The Capital Market Theory and Its Implications for Accounting

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Over the last few decades there has been a considerable amount of research efforts relating to capital market efficiency. The implications of efficient markets for accounting have been discussed in various studies.(1) Capital market theory and the related evidence have contributed a foundation for investment and financial reporting debate. Despite the fact that market efficiency has been refuted by some writers,(2) the efficient market hypothesis is accepted by many researchers, and the Financial Accounting Standards Board also recognizes its significance for accounting theory.(3) Much of this literature, however, is technical and highly complex. Theories and implications of the literature may not be fully understood by the accounting profession, causing a lack of awareness of and a nonuniversal acceptance of this research despite that capital market theory merits wider attention.

The purpose of this paper is to examine the basis of capital market theory

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(1) See, for example, Abdel-Khalik (1972), Beaver (1972, 1973, 1974, 1981a), Bierman (1974), Dyckman, et al. (1975), Gonedes (1972), Gonedes and Dopuch (1974), Lev (1974), Kaplan (1972), and Ronen (1974).

(2) See, for example, Collins (1975), Downes and Dyckman (1973), Jensen (1978), and Miller (1977).

(3) Financial Accounting Standards Board (1975, 1976).

and to discuss the implications of capital market theory for financial reporting policy. The paper serves as an introductory exposition to the literature, yet provides an insight into the meaning and significance of the literature. Hopefully, it will stimulate interest in empirical accounting research, by discussing ways of empirically testing market efficiency.

The paper consists of seven sections. In Section I, the financial aspects of portfolio theory are presented. The market model and the capital asset pricing model are discussed in Sections II and III, respectively. Section IV briefly explains the efficient market hypothesis. The random walk model is commonly identified with the weak form of efficient market hypothesis. However, due to much misunderstanding of the model in the literature, Section V is devoted to an in-depth discussion of the random walk model. To provide an insight into an empirical testing of market efficiency using accounting data, Section VI discusses the research methodology employed by Ball and Brown (1968) as an example. The implications of efficient market hypothesis for accounting are examined in the last section.

To facilitate our presentation, notations are defined below:

P_{it}=market price of a security i at the end of period $t-1$

D_{it}=dividend received from a security i during the period t

R_{it}=return on a security i during the period t

R_p=return on a portfolio

R_f=return on a risk-free security

R_M=return on a market portfolio

E=expectation operand

$E^*(R_p)$=an investor's desired level of expected return on a portfolio

σ_{ii}^2=variance of a security i's returns

σ_p^2=variance of returns on a portfolio

σ_M^2=variance of returns on the market portfolio

$COV(\tilde{R}_i, \tilde{R}_j)$=covariance of a security i's return with a security j's return

β_i=systematic risk of a security i

β_p or $\overline{\text{COV}}$=a portfolio's beta (i.e., covariance of a security return with the return on all other securities in a portfolio)

f=fraction of an investor's initial wealth invested in risky securities

w_i=relative allocation of an investor's initial wealth to security i

I. PORTFOLIO THEORY

When an investor makes a decision to invest in securities, he is interested in security returns. If future outcomes (e.g., future cash flows), costs of replacing the security, and interest rates are perfectly known in advance, the investor would invest until the marginal rate of return on further investment equals to the interest rate. This strategy dictates that the security having the highest rate of return (or net present value) should be selected. Therefore, a perfect certainty investment strategy implies that the investor will usually hold a one-asset portfolio (A portfolio is defined as an investor's holdings of marketable securities).

If, on the other hand, a security's future outcomes are unknown (i.e., random variables with a known probability distribution), the investor must consider two factors simultaneously: (1) expected future cash flows and (2) uncertainties involved in the expectations. This raises the issue as to how risk (uncertainty surrounding expected future cash flows) can be measured. Conceptually, *ex ante* measurement of the risk would involve the dispersion of future price changes of a security. It is, however, an unobservable parameter of the distribution of future price changes. Therefore, it would be estimated by examining the *ex post* sample dispersion of price changes attained. Of course, the use of *ex post* measurement of price volatility as a proxy of *ex ante* risk presumes that the degree of fluctuation in the time series of price changes would remain stable over time. A security's risk in this paper is measured using rates of return instead of price changes for two reasons. First, it is undesirable to measure the risk in terms of price changes because such a measure depends on the absolute magnitude of the price. Observe that the higher the price in dollars per share, the higher the dispersion. Second, the rate of return which includes dividends is expressed as the total return on a dollar invested at the beginning of the period. Symbolically,

$$R_{it}=\frac{P_{it}-P_{it-1}+D_{it}}{P_{it-1}} \tag{1}$$

For the above reasons, the risk in this paper is defined as the dispersion of the rates of return (hereafter, return) from their expected value.

The central question in portfolio analysis is: Given a set of estimates regarding the future outcomes of each security, which securities should be held and in what proportions of the investor's initial wealth? To answer this question, it is necessary to make the following three assumptions:

1. Every investor can rank portfolios by considering only the expected return and risk associated with a portfolio;
2. The risk associated with a portfolio can be measured by the variance of the return; and
3. Every investor is risk averse.

The first assumption implies that every investor is able to express his preferred trade-offs between risk and return. Such trade-offs are expressed in the form of an investor's indifference curve. With the three assumptions combined together, it can be said that for a given expected return an investor always prefers the security with the minimum risk. Alternatively, for a given level of risk an investor always prefers the security with the maximum return. This two dimensional risk-return approach is a basis for the portfolio choice; it is further elaborated below.

An investor's objective is assumed to minimize his risk at a given level of expected return, $E^*(R_p)$, on a n-security portfolio. The problem of choosing an optimal combination of securities is expressed in the following model:

$$\text{minimize } \sigma_p{}^2=\sum_{i=1}^{n}\sum_{j=1}^{n}w_i w_j \mathrm{COV}(\tilde{R}_i, \tilde{R}_j) \tag{2}$$

$$\text{subject to } \sum_{i=1}^{n} w_i E(\tilde{R}_i) \geq E^*(\tilde{R}_p) \tag{3}$$

$$\sum_{i=1}^{n} w_i = 1 \tag{4}$$

The solution to the above problem may be found by using a quadratic programming technique. Note that the solution does not directly indicate how much should be invested in each security. Rather, it signals the optimal proportion of the investor's initial wealth invested in each security. Of all possible combinations of all securities in various proportions that have $E^*(\tilde{R}_p)$, there is only one particular combination that has the lowest risk. Such a combination is an "efficient" portfolio. By varying the desired level of expected return, it is possible to obtain a set of efficient portfolios for different levels of expected return. This set is called the efficient frontier. Any portfolio on the efficient frontier is the one with the minimum risk for a given level of expected return. Graphically,

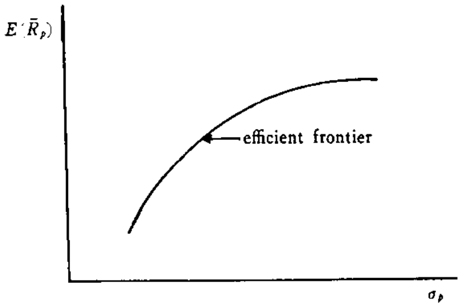


Diagram 1: Efficient Frontier

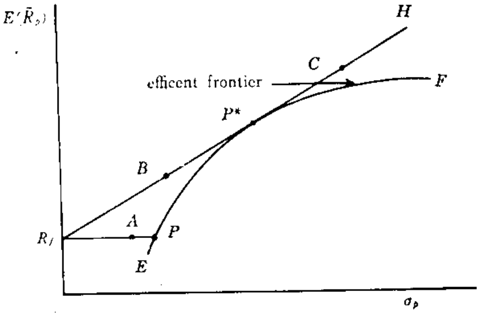


Diagram 2: Efficient Frontier Portfolios

An investor's choice of a portfolio from the efficient frontier is a matter of finding a suitable trade-off between the risk and the expected return.

Case of Lending

The above analysis does not take into account lending and/or borrowing possibilities on the part of the investor. An extension of the above analysis to the case of lending is discussed in this subsection. Another extension to the case of borrowing is considered in the next subsection. Assume that the investor is able to invest at a risk-free rate of return. That is, there exists a risk-free security. We may speak of investing in the risk-free security as "lending." In other words, the investor lends a part of his initial wealth. The combination of lending with an investment in risky securities provides the investor with a large number of alternatives, each determined by particular values of f and w_i.

First, consider the case where $f=1.0$. The n-security portfolio's return is a weighted average of the expected returns on individual securities, with w_i's being used as weights. That is,

$$E(\tilde{R}_p)=\sum_{i=1}^{n}w_iE(\tilde{R}_i) \tag{5}$$

The variance of the portfolio's returns is

$$\sigma_p{}^2=\sum_{i=1}^{n}w_i{}^2\sigma_{ii}{}^2+\sum_{j\neq i}^{n}\sum_{i=1}^{n}w_iw_j\mathrm{COV}(\tilde{R}_i, \tilde{R}_j) \tag{6}$$

The particular value of w_i identifies a single point along the efficient frontier (e.g., point P in Diagram 2). That is, the point along the efficient frontier is a function of w_i.

Next, consider the case where $f=0$. This is the case in which the entire amount of the investor's initial wealth is invested in the risk-free security. It is clear that the actual investment is located at the point R_f in Diagram 2. Finally, consider the case where $0\leq f\leq 1$. For given values of w_i's associated with the point P it is easy to see that the actual investment would lie on curve R_fP by varying the value of f from zero to one. A particular value of f then identifies a single point along curve R_fP (e.g., point A in Diagram 2). That is, a point along curve R_fP is a function of f.

