RISK, RETURN AND EQUILIBRIUM OF THE NYSE: UPDATE, ROBUSTNESS OF RESULTS AND EXTENSIONS

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ABSTRACT

A BRIEF STATEMENT OF THE STUDY'S OBJECTIVES AS WELL AS A SUMMARY OF OUR FINDINGS ARE GIVEN IN THE CLOSING SECTION OF THE PAPER, PAGE 17.

RISK, RETURN AND EQUILIBRIUM OF THE NYSE: UPDATE, ROBUSTNESS OF RESULTS AND EXTENSIONS

1. INTRODUCTION

In a paper now 10 years old, Fama and Macbeth (1973) examined the relationship between average return and risk for common stocks traded in the New York Stock Exchange (NYSE) between January 1935 and June 1968. The Capital Asset Pricing Model (CAPM) of Sharpe (1964) and Lintner (1965) provided the theoretical framework required to formulate testable hypotheses and to design and perform the empirical tests.

The purpose of this paper is threefold. First, we present an update of the Fama-Macbeth (FM) study, extending their results to December 1980. Second, we examine the robustness of the FM result. Specifically, we want to determine if the FM empirical findings, which were based on monthly percentage rate of returns for securities grouped into 20 portfolios, are sensitive to changes in: (1) the definition of security returns (percentage rate of returns vs. logarithmic returns); (2) the length of the differencing interval over which returns are measured (monthly, bimonthly, quarterly, etc...); and (3) the number and size of the portfolios used to carry out the tests. Our third objective is to generalize the stochastic return-generating process specified by FM. They suggest a linear process with three independent variables: the security's systematic risk, the square of the security's systematic risk and the security's unsystematic risk. To these we add three other variables: the security's total risk (variance), the security's relative skewness coefficient (the third moment of the security's return distribution divided by its standard deviation cubed) and the security's coskewness coefficient defined in equation (4) below.

The rest of the paper is organized as follows. In the next section we briefly review the methodology and tests developed by FM (1973), present the sample properties, and introduce a generalization of their stochastic return-generating process which implies several new testable hypotheses.

In section III we present our updated results. In section IV we examine the sensitivity of the FM results to (1) alternative definitions of securities' returns (percentage return vs. logarithmic returns); (2) to changes in the length of the return interval (from one to six months); and (3) to changes in the number (and size) of portfolios (10, 20 and 40 portfolios as well as single securities' portfolios). Two other characteristics were investigated by others (Schallheim - De Magistris (1980)): (1) the sensitivity of FM results to the definition and composition of the market index used as a proxy for the market portfolio and (2) the specification of the statistical model employed to estimate the model's parameters. FM use a simple averaging procedure. Alternatively, one can use the Random Coefficient Regression (RCR) model developed by Swamy (1971)[1]. Schallheim-De Magistris (1980) conclude that the FM results are robust with respect to the choice of the market index and the model's specification. Results obtained with a value-weighted index are qualitatively similar to those reported by FM who used the "Fisher's Arithmetic Index", an equally weighted average of the returns on all NYSE stocks (Fisher (1966)). Also, the RCR model produced results which are in line with those based on FM's simple averaging procedure. Estimates of the market price of risk may differ in magnitude, over some periods, depending on whether the RCR model or the FM procedure is used or whether a value weighted or an equally weighted index is employed. The qualitative results, however, (sign of coefficients and statistical significance) always remain the same. This conclusion is generally confirmed by the sensitivity analysis performed in section IV of this paper. Finally, in section V, we investigate the impact on the risk-return relationship of three additional measures of risk: total risk (variance), relative skewness and coskewness.

The last section contains a summary of our findings.

II. TESTABLE HYPOTHESES, SAMPLE PROPERTIES AND METHODOLOGY

Testable hypotheses

Given the standard assumptions[2] required to derive the Sharpe-

Lintner and Black (1972) CAPM, then, in equilibrium, we have:

$$E(\tilde{R}_i) = E(\tilde{R}_o) + \left[E(\tilde{R}_m) - E(\tilde{R}_o)\right] \cdot \beta_{im}, \tag{1}$$

where β_{im} is the systematic risk of asset i defined as:

$$\beta_{im} = \text{covariance } (\tilde{R}_i, R_m)/\text{variance } (\tilde{R}_m), \tag{2}$$

and $E(\tilde{R}_i)$, $E(\tilde{R}_o)$ and $E(\tilde{R}_m)$ are the expected returns on asset i, the zero-beta asset and the market portfolio, respectively.[3] In a CAPM framework the only relevant measure of risk in the pricing of securities is the systematic or undiversifiable risk also known as the security's beta coefficient.

In order to test empirically the implications of the equilibrium equation (1) we must specify a stochastic return-generating process.[4] We suggest here a generalization of the process proposed by FM:

$$\tilde{R}_{it} = \tilde{\gamma}_{0t} + \tilde{\gamma}_{1t}\beta_{im} + \tilde{\gamma}_{2t}\,\beta^2_{im} + \tilde{\gamma}_{3t}\,SE_i + \tilde{\gamma}_{4t}VAR_i + \tilde{\gamma}_{5t}SKW_i + \tilde{\gamma}_{6t}\,COSKW_i + \tilde{u}_{it}, \tag{3}$$

where SEi is a measure of the i-th security's unsystematic risk[5]; VARi is the i-th security's total risk (variance of the distribution of the i-th security's returns); SKWi is the i-th security's relative skewness coefficient (the third moment, centered on the mean, of the security's return distribution divided by the distribution's standard deviation cubed); COSKWi is the i-th security's systematic skewness defined as:

$$COSKWi = \frac{E(\tilde{R}i - \bar{R}i)(\tilde{R}m - \bar{R}m)^2}{E(\tilde{R}m - \bar{R}m)^3} \tag{4}$$

and $\tilde{u}_{it}$ is a disturbance term assumed to have zero mean and to be uncorrelated with all the other variables in equation (3).

The equilibrium relationship (1) together with the stochastic return-generating process expressed in (3) imply the following seven testable hypotheses.

Hypothesis 1. The relationship between return and systematic risk is linear. This implies that in the following random-coefficient regression:

$$\tilde{R}_{it} = \tilde{\gamma}_{0t} + \tilde{\gamma}_{2t}\beta_{im}^2 + \tilde{u}_{it}, \tag{5.1}$$
$$\tilde{R}_{it} = \tilde{\gamma}_{0t} + \tilde{\gamma}_{1t}\beta_{im} + \tilde{\gamma}_{2t}\beta_{im}^2 + \tilde{u}_{it}, \tag{5.2}$$

the expected value of the random coefficient $\tilde{\gamma}_{2t}$ is zero, that is, $E(\tilde{\gamma}_{2t}) = 0$.

Hypothesis 2. Unsystematic risk is irrelevant in the pricing of risky assets. This implies that in the following random-coefficient regression:

$$\tilde{R}_{it} = \tilde{\gamma}_{0t} + \tilde{\gamma}_{3t}\, SE_i + \tilde{u}_{it}, \tag{6.1}$$
$$\tilde{R}_{it} = \tilde{\gamma}_{0t} + \tilde{\gamma}_{1t}\beta_{im} + \tilde{\gamma}_{3t}\, SE_i + \tilde{u}_{it}, \tag{6.2}$$

the expected value of the random coefficient $\tilde{\gamma}_{3t}$ is zero, that is, $E(\tilde{\gamma}_{3t}) = 0$.

Hypothesis 3. The market price of risk is positive and equals the average excess return on the proxy market portfolio. This implies that in the following random-coefficient regression:

$$\tilde{R}_{it} = \tilde{\gamma}_{0t} + \tilde{\gamma}_{1t}\ \beta_{im} + \tilde{u}_{it} \tag{7}$$

the expected value of the random coefficient $\tilde{\gamma}_{1t}$ is positive and equal to excess return on the proxy market portfolio, that is,

$$\tilde{E}(\tilde{\gamma}_{1t}) = E(\tilde{R}_m) - E(\tilde{R}_o) \text{ or } E(\tilde{\gamma}_{1t}) = E(\tilde{R}_m) - R_f$$

if the risk free asset exists.

Hypothesis 4. The Sharpe-Lintner hypothesis: there is unrestricted borrowing and lending at a unique and known riskfree rate R_f. This implies that the expected value of $\tilde{\gamma}_{0t}$ is equal to R_f, that is, $E(\tilde{\gamma}_{0t}) = R_f$.

