visual inspection of plotted residuals of the individual regressions revealed no consistent pattern. Further insight, nonetheless, may be provided by classifying the regressions on the basis of their Durbin-Watson statistics and noting the frequencies. This has been done in Table 2.

TABLE 2

SPATIAL SERIAL CORRELATION IN COMPLETE MODEL REGRESSIONS

Correlation	Durbin-Watson Statistic: Critical Range at .05 Level	Number of Regressions
Positive	0 - 1.00	8
Indefinite Positive	1.01 - 1.68	37
None	1.69 - 2.32	29
Indefinite Negative	2.33 - 3.00	10
Negative	3.01 - 4.00	0

The above tabulation indicates the possibility of positive serial correlation in more than half of the 84 regressions. However, the problem is irrelevant; the number of significant regressions which exhibit theoretically correct signs is only six. Thus, no inflation of t-statistics is apparent; rather, there are too many insignificant regressions. Since the approach in this research involved the testing of average coefficients, we can eliminate serial correlation as a confounding factor.

A second problem could result from the presence of heteroscedasticity in individual regressions. Visual inspection of the residuals of complete model regressions showed a tendency for large outliers to be associated with low-EPR portfolios.[3] Several regressions were selected randomly and tested, with mostly negative results. The regression for August 1976 is typical of those which did exhibit heteroscedasticity. The corresponding t-statistics appear in parentheses below their associated regression coefficients:

$$\hat{R}_{j,62} = \underset{(.54)}{.0264} - \underset{(-2.11)}{.0879}\,\hat{\beta}_{j,62} + \underset{(2.19)}{.0301}\,\hat{\gamma}_{j,62} + \underset{(1.92)}{.0901}\,EPR_{j,62}$$

The subscript 62 designates the sixty-second month of the study. The coefficient of determination, .584, is supported by a significant F statistic, 7.49. If we were testing only on the basis of this month's regression, we could not reject results contrary to theory; all of the variable-associated coefficients are significant in the wrong direction. To test for heteroscedasticity, Spearman's correlation coefficients were calculated between the residual ranks and those of the independent variables. Results appear in Table 3.

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[3]An outlier is a regression residual which has an absolute value much larger than those of the other residuals generated by the regression.

TABLE 3

HETEROSCEDASTICITY IN CROSS-SECTIONAL REGRESSION FOR PERIOD 62 (AUGUST 1976)

Variable	β	γ	EPR
Sum of Squared Differences	649	1116	1996
Spearman's Coefficient	.512	.161	-.501
t-Statistic	2.53	.69	-2.46
Residual Standard Deviation (1-10)	.0016	.0041	.0038
Residual Standard Deviation (11-20)	.0038	.0042	.0016

It is apparent from the above that the variance of residuals for this sample varies directly with β and inversely with EPR. The significance of the regression coefficients could be attributed to the resulting deflation of their standard errors. The standard deviation of the residuals associated with the ten lowest beta values is less than half of the residuals associated with the ten highest beta observations. The converse is true for EPR-ranked observations. This evidence is not strong: first, the sample size is small; second, heteroscedasticity affects the precision of individual coefficients, but does not induce bias. Given our assumption of stable coefficient distributions over time, the resulting mean coefficients will be unbiased. Further, as noted with serial correlation, our problem does not lie in falsely accepting the hypothesized positive relationship between beta, and negative relationship between gamma, and deflated excess return.