In Diagram 2, any straight-line passing through R_f and a point at or below the efficient frontier represents an available set of investment opportunities. Since these lines differ only in slope, there is one with investment opportunities that dominates all of other efficient frontier portfolios. Consider the curve R_fP^* (in Diagram 2) where P^* is the tangent point of the efficient frontier with the line of the highest slope. Note that the point P^* is also the optimal combination of risky securities. The curve R_fP^* represents investment opportunities with superior expected returns for each level of risk. A particular point along curve R_fP^* is dependent upon the investor's trade-offs between the risk and the expected return.

Suppose the first security ($i=1$) in a n-security portfolio represents the risk-free security. Then the expected return on the portfolio and the variance of the portfolio's expected returns are given by

$$E(\tilde{R}_p)=(1-f)R_f+f\sum_{i=2}^{n}w_iE(\tilde{R}_i) \qquad (7)$$

$$\sigma_p{}^2=f^2\{\sum_{i=2}^{n}w_i{}^2\sigma_{ii}{}^2+\sum_{j=2}^{n}\sum_{j=2}^{n}w_iw_j\text{COV}(\tilde{R}_i,\tilde{R}_j)\} \qquad (8)$$

Note that the lending of an investor's initial wealth reduces both the expected return and the risk.

Case of Borrowing

Suppose that an investor is able to borrow funds at R_f to finance his investment in risky securities. In this case, curve R_fP^* is extended to H in Diagram 2. The line segment P^*H represents investment opportunities that dominate all of other efficient frontier portfolios for those investors who borrow to finance their investment in P^*. That is, every point on this line represents investment opportunities with superior expected returns for each level of risk. Note that borrowing increases both the expected return and the risk. A particular value of f, which is greater than 1, identifies a single point along the curve P^*H. In other words, the actual investment is a function of f. This observation leads to the separation theorem.

The separation theorem developed by Tobin (1958) is stated as follows: The problem of choosing a portfolio of risky securities is independent of the individual investor's attitude toward risk. That is, the problem of selecting an optimal combination of risky securities can be separated from the problem of selecting a risk level. The theorem suggests that an individual investor's problem can be divided into two parts. The first part is a determination of

P^* in Diagram 2, which depends on the value of R_f and the investor's estimates of the probability distributions of R_i's. Therefore, the point P^* can be found by mathematical methods without making any assumption about the investor's preferences. The second part involves a determination of combination that is most desirable to the particular investor, given his attitude toward risky returns. To determine a particular point along curve R_fP^*H, every investor must resolve which risk level he is willing to assume. For example, a relatively risk-averse investor might choose point B in Diagram 2. That is, he invests a part, say 40%, of his initial wealth in P^* and the remaining 60% is invested in the risk-free security ("lending"). An investor who is willing to incur higher risk for higher expected return borrows to finance his investment in P^*, and might choose point C in Diagram 2. That is, he borrows a portion, say 20%, of his initial wealth at the risk-free rate and invests 120% of his initial wealth in P^*. The degree of risk-aversion can be expressed in terms of the Arrow-Pratt measure (Arrow, 1965; Pratt, 1964). However, the discussion of such a measure is beyond the scope of this paper.

Suppose every investor in the capital markets has homogeneous expectations about the probability distribution of R_i for all i's. Then the location of point P^* should be the same for all investors. Therefore, the separation theorem is useful in determining equilibrium conditions in the capital markets. This points is further elaborated in Section III.

The essential feature of the portfolio theory is connoted by a mathematical programming model (see page 4∼5). As indicated earlier, the solution of the problem can be found by using a quadratic programming technique. However, the solution requires estimated values of the model parameters. To determine the expected return and the variance of expected returns of a n-security portfolio, the following variables should be estimated:

individual expected returns: n terms

individual variances: n terms

covariances: $n(n-1)/2$ terms

Therefore, a total of $(n^2+3n)/2$ terms must be estimated. It is clear that the selection of an optimal portfolio requires the estimation of a prohibitively large number of variables. An attempt to alleviate the problem leads to the market model, which is discussed in the next section.

II. MARKET MODEL

Market Model

A search for the economic process responsible for generating security returns lead to the market model as a simplification of the return generating process. That is, the market model is a convenient characterization of a security return. It is hypothesized that the market model characterizes the introduced stochastic process generating security returns. The model was introduced by Sharpe (1963).

It is axiomatic that there exist interrelationships between securities returns. The existence of these relationships is mainly due to economy-wide factors (such as inflation, wars, changes in GNP, etc.) operating simultaneously on all firms in the capital markets and to industry-wide factors operating on firms within a given industry. King (1966) finds that the industry effect is relatively small. He shows that, of total variations in monthly returns on a security,

1. 50% can be explained by overall market movements (the security's co-movement with the market);
2. 40% can be explained by the characteristics of the individual firm; and
3. 10% can be explained by the industry effect.

If, as the empirical evidence suggests, the industry effect is relatively small, it can be assumed that the interrelationship between securities returns result mainly from market-wide factors. Accordingly, these interrelationships can be described by the association of each security's return with that of the market.

Operationally, the market model assumes that the return on each security is linearly related to the market return. More precisely,

$$R_i=\alpha_i+\beta_i R_M+\mu_i \tag{9}$$

where α_i=intercept of linear relation between R_i and R_M

β_i=slope of the linear relationship

μ_i=residual.

The meaning and significance of β_i is discussed below. The market model asserts that a security's return can be decomposed into the following two parts: (1) a systematic portion of return $(\alpha_i+\beta_i R_M)$ that is linearly related to the return on the market portfolio, and (2) an unsystematic ("residual") portion of return that remains after taking out the systematic return. In the words of Beaver (1981),

> The systematic return is perfectly correlated with the return on the market portfolio because it is a linear function of the market portfolio. The unsystematic return is uncorrelated with the return on the market portfolio. The systematic and unsystematic returns are uncorrelated with one another. Hence, the systematic portion of returns across securities is perfectly correlated. The unsystematic portion of returns may be correlated across securities due to factors such as common industry effects.

Under the above construction, the riskiness of an individual security (uncertainty of a security's return) is affected by two factors:

1. "systematic risk" (systematic component) that reflects the variability of the market as a whole. That is, the systematic risk reflects comovement of the security's return with the market index; and
2. "unsystematic risk" (unsystematic component) that reflects the variability specific to the security. That is, the unsystematic risk reflects the variation in the security's return that is independent of market index.

To be more precise, consider the market model.

For any individual security, $R_i=\alpha_i+\beta_i R_M+\mu_i$ (10)

For any portfolio, $R_p=\alpha_p+\beta_p R_M+\mu_p$ (11)

The variance of each security's return can be decomposed into two parts:

$$\sigma_{ii}^2=\sigma^2(\mu_i)+\beta_i^2\sigma_M^2 \tag{12}$$

where $$\beta_i = \frac{COV(\tilde{R}_i, R_M)}{\sigma_M^2} \qquad (13)$$

Likewise, the variance of a portfolio's return can be decomposed into two parts:

$$\sigma_p^2 = \sigma^2(\mu_p) + \beta_p^2 \sigma_M^2 \qquad (14)$$

where $$\beta_p = \frac{COV(\tilde{R}_p, \tilde{R}_M)}{\sigma_M^2} \qquad (15)$$

Note that the portfolio's beta, β_p, is a weighted average of the betas (β_i's) of the individual securities that comprise the portfolio. Having discussed the systematic and unsystematic risks, we now turn our attention to the measure of a security's risk.

Measure of Riskiness

Appendix A shows that the risk of a n-security portfolio, σ_p^2, is approximately equal to $\overline{COV}$. Letting $\overline{COV} = \beta_p$, it is easy to see that, at the portfolio level, the unsystematic risk *can* be diversified away, while only the systematic risk still remains.

For the market portfolio, $\mu_p = 0$. For a well-diversified portfolio, $\mu_p \simeq 0$, $\sigma^2(\mu_p) \simeq 0$ and $\sigma_p^2 \simeq \beta_p^2 \sigma_M^2$. Diversification is accomplished by increasing the number of securities, such that no one security or no one industry represents a disproportionate share of the portfolio. Note that industry "risks" are also unsystematic because they can be reduced or eliminated via diversification across industries. For a diversified portfolio, the systematic component of the return accounts for essentially 100% of the total variance of a portfolio's return, while the unsystematic component is essentially driven to 0%. Therefore, the investor is able to diversify away much of the individual security's risk. Cohen et al. (1973) indicate that, of the total variation in returns of a diversified portfolio, about 85~90% can be explained by the comovement with the market.

A particular security's β_i measures the sensitivity of the security's return to the market return, and thus, indirectly to information about market-wide factors. In other words, a security's β_i value indicates the degree to which the security's return responds to general market movement. Therefore, a security's β_i may be used to predict a change in the market value of the stock as a result of anticipated changes in the market average of the market as a whole. For example, assume that a security has a β_i of 1.65. If the Standard and Poor's 500 Stock Price Index is to rise 20%, the market value of the individual security would be expected to rise 33%.

In a large, diversified portfolio, the unsystematic risk components of each security are practically eliminated and the systematic risk components of the portfolio constitute the portfolio risk. Accordingly, β_i measures the contribution of a security i to the riskiness of the portfolio. Thus, from a portfolio point of view, β_i measures the riskiness of the security i. Recall that β_i indicates the extent to which the security's return is subject to the systematic variability of the market.

Unsystematic risk is the remaining variability in an individual security's returns that cannot be explained by market movements (i.e., systematic risk). Unsystematic risk is not caused by variations in the market and can be avoided by diversification. Sharpe (1981) indicates that, at the individual security level, the systematic component of monthly returns accounts for only 30% of the total variance in a security's return, while the unsystematic portion accounts for 70%.

