Forthcoming: Journal of Finance and Quantitative Analysis

THE CAPITAL ASSET PRICING MODEL INFLATION AND THE INVESTMENT HORIZON: THE ISRAELI EXPERIENCE

by

Haim Levy*

Working Paper No. 16-79

RODNEY L. WHITE CENTER
FOR FINANCIAL RESEARCH
University of Pennsylvania
The Wharton School
Philadelphia, PA 19104

*University of Pennsylvania and the Hebrew University of Jerusalem.

THE CAPITAL ASSET PRICING MODEL, INFLATION AND THE INVESTMENT HORIZON: THE ISRAELI EXPERIENCE

Haim Levy*

I. Introduction

The Capital Asset Pricing Model (CAPM), an equilibrium model for the price determination of risky assets, was developed by Sharpe [16], Lintner [9], [10] and Treynor [21], following the pioneering work of Markowitz [12], [13] and Tobin [20]. In spite of the tremendous impact of this model on the profession, the CAPM still raises many questions, and is inconsistent with a considerable body of empirical evidence.

In a recent breakthrough paper, Roll [15] criticizes virtually all the empirical studies which attempt to test the CAPM, since he proves that if the "market portfolio" is ex-post efficient one would get in the sample as a technical result an exact linear relationship between the average returns of the securities and their corresponding Betas. Nevertheless, one may have the following two interpretations of the results of empirical studies which attempt to test the validity of the CAPM:

(a) Poor empirical results imply that the proxy chosen to represent the market portfolio, e.g., the Fisher Index, is Mean-Variance inefficient (see Roll [15]). If the market-portfolio proxy is significantly inefficient, this

---

* The Hebrew University of Jerusalem, Israel. The author wishes to acknowledge the helpful comments of Zvi Lerman and the referee of this Journal. The author acknowledges the financial support from the Leon Racanati Research Foundation.

in itself is evidence which contradicts the CAPM, since according to this model all investors hold the market portfolio which is expected to be efficient. On the other hand, if the market portfolio is found to be efficient, this provides one piece of evidence in favor of the CAPM. Obviously, this evidence is not sufficient to confirm the CAPM and examination of the coefficients in the second-pass regression supplies further evidence either supporting or contradicting the CAPM. The second-pass regression thus tests solely the hypothesis that the market portfolio is either efficient or inefficient. Nevertheless, this test is an indirect (partial) test of the CAPM, since one expects that if this theoretical model holds, apart from statistical errors, the market portfolio must be efficient. It is worth mentioning that one might reach inconclusive results with the second-pass regression. For example, suppose that the market portfolio is ex-post efficient, i.e., one gets as a technical result a perfect linear fit in the second-pass regression. However, if the intercept is found to be say 10%, while the prevailing risk-free interest rate in the market is 3%, one cannot accept the CAPM in spite of the fact that the market portfolio has been found to be ex-post efficient.

Obviously, the results of the second-pass regression, i.e., the coefficient of determination as well as the sign and the magnitude of the regression coefficients, test the efficiency of the market portfolio on the one hand, and a whole set of assumptions underlying the CAPM, on the other. For example, suppose that most investors do not hold highly diversified portfolios. Hence, they do not hold the market portfolio, and this contradicts one of the basic predictions of the CAPM. In such a case there is no reason to expect the market portfolio to be efficient (see Levy [8]).

However, the examination of the second-pass regression results sheds light on the importance of the assumption that all investors hold the market portfolio.

An additional assumption of the CAPM is that all investors are characterized by the same investment horizon. Obviously, this assumption is an oversimplification of the investors' behavior, and so empirical tests using rates of return calculated for various horizons should reveal the degree of deviation caused by the fact that this assumption may be invalid.

To sum up, testing the CAPM one tests the efficiency of the market-portfolio proxy together with all the other assumptions underlying the CAPM. We agree with Roll [15] that if the market-portfolio proxy is efficient, one gets as a technical result a perfect fit in the second-pass regression in the sample. However, the fact that this market proxy is efficient is in itself a partial confirmation of the CAPM. It only provides partial evidence supporting the CAPM, since the tests are conducted using a proxy for the market portfolio; the true market portfolio probably cannot be identified if we want to consider all possible risky assets as implied by the model.

(b) It is well-known that in order to examine the validity of the CAPM one should use ex-ante rather than ex-post variables. However, ex-ante variables are usually unavailable and ex-post data serve as a proxy for the desired future variables.