A third econometric problem, that of multicollinearity, could also present problems in the cross-sectional regressions. Average simple correlations between beta and gamma, beta and EPR, and gamma and EPR were .77, -.82, -.85 over the 84-month period, and the correlations were fairly stable between periods. This stability can be attributed to the method used, as EPR, beta, and gamma were by design constructed to be stable over time for individual portfolios. Recall that one effect of multicollinearity is that it obfuscates the significance of individual regression coefficients. One might get a high coefficient of determination and a significant F statistic in a particular regression in which none of the coefficients is significant. Thus, an average of coefficients not significantly different from zero might also be close to zero. The problem is compounded when the signs of coefficients in individual cross-sectional regressions are opposite the expected, as these coefficients, if large, not only cancel the effect of coefficients having the correct sign, but also increase the variance of the mean coefficient, thereby increasing the likelihood of accepting a null hypothesis. On the other hand, simple linear correlations between independent variables do not necessarily indicate a confounding degree of multicollinearity. Kraus and Litzenberger [81, 82], for example, found a high correlation between beta and gamma, yet their results strongly supported the three-moment CAPM. Moreover, a given coefficient could be statistically equal to zero in all cross-sectional regressions, yet its mean could be highly significant. While the Kraus-Litzenberger results could possibly be attributed to a less strong instance of this phenomenon, our results cannot. In 22 of 31 significant regressions involving the complete model the sign of the coefficient attached to beta is negative; in 11 of these 22 regressions the signs of the coefficients attached to gamma and EPR are both positive; and in nine, both negative. Given a strict binary taxonomy of coefficient signs and three variable-associated coefficients, eight possible combinations of coefficients emerge. Significant regressions were found in seven of these eight possibilities. It therefore appears that the relationships postulated by the complete model are highly unstable even for the 37 percent of the regressions that were significant. This instability is discussed further in the context of subperiod analysis.

Analysis of Model Components

In this section three hypotheses are examined which supported our general approach to the EPR-risk adjusted return problem. The first hypothesis is: Deflated excess returns were positively related to EPRs during the period tested. Regressions were run using, again, the same portfolio data as used in testing the primary hypothesis with only EPR included as the independent variable. The resultant estimator, expressed in terms of its mean coefficients, was

$$R_{jT} = \underset{(.87)}{.0065} + \underset{(.42)}{.0062}\, EPR_{jT}$$

The above equation indicates that, on average, the EPR-return relationship, as defined in this study, did not exist during the test period.

While the slope coefficient is positive, it is not significantly different from zero. The mean coefficient of determination of all 84 regressions was a relatively small .170. Furthermore, 12 of the 33 significant regressions showed a negative relationship; considering all 84 cross-sectional regressions, the slope coefficient was negative in 39 percent of the cases.

Having failed to show the existence of a positive EPR-return relationship that between EPR and gamma during the same period will now be examined. It was suggested early in this paper that high-EPR securities should earn more than low-EPR securities if their return distributions are characterized by negative or low systematic skewness relative to that of the low-EPR securities' return distributions. The negative correlation between gamma and EPR over the period has already been noted, as have the difficulties involved in testing the relationship. Only the mean coefficients resulting from regressions performed for July of each of the test years are included in the below estimated equation. As expected, the t-statistics are highly significant:

$$\gamma_{jT} = \underset{(51.78)}{1.75} - \underset{(-7.92)}{3.37}\, EPR_{jT}$$

Thus, the evidence is supportive of the skewness explanation for a positive EPR-return relationship; similarly, one would expect lower returns to accrue, on average, to low-EPR securities since their returns are characterized by high positive skewness. Thus, the evidence presented here indicates that the naive explanation should be rejected.

Additionally, the above result fortifies our earlier observation of high collinearity between EPR and gamma.

A third area to be examined in this section involves the validity of the three-moment risk-adjustment process itself. The three-moment CAPM was tested using the portfolios formed on the basis of security beta and gamma, rather than EPR. Results of these regressions, compared to the results of the Kraus-Litzenberger [81, 82] and Friend-Westerfield-Granito [51] studies, are set forth in Table 4. For ease of comparability, the mean coefficients are expressed in percentages, as are those of the other three studies. On average, the coefficients associated with beta and gamma were not significantly different from zero. Further, they both had signs opposite to what the three-moment theory predicts. Only three notable points differentiate the results of this test from those achieved in testing the reduced model: the constant term is not significant; the coefficient associated with gamma is positive, opposite to what the theory predicts; and, the average coefficient of determination, $\bar{r}^2$, is approximately 50 percent higher. The coefficient associated with beta is negative in both this test and the complete model test; thus, its negativity cannot be attributed to the aggregation of securities on the basis of EPR. Hence, the results of this test of the three-moment CAPM do not conform to theory. Rather, they are very close to those of the Friend-Westerfield-Granito study for the 1968-1973 period; those researchers included in their regressions a measure of unsystematic risk whose average coefficient, designated by $\bar{\hat{a}}_4$, is also reported in Table 4.