III. CAPITAL ASSET PRICING MODEL (CAPM)

As indicted in the previous section, the portfolio theory deals with the investment problem under uncertainty faced by a single individual. The theory tells how the investor should act in the capital markets but tells nothing about how market prices of individual securities adjust to differences in risk. On the other hand, the CAPM developed by Lintner (1965), Mossin (1965) and Sharpe (1964) describes the market relationships that result if investors act as prescribed by the portfolio theory. In other words, the CAPM deals with the implications of the assumption that all investors in the capital markets act in the way the portfolio theory says they should. Therefore, the CAPM is an extension of the portfolio theory.

As is seen in the later part of this section, the CAPM asserts that there is a linear relationship between $E(\tilde{R}_i)$ and $\mathrm{COV}(\tilde{R}_i, \tilde{R}_M)$. The crux of the CAPM may be expressed in the form of

$$E(\tilde{R}_i) = R_f + \beta_i[E(\tilde{R}_M) - R_f] \tag{16}$$

It should be pointed out that the CAPM and the market model are derived from different assumptions. To derive the CAPM which describes the expected return on an individual security *i*, we first examine the capital market line.

Capital Market Line (CML)

The CML, which applies to the capital market as a whole, provides an equilibrium relation in the capital market for the efficient combination of risky assets.

Suppose all investors have homogeneous expectations regarding the risk and expected return of available securities, point P^* in Diagram 3, should be the same for all investors. That is, except those highly risk averse investors who invest only in the risk-free asset, every investor agrees that P^* is the best. Therefore, every investor wishes to hold P^* in some combination.

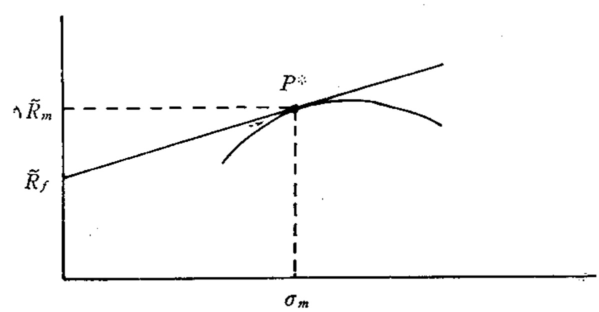


Diagram 3: Capital Market Line

In order for the capital market to be in equilibrium, P^* must contain all securities available in the market. If some securities are not included in P^*, their prices would fall, thereby increasing their expected returns until they become desirable and are included in P^* which is referred to as the market portfolio (M). In equilibrium, every investor's holdings of risky securities contain all of the risky securities available in the market; the proportion of the value of market portfolio assumed by each security equals to the value of that security divided by the value of all securities in the market.

The separation theorem (discussed in Section I) can be now stated: Every investor should hold a combination of the risk-free security and the market portfolio. In equilibrium, the CML passes through point M in Diagram 3. Consequently, for an efficient (perfectly diversified) portfolio,

$$E(\tilde{R}_p)=(1-f)R_f+fE(\tilde{R}_M) \tag{17}$$

Noting that $\sigma_p=f\sigma_M$, the above equation is equivalent to

$$E(\tilde{R}_p)=R_f+\frac{[E(\tilde{R}_M)-R_f]}{\sigma_M}\sigma_p \tag{18}$$

Equation (18) is called the CML. As indicated by Vasicek and McQuown (1972), the equation expresses quantitatively the principle of risk compensation. For an efficient portfolio on the CML, the "excess return" (the expected return on the portfolio in excess of the risk-free rate) is proportional to the risk of the portfolio. The constant of proportionality is $\left[\frac{R_M-R_f}{\sigma_M}\right]$ which is the slope of the CML. The slope may be interpreted as the "market price per unit of risk."

The CML holds only for an efficient portfolio. Since the unsystematic risk is entirely eliminated for an efficient portfolio, the total risk of an efficient portfolio is the systematic risk. However, the CML does not describe the expected return on an individual security (or an inefficient portfolio) and its risk. For an individual security, the total risk is the sum of systematic and unsystematic risks. Since the investor is concerned with the variance of returns on the entire invested portfolio, the variance of the individual security's return does not measure its risk. Rather, the security's risk is measured according to how it contributes to the risk of the portfolio. Therefore, a security's expected return should be related to its degree of systematic risk rather than to its degree of total risk. This leads to the security market line which is a logical extension of the CML.

Security Market Line (SML)

The SML, which holds for individual securities (and portfolios), provides an equilibrium relationship between the expected return on a risky security and its risk. It states that in equilibrium a security i's expected return equals to the sum of R_f and a risk premium and that there exists a linear relationship between $E(\tilde{R}_i)$ and $COV(\tilde{R}_i, \tilde{R}_M)$ such that the greater the risk, the higher the $E(\tilde{R}_i)$. In other words, the excess return on a security i is proportional to the relevant risk of the security $\left[\frac{COV(\tilde{R}_i, \tilde{R}_M)}{\sigma_M}\right]$. As in the CML, the constant of proportionality is $\left[\frac{E(\tilde{R}_M)-R_f}{\sigma_M}\right]$.

The SML is expressed in the form of

$$E(\tilde{R}_i)=R_f+\left[\frac{E(\tilde{R}_M)-R_f}{\sigma_M}\right]\left[\frac{COV(\tilde{R}_i, \tilde{R}_M)}{\sigma_M}\right] \tag{19}$$

which is shown in Diagram 4.

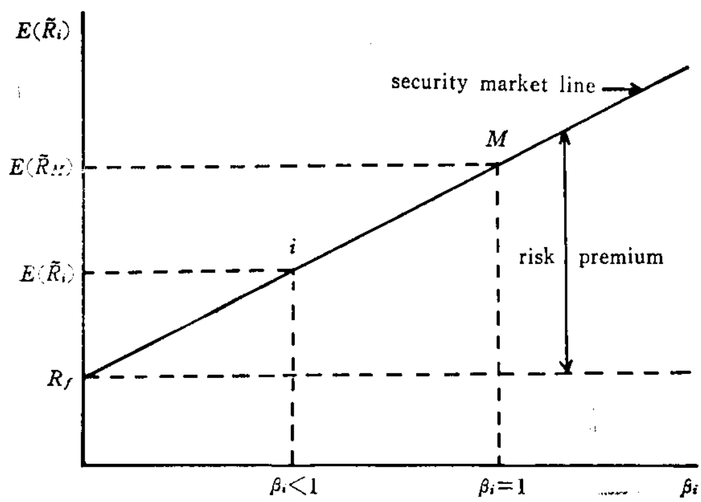


Diagram 4: Security Market Line

Letting $\beta_i=\frac{COV(\tilde{R}_i, \tilde{R}_M)}{\sigma_M{}^2}$, equation (19) can be written as

$$E(\tilde{R}_i)=R_f+\beta_i[E(\tilde{R}_M)-R_f] \tag{19'}$$

showing that β_i measures the responsiveness a security i's expected return to the expected return on the market portfolio.

Note that the risk is measured in terms of β_i (or β_p) but not in terms of σ_i (or σ_p). For an efficient portfolio, the SML reduces to the CML, since $E(\tilde{R}_p)$ is perfectly correlated with $E(\tilde{R}_M)$. Inefficient securities and portfolios lie along the SML but not along the CML. Equation (19) is expressed in terms of the risk-free rate and a premium for risk. The risk premium term (the second term of the right-hand side of equation (19)) is the product of the market price of risk and the individual risk of security i. The risk premium on the market is necessary to induce risk-averse investors to invest in risky securities. In equilibrium, the pricing of an individual security i (or equivalently, its expected return) reflects only its systematic risk component, measured by β_i. The unsystematic risk element which is unrelated to the market return is not present, since it is not expected to affect the security's price and return. Stated differently, only the systematic risk element commands a price in the form of increased return. This is because unsystematic risk element can be eliminated by increasing the number of securities in an investor's portfolio. Consequently, the capital market does not offer any compensation for bearing unsystematic risk. However, since systematic risk element (β_i) cannot be eliminated by diversification, investors in a risk-averse capital market demand compensation for bearing this risk in the form of higher return (and lower prices). Investors must be paid to assume an additional degree of risk. Thus, in equilibrium, β_i is a complete measure of risk and no other risk components would affect the security's price and return. That is, any return on the market portfolio in excess of R_f must be the compensation for risk taking.

The relation between a security i's actual risk premium and actual R_M is given by

$$R_i - R_f = \hat{a}_i + \hat{b}_i(R_M - R_f) + \hat{\mu}_i \qquad (20)$$

The values of $\hat{a}_i, \hat{b}_i$, and $\hat{\mu}_i$ are estimated by regressing R_i on R_M, and μ_i represents the variability in R_i which is not associated with variation in R_M.

Interpretation of β_i

The β_i measures the average change in a security's return for each change in the return on the market portfolio. For example,

1. $\beta=1$ means that, on the average, a 1% change in the market's return is accompanied by a 1% change in the return on the security.
2. $\beta>1$ means that, on the average, a change in the market's return is accompanied by a larger change in the security's return.
3. $\beta<1$ means that, on the average, a change in the market's return is accompanied by a smaller change in the security's return.