Hypothesis 5. The Levy and Mayshar hypothesis: assuming that financial markets are not perfect in the sense that investors hold few securities (Levy) or that transactions costs are nonzero (Mayshar) then Levy (1978) and Mayshar (1981) derive a generalized CAPM which predicts that in the following random-coefficient regressions:

$$\tilde{R}_{it} = \tilde{\gamma}_{0t} + \tilde{\gamma}_{4t}\ \mathrm{VAR}_i + \tilde{u}_{it} \tag{8.1}$$

$$\tilde{R}_{it} = \tilde{\gamma}_{0t} + \tilde{\gamma}_{1t}\beta_{im} + \tilde{\gamma}_{4t}\ \mathrm{VAR}_i + \tilde{u}_{it}, \tag{8.2}$$

the expected value of the random coefficient $\tilde{\gamma}_{4t}$ is positive, that is, $E(\tilde{\gamma}_{4t}) > 0$. We can reject Levy's hypothesis (1978) and Mayshar's hypothesis (1981) if $E(\tilde{\gamma}_{4t}) = 0$. There two hypotheses will be further discussed in section V.

Hypothesis 6. Investors choose among assets as if the distributions of asset returns are symmetrical. This implies that in the following random coefficient regressions:

$$\tilde{R}_{it} = \tilde{\gamma}_{0t} + \tilde{\gamma}_{5t}\ \mathrm{SKW}_i + \tilde{u}_{it} \tag{9.1}$$

$$\tilde{R}_{it} = \tilde{\gamma}_{0t} + \tilde{\gamma}_{1t}\beta_{im} + \tilde{\gamma}_{5t}\ \mathrm{SKW}_i + \tilde{u}_{it},$$

the expected value of the random coefficient $\tilde{\gamma}_{5t}$ is zero, that is, $E(\tilde{\gamma}_{5t}) = 0$.

Hypothesis 7. The Kraus-Litzenberger hypothesis: assuming that asset returns are nonsymmetrically distributed, Kraus-Litzenberger (1976) derive a three-moment CAPM which predicts that in the following random coefficient regressions:

$$\tilde{R}_{it} = \tilde{\gamma}_{0t} + \tilde{\gamma}_{6t}\ \mathrm{COSKW}_i + \tilde{u}_{it} \tag{10.1}$$

$$\tilde{R}_{it} = \tilde{\gamma}_{0t} + \tilde{\gamma}_{1t}\beta_{im} + \tilde{\gamma}_{6t}\ \mathrm{COSKW}_i + \tilde{u}_{it} \tag{10.2}$$

the expected value of the random coefficient $\tilde{\gamma}_{6t}$ has the opposite sign of the market index's skewness coefficient (cube root of the third moment), that is,

$$\text{Sign } E\ (\tilde{\gamma}_{6t}) \equiv \text{Sign}\left[E(\tilde{R}_{mt} - \bar{R}_m)^3\right]^{1/3}.$$

If $E\ (\tilde{\gamma}_{6t}) = 0$, we can reject the Kraus-Litzenberger hypothesis.

Sample properties

The data source for this study is the same as that used by FM (1973). They are the monthly percentage returns adjusted for dividends, capital gains and any changes in capitalization for all common stocks which traded on the NYSE during the period January 1926 through December 1980. The FM study begins in January 1926 and end in June 1968. The Schallheim - De Magistris study begins in January 1926 and ends in December 1974. All these data are from tapes of the Center for Research in Security Prices of the University of Chicago. The proxy for the market portfolio is the "Fisher's Arithmetic Index" (Fisher (1966)) which is an equally weighted average of the returns on all stocks listed on the NYSE on any given month t.

Methodology

The methodology employed is an exact replication of that of FM (1973). For details the reader is referred to the FM article and footnote 6 in this paper. The tests are performed on portfolios rather than individual securities in order to reduce the magnitude of measurement errors affecting the estimated beta coefficients of individual securities. In the next section we examine the sensitivity of the results to the choice of the number of portfolios, including single-securities' portfolios. Essentially, the FM methodology is based on a three-step procedure. First, individual securities betas are estimated using the market model with monthly returns (see footnote 5) and then grouped into portfolios. This constitutes the portfolio-construction period. It is followed by an estimation period over which the set of independent variables in equation (3) are computed and the beta coefficients recalculated. The tests are carried out over the third and last period by running a series of consecutive cross-sectional regressions month after month by regressing the actual realized return on a given month against different sets of corresponding independent variables[6]. This procedure generates a time-series stream of estimated coefficient $\tilde{\gamma}_{kt}$ which are then averaged out to test the validity of the hypothesis stated above, that is, $\bar{\hat{\gamma}}_k \equiv E(\bar{\tilde{\gamma}}k)$.

III. UPDATED EMPIRICAL RESULTS

As pointed out in the previous section, FM results end on June 1968. They were extended by Schallheim - De Magistric (1980) to December 1974. Here we present results up to December 1980. We wrote our computer programs to replicate the FM methodology. The numbers reported in tables 1(a) to 1(f) indicate that we were successful in duplicating FM results[7]. The lower part of the tables reports our results over periods identical to those of FM. The upper part contains our updated results. Several observations should be made. The estimated market price of risk ($\hat{\gamma}_1$ in table 1(a)) over the longest period (the 46 years between 1935 and 1980) is the same as that reported by FM over their longest period (the 35 1/2 years between 1935 and June 1968). Both equal .0084 or roughly 10 percent per year[8]. This result is in line with estimates of the market excess returns over periods of similar length[8]. In general the estimated market price of risk is not stable and is often not statistically different from zero. Referring to the upper part of table 1(b), 1(c), 1(d), 1(e) and 1(f) we cannot, with the updated result, reject hypotheses 1, 2, 3, and 4. The risk-return relationship appears to be linear and positive and unsystematic risk does not seem to play a role in the pricing of securities[10].

Finally, referring to table 1(a) through table 1(f), we see that the serial correlation coefficients of the $\hat{\gamma}_{kt}$ are generally not statistically different from zero[11]. Thus, the behavior through time of the coefficients $\tilde{\gamma}_{kt}$ is consistent with the notion of an efficient market.

IV. ROBUSTNESS OF THE FAMA-MACBETH RESULTS WITH RESPECT TO RETURN DEFINITION RETURN INTERVAL AND PORTFOLIO SIZE

Proportional vs. logarithmic returns

When measuring returns one can use either proportional rates of return (R_{it}) defined as:

$$R_{it} = \frac{P_{it} + D_{it} - P_{i,t-1}}{P_{i,t-1}}$$

or logarithmic returns (r_{it}) such as:

$$r_{it} = \ln (1 + R_{it}).$$

The two returns may also be written in the risk premium form by deducting the risk free rate R_{ft} from R_{it} or deducting ln $(1 + R_{ft})$ from r_{it}. FM and many others have adopted proportional rates of return in their tests of CAPM with Black, Jensen and Scholes (1972) and Foster (1978) using the risk premium form. Others, such as Basu (1977) have used the logarithmic variant in the risk premium form. Kraus and Litzenberger (1976) adopt a third alternative. They measure return in deflated risk premium form as:

$$R^{*}_{it} = \frac{R_{it} - R_{ft}}{1 + R_{ft}} \tag{11}$$

There is no guidance in the literature as to which measure of return should be given preference over the others. Depending on the underlying CAPM specification either proportional or logarithmic returns can be a priori justified to conduct empirical work.

Rosenberg and Marathe (1979) addressed the question of whether returns should be measured in the proportional or the logarithmic form. After surveying the relative merits of each specification they concluded that: "... from a theoretical point of view, neither model is satisfactory Since no form of the model is dominant in theoretical tractability one might ask whether goodness of fit to the data can be used to determine the choice. To our knowledge, this question is not fully resolved .. Clearly, further work on the interface between proportional and logarithmic models is necessary".

We know of two yet unpublished papers which investigate the effect of the return specification on the estimated parameters of the CAPM. The paper by Hawawini and Vora (1982) looks at the problem analytically and empirically. They demonstrate that proportional betas are larger (smaller) than logarithmic beta when betas are higher than (smaller) than one. They also show that the slope of the estimated Security Market Line ($\hat{\gamma}_1$) obtained with proportional returns is generally larger than that obtained with lagarithmic returns. This issue is also examined by Price and Price (1983).

