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The relationship between portfolio theory and the efficient market hypothesis

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INTRODUCTION

Recent issues of *The Investment Analysts Journal* have dealt independently with portfolio theory and the efficient market theory.[2] Portfolio theory and the efficient market hypothesis are not unrelated although of independent origin. In this paper the relationship which exists, the interdependence and compatibility, of these two important areas of study, is briefly discussed.

THE NATURE AND ORIGINS OF THE EFFICIENT MARKET HYPOTHESIS

The origins of portfolio theory are to be found in the concepts of probability, risk and utility. Inasmuch as modern developments in these concepts, such as the work of Von Neumann and Morgenstern,[3] owe a great deal to the famous treatise by Bernoulli,[4] so modern developments in the concept of efficient markets owes much to an equally significant work by Bachelier.[5]

Louis Bachelier's study of commodity prices led him to the conclusion that they followed a 'random walk', although he did not use this specific term. He presented convincing evidence that commodity speculation in France was a 'fair game' in that neither buyers nor sellers could expect to show a profit. In other words, the current price of a commodity is an unbiased estimate of its future price. As has been so aptly stated – "Bachelier's earlier work was pregnant with meaning for investors, but the gestation period was one of the longest on record".[6]

It was not until 1958, fifty-eight years later, with the presentation of Osborne's paper,[7] that modern work on the 'random walk' theory appears, although during that period the independent works of Kendall and Working writing in another context had some bearing on the topic.[8]

Osborne, a physicist, examined the numbers representing share prices and compared their movements with those that characterise the movements of tiny particles suspended in solution–known as 'Brownian motion'. As he stated:

"It is the purpose of this paper to show that the logarithms of common-stock prices can be regarded as an ensemble of decisions in a statistical steady state, and that this ensemble of logarithms of prices, each varying with the time, has a close analogy with the ensemble of co-ordinates of a large number of molecules. We wish to show that the methods of statistical mechanics, normally applied to the latter problem, may also be applied to the former."[9]

Osborne concludes that his paper "shows the essence of risk-taking consequent to the expectation of a gain, how the gain should be measured, and the symmetrical properties of the stock market as a market both for stocks and money, as a fair meeting ground between buyers and sellers."[10]

One year later, 1959, an article by Roberts represents another work in the modern development of the theory.[11] Roberts in his article gives credit for the earlier works by Kendall and Working and gives as the main reason for his paper "a call to the attention of financial analysts' empirical results that seem to have been ignored in the past, for whatever reason, and to point out some methodological implications".[12] He discusses what he terms 'The Chance Model' as developed by Kendall and concludes that stock price patterns familiar in 'technical analysis' could be generated by using random numbers. In other words he, like Osborne, suggested that movements or changes in stock prices were random. The work by Osborne and Roberts stimulated academics to test empirically this 'random walk' theory of stock market behaviour and papers published in the early sixties by Moore (1962),[13] Granger and Morgenstern (1963),[14] Fama (1965),[15] and others,[16] substantiated their findings.

Only insignificant departures from randomness were found. This significant and controversial development was largely ignored by the practitioners in the financial community despite the 'call to their attention' by Roberts, endorsed by the others cited. These early investigations provided evidence that successive price changes, in securities, are substantially independent. They were tests of the so-called 'weak-form' of the random-walk hypothesis. A hypothesis which was a direct denial of the validity of chartism or technical analysis, and a direct, but more complex, challenge to fundamental analysis which is probably why practitioners chose to ignore it. As Fama so succinctly put it in his conclusion:

"In sum the theory of random walks in stock market prices presents important challenges to both the chartist and the proponent of fundamental analysis. For the chartist, the challenge is straightforward. If the random walk model is a valid description of reality, the work of the chartist, like that of the astrologer, is of no real value in stock market analysis. The empirical evidence to date provides strong support for the random walk model. In this light the only way the chartist can vindicate his position is to *show* that he can *consistently* use his techniques to make better than chance predictions of stock prices. It is not enough for him to talk mystically about patterns that he sees in the data. He must show that he can consistently use those patterns to make meaningful predictions of future prices.