Vasicek and McQuown (1972) call β_i a measure of "relative riskiness" in the following sense:

$$\beta_i=\left[\frac{COV(\tilde{R}_i,\tilde{R}_M)}{\sigma_M}\right]\left[\frac{1}{\sigma_M}\right] \tag{21}$$

The term inside the first bracket is a measure of the systematic risk of a security i. Note that σ_M is a measure of the market portfolio's risk. Thus, using σ_M as a measurement base, β_i can be represented by

$$\beta_i=\frac{\text{Systematic Risk}}{\text{Market Risk}}$$

It is possible for a security with a great deal of total risk to actually have lower systematic risk than a security with only a moderate amount of total risk. As an example, consider two securities having the following characteristics:

$i=1$	$i=2$
$\sigma_1=10$	$\sigma_2=2$
$\beta_1=1.2$	$\beta_2=1.0$

As an individual security, security one ($i=1$) is considerably more risky than security two ($i=2$). As a part of a well-diversified portfolio, security one is much less risky than security two.

Usefulness of the CAPM in Accounting

Thus far, only the theoretical aspects of the CAPM have been discussed. In essence, the CAPM describes the process by which security prices change. Note that the usefulness of the model does not lie in its ability to forecast a security's return. Rather, its contribution lies in prescribing the relation between expected risk and expected return. The CAPM is a descriptive model in that it predicts how an efficient market would behave if the assumptions of the model are satisfied. The validity of the CAPM, however, can be empirically tested. Jensen (1972) shows that the returns forecasted by the model to not vary much from observed returns, so as to cause a rejection of the model. He shows that with few exceptions the results are unaffected by relaxing the assumptions of the model. However, the empirical validity of the CAPM is not a closed issue. In fact, Rolls (1977) has claimed that the model cannot be tested empirically.

The CAPM is useful in accounting because it provides empirical support for ascertaining the informational needs of investors in the capital markets. When information causes investors to alter their assessments of risks and returns, it is said to have informational content. Therefore, one means of documenting investors' reactions to accounting information is to examine changes in security's returns associated with the annoucement of the information. As with the market model, the CAPM provides a reliable basis for assessing changes in a security's expected return associated with the firm-specific information. A "standard" methodology to examine the effects of accounting information is illustrated below to elaborate our point.

Suppose we wish to examine the effects of the announcement of stock splits. The first step is to identify companies that have announced the same type of accounting information (for example, companies reporting stock splits). We then determine the return on an individual security within the entire group. However, it is not completely satisfactory if we merely look at changes in the security's market price over the period of time surrounding announcement of the stock splits, because changes in a security's price may be attributable to market-wide events. Thus, it is necessary to eliminate from an individual security's return the effects due to events effecting the entire economy. The effects of market-wide events on their returns are removed through the CAPM, leaving only the return associated with firm-specific events. An examination of the "residuals" would indicate whether investors reacted positively or negatively to the announcement of the stock splits, or had no reaction.

In view of the importance of the methodology, a detailed application of the methodology is examined in Section VI.

IV. EFFICIENT MARKET HYPOTHESIS (EMH)

Definition of Market Efficiency

Fama (1970), Beaver (1981, 1981a), Neave and Wiginton (1981), and others offer detailed discussions of the EMH. Fama (1970) defines the notion of market efficiency as follows: "A security market is efficient if security prices fully reflect the information available." However, the terms "fully reflect" and "information available" in the definition are vague and nonoperational for an empirical testing of market efficiency. Therefore, an attempt should be made to clarify the concept of market efficiency in order to test market efficiency. One approach is to focus on the pricing efficiency in a capital market, which is a major implication on market efficiency. According to Neave and Wiginton (1981), pricing efficiency implies that the expected price of a particular security one period into the future, conditional on current relevant information, is equal to today's price plus the expected return (commensurate with the risk involved) for the next period. That is,

$$E(P_{it+1}|\phi_t)=P_{it}[1+E(\tilde{R}_{it+1}|\phi_t)] \qquad (22)$$

where P_{it+1}=price of security i at time $t+1$

ϕ_t=set of relevant information available at time t

R_{it+1}=return on security i for period $t+1$

This model of price determination states that tomorrow's price is a random variable that fully reflect today's relevant information.

Rational investors only purchase securities having positive expected returns. Therefore,

$$E(\tilde{R}_{it+1}|\phi_t)\geq 0 \qquad (23)$$

or, equivalent in terms of prices,

$$E(\tilde{P}_{it+1}|\phi_t) \geq P_t \quad (24)$$

Such a sequence of prices is said to follow a stochastic process known as a submartingale ("submartingale model of pricing efficiency"). Note that the submartingale model of pricing efficiency does not imply that actual returns are never negative. Rather, it implies that the expected difference between actual and expected returns is zero. That is,

$$E[\tilde{R}_{it+1} - E(\tilde{R}_{it+1}|\phi_t)] = 0 \quad (25)$$

The above equation is called a fair game model (i.e., a fair game with respect to information ϕ_t and trading scheme). $E(\tilde{R}_{it+1}|\phi_t)=0$ means that any trading scheme based on ϕ_t has an expected excess return of zero.

The submartingale model of pricing efficiency implies that security pricing decisions based entirely on analyses of ϕ_t cannot be used systematically to earn future excess returns ("inability to earn abnormal returns"). Thus it is called a fair game model. Note that the expression $E(\tilde{R}_{it+1}|\phi_t) \geq 0$ indicates that in a fair game investors may earn positive returns. A fair game does preclude earning, on the average, abnormal or excess returns. In addition, the value of $E(\tilde{R}_{it+1}|\phi_t)$ can be obtained from either the market model or the CAPM.

According to Beaver (1981), the fair game approach and the abnormal expected returns approach to the term "fully reflect" (consequently, the definition of market efficiency) suffer from a number of ambiguities. For example, abnormal returns must be defined relative to some benchmark of "normal expected returns." He notes that portfolio theory and the CAPM permit the specification of a risk-adjusted return. However, he claims that there are other ambiguities associated with such notions. For example, how is the concept of abnormal expected returns to be viewed when investors have heterogeneous beliefs? Accordingly, he defines market efficiency with respect to an information item as a condition that prices act as if everyone knows that information. Furthermore, he makes a distinction between information signal efficiency (y-efficiency) and information system efficiency (η-efficiency) to remove the ambiguity surrounding the term "information available."

Information system efficiency is defined as follows: A security market is said to be efficient with respect to some specified information system if, and only if, the prices act *as if* everyone observes the signals from that information. In other words, prices act as if there is universal knowledge of that information. If prices have this property, they "fully reflect" the information system. A more formal statement of the above definition is: The market is efficient with respect to some information system (η) if, and only if, the prices of the securities are the same as they would be in an otherwise identical economy except that every individual has access to η as well. Signal efficiency (y-efficiency) is defined in the similar manner. Acknowledging that universal knowledge certainly does not exist, he maintains that the definition of market efficiency states only that prices act as if such conditions hold. In other words, the prices that prevail with limited knowledge are the same as prices that would prevail if everyone knew such information.

A comment on the definition of market efficiency is in order. Only the following two conditions are necessary to ensure pricing efficiency (fair game):

(1) A sufficient number of investors have access to the relevant information; and

(2) Heterogeneous expectations do not enable some investors systematically to outperform others.

Note that for transactions to occur, individuals must disagree in their evaluations. It is the aggregation and modification of these evaluations in the transaction process which produces the unbiased valuation of securities in an efficient market. In a fair game market, all participants have equal opportunities to earn normal returns.

Classification of Market Efficiency

Fair game efficiency may be defined in several ways. The issue of which definition is suitable involves the set ϕ_t of currently relevant information. By defining the set ϕ_t in various ways, it is possible to distinguish between various degrees of market efficiency. It is critical to specify the information set ϕ_t for which market efficiency condition is being defined, since the market may be efficient with respect to some sets ϕ_t but not others. Such a classification also helps us to appreciate the implications of various empirical tests of market efficiency. Fama(1970) delineates three major forms of market efficiency: weak, semi-strong and strong. Each of these is discussed below.

Weak Form Efficiency

This form states that equilibrium expected returns (prices) "fully reflect" the history of past security returns (prices), i.e., all information contained in the historical pattern of market prices. Here, if the market is efficient, successive price changes for individual securities, as well as a whole, are independent, and the sequence of past price changes cannot be used in any meaningful way to predict future security prices. Therefore, there are no superior trading rules based solely upon a knowledge of past security returns (prices). However, it is possible that superior trading rules may exist that are based upon other publicly available information.

Weak form tests of efficiency are discussed in the next section under the heading of Random Walk Model. Basically, these tests concentrate on the behavior of price change sequences or the efficacy of mechanical trading results.

Semi-Strong Form Efficiency

This form states that equilibrium expected returns (prices) fully reflect all publicly available information (e.g., financial statements, SEC filings, press releases, stock splits, mergers, etc.). Here, if the market is efficient, no trading schemes based upon publicly available information will permit investors to earn excess returns. However, it is possible to earn excess returns with inside information. Approaches to testing semi-strong efficiency focus on the speed of price adjustment to new information or an changes in market price for periods prior to and subsequent to public announcement of information to see whether prices react in a "proper" manner to new information.

Strong Form Efficiency

This form states that equilibrium expected returns (prices) fully reflect all information, including nonpublic (inside) information. If the market is efficient in this sense, then there are no superior trading schemes, even for those schemes that incorporate inside information. Tests of the strong form efficiency are difficult to device, but some(4) have been attempted by focusing on the efficiency of professionally managed portfolios. The argument for the above approach is that professional portfolio managers may be more skillful than the typical investor. The professional manager has many sources of information not available to the general public and has the resources to use this information. Furthermore, the portfolio manager competes with many other professionals having similar resources.