They present empirical results based on the FM procedure and show that $\hat{\gamma}_1$ are generally not significantly different from zero when the tests are performed with logarithmic returns.

Our results are presented in Table 2 for regressions (7) and (6.2) with returns measured in the logarithmic form. These results should be compared with those in Tables 1(a) and 1(f) which are based on proportional returns. As we can see in Table 2, estimated coefficients based on the logarithmic specification are not significantly different from zero. This conclusion holds regardless of the length of the return interval or the choice of a test period. We have found that the logarithmic specification produced results that are inferior to the proportional specification, confirming the results of Price and Price (1983) but not those of Hawawini and Vora (1982) who showed that one cannot establish unambiguously the superiority of one specification over the other. It should be pointed out, however, that Hawawini and Vora performed their empirical tests of the CAPM according to the methodology of Black, Jensen and Scholes (1972) rather than the FM methodology. This may explain the different results. More analytical work is needed in this area before we could draw definite conclusions.

Effect of return interval length

The FM study as well as the updated results presented in this paper are based on monthly returns. We now turn to the effect of changes in the length of the return interval on the estimated average coefficients $\bar{\hat{\gamma}}_k$ ($k = 0,1$). Results are presented in table 3 for the longest period in the FM paper (1935-6/1968) and the longest period of our updated study (1935-1980) for both regressions (7) and (6.2) and for return intervals of length T equal to 1, 2, 3, 4 and 6 months. We notice that, in general, lengthening the differencing interval over which returns are measured affects the magnitude but not the sign or the statistical significance of the average value of the estimated γ_k coefficients.

This intervalling effect can be examined analytically. Consider the coefficient $\gamma_1(T)$ estimated over return interval of length T. If the total number of monthly intervals is N then the number of estimated coefficients $\gamma_1(T)$ is equal to $n = N/T$. The second column in table 3 gives the number of observations n. As T increases, n drops. We have by definition:

$$\hat{\tilde{\gamma}}_1(T) = \frac{1}{n} \sum_{t=1}^{n} \hat{\gamma}_{1t}(T) = \frac{1}{n} \sum_{t=1}^{n} \left[\frac{Cov(\tilde{R}_{it}(T), \hat{\tilde{\beta}}_{im}(T))}{Var(\hat{\tilde{\beta}}_{im}(T))} \right] \tag{12}$$

If returns are measured in the logarithmic form or if proportional returns are small relative to one (that is, $R_{it} \approx \log(1 + R_{it})$) then returns are additive as T varies. Assuming stationarity then Hawawini (1980a) shows that:

$$\tilde{R}_{it}(T) = T \cdot \tilde{R}_{it}(1) \tag{13.1}$$

$$\text{and } \hat{\beta}_{im}(T) = \lambda(T)\hat{\beta}_{im}(1) \tag{13.2}$$

with $\lambda(T) > 0$. $\lambda(T)$ is a function of T as well as a function of the structure of intertemporal cross-correlations between securities' returns and those of the proxy market portfolio as well as serial correlations in the returns of the proxy market portfolio. In the absence of these correlation structures $\lambda(T)$ equals one and $\beta_{im}(T) = \beta_{im}(1)$, that is, estimated beta coefficients are invariant to changes in the length of the return interval. In the presence of intertemporal cross-correlations and market autocorrelation $\lambda(T)$ may be greater or smaller than one[12].

If we assume away intertemporal cross-correlations and market-index autocorrelation (that is, $\lambda(T) = 0$) then substituting (13.1) and (13.2) in equation (12) yields:

$$\bar{\hat{\gamma}}_1(T) = \frac{1}{n} \sum_{t=1}^{n} \left[\frac{Cov(TR_{it}(1), \beta_{im}(1))}{Var(\beta_{im}(1))} \right] = \frac{1}{n} \sum_{1=t}^{n} \left[T \cdot \hat{\gamma}_{1t}(1) \right], \tag{14.1}$$

that is, $\bar{\hat{\gamma}}_1(T) = T \cdot \bar{\hat{\gamma}}_1(1)$.

Also, given equations (14.1) and (13.1) it follows from regression (3) that:

$$\bar{\hat{\gamma}}_0(T) = T \cdot \bar{\hat{\gamma}}_0(1) \tag{14.2}$$

We should expect, for example, the average value of the bi-monthly estimated coefficients $\bar{\hat{\gamma}}_0(2)$ and $\bar{\hat{\gamma}}_1(2)$ to be equal to twice the average value of the corresponding monthly coefficients.

Given that $\bar{\hat{\gamma}}_0(1) = .0052$ and $\bar{\hat{\gamma}}_1(1) = .0084$ in table 3 over the period 1935-1980 we should expect the following values for $\bar{\hat{\gamma}}_0(T)$ and $\bar{\hat{\gamma}}_1(T)$:

	T=2	T=3	T=4	T=6
(1) Predicted value of $\gamma_0(T)$	0104	.0156	.0208	.0312
(2) Estimated value of $\gamma_0(T)$	.0119	.0148	.0231	.0320
Difference (1) - (2)	-.0015	-.0008	-.0023	-.0008
(3) Predicted value of $\gamma_1(T)$	.0168	.0252	.0336	.0504
(4) Estimated value of $\gamma_1(T)$	.0148	.0270	.0302	.0530
Difference (3) - (4)	-.0020	-.0018	+.0030	-.0026

The predicted values of $\gamma_k(k = 0,1)$ are close but not equal to their corresponding estimated values. Note that the differences between predicted and estimated values are not always positive or negative. There is no systematic over or underestimation. Differences may be explained by recalling that: (1) for (14.1) and (14.2) to hold exactly there should be zero intertemporal correlations and zero market index autocorrelations, and (2) returns must be additive. These two conditions are usually not satisfied by the data which explains the departure of $\gamma_k(k = 0,1)$ from predicted values. Nevertheless, differences in values are not significant in magnitude and we can conclude that over relatively long estimation periods the FM estimates of the intercept and slope of the security market line are not significantly affected by the length of the return interval beyond the effect reflected in equations (14.1) and (14.2).

One should be careful before concluding that our results are obvious and could have been easily predicted without the help of the analysis developed in this section. This is not the case. The fact that $\bar{\hat{\gamma}}_0(T)$ and $\hat{\gamma}_1(T)$ behave in line with what equations (14.1) and (14.2) predict is due to the methodology employed to estimate these coefficients. If γ_0 and γ_1 were estimated using the two-stage, pure cross-sectional approach of Black-Jensen and Scholes (1972) the behavior of $\gamma_0(T)$ and $\gamma_1(T)$ in response to changes in T would have been quite different from that predicted by equations (14.1) and (14.2). Significantly large differences were found by Hawawini-Vora (1980,1983) between $\hat{\gamma}_0(T)$ and $T.\hat{\gamma}_0(1)$ as well as between $\hat{\gamma}_1(T)$ and $T.\hat{\gamma}_1(1)$ when the Black-Jensen Scholes (1972) methodology is used to estimate the intercept and slope of the Security Market Line[13].

Effect of portfolios' number and size

The estimated betas of individual securities are not equal to the firms' true betas because of measurement errors. By grouping the beta of securities into portfolio one can reduce the size of the measurement errors at the portfolio level since some betas over-estimate their true value while others underestimate it. Portfolio betas are thus closer to their true value than security betas. For this reason, most tests of the CAPM are conducted with portfolios rather than securities. FM use 20 portfolios of varying size since the number of available securities is not constant over the test period.

To what extent are the estimated parameters γ_0 and γ_1 affected by the number (and size) of the portfolios employed in testing the CAPM ? We report results in table 4 for the 5-year test period beginning in January 1976 and ending in December 1980. We selected this period arbitrarily from among all subperiods for which the parameters were statistically significant for the case of 20 portfolios. Similar results were obtained over the other subperiods. Three alternatives were examined: halving the number of portfolios (10 portfolios of approximately 80 securities instead of 20 portfolios of approximately 40 securities); doubling the number of portfolios (40 portfolios of approximately 20 securities instead of 20 portfolios of approximately 40 securities); and looking at single-security portfolios (798 portfolios of one security). In order to investigate the joint effect of portfolio number and return intervals, if any, we report results for $T = 1, 2, 3, 4$ and 6.