TABLE 4

COMPARISON OF THREE-MOMENT MODEL
REGRESSION COEFFICIENTS

Researcher	Period	$\bar{\hat{a}}_0$	$\bar{\hat{a}}_1$	$\bar{\hat{a}}_2$	$\bar{\hat{a}}_4$	$\bar{r}^2$ [d]
Kraus-Litzenberger[a]	1936-1970	-.11 (-.32)[c]	1.12 (2.23)	-.21 (-1.91)		.45
Friend-Westerfield-Granito[b]	1964-1968	-1.95 (-.18)	.82 (.11)	-.01 (0)	37.75 (1.65)	.55
	1968-1973	.92 (1.09)	-.87 (-.09)	.13 (.02)	-10.05 (-1.32)	.22
Feller	1971-1978	.64 (1.26)	-.16 (-.17)	.02 (.07)		.37

[a]See [82], p. 1096, Table II.

[b]See [51], p. 914, footnote 31.

[c]The t-statistics appear in parentheses below the associated regression coefficient.

[d]Average coefficient of determination of cross-sectional regressions.

To this point the test results have been contrary to those expected. Neither the positive EPR-return relationship nor the return-generating process represented by the three-moment CAPM appears to have been valid during the period tested. In the following section the behavior of these relationships during various subperiods is examined.

Analysis of Subperiods

The 84-month period over which the data were analyzed included four distinct market phases. Thus, four subperiods of 21 months each were used to determine whether any of the hypothesized relationships were significant contingent on a particular configuration of market conditions. Results of this analysis are not to be generalized; rather, they are to be considered an aid in understanding the results previously presented.

Table 5 defines the ranges of the subperiods and provides a synopsis of the relative level of market-related variables in each interval. Subperiod I may be termed a normal growth period. The annualized average market return was approximately 10 percent; the proxy for the risk-free rate was comparatively low, and negatively correlated to monthly movements in the market return index. Stock prices, on average, rose nearly 12 percent during the period, and were fairly high compared to reported earnings. Subperiod II provides a classic bear market pattern. Interest rates and EPRs rose as stock prices declined sharply. The average monthly return of the market portfolio proxy was negative. The third subperiod, contrarily, typifies

TABLE 5

MARKET STATISTICS FOR FOUR SUBPERIODS

Subperiod	Months	$\overline{R}_F$ [a]	$\overline{R}_M$ [b]	Correlation between $(R_F:R_M)$	$\overline{EPR}_M$ [c]	Market Index Price Growth[d]
I	Jul. 1971-Mar. 1973	.0033	.0082	-.34	.0561	.119
II	Apr. 1973-Dec. 1974	.0058	-.0178	-.26	.0981	-.385
III	Jan. 1975-Sep. 1976	.0041	.0250	.12	.0894	.535
IV	Oct. 1976-Jun. 1978	.0042	0	.19	.1094	-.092

[a]Mean monthly return of one-month-to-maturity Treasury Bills during subperiod.

[b]Mean monthly return of Standard and Poor's 500 stocks during subperiod.

[c]Mean earnings-price ratio of Standard and Poor's 500 stocks during subperiod.

[d]Percentage change in Standard and Poor's 500 Price Index during subperiod.

a bull market following an abrupt recovery. Interest rates and EPRs fell, while stock prices rose, on average, more than 50 percent. The mean monthly return on the market proxy was a healthy 2.5 percent. Subperiod IV denotes a period of stagnation, or zero growth. Stock prices generally fell, but dividend yields were adequate to cancel the negative price yields and give an average market return of zero. EPRs were, on average, nearly twice as high as in the first subperiod, but interest rates remained at the same level as in the third subperiod.