V. RANDOM WALK MODEL (RWM)(5)

The RWM which is commonly identified with the weak form of efficient market hypothesis, provides an excellent approximation to the "underlying" process to generate security price series. However, the RWM has been much misunderstood in the literature. There has been confusion in the literature about the meaning of the RWM. Consequently, the RWM has not been fully accepted either in the academic world or among financial analysts. It is therefore worthwhile to devote a separate section to the RWM.

Factious Assertions

At least five incorrect assertions are commonly made with regard to random stock prices.

Assertion (1): "The market price of a security changes randomly." Contrary to this assertion, the RWM simply implies that, at any given point in time, the next period's price change is random with respect to the state of knowledge at that moment.

Assertion (2): "It is like the scientist who proved conclusively that a fly

(4) See, for example, Finnerty (1976), and Lorie and Niederhoffer (1968).

(5) This section relies on Granger and Morgenstern (1970), pp. 71-102.

couldn't fly. I have several friends who have made lots of money with technical analysis. However, only if all the money were made by these traders, might I believe them." (Rotnem, (1968)). It should be emphasized that the RWM has nothing to do with the fact that some people have methods of making money on the stock market or knew of people who had.

Assertion (3): "The random walk hypothesis says little more than the stock market is competitive." (Wallich, (1968)). Although the RWM makes a statement about prices, it does not say nor assume a particular state of the market.

Assertion (4): "The trouble with the Random Walk Myth centers on the *fact* that, on the one hand, it assumes a highly competitive, efficient stock pricing mechanism and, on the other hand, it denies the rewards of those 'capable', 'well informed' experts who make it market what it is, by operating in it." (Rinfret, (1968)). Observe that the "fact" is wrong. There is no such "assumption" and no denial of rewards in a relative sense. Any "capable" of "well informed" expert is able to perform better than the majority of the players in the market "game" and so is worth consulting.

Assertion (5): "I view the RWM as an attack on the professional ability of professional financial analysts." This viewpoint is pervasive among financial analysts. However, the RWM does not constitute an attack on the professional ability of fiancial analysts, since the RWM is about absolute prices and says little or nothing about relative price movement. Analysts rarely, if ever, attempt to predict a future price although they may occasionally make statements that they believe the market is going to rise or fall over the next some periods. Such statements are usually very imprecise and their accuracy has not been tested. Once an investor has decided to purchase security, the analyst's job is to advise on which stocks to buy or to sell. That is, the analyst attempts to make a decision about future relative price changes.

Forms of the RWM

Let P_t=price at time t

P_{t-s}=price at time t-s and $0<s<t$

ε_t=residual series at time t

Consider a set of market prices of a particular security, P_t, P_{t-1}, $P_{t-2}\cdots$ Each price is a random variable and the complete set of prices has a multivariate distribution. Now consider the conditional distribution of P_t given the circumstance that previous prices (P_{t-s}) have specific, given values. This conditional distribution has a mean (expected value) of $E(\tilde{P}_t|P_{t-s})$. We might hyothesize that the value of P_t would depend to some extent on previous prices. Therefore, we would expect the conditional mean $E(\tilde{P}_t|P_{t-s})$ to depend on the earlier prices observed. It is then intersting to ask how the absolute magnitude of P_t can be predicted on the basis of P_{t-s}. There are several models (processes) to predict P_t, each of which is discussed below.

(1) Martingale Process

The martingale process states that the optimal predictor of P_t is simply P_{t-1}. In other words, the best predictor of tomorrow's price is today's price, or equivalently, price changes in a particular security cannot be predicted from the earlier price changes in the security. Given a sequence of actual prices, can one predict future price changes by using the past prices? The answer here is no. More precisely,

$$E(\tilde{P}_t|P_{t-s})=P_{t-1} \tag{26}$$

(2) Submartingale Process

The market equilibrium conditions state that the expected price of a particular security one period into the future, conditional on the earlier prices, is equal to today's price plus the expected reutурn (commensurate with the risk involved) for the next period. That is,

$$E(\tilde{P}_t|P_{t-s})=P_{t-1}+E(R_t|P_{t-s})P_{t-1} \tag{27}$$

It is axiomatic that rational investors only purchase securities having positive expected returns; thus

$$E(\tilde{R}_t|P_{t-s})>0 \tag{28}$$

Or, equivalently in terms of prices,

$$E(P_t|P_{t-s})>P_{t-1} \tag{29}$$

This sequence of prices is said to follow a submartingale process.

(3) Random Walk Model (RWM)

The RWM is a special case of the martingale process, with an additional assumption of distribution of price changes. More precisely,

$$P_t = P_{t-1} + \tilde{\varepsilon}_t \tag{30}$$

Where $E(\tilde{\varepsilon}_t) = 0$

$$\mathrm{COV}(\tilde{\varepsilon}_t, \tilde{\varepsilon}_{t-s}) = 0 \text{ for all } s \neq 0$$

$\mathrm{COV}(\tilde{\varepsilon}_t, \tilde{\varepsilon}_{t-s})$ means that the residuals are uncorrelated with each other. Note that a probability distribution for $\tilde{\varepsilon}_t$ need not be specified nor considered. The only assumption that we must make is that variance of $\tilde{\varepsilon}_t$ exists and is finite. The RWM asserts that successive price changes are independent of previous movements. Indepent price changes mean that information about the time series up to time t-1 cannot be utilized to access the probability distribution of price changes at time t.

There are three possible forms of the RWM as follows:

(i) P_t is a second-order martingale if $\tilde{\varepsilon}_t$ and $\tilde{\varepsilon}_{t-s}$ are uncorrelated.

(ii) P_t is a strict random walk model if $\tilde{\varepsilon}_t$ and $\tilde{\varepsilon}_{t-s}$ are independent.

(iii) P_t is a Wiener process if $\tilde{\varepsilon}_t$ and $\tilde{\varepsilon}_{t-s}$ are independent, and $\tilde{\varepsilon}_t$ are all identically normally distributed.

It is important to observe that two variables can be uncorrelated, yet not be independent, but the vice versa is not true.

(4) Logarithmic Transformation

The RWM ($P_t = P_{t-1} + \varepsilon_t$) can be transformed into

$$\log P_t = \log P_{t-1} + \tilde{\eta}_t \tag{31}$$

where $E(\tilde{\eta}_t) = 0$

$$\mathrm{COV}(\tilde{\eta}_t, \tilde{\eta}_{t-s}) = 0 \text{ for all } s \neq 0$$

The logarithmic transformation does not change the RWM except at low frequencies. If the percentage change in price (ε/P_{t-1}) is small, the two models are approximately the same. The use of the transformation is not vital when the predictive form of the RWM is considered. However, the use of the transformation is usually of importance when the distribution of the residual terms ($\tilde{\varepsilon}_t$) is considered rather than autocorrelation properties.

Implications of the Model

The following points about the above models must be emphasized:

(1) The type of question asking "what will the price of General Motors be next Friday?" That is, prices are to be predicted in absolute terms.

(2) A limitation is placed on information that is to be used when making the prediction. That is, the prediction is to be made *only* using past prices of General Motors.

With respect to the first point above, each of the models makes a statement about the ability to predict price changes in absolute terms (i.e., the actual value of the price change). The models say little or nothing about the possibility of one being able to predict the relative price change of one security compared to another. It may be possible, given 100 securities, to determine which securities are most likely to make the longest relative gains over the next period.

With respect to the second point, the models assert that future price changes are not predictable using linear combinations of previous changes. That is, the models state that past prices do not contain information useful for predicting future prices. The models, however, do not say that price changes are unpredictable. Specifically, they make no statement about the usefulness of other sources of information. It is conceivable that one could introduce other variables which have some predictive values. Examples of such variables would include earnings, dividends, GNP, inside information, etc.

In summary, the implications of these models are that:

(1) the best predictor of tomorrow's price is today's price;

(2) the best predictor of *any* future price is the most currently available price. Note this conclusion is obtained by a continual reapplication of the first implication; and

(3) the price series will contain no purely cyclical components such as a

seasonal pattern or a trend term.

Testing the RWM

As indicated in the previous section, weak form tests of market efficiency have concentrated on characterizing behavior of price change sequences or the efficacy of mechanical trading rules. These approaches are discussed below.

(1) Serial correlations

The most obvious test is to examine correlation coefficients. The RWM implies that serial correlation of $\bar{\varepsilon}_t$'s are zero. If we assume stationary expected prices over the sample period, this property can be examined by computing the serial correlation coefficients for the observed price changes over the sample period. If such correlation coefficients were not significantly different from zero, the weak form efficiency would not be rejected.

Consider a particular security price series P_t observed at time intervals of unit T (e.g., if P_t is observed daily, then T is one day, etc.). The first difference of this series is then

$$\varepsilon_t(T) = P_t - P_{t-1}, \quad t = 0, 1, 2, \cdots \tag{32}$$

$\varepsilon_t(T)$ represents the actual price chage over the time interval T. If there is to be any correlation in the residual series, the most likey is between adjacent terms ε_t and ε_{t-1} (i.e., the first serial correlation). Therefore, we calculate the first serial correlation of the changes in the security prices, and then observe whether the serial correlations are consistently near zero. Estimates of serial correlations for various sesurity price series and various values of T should be made.

(2) Trading Rules

Another test of weak form efficiency is based on trading rules. A filter rule x% is defined as follows: If the daily closing price of a security moves up at least x%, buy and hold the security until its price moves down at least x% from a subsequent high, at which time simultaneously sell and go short. The short position is maintained until the daily closing price rises at least x% above subsequent low, at which one simultaneously covers and buys. Moves less than x% in either direction are totally ignored. The use of filter rules is profitable only if successive price changes are dependent. Therefore, we may test various trading schemes that are based upon observed movements of market prices to determine whether such schemes would enable one to consistently earn an excess return. The weak form efficiency may be rejected if it can clearly be demonstrated that any mechanical trading rules based on historical price patterns will earn excess returns. Operationally, a set of proposed rules specifying the timing of purchases and sales of particular securities must be shown to earn a return net of transaction costs, greater than a simple buy-and-hold strategy for the same set of shares.