Halving our doubling the number of portfolios does not seem to affect γ_1 significantly, although γ_1 seem to decrease as the number of portfolios increases. Contrary to γ_1, γ_0 appears to be significantly affected by the number of portfolios although the γ_0 are not statistically different from zero. When we move to the extreme case of single-security portfolios we observe values of γ_0 and γ_1 which are significantly different from those obtained with 10 to 40 portfolios. These single security estimates, however, are generally not statistically different from zero. Notice also that the average value of R-square decreases significantly as the number of portfolios increases. The results are also sensitive to the length of the return interval. In the case of semi-annual return, γ_1 based on securities is the third of the value of γ_1 based on 10 portfolios. As the number of portfolios increases the Security Market Line seems to rotate clockwise regardless of the length of the return interval over which securities' returns are measured. We do not have an explanation for this phenomenon which may be partly due to the problem of measurement errors in betas.

IV. TOTAL RISK (VARIANCE) AND SKEWNESS AS EXPLANATORY VARIABLES

The variance effect

The standard CAPM assume that all investors hold in their portfolio all the available securities. Market experience and casual observation of investors' diversification behavior indicate, however, that this assumption is never satisfied in reality because of several market imperfections such as transaction costs, indivisibility of investment and lack of full and costless information.

Taking the composition of investors' partially diversified portfolios as exogenously given,Levy (1978) and Mayshar (1981) derive pricing equation different from the standard CAPM given in equation (1).

Levy shows that if investors hold a limited number of securities (say three or four stocks) then the variance of the i-th security becomes more important than systematic risk in the pricing of that security. Mayshar (1981) introduces transaction costs implicitly in the pricing mechanism to derive an alternative to the standard CAPM formula which can be written as:

$$E(\tilde{R}_i) = (R_F + t) + \lambda \left[\gamma_i \mathrm{VAR}(\tilde{R}_i) + \delta_i \cdot \beta_i \right] \tag{15}$$

where λ is a measure of market risk aversion independent of asset i, t is a measure of marginal transaction costs; and γ_i and δ_i are non negative parameters which depend on the relative concentration of holdings of asset i.

The implication of Levy's and Mayshar's work for empirical tests of the CAPM is that the variance of the return distribution of the i-th security should be explicitly recognized as an independent variable in cross-sectional regression analysis and the average value of the estimated coefficients γ_{4t} in regressions (8.1) and (8.2) should be statistically different from zero.

Using the FM methodology we run regressions (8.1) and (8.2) over the same test-periods as FM as well as over the updated test periods given in the upper parts of tables 1(a) to 1(f). We could not find a single test period over which the average of the estimated coefficients γ_{4t} were statistically different from zero when both systematic risk and variance were used as independent variables (regression (8.2)). The systematic risk variable, however, produced average estimated coefficients that were often statistically different from zero. When variance was used as the only independent variable (regression (8.1)) the average of the estimated coefficients γ_{4t} were significant only over those test periods for which systematic risk has also significant coefficients. This is simply due to the fact that systematic risk and variance are highly correlated variables. An example of the results we obtained is reported in table 5 for the FM longest test period as well as for our longest test period. Note that the results hold regardless of the length of the differencing interval over which returns are measured. We must reject the Levy-Mayshar hypothesis according to which total risk (variance) plays an important role in the pricing of securities traded on the NYSE. Even if investors in this market hold a few securities in their portfolios, the empirical results indicate that investors behave as if only systematic risk mattered.

The skewness effect

The Sharpe-Lintner CAPM is based on the assumption that securities' returns are normally distributed. Later, Fama (1971) developed the theory for the case of symmetric stable distributions. Arditti (1967), Jean (1971), Simonson (1972), Rubinstein (1973), and others extended the analysis to include skewed distributions with finite variances. More recently, Duvall and Quinn (1981) advanced the theory of skewness preference to cover those markets in which securities' returns are characterized by non-symmetric stable distributions.

Turning to empirical work, several studies have presented evidence indicating that historical return distributions on the NYSE are skewed. In particular, the return distributions of large portfolios tend to be positively skewed (Francis (1975)). Do investors take this skewness into account when pricing securities ? If so, we should expect an inverse relationship between average returns and skewness since investors should be willing to accept lower average returns in order to hold portfolios with positively skewed returns. The evidence on the empirical relationship between average returns and skewness is not conclusive. Although economic theory suggests a negative relationship, evidence of a significant positive relationship has been reported in the literature (Francis (1975)). This phenomenon may be due, partly, to regressions that are econometrically flawed and partly to the difficulties in measuring skewness empirically (Hawawini (1980b)).

In order to evaluate the effect of skewness in the risk-return relationship we run regressions (9.1) and (9.2) using FM methodology. Our results are summarized in table 6 for two long test periods

(FM's longest and our longest test period). Similar results were obtained over all other shorter test periods. Skewness, measured as the third moment of the return distribution divided by the cube of the standard deviation, is positively related to average returns. Since distributions are positively skewed, this result contradicts what theory predicts. Note, however, that when systematic risk is added as an explanatory variable, the skewness effect disappears and systematic risk emerges as the only significant risk variable. It is probably because skewness is positively correlated with variance and systematic risk that we observe a positive relationship between average return and skewness when the latter is the only independent variable.

The regression results reported in table 6 as well as unreported evidence indciate that, although return distributions may be skewed, investors seem to behave as if return distributions were symmetrical. Once systematic risk is accounted for, skewness does not appear to be related to average returns. This conclusion holds regardless of the length of the differencing interval over which returns are measured.

The coskewness effect

Skewness after all may not be the relevant variable in testing investors' attitudes in markets characterized by asymmetrical distributions. Three-moment portfolio theory suggests that the relevant variable is systematic or undiversifiable skewness. This variable is best measured by the coskewness of an asset's returns with those of the proxy market portfolio.

Kraus and Litzenberger (1976) derived an equilibrium pricing formula in which a security's risk premium is positively related to its systematic risk (beta coefficient) and inversely related to its systematic coskewness (given that the market portfolio's returns are positively skewed).

They tested their model by running a regression similar to (10.2) except that they measured security returns in the deflated risk premium form given in equation (11). They found that estimated beta coefficients were positively related to returns, both coefficients being statistically different from zero. Coskewness was measured according to the definition given in equation (4).

We run regressions (10.1) and (10.2) using FM methodology in order to test the Kraus-Litzenberger hypothesis and see if using the FM testing procedure with proportional returns would confirm their results. The evidence we gathered leads us to reject the Kraus-Litzenberger hypothesis. After accounting for systematic risk, coskewness does not seem to be related to returns regardless of the length of the differencing interval over which returns are measured. In table 7 we present results for the two longest test periods which returns measured over differencing intervals of 1, 3 and 6 months. Results over all the other test periods produced the same conclusion.

V. CONCLUDING REMARKS AND SUMMARY OF FINDINGS

In this paper we presented updated estimates of the market price of risk using the FM methodology. Our empirical analysis begins in January 1935 and ends in December 1980.

We have also examined the sensitivity of the FM results to changes in the definition of securities' returns, the length of the return interval and the number of portfolios used to carry out the empirical tests. Finally, we investigated whether the variance, skewness and co-skewness were related to securities' returns.

We conclude with a summary of our findings.

(1) The estimated market price of risk on the NYSE over the period 1935-1980 is equal to 10 percent per annum. This estimate is the same as that found over the period 1935-6/1968 by Fama and Macbeth (1973).

(2) The estimated market price of risk on the NYSE is not very sensitive to the length of the return interval over which returns are measured (for differencing interval of a month to 6 months length). In general, most of the FM conclusions are preserved when their tests are conducted over longer return intervals.

(3) The definition of returns, however, affects the estimates of the Security Market Line. In general, logarithmic returns yield estimates of the market price of risk that are not significantly different from zero.

(4) Changing the number of portfolios from 20 to 10 or 40 does not affect significantly the estimated market price of risk on the NYSE. Significant changes in the magnitude of the estimated price of risk occur when the model is run with individual securities.

(5) Once systematic risk is accounted for, the variance of securities' returns is not related to securities' returns. We reject the Levy-Mayshar hypothesis according to which market imperfections lead to a pricing formula in which variance is the predominante measure of risk.

(6) Once systematic risk is accounted for, the skewness of securities' returns is not related to securities' returns. Although empirical return distributions are skewed, securities are priced as if investors made decisions on the basis of symmetrically distributed returns.