Table 6 gives a summary of subperiod regression results. The average coefficients and their t-values have been calculated in the same manner as those relevant to the whole 84-month period. Our first observation is that in only two instances is a coefficient significant. In the complete model the coefficient associated with systematic skewness in the second subperiod is negative and significant, as hypothesized; in the same model and subperiod, however, that associated with beta is negative and not significantly different from zero. For the third subperiod, the coefficient attached to beta in the complete model regressions is, contrary to theory, negative and significant. Gamma and EPR had no explanatory validity, on average, during this period, so this result is even more confusing. In a market characterized by very high returns, one would expect the highly volatile securities to have proportionally higher returns. Our results indicate the contrary; in general, the less volatile securities earned comparatively more.

Our second general observation is that the explanatory power of the models, measured by mean coefficients of determination, varies

TABLE 6

AVERAGE REGRESSION COEFFICIENTS OF EPR-SORTED PORTFOLIOS IN SUBPERIODS

Subperiod	Model	$\bar{\hat{a}}_0$	$\bar{\hat{a}}_1$	$\bar{\hat{a}}_2$	$\bar{\hat{a}}_3$	$\bar{r}^2$ [b]
I	Reduced	.0067 (.34)[a]	-.0023 (-.12)	-.0042 (-.65)		.369
	EPR Only	-.0034 (-.32)			.0181 (.38)	.283
	Complete	.0019 (.11)	.0007 (.04)	-.0035 (-.89)	.0095 (.21)	.422
II	Reduced	-.0001 (0)	-.0111 (-.44)	-.0090 (-1.11)		.218
	EPR Only	-.0260 (-1.58)			.0294 (1.17)	.117
	Complete	.0375 (1.19)	-.0354 (-1.27)	-.0140 (-1.82)	-.0565 (-.128)	.297
III	Reduced	.0610 (3.19)	-.0358 (-1.68)	.0100 (1.42)		.194
	EPR Only	.0376 (1.98)			-.0114 (-.56)	.164
	Complete	.0765 (1.79)	-.0467 (-1.88)	.0064 (.68)	-.0285 (-.77)	.320
IV	Reduced	-.0045 (-.27)	.0205 (1.00)	-.004 (.07)		.191
	EPR Only	.0176 (2.13)			-.0115 (-.91)	.117
	Complete	-.0150 (-.77)	.0256 (1.22)	.0020 (.37)	.0129 (.70)	.245

[a]The t-statistics appear in parentheses belowthe associated regression coefficient.

[b]Average coefficient of determination for 21 cross-sectional regressions.

varies greatly from subperiod to subperiod. Over-all, the models best explain the variance of deflated excess returns in the first subperiod, that of normal growth; additionally, the signs of the complete model's coefficients are as dictated by theory, but none of these coefficients is significant. The EPR-return relationship is positive in the first two subperiods, negative in the last two, and not significant in any of the four. The EPR's highest coefficient, and highest coefficient t value, appear in subperiod II, when the market was in its bear phase. The addition of EPR to the reduced model during this subperiod resulted in its coefficient's sign changing from positive to negative; moreover, the coefficient associated with systematic skewness was inflated such that it became significant. The negative coefficient associated with beta, in absolute terms, tripled, yet remained not significant.