(3) Sign Reversals

The series of price changes is replaced by the series of symbols (+ and − signs). A run is then defiend as a sequence of one or the other of the symbols. For example, the series (+ + − − + + + + − + + −) consists of six runs. Let

+sign=price change is positive

−sign=price change is zero or negative

We consider the number of sequences and reversals in the series of + and − signs, a sequence being either + + + or − −, and a reversal being either + − or − +. If the successive price changes are independent, then we expect that the number of sequences and the numer of reversals would be roughly equal. Therefore, it is reasonable to see if the difference between the number of reversals is statistically significant.

VI. THE BALL AND BROWN APPROACH

A standard methodology for examining the effects of accounting information is briefly described at the end of Section V. The Ball and Brown study (1968) is a good example of this methodology. Since the study constitutes a break-through in empirical accounting research in accounting, the research methodology employed in the study is explained in detail.

The objective of the study is to assess the usefulness of accounting income numbers by examining their information content *and* their timeliness. This objective is accomplished by exploring the relationship between security price changes and earning changes. The behavior of security prices is an operational test of the usefulness of accounting information.

As for the motivation for the study, Ball and Brown argue that

> Because accounting lacks an all-embracing theoretical framework, dissimilarities in practies have evolved. As a consequence, net income is an aggregate of components which are not homogeneous. It is thus alleged to be a 'meaningless' figure... Yet it is dangerous to conclude, in the absence of further empirical testing, that a lack of substantitive meaning implies a lack of utility. (p. 160)

Critics of financial accounting standards (e.g., Briloff)[6] imply that securities can be mispriced because of accounting practices. In other words, the market could be fooled by accounting "gimmickery" that increases reported earnings but has no real economic effect on the firm.

Empirical research in response to these contentions represents an important methodological contribution to accounting research because it tests various allegations. It represents a considerable departure from prior financial accounting research.

Since accounting information is one source of information, Foster (1978) notes that the following issues are important:

(1) What evidence is there that accounting information plays an important role in the capital asset price revaluation process?

(2) What evidence is there that the capital maket reacts to accounting earnings in the mechanistic way suggested by the capital asset pricing model (or market model)?

(3) What evidence is there about the timeliness of accounting data?

Ball and Brown attempt to provide answers to these qestions.

Hypothesis

Ball and Brown reason that the market participants would have opinions

(6) See Briloff (1969, 1972, 1976, 1981).

reflected in their forecasts of what the earnings numbers should be, and, collectively, these forecasts would be reflected in a market forecast of the security's price. They further reason that the reaction of a stock's price would reflect the difference between the firm's actual earnings and the market's forecast. Accordingly, Ball and Brown form estimates of the market's earnings forecast and then evaluate a security price reaction to the "good news" of actual earnings (in excess of the forecast) and to the "bad news" of actual earnings (short of the forecast). This reaction is measured as if the market participant had access to good or bad news prior to the availability of this news to the market.

The major problem involved in determining the informational content of a financial report is to identify the portion of total information that was expected by investors prior to the information release. Note that only the unexpected portion of the total information would be relevant to the market. If investors could perfectly predict the content of the next financial statement, then the released report would not convey relevant information except for confirming investors' expectations. Therefore, it is reasonable to hypothesize that the larger the discrepancy between the expected and actual financial outcomes, the larger the amount of information provided by the financial report. The first stage of their analysis involves a determination of the market's expectation of earnings. Unfortunately, this expectation cannot be directly observed in the market. Therefore, some general prediction model has to be used to provide an expectation. Ball and Brown elect to use equation (33) (p. 34) as the prediction model ("index model") on the basis of their early findings (1967) that a substantial part of a firm's earnings variability is associated with the variablity of aggregate earnings of all firms.

Under the assumption that investors' expections of future earnings are formed by the prediction model ("index model"), Ball and Brown use the sign of $\hat{\mu}_{jt}$ (equation (35)) in determining the value of the incremental information content of the income numbers in the following manner:

Let positive sign of $\hat{\mu}_{jt}$=good news
negative sign of $\hat{\mu}_{jt}$=bad news
$\hat{\mu}_{jt}$ of zero =no news

If the released income number contained new information which were not yet impounded in the firm's security price, then the following conjectures could be made:

(1) "Good news" would trigger an increase in the firm's security price. The reason for this would be that upon receiving new favorable information, investors would revise upward their previous assessment of the security's profitability.

(2) Conversely, "bad news" would trigger a decrease in the security price.

(3) "No news" would have no effect on the security price, since the market's expectations already impounded in the security price was confirmed by the released income number.

In summary, it is reasonable to hypothesize that there is an association between income forecast errors ($\hat{\mu}_{jt}$) and changes in security price.

The extent of association between income forecast errors and security price changes would indicate to what extent the information conveyed by the annual income numbers is new and relevant to investors. However, instead of considering the total security price changes, Ball and Brown extract the change that reflects a general movement in the market. This is done by focusing on the market model residuals (ν_{tm}) in equation (36). Thus, attention is confined to the price change specific to the individual security considered.

We may now rewrite the above hypothsis as follows: There is an association between income forecast errors ($\hat{\mu}_{jt}$) and changes in a firm-specific price (ν_{jt}). In fact, this hypothesis is tested by Ball and Brown (see their footnote (a) in Table 5). They conclude that "the latter shows it is more unlikely that there is no relationship between the sign of the income forecast error aud the sign of the rate of return in most of the months up to that the annual report announcement." (p. 170) Note that a measure of changes in a firm-specific price is further related to the excess return (abnormal performance index on p. 168) that could be made over time prior to the announcement date.

Methodology

(1) Sample Selection

Sample comprises 261 New York Stock Exchange (NYSE) firms which satisfy the following criteria:

1. Earnings data available on "Compustat" tapes for each of the years 1946～1966;
2. Fiscal year ending December 31;
3. Price data available on "CRSP" tapes for at least 100 months; and
4. Wall Street Journal (WSJ) announcement dates available.

The above set of firms is chosen due to having earnings data available on the Compustat tape and secturity return data available on the CRSP monthly tape. Their analysis is then limited to nine fiscal year 1957～1965.

(2) Earnings Announcement Date

American firms generally release details of annual earnings through three main media:

1. An estimate by a company official after the end of the fiscal but before the end-of-year results are fully determined;
2. A preliminary release of earnings, sales, etc., prior to the issuance of the annual report;
3. The annual report.

Not all firms use the first medium, and the officials' forecasts are frequently imprecise. Furthermore, the preliminary report usually contain the same numbers for net income and earnings per share as are given later with the annual report. Therefore, the announcement date on which the preliminary earnings are reported in the WSJ is used for the study.

(3) Estimation of Sign of Earnings Change

Two models (index model and random-walk model) are used to classify firms into those with positive earnings changes and those with negative earnings changes. The index model is in the form of

$$\Delta I_{jt}=\hat{\alpha}_{1jt}+\hat{\alpha}_{2jt}\Delta M_t+\hat{u}_{jt} \tag{33}$$

where ΔI_{jt}=change in firm j's earnings in year t

ΔM_t=Change in the market's (all Compustat firms other than firm j) average earnings in year t

The random-walk model is also used to classify the firms into positive and negative earnings changes as follows:

$$E(\hat{I}_{jt})=I_{jt-1} \tag{34}$$

$$\mu_{jt}>0 \text{ if } \Delta\hat{I}_{jt}-\Delta I_{jt}<0$$

$$\mu_{jt}<0 \text{ if } \Delta\hat{I}_{jt}-\Delta I_{jt}>0$$

The sign of $\hat{\mu}_{jt}$ using the index model is determined in the following manner:

Step (1) Let $t=2$

Observe I_{jt} and I_{jt-1}.

Determine earnings change for t earnings vis-a-vis $t-1$ earnings (i.e., $\Delta I_{jt}=I_{jt}-I_{jt-1}$)

Observe M_t and M_{t-1} and determine the change ($\Delta M_t=M_t-M_{t-1}$).

Step (2) Repeat Step (1) until $t=T-1$.

Step (3) Regress ΔI_{jt} on ΔM_t to obtain $\hat{a}_{1jt}$ and $\hat{a}_{2jt}$.

Step (4) At the end of year T, observe M_t and determine the change ($\Delta M_t=M_t-M_{t-1}$)

Using a set of data ($\hat{a}_{1jt}$, $\hat{a}_{2jt}$, and ΔM_t) and the index model, estimate $\Delta\hat{I}_{jt}$.

Step (5) Determine unexpected income change (or forecast error).

$$\hat{\mu}_{jt}=\Delta I_{jt}-\Delta\hat{I}_{jt} \tag{35}$$

(4) Estimation of Security Returns Surrounding Earnings Announcement

Consider the market model,

$$\tilde{R}_{jt}=\hat{b}_{ij}+\hat{b}_{2j}\tilde{R}+\hat{v}_{jt} \tag{36}$$

where R_{jt}=return on security j in month t

R_{Mt}=market return in month t

ν_{jt}=residual in month t

The residual ($\hat{\nu}_{jt}$) estimates the effect on the returns of security j of firm-specific information made available in period t. The estimates of ν_{jt} for each firm are cumulated for the 12 months up to and including the earnings announcement and the 6 months subsequent to that announcement. That is, in examining the speed of price adjustment to new information, changes in market prices for the periods prior to and subsequent to the public announcement are analyzed.