(7) Once systematic risk is accounted for, systematic skewness (coskewness of securities' returns with those of the market) is not related to securities' returns. We reject the Kraus-Litzenberger hypothesis according to which skewed distributions yield a pricing formula in which coskewness is inversely related to the securities' returns.

In general, the FM results presented in their 1973 paper seem very robust, except for the case of the definition of securities' returns. Using logarithmic returns produces results which are insignificantly different from zero. More work is needed in this area before we could reach definitive conclusions regarding the proper definition of returns in tests of the CAPM.

FOOTNOTES

1. The RCR model provides estimates that are statistically superior to those obtained by the FM sample averaging technique. "The simple averaging procedure of FM assumes that the market parameter estimates for each month should be weighted equally in determining the mean market parameters, regardless of the variance of these parmeter estimates. Each monthly ordinary least squares estimator of the mean market parameter is BLUE in each monthly equation. However, the FM pooling procedure of simple averaging is inefficient, because it does not use all the information available from the ordinary least square estimators. The RCR weighted average has minimum variance among all linear unbiased estimators because it incorporates the relative variation of the ordinary least squares estimators in obtaining the mean market parameter vector" (Schallheim-De Magistris (1980, p. 62).

2. These assumptions are as follows. Financial markets are perfect in the sense that investors are price-takers, securities are infinitely divisible, and there are no transactions and information costs and no taxes. The one-period percentage returns on risky securities are assumed to be normally distributed with known expected value and variance or to conform to some other two-parameter symmetric stable distribution (Fame (1971)). Investors are risk-averse and behave as if they maximize their one-period expected utility of portfolio returns.

3. A zero-beta asset is an asset whose returns are uncorrelated with the market portfolio and whose expected return is $E(R_o)$. In a portfolio context, a zero-beta asset is considered riskless although the variance of the distribution of its return - its total risk - is not equal to zero. The market portfolio is a portfolio consisting of all available risky assets held in proportion to their market value.

4. The equilibrium relationship given by equation (1) is stated in terms of expected, <u>ex ante</u> returns. In order to test its implications for the historical, <u>ex post</u> behavior of securities' prices we must specify a stochastic model of the generation of returns.

5. The i-th security's beta coefficient and its unsystematic risk are generated by the well-known market model (see Sharpe (1963), Beja (1972) and Fama (1971, 1973):

$$\tilde{R}_{it} = \alpha_i + \beta_{im}\tilde{R}_{mt} + \tilde{e}_{it},$$

from which we get

$$\hat{\beta}_{im} = \hat{Cov}(\tilde{R}_{it},\tilde{R}_m)/\hat{Var}(\tilde{R}_m t),$$
$$\hat{\alpha}_i = \bar{R}_i - \hat{\beta}_{im}\cdot\bar{R}_m$$

and

$$SE_i = \hat{\sigma}(\tilde{e}_i) \equiv \hat{\sigma}(\tilde{R}_{it} - \hat{\alpha}_i - \hat{\beta}_{im}\tilde{R}_{mt})$$

where hats signify least square estimates.

6. Recall that the independent variables were estimated over the preceding "esimtation period" (stage two of the FM procedure). Consequently, all the tests of the CAPM performed in this study are predictive tests since the set of independent or explanatory variables were estimated over a period that precedes the month over which the portfolios' returns were calculated. Note, also, that the independent variables are re-estimated continually after dropping the first month of the "estimation period" and adding the first month of the "testing period" and so on month after month. Hence, the set of independent variables is continually updated keeping the length of the "estimation period" constant but extending the "estimation period" into the "test period".

Results were tabulated with 5 decimal points but we present here tables with 4 or less decimal points for the purpose of comparison with the FM results and to save space. The more precise results are available from the authors on request. We should also point out that the results obtained by Schallheim-De Magistris (1980) are often significantly different from those obtained by FM (1973).

Note that one cannot be sure that the annual market price of risk will be 12 times the monthly estimate of .0084. There may be an intervalling effect beyond the obviously predictable multiplicative effect. This is one of the issues we raise in the next section.

See, for example, the numbers reported by Ibottson and Singuefield (1982).

10. Two additional observations should be made. First, the fact that $\bar{\hat{\gamma}}_2$ in table 1(b) and $\hat{\gamma}_3$ in table 1(d) are statistically significantly different from zero is simply due to the fact that both β_i^2 and SE_i are positively correlated to β_i. Regarding hypothesis 4 (the Sharpe-Lintner hypothesis) we do not report the average return on the risk free asset but the value of $\bar{\hat{\gamma}}_0$ over the longest period (1930-1980) equals 6.24 percent (.0052 x 12) which corresponds to the average yield one would have received on short-term government securities or equivalent low risk asset over the same period. In this respect see, for example, the numbers reported by Ibottson and Singuefield (1982).

11. The critical value (ρ_c) of the serial correlation coefficient at the 5 percent level of significance was calculated $\rho_c(n) = (2/\sqrt{n-1})$ where n is the number of monthly observations. We have :

n	552	528	480	402	150	120	78	60
$\rho_c(n)$	.085	.087	.092	.100	.164	.183	?228	.260

The few nonzero serial correlation coefficients are usually for $\bar{\hat{\gamma}}_0$, the estimated intercept coefficient.

12. Levhari and Levy (1977) have shown analytically that if returns are independently distributed and measured in proportional form (percentage rates of return) then one should expect the estimated betas of defensive securities ($\beta < 1$) to fall as the length of the return interval is increased and the estimated betas of aggresive securities ($\beta > 1$) to rise as the length of the return interval decreases. This behavior of beta is different from that predicted by equation (12.2) (Hawawini (1980)) Hawawini and Vora (1981, 1984) in a comment and a reply to Levhavi and Levy show that the data seem to conform better to the temporal behavior of beta predicted by equation (12.2) than the behavior predicted by Levhavi and Levy.

13. Hawawini and Vora (1980) show that:

$$\frac{1}{\hat{\gamma}_1(T)} \frac{d}{dT}\left(\frac{\hat{\gamma}_1(T)}{T}\right) = -\left(\frac{1}{T}\right)^2 k; \; k > 0$$

implying that $\left(\frac{\hat{\gamma}_1(T)}{T}\right)$ will decline (rise) in response to an increase in T given that $\gamma_1(1)$ is positive (negative).

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TABLE 1(a): TEST OF HYPOTHESIS 3: RESULTS FOR REGRESSION (7)

$$\tilde{R}_{it} = \tilde{\gamma}_{ot} + \tilde{\gamma}_{it}\hat{\beta}_{im} + \tilde{\mu}_{it}$$

Period	No. of Obs.	$\bar{\hat{\gamma}}_0$	$t(\bar{\hat{\gamma}}_0)$	$\rho(\hat{\gamma}_0)$	$\bar{\hat{\gamma}}_1$	$t(\bar{\hat{\gamma}}_1)$	$\rho(\hat{\gamma}_1)$	$\bar{r}^2$	$\sigma(r^2)$
35-80	552	.0052	3.29*	.169*	.0083	3.04*	.051	.3289	.2787
35-78	528	.0050	3.09*	.173*	.0080	2.85*	.049	.3256	.2795
35-74	480	.0055	3.25*	.165*	.0063	2.17*	.022	.3251	.2790
7/68-80	150	.0025	0.83	.162*	.0082	1.57	.172*	.3390	.2676
7/68-74	78	.0020	0.46	.133	-.0045	-0.68	.089	.3248	.2589
66-70	60	.0079	1.56	.123	-.0011	-0.16	.011	.3354	.2679
71-75	60	.0000	-0.01	.092	.0067	0.80	.082	.3254	.2586
76-80	60	.0003	0.06	.220	.0210	2.39*	.237	.3659	.2807
35-6/68	402	.0062	3.37*	.168*	.0083	2.60*	.003	.3251	.2831
35-45	132	.0039	0.91	.146	.0161	1.96	-.056	.3121	.2758
46-55	120	.0087	3.73*	.096	.0026	0.69	.072	.3540	.2994
56-6/68	150	.0061	2.46*	.255*	.0062	1.72	.151	.3134	.2761