The challenge of the theory of random walks to the proponent of fundamental analysis, however, is more involved. If the random walk theory is valid and if security exchanges are 'efficient' markets, then stock prices at any point in time will represent good estimates of intrinsic or fundamental values. Thus, additional fundamental analysis is of value only when the analyst has new information which was not fully considered in forming current market prices, or has new insights concerning the effects of generally available information which are not already implicit in current prices.

If the analyst has neither better insights nor new information, he may as well forget about fundamental analysis and choose securities by some random selection procedure."[17]

What was the significance of the research and evidence offered that successive share price changes were

†All references appear at the conclusion of this paper.

substantially independent? The significance lies not in the findings themselves but in the question that they raised as to the nature of the economic process which produced such results.

The answer to the question was found in the characteristics of the market itself, in effect, in the market-making mechanism which operated. It was found, in the first place, that the New York Stock Exchange was an efficient market. Subsequent studies indicated that The London Stock Exchange and the Tokyo Stock Exchange were also efficient. As is evidenced by the recent publication of research findings in South Africa, there is considerable evidence favouring the efficiency of The Johannesburg Stock Exchange,[18] although some qualifications may be necessary.[19]

There are three forms of market efficiency:

Firstly, there is the 'weak form' which is directly derived from the random walk theory and which states that current share prices fully reflect the information implied by the historical sequence of past prices. In other words, a knowledge of past share price movements cannot be used to predict future price changes. This means that technical analysis or charting cannot lead to superior portfolio performance.

The second form is that termed the 'semi-strong' form of the efficient market hypothesis and holds that current share prices fully reflect *all publicly available* information. This implies that an investor cannot earn superior returns on using information which is generally available. This is the situation referred to by Fama in the second paragraph of his conclusion quoted above.

Finally, there is the 'strong' form which states that *all* information, not only publicly available information, is impounded in security prices. This means that there is no opportunity for any investor to earn superior returns based on inside information.

It is generally accepted by economists that empirical studies have provided sufficient evidence to accept the weak and semi-strong forms of the efficient market hypothesis.[20] It is in this sense that in this paper any reference to efficient markets is made. The strong form is, at this stage, considered unproven. As Beaver states:

"Empirical evidence indicates that prices react quickly and in an unbiased fashion to a variety of events, including announcements of stock splits, stock dividends, secondary offerings and rights issues, as well as both annual and interim earnings announcements. This finding is exactly what one would expect in a market where the security prices at any point in time fully reflect the information released."[21]

PORTFOLIOS IN EFFICIENT MARKETS

Portfolio analysis and selection is followed by the evaluation of portfolio performance and, where necessary, the revision of a portfolio structure in accordance with an investor's utility preferences. These last two stages, evaluation and revision, may be termed portfolio management since they represent ex post evaluation of analysis and selection. The effectiveness and efficiency of the analytical and selection models can only be measured through this ex post process.

In the extensive literature on capital markets the development of the capital asset pricing model of Sharpe,[22] and Lintner,[23] is discussed within the constraints of rigorous assumptions. It is obvious that all existing features of capital market theory do not inherently correspond to reality very well. What the proponents do assume however, is that there is sufficient correspondence between reality and the extent of capital market theory exposed to warrant the attention of financial analysts. Similarly, the requirements for a perfectly efficient market are as rigorous; furthermore an equilibrium state of an efficient market model describes the equilibrium state of efficient capital markets. The requirements are that all new information is immediately and costlessly available to all interested parties, that there is no inflation, there are zero transaction costs and taxes, and all interested parties have the same time horizons and homogeneous expectations with regard to prices.

These conditions cannot of course be found in the 'real' world. But as Fama has pointed out,[24] the necessary conditions for efficiency are not quite so stringent.