(5) Construction of Abnormal Performance Index (API)

The API methodology is adopted in estimating security returns in the period surrounding the earnings annoucement. Consider the Sharpe-Lintner capital asset pricing model:

$$E(\tilde{R}_{jt})=R_{ft}+\beta_j[E(\tilde{R}_{Mt}-R_{ft})] \qquad (37)$$

where R_{ft}=return on a risk-free asset in period t

β_j=relative risk of security j

Using the above model in an empirical study means replacing monthly expected returns by monthly realized returns:

$$\tilde{R}_{jt}=R_{ft}+\hat{\beta}_j[\tilde{R}_{Mt}-R_{ft}]+\hat{\nu}_{jt} \qquad (38)$$

The β_j is empirically estimated from an ordinary least squares regressions (OLS). Given the OLS estimate of β_j, the abnormal return of security j in month t is

$$\hat{\nu}_{jt}=(\tilde{R}_{jt}-R_{ft})-\hat{\beta}_j(R_{Mt}-R_{ft}) \qquad (39)$$

The $\hat{\nu}_{it}$ is an estimate of the abnormal return for month t. The API over 12-month period is estimated as follows:

$$\mathrm{API}_{12}=\sum_{t=1}^{12}\hat{\nu}_{jt} \qquad (40)$$

Results

Association between income forecast errors and stock price changes

A significant association between the sign of price changes and the sign of earnings changes is found. Positive earnings changes are associated with positive a API. When actual earnings are above expectations, there is a continuous price increase up to the announcement month. conversely, when actual earnings are below expectations, prices decrease continuously. Most of the changes in the abnormal return occur prior to the month that annual earnings are announced. Interestingly, slight price adjustments continue for as long as two months after the announcement. However, the API displays no significant behavior in the months following the earnings anouncement. These results thus indicate that unexpected income changes are associated with stock price movements.

Information content

Of all the information about an individual firm that becomes available during the year, about 50% or more is captured in that year's income number. Therefore, the information content of the income number is considerable.

Timeless

The annual income report does not rate highly as a timely medium. Much of the price reaction associated with earnings occur prior to the announcement of annual earnings. That is, most of the information contents of the annual earnings are anticipated by the market before the income numbers are released. This "anticipatory" effect is consistent with the notion that price reflect earnings expectations.

The positive slope (in the upper half of Figure 1) indicates that residual price changes are positive for several months prior to the announcement. In fact, a small proportion of total price movement occurs in the month of announcement. As for the bottom half of Figure 1, the slope is negative. Again, much of the downward drift has occurred by the month of announcement. On average, only 10% to 15% of the cumulative price adjustments take place in the month of announcement. This finding may be explained by the fact that a substantial portion of the relevant accounting information is leaked (or publicly released) to the market during the year before the formal release of the annual income numbers. Such an early leakage would permit investors to revise their predictions of annual earnings. More timely media would include interim reports, statements by company officials, quarterly dividends, and earnings forecast by analysts.

EMH support

Despite an early leakege mentioned in the above, it seems that the release of income figures provides relevant information to investors and trigger portfolio rearrangements. The study indicates that there is a correlation between earnings numbers and security returns and that this earnings information is quickly impounded in security prices in an unbiased manner. That is, the results are consistent with the semi-strong form of the EMH.

Excess profits

The annual stock price appreciation of companies experiencing above-expectation earnings is more than 7% greater than the price change that could be attributed to general market effects. Over the year, the stocks of companies with disappointing earnings fall almost 10% below the level that might have been expected merely from general market movements. Therefore if an investor knew the sign of the change in earnings 12 months in advance of their public release, he could earn an abnormal return. That is, the ability to predict the direction of earnings changes would pay handsomely.

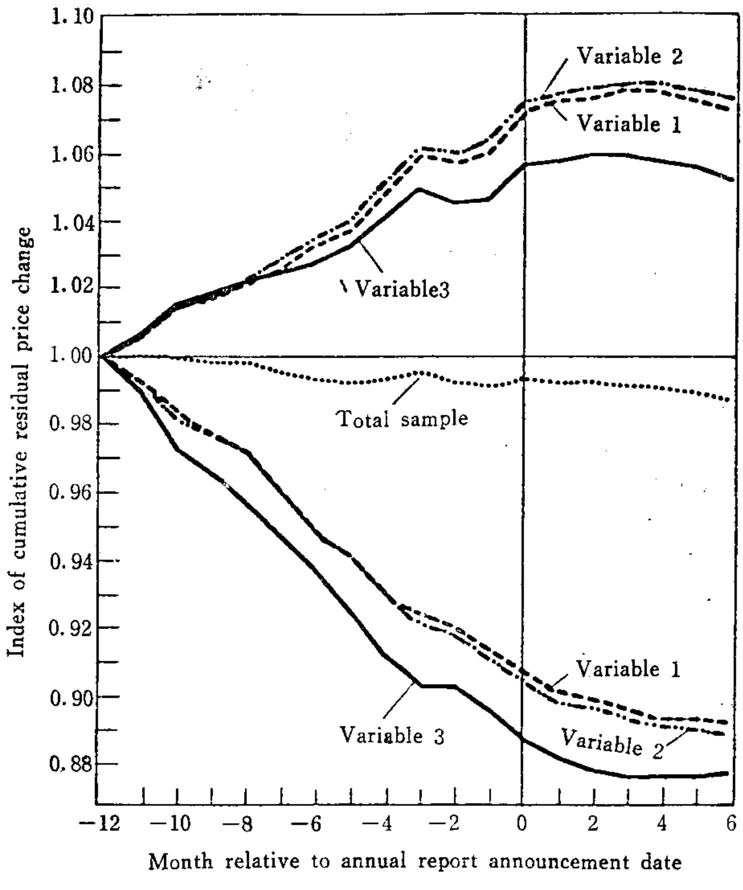
VII. ACCOUNTING IMPLICATIONS

The Ball and Brown study (1968) discussed in the previous section reports results consistent with the hypothesis that earning reports convey information in the sense of leading to changes in equilibrium prices of securities. Other studies[(7)] also report there results. Numerous studies subsequently discuss the implications of the efficient market hypothesis for accounting. The major implications of market research are identified below.

(7) For excellent reviews of empirical research, see Beaver (1981), Dyckman, et al. (1975), Fama (1970, 1976), Foster (1978), Jensen (1972), and Kaplan (1978).

1. Desirability assertion: The security price research is useful for assessing the desirability of alternative methods of accounting.
2. Information source assertion: Accounting data is only one of a number of competing sources of information. One role of accounting reports is to generate and disseminate information at lower cost than alternative sources.
3. Disclosure assertion: Many reporting issues can be resolved by a simple disclosure policy, and increased disclosure prevents individuals from obtaining abnormal returns

Fig. 1*: Monthly Residual Price Change



Monthly residual price change for positive and negative residual earnings changes. The top set of lines represents the cumulative residual price change associated with positive residual earnings changes measured three ways (i.e., variables 1 through 3). The bottom set of lines represents the cumulative residual price changes associated with negative residual earnings changes measured three ways. The cumulative residual price changes start with a hypothetical portfolio of 1.00 (e.g., $1) twelve months prior to the announcement. The graph shows the value of that portfolio over time.

* Source: Ball and Brown (1968), Figure 1, p. 169.

accruing from inside information.

4. Predictive ability assertion: Investors are concerned with the expected return and the risk of a portfolio. One role of accounting reports is its predictive ability with respect to the risk of the security.

Some of the above implications are open for debates. This section briefly discusses each of the four implications.

Desirability Assertion

It has been suggested that capital markets react to accounting number and that the relation of accounting data and security price behavior is useful for guiding the development of accounting policies. Capital market evidence is useful for assessing the desirability of alternative accounting techniques and regulations. Beaver (1972) claims that knowledge of the association between alternative methods of accounting and behavior of security prices is an essential part of knowledge of what pieces of information are impounded in security prices. He argues that the association with security prices provides a simplified preference ranking of alternative methods of accounting. That is, the method which is more highly associated with (impounded in) security prices ought to be the method reported in financial statements. He states:

> It is inconceivable that optimal information systems for investors can be selected without a knowledge of security behavior (p. 409).

Gonedes (1972) maintains that accounting should devote itself to the product of numbers that maximize information content, as indicated (directly or indirectly) by market reactions. In other words,

> Observation of the market reaction of recipients of accounting outputs should govern evalutions of the actual information content of accounting numbers produced via a given set of procedures and the informational content of accounting numbers produced via an alternative set of accounting procedures. (1972, p. 12).

Beaver and Dukes (1972) apply the approach to draw policy inferences to the question of the relative desirability of flow-through and interperiod tax allocation.

This wisdom of interpreting market evidence, however, has been contested by some accountants. Gonedes and Dopuch (1974) identify the desirability and the effect assertions used in the predictive approach for the evaluation of alternative procedures. The effect assertion means that the capital market study is useful for assessing the effects of alternative accounting methods. According to them, although the effect assertion is valid, the desirability assertion is logically invalid. They show that if individuals are able to freely obtain information generated by firms and need not decide what information to purchase, the market efficiency fails to provide criteria for selecting the optimal policy for information-production. Since the free riders cannot be prevented from using information produced under the existing institutional setting, the prices of firms's ownership shares cannot provide criteria by which the optimal information-production decisions are made. May and Sundem (1973) also claim that the behavior of security prices provide an incomplete basis of choosing among alternative methods of accounting because it fails to assess the potential effects on securities prices of alternative methods that would generate information that is currently unknown to the market agents. Unfortunately, their argument befuddles the issue in a sense that the desirability assertion is dismissed by making use of the effect assertion.