It may be that the market portfolio is ex-post inefficient, but nevertheless serves as the best proxy for the ex-ante variables, in the sense that the Beta estimates obtained with the proxy portfolio are the best. Thus, we are trying to fit a positive model which explains price behavior, and analyze it with respect to the normative model developed by Sharpe, Lintner and Treynor. Indeed Friend, Westerfield and Granito [5] substitute

<u>ex-ante</u> (expected) for <u>ex-post</u> variables in testing the CAPM. These <u>ex-ante</u> variables were taken from a sample of financial institutions. They also introduce a large sample of individual bonds. They found that using <u>ex-ante</u> data in lieu of <u>ex-post</u> data does not result in a close correlation between average return and Beta.

In this paper, we re-examine empirically the validity of the CAPM, as well as that of the one-parameter performance measure (reward-to-volatility), using a sample of Israeli data, taken from a small security market which is thin and extremely underdeveloped. We introduce a new dimension to the empirical tests by analyzing the validity of the CAPM, and of the one-parameter performance index, for different assumed investment horizons. We furthermore introduce two important factors which cannot be ignored in any empirical tests of the Israel securities market, namely, the bond market and inflation. While these factors are usually ignored (presumably for convenience) in empirical studies testing the validity of the CAPM in American security markets, their role is so central to the Israeli economy that they cannot be disregarded when using Israeli data.

The empirical evidence based on the Israeli data reveals some striking phenomena. Since the Israeli securities market is quite small, and since a relatively insignificant (and possibly random) excess demand or excess supply may induce large fluctuations in the stock prices, one would expect the CAPM to yield very poor results with Israeli data. To our surprise, however, Israeli data produced very strong results, free of some of the inconsistencies between the theoretical model and the empirical results which characterize the American securities market. Indeed, to the best of my knowledge, this is the first time that empirical findings are almost fully consistent with the CAPM. Possibly the thinness of the Israeli market, and in particular the existence of a riskless interest rate in real terms, account for these results. A second phenomenon revealed in our study is the central role played by the assumed investment horizon. Results that were poor and inconsistent with the CAPM improved dramatically once we varied the assumed investment horizon. We believe that these phenomena are of crucial importance to any empirical study, and are not restricted to the test of the CAPM.

It is interesting to note that all empirical results known to the author of this paper which use individual stocks (rather than portfolios) and short horizons (i.e., weekly, monthly or even quarterly data) show a very poor fit. If we adopt the kind of interpretation proposed in (a) above, we still have the following perplexing issue: why is it that the market portfolio is always "far" from the efficient set when we use monthly data while the "distance" decreases once we use annual data. We devote some consideration to this issue throughout the paper.

In Section II we review briefly the CAPM assumptions and the empirical results obtained in most studies. In Section III, we analyze the Israel securities market for various investment horizons. We test the CAPM and the one-parameter performance index on Israeli data using nominal as well as real (inflation-adjusted) rates of return. We also test the impact of the inclusion of bonds in the "market portfolio" on the CAPM tests and on the estimates of the systematic risk. Concluding remarks are given in Section IV.

II. CAPM: Assumptions and Empirical Evidence

The basic assumptions of the CAPM are the following: every investor makes decisions solely in terms of the mean and the variance; all investors are one-period expected utility maximizers; the investment horizon is identical for all; there exist homogeneous expectations; there is a perfect market with a riskless borrowing rate equal to the lending rate; there is no transaction cost; and, finally, the market is in equilibrium. On the basis of these assumptions, one would expect to find the following relationship:

$$ER_i = R_f + [ER_m - R_f]\beta_i \qquad (1)$$

where ER_i - is the expected rate of return on security i.

ER_m - is the expected rate of return on the "market portfolio"

R_f - is the risk-free interest rate

β_i - is the i-th asset systematic risk

Obviously, equation (1) is an equilibrium equation in terms of <u>ex-ante</u> parameters. However, in order to examine the validity of the CAPM, it is common to use <u>ex-post</u> data as a proxy. We first employ time-series regressions in order to estimate the systematic risk $\hat{\beta}_i$, and then, in order to examine the validity of the CAPM, we use the cross-sectional regression of the form,

$$\overline{R}_i = \hat{\gamma}_0 + \hat{\gamma}_1\hat{\beta}_i + e_i \qquad (2)$$

Here $\overline{R}_i$ is the average <u>ex-post</u> rate of return on the i-th security and $\hat{\beta}_i$ is the estimate of its systematic risk. If the CAPM does explain price behavior one expects to find:

(a) $\hat{\gamma}_0$ is positive and not significantly different from the risk-free interest rate.

(b) $\hat{\gamma}_1$ is positive and serves as an estimate of the average rate of return on the market portfolio in excess of the risk-free interest rate.

(c) The second-pass regression has a relatively high coefficient of correlation, otherwise some important explanatory factors have been left out.