As long as transaction costs are not prohibitive, information is readily available to a sufficient number of interested parties and there is no evidence of consistently superior or inferior participation by investors then efficiency will prevail. As Vasicek and McQuown have stated: "The theory of efficient markets represents the best description of capital markets available at present, and probably the only one that considers explicitly uncertainty and risk."[25]

This is the link between portfolio theory and efficient markets, in that the common area of study or interest is the behaviour of security prices (and hence returns) under conditions of risk and uncertainty. In fact, it is claimed that the capital asset pricing model is the most significant part of the efficient market model of capital market theory.[26]

The basic mathematical formulation of the model which Fama terms the 'expected-returns' model, may be stated as:

$$E_p = R_f + \frac{(ER_m - R_f)}{\sigma_m}\sigma_p \qquad (1)$$

where E_P is the expected return on the portfolio, R_f is the pure interest rate, ER_m is the expected return on the market portfolio, σ_m is the standard deviation of return on the market portfolio and σ_p is the standard deviation of return on the portfolio.

This is the model for an efficient portfolio on the Capital Market Line in risk-return space. The equation for individual securities may be stated as:[27]

$$ER_i - R_f = \frac{(ER_m - R_f)}{\sigma^2_m}\sigma_{im} \qquad (2)$$

where ER_i is the expected return on security i, σ^2_m is the variance of return on the market portfolio, σ_{im} is the covariance between the individual security and the market portfolio and all other terms are as before.

Equation 2 can be restated by introducing the beta coefficient into the equation and this then gives the following relationship:

$$ER_i - R_f = B_i\,(ER_m - R_f) \qquad (3)$$

where all terms are as before and B_i is the beta coefficient on investment i.

In other words, in an efficient market the expected return on each investment (or security) in excess of the risk-free rate is related only to its beta. This representation is a prescriptive model, it predicts how an efficient market would appear if the assumptions of the model are fulfilled. As such the model can therefore be tested empirically.

One study dealing with the empirical validation of the efficient market model is the work by Black, Jensen and Scholes.[28] The principal conclusion to be drawn from this study is that although the relationship between expected excess return of a security or portfolio and its systematic risk is linear, it is not directly proportional. The empirically derived Security Market Line (SML) exhibits a positive intercept, and a slope that is flatter than that predicted by Equation 1. The model appears to conform to the following form:

$$ER_i - R_f = y + B_i (ER_m - R_f - y) \quad (4)$$

where y is a positive quantity.

Thus Equation 4 can be restated ex post in a more familiar regression form:

$$R - R_f = A + B (R_m - R_f) + C \quad (5)$$

As before, the values of the regression coefficients, A and B, can be estimated. A is the alpha coefficient and B the beta coefficient, and C is a random variable with an expected value of zero and a variance of Q_i.

The findings of Black et al imply that securities and portfolios with systematic risk (beta) lower than that of the market portfolio exhibit a positive abnormal return, whereas securities and portfolios with beta higher than that of the market show negative abnormal returns. That is to say, high risk securities are observed to return less than what is predicted by the simple model (Equation 1), and the converse for low risk securities. This is termed the 'beta twist'. Furthermore the higher the beta the lower the alpha and vice versa. This result is termed the 'alpha effect'. Once again it is noted that the results are in conflict with the simple capital asset pricing model.

In another study Black investigated the market equilibrium under the assumption there is no risk-free asset, thereby excluding both borrowing and lending at a risk-free rate.[29] Black shows that ideally every investor holds a linear combination of the market portfolio and another portfolio which, although risky, possesses no market risk.

This latter portfolio, which he terms a zero-beta portfolio, consists of long and short holdings in risky assets in such proportions that the systematic risk, or beta, is zero. The zero-beta portfolio takes on the role previously played by the risk-free asset. The expected rate of return on a security is still a linear function of the security's beta and the intercept of this relationship is the expected rate of return on the zero-beta portfolio. The SML can thus be described by the equation:

$$ER_i = ER_z + B_i (ER_m - ER_z) \quad (6)$$

where ER_z is the expected return on the zero-beta portfolio and all other terms are as before. This equilibrium equation is of the form in Equation 4 and therefore consistent with empirical results.