Notes: (1) An asterisk indicates significance at the 5 percent level

(2) Returns are measured in percentage form over monthly intervals

(3) Cross-sectional regressions are run with 20 portfolios

TABLE 1(b): TEST OF HYPOTHESIS 1: RESULTS FOR REGRESSION (5)

$$\tilde{R}_{it} = \tilde{\gamma}_{ot} + \tilde{\gamma}_{2t}\hat{\beta}^2_{im} + \tilde{\mu}_{it}$$

Period	No. of Obs.	$\bar{\hat{\gamma}}_0$	$t(\bar{\hat{\gamma}}_0)$	$\rho(\hat{\gamma}_0)$	$\bar{\hat{\gamma}}_2$	$t(\bar{\hat{\gamma}}_2)$	$\rho(\hat{\gamma}_2)$	$\bar{r}^2$	$s(r^2)$
35-80	552	.0089	5.44*	.076	.0039	2.95*	.041	.3178	.2732
35-78	528	.0085	5.10*	.082	.0038	2.77*	.039	.3158	.2748
35-74	480	.0084	4.71*	.092	.0029	2.04*	.011	.3149	.2742
7/68-80	150	.0061	1.98*	.091	.0041	1.58	.161	.3265	.2595
7/68-74	78	.0001	0.03	.168	-.0023	-0.69	.078	.3162	.2535
66-70	60	.0077	1.59	.203	-.0009	-0.27	.109	.3242	.2637
71-75	60	.0026	0.49	.081	.0036	0.85	.067	.3215	.2531
76-80	60	.0095	2.35*	-.067	.0010	2.46*	.236	.3430	.2679
35-6/68	402	.0100	5.16*	.069	.0039	2.49*	-.009	.3146	.2784
35-45	132	.0108	2.28*	.029	.0077	1.90	.068	.3081	.2796
46-55	120	.0103	3.81*	.083	.0008	0.51	.069	.3343	.2856
56-6/68	150	.0089	4.07*	.198*	.0030	1.74	.150	.3046	.2725

<u>Notes</u>: (1) An asterisk indicates significance at the 5 percent level

(2) Returns are measured in percentage form over monthly intervals

(3) Cross-sectional regressions are run with 20 portfolios

TABLE 1(c): TEST OF HYPOTHESIS 1: RESULTS FOR REGRESSION (5.2)

$$\tilde{R}_{it} = \tilde{\gamma}_{ot} + \tilde{\gamma}_{it}\hat{\beta}_{im} + \tilde{\gamma}_{2t}\hat{\beta}^2_{im} + \tilde{\mu}_{it}$$

Period	No. of Obs.	$\bar{\gamma}_0$	$t(\bar{\gamma}_0)$	$\rho(\hat{\gamma}_0)$	$\bar{\gamma}_1$	$t(\bar{\gamma}_1)$	$\rho(\hat{\gamma}_1)$	$\bar{\gamma}_2$	$t(\bar{\gamma}_2)$	$\rho(\hat{\gamma}_2)$	$\bar{r}^2$	$\sigma(r^2)$
35-80	552	.0041	1.37	.027	.0105	1.52	.009	-.0009	-0.27	-.056	.3948	.2718
35-78	528	.0040	1.33	.010	.0100	1.44	-.012	-.0008	-0.23	-.070	.3909	.2720
35-74	480	.0034	1.25	.006	.0108	1.71	-.011	-.0021	-0.71	-.057	.3840	.2711
7/68-80	150	.0046	0.58	.038	.0031	0.17	.004	.0027	0.32	-.089	.4227	.2616
7/68-74	78	.0010	0.12	-.021	-.0018	-0.10	-.100	-.0015	-0.17	-.170	.3816	.2510
66-70	60	.0031	0.37	-.106	.0102	0.55	-.120	-.0056	-0.72	-.254	.3812	.2555
71-75	60	.0083	0.64	.017	-.0135	-0.50	-.024	.0105	0.74	-.066	.4040	.2527
76-80	60	.0024	0.18	.165	.0155	0.46	.134	.0029	0.21	.013	.4694	.2754
35-6/68	402	.0039	1.37	.013	.0133	1.99*	.011	-.0022	-0.72	-.022	.3845	.2752
35-45	132	.0049	0.78	-.113	.0141	0.93	-.038	.0008	0.11	-.067	.3598	.2759
46-55	120	-.0008	-0.26	.044	.0230	2.69*	-.013	-.0093	-3.00*	-.110	.4306	.2811
56-6/68	150	.0067	1.47	.186*	.0047	0.48	.107	.0009	0.20	.074	.3693	.2669

Notes: (1) An asterisk indicates significance at the 5 percent level

(2) Returns are measured in percentage form over monthly intervals

(3) Cross-sectional regressions are run with 20 portfolios

TABLE 1(d): TEST OF HYPOTHESIS 2: RESULTS FOR REGRESSION (6.1)

$$\tilde{R}_{it} = \tilde{\gamma}_{ot} + \tilde{\gamma}_{3t} SE_i + \tilde{\mu}_{it}$$

Period	No. of Obs.	$\bar{\hat{\gamma}}_0$	$t(\bar{\hat{\gamma}}_0)$	$\rho(\hat{\gamma}_0)$	$\bar{\hat{\gamma}}_3$	$t(\bar{\hat{\gamma}}_3)$	$\rho(\hat{\gamma}_3)$	$\bar{r}^2$	$\sigma(r^2)$
35-80	552	.0031	1.47	.123	.1180	2.77*	.111	.3057	.2602
35-78	528	.0032	1.46	.119	.1114	2.56*	.110	.3009	.2591
35-74	480	.0045	1.97	.088	.0832	1.85	.095	.2974	.2563
7/68-80	150	-.0008	-0.18	.182	.1176	1.30	.153	.3276	.2634
7/68-74	78	.0038	0.66	.058	-.0972	-0.79	.086	.2966	.2447
66-70	60	.0090	1.29	.043	-.0202	-0.13	.095	.3148	.2601
71-75	60	-.0045	-0.65	.064	.1330	0.90	.056	.2978	.2380
76-80	60	-.0078	-1.16	.315*	.3281	2.37*	.220	.3699	.2825
35-6/68	402	.0046	1.86	.089	.1182	2.47*	.084	.2976	.2588
35-45	132	.0029	0.52	.015	.1543	1.76	-.020	.3054	.2650
46-55	120	.0085	2.81*	.049	.0491	0.70	.072	.3111	.2638
56-6/68	150	.0030	0.78	.227*	.1416	1.65	.169	.2798	.2498

Notes: (1) An asterisk indicates significance at the 5 percent level

(2) Returns are measured in percentage form over monthly intervals

(3) Cross-sectional regressions are run with 20 portfolios

TABLE 1(e): TEST OF HYPOTHESIS 2: RESULTS FOR REGRESSION (6.2)

$$\tilde{R}_{it} = \tilde{\gamma}_{0t} + \tilde{\gamma}_{1t}\hat{\beta}_{im} + \tilde{\gamma}_{3t}SE_i + \tilde{\mu}_{it}$$

Period	No. of Obs.	$\bar{\hat{\gamma}}_0$	$t(\bar{\hat{\gamma}}_0)$	$\rho(\hat{\gamma}_0)$	$\bar{\hat{\gamma}}_1$	$t(\bar{\hat{\gamma}}_1)$	$\rho(\hat{\gamma}_1)$	$\bar{\hat{\gamma}}_3$	$t(\bar{\hat{\gamma}}_3)$	$\rho(\hat{\gamma}_3)$	$\bar{r}^2$	$\sigma(r^2)$
35-80	552	.0040	1.93	.090	.0059	2.07*	-.081	.0412	0.94	.000	.3862	2654
35-78	528	.0042	2.00*	.082	.0065	2.20*	-.073	.0266	0.61	-.005	.3833	.2660
35-74	480	.0050	2.33*	.048	.0056	1.91	-.074	.0130	0.32	-.018	.3843	.2654
7/68-80	150	-.0006	-0.13	.153	.0013	0.19	-.032	.1069	0.94	.005	.3899	.2598
7/68-74	78	.0017	0.30	.007	-.0050	-0.60	.050	-.0059	-0.05	-.050	.3817	.2548
66-70	60	.0110	1.81	-.025	.0039	0.52	-.075	-.1157	-0.92	-.192	.3886	.2537
71-75	60	-.0085	-1.25	.002	-.0097	-0.86	.063	.3052	1.58	-.024	.3772	.2600
76-80	60	-.0035	-0.52	.307*	.0124	1.19	-.194	.1386	0.76	-.008	.4049	.2706
35-6/68	402	.0057	2.42*	.052	.0077	2.48*	-.117	.0167	0.39	-.008	.3849	.2678
35-45	132	.0028	0.51	.030	.0129	1.89	-.268	.0539	0.71	-.005	.3843	.2689
46-55	120	.0113	3.59*	-.026	.0079	1.62	.045	-.1163	-1.90	-.226	.4156	.2772
56-6/68	150	.0038	1.17	.123	.0029	0.70	.033	.0902	1.16	.086	.3606	.2582