Further discussion of the subperiod analysis would prove redundant. In no case did the models yield evidence supporting the hypothesized relationships. Thus, we conclude that the EPR-return relationship did not, in a statistical sense, exist during any of the subperiods tested. Similarly, the risk-adjustment process failed to correctly measure risk. A further look at the three-moment risk-adjustment model is warranted. Table 7 summarizes the subperiod results. In subperiod I, that of normal growth, the explanatory power of the model is highest; nearly 50 percent of the variance of deflated excess returns is, on average, explained. However, the coefficients have signs contrary to three-moment CAPM theory, and the constant term

TABLE 7

AVERAGE REGRESSION COEFFICIENTS OF BETA- AND GAMMA-SORTED PORTFOLIOS IN SUBPERIODS

Subperiod	$\bar{\hat{a}}_0$	$\bar{\hat{a}}_1$	$\bar{\hat{a}}_2$	$\bar{r}^2$ [a]
I	.0162 (1.79)[b]	-.0274 (-1.53)	.0082 (1.91)	.477
II	.0003 (.02)	-.0273 (-1.10)	.0004 (.05)	.413
III	.0109 (.96)	.0311 (1.60)	-.0076 (-.93)	.325
IV	-.0017 (-.31)	.0172 (1.59)	-.0002 (-.04)	.283

[a]Average coefficient of determination for 21 cross-sectional regressions.

[b]The t-statistics appear in parentheses below the associated regression coefficient.

and coefficient of systematic skewness are both statistically significant. None of the coefficients for any other subperiod is significant. Although the coefficient signs conform with theory in subperiods III and IV, it must be inferred that the model was invalid for the subperiods tested.

Conclusions and Suggestions for Further Research

This research has yielded results which conflict with those of previous studies. The EPR-return relationship did not exist in any subperiod whether returns were risk adjusted or not. Several possible explanations are suggested. First, the period examined is relatively short; on the other hand, Basu [11, 12], Dreman [35], and others found the positive EPR-return relationship in periods of comparable length. Second, in collecting the samples securities were excluded only if data were insufficient to calculate the measures used in the analysis or if companies' fiscal years ended in a month other than those designating a calendar quarter. Basu's exclusion of certain categories of securities has already been discussed. Dreman's sample was also limited; only industrial securities listed on the New York Stock Exchange were included; more significantly, all securities having an EPR of .0133 or less were eliminated. If Dreman's procedure had been followed in this research, the samples would have been decreased at least 10.4 percent in each period tested, and as much as 25.6 percent in the seventh year of the study. Dreman's results, therefore, are founded on a biased sample.

A consideration of testing intervals is of interest, also. Basu's [11] study was performed over the April 1957-March 1971 period, during which the Standard and Poor's 500 Price Index grew at an annualized average rate of 6 percent. Dreman [35] indicated two beginning dates, August 1967 and August 1970, and one terminal date, August 1976, in defining his study periods. During the longer of the periods the index rose at a relatively low rate of 1 percent; during the second it rose at an annualized rate of 5 percent. Unlike our study, which covered a period wherein stock prices declined at an average rate of 1 percent per year, the Basu and Dreman studies were performed over periods in which stock prices increased; moreover, both of these studies terminated at a time when the general level of stock prices was at a local maximum.

Further, the Basu [11] and Dreman [35] results must be attributed at least partially to the cumulative investment bias. This research was directed toward determining the existence, on average, of a positive EPR-return relationship, whereas Basu and Dreman were primarily testing whether, with reinvestment, high-EPR securities have higher returns, on average, than do low-EPR securities. The distinction is critical, and demonstrable. Hypothetical data used in the below example are provided in Table 8. Assume that five portfolios are ranked on EPR as in the first column of the table, and that the monthly return of each portfolio in each of the first eleven months is .001. If return is regressed on EPR in each of the 11 months, the resultant slope coefficient is obviously zero. Regressing portfolio return in month 12

TABLE 8

HYPOTHETICAL DATA FOR CUMULATIVE REINVESTMENT BIAS EXAMPLE

EPR	Return in Months 1-11	Return in Month 12	Geometric Sum 12 Months' Returns	Geometric Mean 12 Months' Returns	Geometric Sum Compounded 14 Years
.01	.001	0	.0111	.00092	.167
.02	.001	.004	.0151	.00125	.233
.03	.001	.006	.0171	.00141	.268
.04	.001	.008	.0191	.00158	.303
.05	.001	.010	.0212	.00175	.341

on EPR yields a slope coefficient of .24; its t value at the .05 level is 13.42, much greater than the value of 2.35 required for significance. Moreover, if one regresses either the geometric sum or geometric mean of the 12 months' returns on EPR, one finds in the former case a slope coefficient of .242 ($t = 13.86$), and in the latter case a coefficient of .020 ($t = 13.89$). Further, if one compounds the monthly geometric mean returns over 14 years, the number of years analyzed in Basu's study [11], the terminal return of the high-EPR portfolio is more than twice that of the low-EPR portfolio.