Some studies yield contrary evidence in regard to the expected returns model.[30] Nevertheless it is interesting to note Fama's view that: "in short, the evidence in support of efficient markets model is extensive, and (somewhat uniquely in economics) contradictory evidence is sparse".[31] And, as Vasicek and McQuown point out:

"If the efficient market model is to be applicable to *real* capital markets, and not idealised ones, it must be able to explain actual observed price changes. The beta coefficient in the model has been estimated by numerous investigators and found to be usefully stable and to be related in the predicted way to rate of return: the higher the beta, the higher the observed rate of return. This fact alone is sufficient to place the efficient market model in that rare class of theories that can be usefully employed."[32]

IMPLICATIONS FOR PORTFOLIO MANAGEMENT

What are the implications of an efficient market for portfolio management? In so far as security analysis is concerned the efficient market hypothesis clearly suggests that neither technical analysis nor fundamental analysis is worthwhile, unless, as Lorie and Hamilton point out, the magnitude of investable funds is sufficient or if there is sound originality in the process of analysis.[33] The process of portfolio management is fairly easy to describe. The entire process is sufficiently straightforward to permit the writing of a computer programme to reproduce almost exactly the portfolio which a professional manager selected.[34]

Believers in efficient markets will change the process of professional portfolio management.

Black, for example, presents an extreme but cogent case for a 'passive' strategy of portfolio management.[35] "If an investor does this, then he won't try to outguess turns in the market. He won't try to pick individual stocks that he thinks will do better than other stocks. He will buy a well diversified portfolio, and hold on to it. He will generally sell only to establish tax losses, or when he needs the money. He may borrow against his portfolio when he needs money, instead of selling, to avoid realising capital gains. He will minimise investment expenses, brokerage costs, and taxes".[36] As Black quite correctly points out, a passive portfolio strategy does not imply the random purchase of securities; it does imply choosing a well diversified portfolio in accordance with the investor's utility towards risk. In other words, there still remains the need for estimates of the contributions which individual securities make to the riskiness of diversified portfolios.

If riskiness could be judged by reference to historical data then the task would be made much easier. A study by Blume indicates that riskiness tends to change only slowly through time so that historic measures of risk provide the basis for fairly good objective estimates of future risk.[37]

It seems evident therefore that although portfolio theory taken together with the concept of efficient markets has important implications for portfolio management, a knowledge and understanding of the important relationships between risk and return, and the partitioning of risk into systematic and unsystematic risk, are extremely important in successful portfolio management. Furthermore, it is suggested that in the light of efficient markets and portfolio theories, individual securities cannot be priced upon the basis of their risk considered in isolation from other securities. The function

of the security analyst is rather to estimate security return, risk and covariance with other securities or a market index, so that the portfolio manager is no longer provided with a buy, hold or sell recommendation, but rather with an estimate of the parameters of the distribution of security returns.

Two assumptions underlying capital market theory are liquidity and divisibility. This implies that each investor can change the composition of a portfolio of assets at any time when either his requirements or his perceptions of the characteristics of the assets change. The sensitivity of capital markets to information affecting the return-risk characteristics of individual investments is fundamental to the concept of efficient markets. Therefore it is in the interests of each investor to acquire information about the securities traded in capital markets. "Such information allows the investor to evaluate the prospects of each investment opportunity, and therefore to invest in the portfolio with the most promising performance. The demand for this information generates the existence of various information channels expected to provide the investor with pertinent knowledge, such as periodic income statements, balance sheets of companies, stock prices and volumes."[38] However, the reliability of some of such disseminated information is currently under challenge and this matter must be considered as a separate issue.

CONCLUSION

It has been the aim of this brief paper to show the close relationship which exists between portfolio theory and the efficient market hypothesis. Furthermore, it is suggested that these two theories will have important conceptual effects on security analysis in practice. The current role of the security analyst may well have to be revised as the theories discussed gain greater acceptance by the financial community.

ACKNOWLEDGEMENT

The author gratefully acknowledges the comments made on the draft of this paper by his colleague Professor I. R. Woods, Head of the Department of Business Administration, University of Natal, Pietermaritzburg. However, full responsibility for any shortcomings rests with the author.

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1 This paper is an adaptation from part of an unpublished MCom dissertation submitted and accepted by the author to the University of South Africa.

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