Notes: (1) An asterisk indicates significance at the 5 percent level

(2) Returns are measured in percentage form over monthly intervals

(3) Cross-sectional regressions are run with 20 portfolios

TABLE 1(f): TEST OF HYPOTHESES 1 AND 2: REGRESSION: $\tilde{R}_{it} = \tilde{\gamma}_{0t} + \tilde{\gamma}_{1t}\hat{\beta}_{im} + \tilde{\gamma}_{2t}\hat{\beta}^2_{im} + \tilde{\gamma}_{3t}SE_i + \tilde{\mu}_{it}$

Period	No. of Obs.	$\bar{\bar{\gamma}}_0$	$t(\bar{\bar{\gamma}}_0)$	$\rho(\gamma_0)$	$\bar{\bar{\gamma}}_1$	$t(\bar{\bar{\gamma}}_1)$	$\rho(\hat{\gamma}_1)$	$\bar{\bar{\gamma}}_2$	$t(\bar{\bar{\gamma}}_2)$	$\rho(\hat{\gamma}_2)$	$\bar{\bar{\gamma}}_3$	$t(\bar{\bar{\gamma}}_3)$	$\rho(\hat{\gamma}_3)$	r^2	$\sigma(r^2)$
35-80	552	.0004	0.12	.018	.0102	1.53	-.004	-.0027	-0.85	-.042	.0756	1.75	-.011	.4431	.2570
35-78	528	.0005	0.13	.005	.0110	1.63	-.021	-.0029	-0.88	-.055	.0623	1.41	-.007	.4402	.2574
35-74	480	.0000	0.00	-.014	.0121	1.98*	-.023	-.0042	-1.37	-.041	.0583	1.31	-.015	.4354	.2563
7/68-80	150	.0022	0.23	.080	-.0037	-0.22	.001	.0029	0.34	-.063	.0941	0.93	.019	.4168	.2499
7/68-74	78	.0012	0.10	.052	-.0049	-0.25	-.067	-.0006	-0.06	-.087	.0047	0.03	.093	.4325	.2400
66-70	60	.0097	0.73	-.014	.0044	0.21	-.046	.0003	0.03	-.085	-.0918	-0.55	-.010	.4398	.2462
71-75	60	-.0107	-0.77	.066	-.0078	-0.29	-.018	-.0018	-0.13	-.045	.3392	2.32*	.042	.4394	.2438
76-80	60	.0006	0.04	.162	.0049	0.17	.111	.0044	0.32	.009	.1205	0.77	-.072	.4976	.2629
35-6/68	402	-.0002	-0.06	-.045	.0154	2.33*	-.017	-.0048	-1.56	-.029	.0687	1.49	-.053	.4359	.2596
35-45	132	-.0025	-0.29	-.014	.0208	1.42	-.073	-.0054	-0.76	-.062	.0879	1.06	-.094	.4237	.2648
46-55	120	.0013	0.32	-.063	.0223	2.62*	-.012	-.0080	-2.49*	-.123	-.0461	-0.77	-.243	.4733	.2641
56-6/68	150	.0006	0.10	.116	.0052	0.51	.062	-.0018	-0.37	.049	.1437	1.66	.019	.4168	.2499

Notes: (1) An asterisk indicates significance at the 5 percent level

(2) Returns are measured in percentage form over monthly intervals

(3) Cross-sectional regressions are run with 20 portfolios

TABLE 2: REGRESSIONS (7) AND (6.2) RUN WITH <u>LOGARITHMIC</u> RETURNS[3]

Period[1]	No. of Obs.	$\bar{\hat{\gamma}}_0$	$t(\bar{\hat{\gamma}}_0)$	$\bar{\hat{\gamma}}_1$	$t(\bar{\hat{\gamma}}_1)$	$\bar{\hat{\gamma}}_3$	$t(\bar{\hat{\gamma}}_3)$	$\bar{r}^2$	$\sigma(r^2)$
<u>T=1</u>									
35-80	552	.0028	4.14*	.0006	0.52			.3333	.2782
	552	.0027	3.03*	.0005	0.38	-.0005	-0.01	.3870	.2647
35-6/68	402	.0031	4.09*	.0007	0.49			.3312	.2813
	402	.0037	3.59*	.0018	1.17	-.0468	-1.02	.3853	.2667
<u>T=6</u>									
35-80	92	.0120	2.49*	.0084	0.92			.4217	.2735
	92	.0129	2.45*	.0080	1.09	-.0304	-0.34	.4577	.2635
35-6/68	67	.0132	2.47*	.0100	0.96			.4104	.2824
	67	.0151	2.64*	.01015	1.09	-.0470	-0.42	.4496	.2720

<u>Notes</u>: (1) T is the length of return interval in months

(2) An asterisk indicates statistical significance at the 5 percent level

(3) Results in the table above should be compared with those obtained with percentage returns found in Table 3

(4) Cross-sectional regressions are run with 20 portfolios

TABLE 3: EFFECT OF RETURN INTERVAL LENGTH ON REGRESSIONS (7) AND (6.2)

$$\tilde{R}_{it} = \tilde{\gamma}_{ot} + \tilde{\gamma}_{1t}\hat{\beta}_{im} + \tilde{\gamma}_{3t}SE_i + \tilde{\mu}_{it}$$

Period	No. of Obs.	$\bar{\hat{\gamma}}_0$	$t(\bar{\hat{\gamma}}_0)$	$\bar{\hat{\gamma}}_1$	$t(\bar{\hat{\gamma}}_1)$	$\bar{\hat{\gamma}}_3$	$t(\bar{\hat{\gamma}}_3)$	$\bar{r}^2$	$\sigma(r^2)$
T=1									
35-80	552	.0052	3.29*	.0084	3.04*			.3289	.2787
	552	.0040	1.93	.0059	2.07*	.0412	0.94	.3862	.2654
35-6/68	402	.0062	3.36*	.0084	2.60*			.3251	.2831
	402	.0057	2.42*	.0077	2.48*	.0167	0.39	.3849	.2678
T=2									
35-80	276	.0119	3.44*	.0148	2.59*			.3658	.2768
	276	.0085	1.95	.0087	1.41	.0673	1.11	.4169	.2660
35-6/68	201	.0140	3.39*	.0146	2.26*			.3567	.2792
	201	.0109	2.07*	.0091	1.34	.0557	0.80	.4075	.2671
T=3									
35-80	184	.0148	2.57*	.0270	2.86*			.3761	.2815
	184	.0105	1.52	.0224	2.42*	.0265	0.41	.4252	.2639
35-6/68	134	.0173	2.57*	.0273	2.52*			.3624	.2858
	134	.0153	1.99*	.0247	2.31*	-.0108	-0.16	.4092	.2678
T=4									
35-80	138	.0231	3.24*	.0302	2.50*			.3571	.2748
	138	.0131	1.49	.0173	1.50	.1184	1.78	.4144	.2630
35-4/68	100	.0251	2.97*	.0314	2.30*			.3322	.2732
	100	.0201	1.91	.0218	1.62	.0680	0.92	.3864	.2630
T=6									
35-80	92	.0320	2.44*	.0530	2.68*			.3737	.2689
	92	.0279	1.75	.0401	2.20*	.0978	0.96	.4288	.2591
35-6/68	67	.0411	2.68*	.0490	2.41*			.3644	.2790
	67	.0447	2.46*	.0516	2.50*	-.0018	-0.01	.4112	.2719

Notes: (1) T is the length of the return interval in months
(2) An asterisk indicates statistical significance at the 5 percent level
(3) Cross-sectional regressions are run with 20 portfolios

TABLE 4: EFFECT OF THE NUMBER OF PORTFOLIOS (N_p) ON REGRESSION (7)
FOR TEST PERIOD 1/76 TO 12/80 (5 YEARS)