Some comments on the effect assertion are in order. It is well to note that the market may not be able to sense what information can be generated by the alternative methods that a firm is not currently using. Furthermore, it is conceivable that different accounting methods which generate different sets of information may trigger different market reactions, thereby leading to different market equilibria. In the efficient market, all securities are believed to be appropriately priced relative to one another given available information. However, the market efficiency does not guarantee all securities are always appropriately priced. Security prices are, in part, determined by accounting information disseminated which is not always reliable. If, the market uses a complete and more accurate set of information, a security price would closely reflect the underlying values. Because of the incomplete information, the market price set with available information may differ from an equilibrium price that would have been set with better information available to the market. Although the market reaction to alternative methods measuring the same underlying signal does not provide sufficient justification for the desirability assertion, different reations induced by different methods can show whether the choice among alternatives has any effects on the prices of a firm's ownership shares.

Information Source Assertion

Investors gather and analyze information about firm's ownership shares to evaluate the prospects of each investment opportunity. Investors' demand for information creates the supply of information, resulting in the existenece of various information sources. The market evidence indicates that the movements of securities prices reflect the anticipatory content of accounting information by significant lengths of time (weeks or months). For example, Ball and Brown (1968) report that the market has already reflected much of accounting number by the time earnings are announced or financial statements are issued. This suggests that accounting data is not the only source of information available to the market for assessing the underlying values of securities. It is then clear that if accounting reports fail to contain relevant information on a timely basis, the market will use other competing sources.

The market efficiency results from the market agents' expension of resources (funds, time, efforts, etc.) to produce and evaluate information. It follows that accountants should be concerned with minimizing the social costs of market efficiency by providing only the information where competing sources are less efficient. Within the context of the market efficiency, one objective of accounting reports is to provide information at lower cost than the alternative sources. In balancing the social benefits and the social costs of accounting reports, Beaver (1973) mentions three types of costs: (1) the costs of abnormal returns' being earned by insiders who have monopolistic access to information, (2) the unnecessary transaction costs incurred by investors erroneously believing that they can "beat the market" using published financial statements, and (3) the excessive information costs which include the costs of failure to report an item that is more expensive to obtain through although alternative sources and/or the cost to report an item that has less value than the costs or items that could have been reported through other, less expensive sources. He then suggests that the Financial Accounting Standards Board should strive for policies that will eliminate excess costs of information. It should also be noted that if accounting information is unreliable, the market will incur costs to adjust the information. Even when it is feasible to obtain the same information through alternative sources, these unnecessary costs of adjustment should be avoided by increasing the reliability of accounting reports.

Disclosure Assertion

Inside information of a firm may improve its possessors' assessment of both the return and the risk of the firm's ownership shares. Investors who have a monopolistic access to inside information of the firm may be able to detect deviations from the underlying value of the security, thereby earning abnormal returns by making use of the undisclosed items. As mentioned in the previous subsection, the costs of abnormal returns' being earned by insiders who have monopolistic access to information should be avoided. The leads to a suggestion that increasing amount of disclosure in accounting reports be required. Beaver (1973) argues that if there is no additional costs to the firm in disclosing an item and there is no costs to investors to adjusting accounting data from one method to other method, the item in question should be disclosed. This implies a policy of much fuller disclosure than is currently required by generally accepted accounting principles. In fact, the Securities and Exchange Commission is currently moving in this direction, which is justifiable in the Beaver sense.

The evidence of the capital market studies indicates that the market is not misled by changes in accounting methods. That is, the market is not fooled by accounting "gimmickery" in financial reporting that increase reported earnings but have no economic effect on the firm. This presumes that information about the effects on earnings of an arbitrary choice of an alternative accounting method is available to the market through either some forms of accounting disclosure or other competing sources of information. This leads to a suggestion that accountants should disclose the method being employed and data sufficient to permit adjustment to the non-reported method. The problem of inside information may arise from insufficient disclosure. The fact that the market is quite sophisticated in reflecting information implies that there is no difference in the effects of different forms of disclosure on securities prices. That is, as long as an item is disclosed either in the footnotes or in the body of statements, the substance of the disclosure is fully reflected in securities prices. With respect to the "simple disclosure solution" to many reporting issues, Beaver (1973) suggests that the Financial Accounting Standards Board should shift its resources to those controversies whether there is nontrivial additional costs to the firms or to investors in order to obtain certain types of information. Whether such information should be a required part of reporting standards is conceived of as a substantive issue. An example of such a nontrivial solution is replacement cost accounting for depreciable assets.

It should be emphasized that a reporting policy of more disclosure is justified until the social benefits of more disclosure exceed the social costs. An increased disclosure would make financial statements increasingly complex to the extent that only sophisticated readers would understand them. The market efficiency in terms of setting equilibrium prices of securities, which is the social value of accounting information, is insured by analyses of the sophisticated readers. One solution to insure the readability of financial statements and yet to protect the interests of average investors would be differential disclosure between the naive investors and the sophisticated analysts.

Beaver (1981) also recognizes the fact that an aggregation of data would result in a loss of information. The society will incur costs in restoring information lost in aggregation. This is consequences of incomplete disclosure due to aggregated data. Individual investors form opinions about the risk and the return on a security using information available. The fact that securities are constantly traded in the capital markets is equivalent to saying that individuals disagree the interpretation of information in evaluating the risk and the return. Financial accounting information aids investors in evaluating risk and return on securities. Even if the market collectively may not be misled by changes in accounting methods and incomplete disclosure, it is still possible that individual investors may not be.

Predictive Ability Assertion

One role of financial statements is to aid investors in evaluating the return and the risk of a security. As indicated in Section II, investors are concerned with the portfolio level rather than the individual security level. With an efficient portfolio, the unsystematic component risk of a security is diversified away while the systematic risk still remains. That is, a security's β is the exclusive measure of risk. It is then suggested that investors need only the information about the firm's systematic risk coefficient. This leads to a conclusion that the role of financial accounting information becomes its predictive ability with respect to β coefficient.

The above conclusion presumes that investors' holdings of marketable securities are perfectly diversified. However, an investor's actual portfolio may not be efficient due to transaction and information costs. With an inefficient portfolio, the investor is also concerned with the unsystematic risk of a security. For this reason, it would be erroneous to imply that the β coefficient is all the information needed by an investor. If most investors neither own or seek to form efficient portfolios, it would be interesting to investigate to what extent the market model or the capital asset pricing model is important in developing accounting standards and policies.

(8) See footnote 1.

Appendix A: Effects of Diversification

This appendix mathematically explains the potential effect of diversification.[9] Consider the risk of a portfolio with n securities.

$$\sigma_p{}^2=\sum_{i=1}^{n} \text{variance of } (w_iR_i)+\sum_{i=1}^{n}\sum_{j=k+1}^{n}\text{COV}(w_i\tilde{R}_i, w_j\tilde{R}_j) \tag{41}$$

where w_i=proportion of wealth invested in security i.

$$\sum_{i=1}^{n} w_i=1$$

We want to show that $\sigma_p{}^2$ is approximately equal to $\overline{\text{COV}}$ (the average covariance of the return on an individual security with the return from all other securities in the portfolio). Let $w_i=w_j=\frac{1}{n}$ for all i (i.e., equal proportion across securities)

$$\overline{\text{COV}}=\frac{1}{n(n-1)}\sum_{i=1}^{n-1}\sum_{j=k+1}^{n}\text{COV}(\tilde{R}_i, \tilde{R}_j) \tag{42}$$

Assume of $\sigma_{ii}{}^2$ are finite (bonded). The riskiness of n-security portfolio can be rewritten as:

$$\sigma_p{}^2=\sum_{i=1}^{n} w_i{}^2\sigma_{ii}{}^2+\sum_{i=1}^{n-1}\sum_{j=k+1}^{n} w_iw_j\text{COV}(\tilde{R}_i, \tilde{R}_j)$$

$$=\sum_{i=1}^{n}\left(\frac{1}{n}\right)^2\sigma_{ii}{}^2+\sum_{i=1}^{n-1}\sum_{j=k+1}^{n}\left(\frac{1}{n}\right)\left(\frac{1}{n}\right)\text{COV}(\tilde{R}_i, \tilde{R}_j)$$

$$=\frac{1}{n}\sum_{i=1}^{n}\sigma_{ii}{}^2+\frac{1}{n}\sum_{i=1}^{n-1}\sum_{j=k+1}^{n}\text{COV}(\tilde{R}_i, \tilde{R}_j) \tag{43}$$

Note that since all of $\sigma_{ii}{}^2$ are bounded, $\frac{1}{n^2}\sum_{i=1}^{n}\sigma_{ii}{}^2$ tends to zero as n becomes arbitrarily large. In other words, as the portfolio size increases the riskiness of an individual security becomes less and less significant. This is called the "diversification effect."

Looking at the second summation of the right-hand side of equation (43), we have

$$\frac{1}{n^2}\sum_{i=1}^{n-1}\sum_{j=k+1}^{n}\text{COV}(\tilde{R}_i, \tilde{R}_j)=\frac{1}{n^2}(n)(n-1)\overline{\text{COV}}$$

$$=\left(\frac{n-1}{n}\right)\overline{\text{COV}} \tag{44}$$

The term $\left(\frac{n-1}{n}\right)\overline{\text{COV}}$ approaches to $\overline{\text{COV}}$ as n becomes arbitrily large. In sum, $\sigma_{ii}{}^2$ is approximately equal to $\overline{\text{COV}}$.

(9) For a more detailed proof, see Fama and Miller (1972), pp. 253-255.

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