During the 84-month period of this study, the EPR-return relationship was significant and positive in only 21 months. Nine of those months occurred in the first subperiod studied, when the market as a whole experienced normal growth. On the other hand, a significant negative relationship was found in three months of the same subperiod. It is of interest, then, to observe the relationship, if any, between EPR significance and market return. The significant regression coefficients were cross-classified on the basis of their positivity and negativity, and on the basis of the market return proxy's positivity or negativity during the same month. Theoretical values for each of the four cells were determined, and a corrected chi-square statistic calculated.[4] The statistic value, 4.21, was less than the table statistic, 6.33, necessary to reject a null hypothesis at the .01 level. We can conclude with 99 percent certainty that, given our sample, the

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[4]The chi-square test procedure is in Chou [31], pp. 551-553.

direction of the EPR-return relationship was independent of the direction of the market return in any month in which the relationship was significant. To check for clustering of significant positive EPR-return relationships, a runs test was performed based on the significance of coefficients in months succeeding those in which a positive significant relationship was found.[5] The calculated z statistic, 1.45, was less than the critical value, 1.68, required for rejection of the null hypothesis at the .05 level. Thus, the evidence supports the position that the positive EPR-return relationship occurs randomly, and is not dependent on any particular direction of market movement.

Explaining the failure of the three-moment CAPM to correctly assess risk during the test period is somewhat more difficult. It may be that the market return proxy used in this study better represents the unique efficient market portfolio than does the equal-weighted index used by Kraus and Litzenberger [81, 82]. This, however, is conjectural since the composition of the true market portfolio is unknown.

The results of this study are based on a period much shorter than that studied by Kraus and Litzenberger [81, 82]. Recall that the Friend-Westerfield-Granito [51] results for the 1968-1973 period are very similar to those found in this study for the 1971-1978 period. It may be that the return-beta-gamma relationship is unstable, and

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[5]See Chou [31], p. 539.

variable in shorter periods, or it may be that secular economic changes have fundamentally altered the hypothesized relationship such that, on average, ex post returns run contrary to expectations. The Kraus-Litzenberger results are, after all, derived from a period characterized by a 30-year bull market. Contrarily, the last decade has been typified by relatively high inflation, lower productivity, and an energy crisis. An increase in uncertainty, abetted by an increase in the frequency of potentially catastrophic economic events, has resulted in investment values following a pattern reminiscent of a sine wave. Return distributions, then, are not likely so stable as was the case during the period studied by Kraus and Litzenberger. Thus, uncertainty about the course of market values in general, and about the relationship between individual assets and measures of the general market level, has perhaps diminished the value of the historical information used to calculate volatility and skewness measures. Conceivably, unsystematic risk will receive more emphasis in future research. The essential problem, however, lies in the diversity of empirical methods available to the researcher; different methods, applied to the same research problem, yield conflicting results. Similarly, diverse definitions of a particular problem lead to diverse conclusions.

As for our problem, none of the inferences derived from this research yields a strong conclusion. We conclude that the risk-adjustment process exemplified by the three-moment CAPM is an invalid estimator of ex post returns during the interval tested. I can offer no alternative theoretically sound model for investment risk assessment.