$T^{(1)}$	$n^{(2)}$	$N_p^{(3)}$	$\bar{\bar{\gamma}}_0$	$t(\bar{\bar{\gamma}}_0)$	$\bar{\bar{\gamma}}_1$	$t(\bar{\bar{\gamma}}_1)$	$\bar{r}^2$	$\sigma(r^2)$
1	60	10	.0001	0.01	.0212	2.40*	.4704	.3123
1	60	20	.0003	0.06	.0210	2.39*	.3659	.2807
1	60	40	.0013	0.30	.0198	2.32*	.2479	.2274
1	60	798	.0076	2.06*	.0114	1.86	.0343	.0559
2	30	10	.0031	0.37	.0404	1.99*	.5585	.3381
2	30	20	.0020	0.21	.0411	1.88	.4302	.2998
2	30	40	.0039	0.48	.0395	1.99*	.3359	.2881
2	30	798	.0176	2.53*	.0208	1.65	.0479	.0647
3	20	10	.0010	0.06	.0632	2.28*	.5626	.2759
3	20	20	.0037	0.22	.0603	2.20*	.4145	.2493
3	20	40	.0040	0.26	.0598	2.36*	.2990	.2078
3	20	798	.0273	2.09*	.0285	1.73	.0404	.0478
4	15	10	.0105	0.53	.0743	1.90	.5197	.3605
4	15	20	.0120	0.62	.0726	1.90	.4154	.3120
4	15	40	.0156	0.92	.0686	1.94	.3109	.2611
4	15	798	.0480	3.01*	.0249	1.41	.0429	.0456
6	10	10	-.0010	-0.03	.1284	2.08*	.4151	.2833
6	10	20	.0064	0.20	.1200	2.06*	.3837	.2643
6	10	40	.0190	0.68	.1057	2.06*	.3045	.2394
6	10	798	.0631	2.85*	.0462	2.10*	.0292	.0315

<u>Notes</u>: (1) T is the length of the return interval in months
(2) n is the number of return observations
(3) N_p is the number of portfolios; N_p = 798 for single securities' portfolios
(4) An asterisk indicates statistical significance at the 5 percent level

TABLE 5: TEST OF HYPOTHESIS 6: THE VARIANCE EFFECT: REGRESSIONS (8.1) AND (8.2)

$$\tilde{R}_{it} = \tilde{\gamma}_{0t} + \tilde{\gamma}_{1t}\hat{\beta}_{im} + \tilde{\gamma}_{4t}VAR_i + \tilde{\mu}_{it}$$

Period[1]	No. of Obs.	$\bar{\gamma}_0$	$t(\bar{\gamma}_0)$	$\bar{\gamma}_1$	$t(\bar{\gamma}_1)$	$\bar{\gamma}_4$	$t(\bar{\gamma}_4)$	$\bar{r}^2$	$\sigma(r^2)$
T=1									
35-80	552	.0856	5.24*	–	–	.3447	2.23*	.3019	.2589
	552	.0056	3.02*	.0070	1.82	-.0005	-0.01	.3884	.2665
35-6/68	402	.0098	5.01*	–	–	.3644	2.08*	.2946	.2589
	402	.0059	3.08*	.0092	2.69*	-.1017	-0.62	.3815	.2715
T=3									
35-80	184	.0243	4.32*	–	–	.3435	2.21*	.3380	.2548
	184	.0151	2.41*	.0236	2.01*	-.1439	-0.96	.4312	.2678
35-6/68	134	.0276	4.10*	–	–	.3714	2.10*	.3213	.2552
	134	.0169	2.32*	.0263	1.98*	-.2242	-1.33	.4201	.2728
T=6									
35-80	92	.0570	4.22*	–	–	.3402	2.21*	.3059	.2282
	92	.0258	1.92	.0628	2.40*	.0738	0.55	.4301	.2588
35-6/68	67	.0675	4.08*	–	–	.3510	2.01*	.2856	.2298
	67	.0241	1.57	.0883	2.88*	-.0548	-0.38	.4250	.2695

Notes: (1) T is the length of the return interval in months

(2) An asterisk indicates statistical significance at the 5 percent level

(3) Cross-sectional regressions are run with 20 portfolios

TABLE 6: TEST OF HYPOTHESIS 6: THE SKEWNESS EFFECT: RESULTS FOR REGRESSIONS (9.1) AND (9.2)

$$\tilde{R}_{it} = \tilde{\gamma}_{0t} + \tilde{\gamma}_{1t}\hat{\beta}_{im} + \tilde{\gamma}_{5t}SKW_i + \tilde{\mu}_{it}$$

Period(1)	No. of Obs.	$\bar{\hat{\gamma}}_0$	$t(\bar{\hat{\gamma}}_0)$	$\bar{\hat{\gamma}}_1$	$t(\bar{\hat{\gamma}}_1)$	$\bar{\hat{\gamma}}_5$	$t(\bar{\hat{\gamma}}_5)$	$\bar{r}^2$	$\sigma(r^2)$
<u>T=1</u>									
35-80	552	.0094	5.07*	–	–	.0544	2.38*	.1837	.2010
	552	.0043	2.65*	.0091	3.22*	.0068	0.51	.3765	.2671
35-6/68	402	.0097	5.02*	–	–	.0689	2.49*	.2160	.2140
	402	.0052	2.76*	.0095	2.83*	.0040	0.27	.3675	.2694
<u>T=3</u>									
35-80	184	.0227	3.46*	–	–	.1331	2.34*	.2389	.2253
	184	.0116	2.03*	.0238	2.38*	.0108	0.40	.4163	.2710
35-6/68	134	.0238	3.14*	–	–	.1409	2.03*	.2411	.2246
	134	.0138	2.07*	.0220	1.88	.0283	0.96	.4033	.2747
<u>T=6</u>									
35-80	92	.0543	3.53*	–	–	.2202	2.77*	.1887	.1735
	92	.0341	2.54*	.0528	2.53*	.0495	0.11	.4087	.2648
35-6/68	67	.0682	3.84*	–	–	.2231	2.53*	.1890	.1807
	67	.0420	2.60*	.0481	2.20*	.0218	0.41	.3920	.2761

<u>Notes</u>: (1) T is the length of the return interval in months

(2) An asterisk indicates statistical significance at the 5 percent level

TABLE 7: TEST OF HYPOTHESIS 7: THE COSKEWNESS EFFECT: RESULTS FOR REGRESSIONS (9.3) AND (9.4)

$$\tilde{R}_{it} = \tilde{\gamma}_{0t} + \tilde{\gamma}_{1t}\hat{\beta}_{im} + \tilde{\gamma}_{6t}COSKW_i + \tilde{\mu}_{it}$$

Period(1)	No. of Obs.	$\bar{\bar{\gamma}}_0$	$t(\bar{\bar{\gamma}}_0)$	$\bar{\bar{\gamma}}_1$	$t(\bar{\bar{\gamma}}_1)$	$\bar{\bar{\gamma}}_6$	$t(\bar{\bar{\gamma}}_6)$	$\bar{r}^2$	$\sigma(r^2)$
T=1									
35-80	552	.0100	4.67*	–	–	.0037	2.49*	.1988	.2163
	552	.0055	3.14*	.0094	2.56*	-.0014	-0.70	.3815	.2715
35-6/68	402	.0123	5.03*	–	–	.0022	1.29	.2104	.2273
	402	.0063	3.00*	.0101	2.30*	-.0019	-0.77	.3694	.2765
T=3									
35-80	184	.0189	2.87*	–	–	.0232	3.00*	.2814	.2496
	184	.0182	2.94*	-.0010	-0.05	.0247	1.43	.4281	.2751
35-6/68	134	.017	2.29*	–	–	.0277	2.75*	.2950	.2575
	134	0.211	3.07*	-.0105	-0.43	.0342	1.46	.4156	.2799
T=6									
35-80	92	.0612	3.71*	–	–	.0208	2.22*	.2046	.2020
	92	.0257	1.85	.0928	2.62*	-.0331	-1.67	.4235	.2623
35-6/68	67	.0752	4.07*	–	–	.0114	1.20	.2065	.2023
	67	.0303	1.89	.0942	2.29*	-.0341	-1.39	.4143	.2719

Notes: (1) T is the length of the return interval in months

(2) An asterisk indicates statistical significance at the 5 percent level

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