Likewise, I cannot affirm that EPR is a proxy for return skewness. In the period tested, and in all four of the subperiods, the market index returns exhibit positive skewness, and none of the portfolios tested is characterized by a negative gamma. On the other hand, low-EPR portfolios are characterized by high positive skewness in their return distributions. If market returns had been negatively skewed, then these same securities would have been typified by a greater degree of negative skewness. Since gamma measures portfolio skewness in relation to market skewness, symmetry in portfolio skewness is categorical if market return skewness measures alternate in sign from period to period. Thus, the assumption of stability in the relationship between security or portfolio return skewness and that of the market over time represents an antinomy with the proposition that the market is efficient in regard to information dissemination. I suggest only what is self-evident; beta and gamma summarize historical information, whereas EPR measures current information. The historical might well be irrelevant, and the current based on either misinformation or spurious expectations. Future research must be directed toward explaining why the elegant capital asset pricing theory and why the EPR-return empirical phenomenon are valid predictors of investment value in some periods, and invalid predictors in others. Specifically, return distributions of securities ranked by EPR must be examined at different points in time, rather than on average over time. Such examination would include procedures for risk assessment based on measures of total volatility and absolute skewness rather than their market-related counterparts; and, individual securities' return distributions would be examined for changes between periods. This, however, will be accomplished in a future project.

Summary

This final chapter presents the research results and the conclusions inferred from them. First, we conclude that, for the period tested, the three-moment extension of the capital asset pricing model does not explain the structure of realized security returns; portfolio deflated excess returns, on average, are not significantly related to the measures of either portfolio volatility or portfolio skewness. Second, we conclude that, for the period tested, portfolio mean earnings-price ratios do not explain the structure of realized portfolio deflated excess returns, whether these returns are adjusted for risk, or not adjusted for risk. Third, we conclude that there exists a theoretically sound justification for lower-than-average returns to be associated with securities typified by low earnings-price ratios; if non-skewness risk is held constant, then such securities are less risky because their return distributions exhibit greater-than-average positive skewness. This third conclusion is somewhat attenuated when we consider the irrelevance of both skewness and earnings-price ratios in the prediction of equity returns.

We can only speculate on reasons for the three-moment model's failure to correctly estimate investment returns. It is possible that the data collected for the relatively short period covered in this research are atypical; or, perhaps, given the fundamental economic changes that occurred during the test period, the model is an invalid specification of the risk-return relationship. The positive association between earnings-price ratios and returns found by other researchers may be attributed to their failure to adjust for sampling bias; period-selection bias; and, cumulative reinvestment bias. Our finding of an inverse relationship between earnings-price ratios and the skewness measure is, perhaps, the most definitive; it allows us to reject the naive rationale for a positive relationship between earnings-price ratios and equity returns. Nevertheless, our three conclusions are suggestive of a fourth: further research is necessary to resolve the interconnection between risk and return, and to determine the pertinence, if any, of earnings-price ratios to the return-generating process.

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BIOGRAPHICAL SKETCH

James F. Feller was born in South Bend, Indiana, on October 15, 1942, and lived in Mishawaka, Indiana, until September 1959, when his family moved to Orlando, Florida. Following his graduation from high school in June 1960, he enlisted in the United States Air Force; three years of his enlistment were spent with the Fifth Air Force in Japan. Following his release from active duty, Dr. Feller returned to Florida, where he worked as a medical technologist. He spent most of 1966 in Australia, working as a laborer. In December 1966, he returned to the United States, enrolled in the University of South Florida, and graduated in December 1968, having earned the degree of Bachelor of Arts. Dr. Feller subsequently moved to Jacksonville, Florida, to take a position with the Prudential Insurance Company of America; his duties included systems analysis and computer programming. In September 1970, he entered the graduate program of the College of Business Administration of the University of Florida. Dr. Feller received the degree of Doctor of Philosphy in August 1979. He currently resides in Tampa, Florida, with his wife, Patricia Ann, and son, Frank Erik.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

William M. Howard, Chairman
Professor of Insurance and Finance

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Fred D. Arditti
Professor of Economics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Steven Manaster
Assistant Professor of Finance

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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This dissertation was submitted to the Graduate Faculty of the Department of Finance in the College of Business Administration and to the Graduate Council, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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