(d) The one-parameter performance measures, e.g. reward-to-volatility, are unrelated to the risk index.[1] Thus in a regression of the form

$$(R/V)_i = \hat{a}_0 + \hat{a}_1 \hat{\beta}_i + e_i \tag{3}$$

one would expect $\hat{a}_1$ not to be significantly different from zero, where we define $(R/V)_i = (\overline{R} - R_f)/\hat{\beta}_i$, and $\hat{\beta}_i$ stands for the estimate of the i-th security systematic risk.

Unfortunately, virtually all empirical studies based on the American market have yielded the following unsatisfactory results:

(a) $\hat{\gamma}_0$ is much higher than the observed riskless interest rate.

(b) $\hat{\gamma}_1$ is much lower than the observed average rate of return on the market portfolio in excess of the riskless interest rate.

(c) the second-pass R^2 is quite low.

(d) the estimate $\hat{a}_1$ is significantly different from zero and, in most cases, it is negative.

We will mention here only a few of these studies. Douglas [3], who studied the period 1926-1960, found that the average return, $\overline{R}_i$, was

---

1. Since the other one-parameter performance measures are related to Treynor's Reward-to-Volatility index (see Friend and Blume [4]), we will analyze in this paper only this index.

significantly (positively) related to the variance of the security return and not to its Beta. This, of course, is inconsistent with the CAPM. Lintner [11] studied the period 1954-1963. To his cross-section analysis he added the residual variance $\hat{S}^2_{e_i}$, as estimated from the first-pass regression. According to the CAPM the coefficient of this factor should not be significantly different from zero. However, Lintner found this coefficient to be significantly greater than zero, and, in addition, he found that $\hat{\gamma}_0$ was much greater than R_f, and $\hat{\gamma}_1$ much smaller than the observed excess return $(\bar{R}_m - R_f)$.

Using a different set of data and a relatively longer horizon (i.e. annual rates of return), Miller and Scholes [14] obtained very similar results. In their study of the period 1954-1963, they found, in the empirical test of the CAPM, that $\hat{\gamma}_0 = 0.122$, $\hat{\gamma}_1 = 0.071$ and the $R^2 = 19\%$. By adding the estimate of the residual variance $\hat{S}^2_{e_i}$ as an independent variable, they increased the R^2 to 33%. They also found the coefficient of $\hat{S}^2_{e_i}$ to be positive and highly significant. Black, Jensen and Scholes (B-J-S) [1] confirmed the systematic bias from the CAPM. In particular, they found that, on the average, high-risk securities earned less than the amount predicted by the CAPM, while the opposite was true for low-risk securities.

Though all these unsatisfactory results can be attributed simply to an incorrect choice of the market portfolio proxy, there have been many attempts in other directions to explain these inconsistencies with the CAPM theory. For example, Miller and Scholes (M-S) investigated several possible causes of bias in the empirical analysis: failure to measure adequately the risk-free interest rate, skewness of the rates of return distribution, errors in estimating the systematic risk (and also use of an improper index for the market portfolio).

Similarly, Friend and Blume, who examined the properties of the one-parameter performance measures, found a strong correlation between $(R/V)_i$ and the risk index $\hat{\beta}_i$, a result that again contradicted the CAPM. They argued that the unrealistic assumption of a borrowing (risk-free) rate equal to the lending rate is the main factor responsible for the bias against high-risk portfolios.

None of the papers mentioned above, however, gave careful consideration to the assumed investment horizon. For example, Douglas used quarterly and annual rates of return. Friend and Blume and Black, Jensen and Scholes used monthly rates of return; Lintner and Miller and Scholes used annual data. We shall show below that the investment horizon plays a crucial role in explaining prices of stocks in the Israeli market. We found that the assumed investment horizon plays a central role also in the American market, but for brevity's sake we will not report on these empirical findings in this paper.

Investigation of the impact of the investment horizon on the performance index was first carried out in Levy [7]. While Levy [7] analyzed the relationship between Sharpe's [17] reward-to-variability index and the assumed investment horizon, Levhari and Levy [6] analyzed the impact of changes in the investment horizon on the systematic risk, β, as well as on the reward-to-volatility index. These two papers showed theoretically that there is some systematic relationship between the performance measures (as well as β) and the investment horizon, and that there is a <u>mathematical bias</u> stemming from the choice of an improper horizon.

In the next section we investigate the CAPM with Israeli data. We will analyze in particular the impact of the assumed investment horizon, inflation and the inclusion of bonds in the market portfolio on the empirical tests.

III. CAPM: The Israeli Experience

Virtually all empirical studies of the American stock exchange employ nominal rates of return and use as a market-portfolio proxy some index of stocks, e.g., the Fisher Index, the Dow-Jones, etc. In analyzing the Israel securities market, we must also take into account inflation and the bond market. Table 1 presents some basic data which demonstrate the importance of inflation and the crucial role of the bond market in the Israel securities market. In spite of the fact that the period of twelve years covered in this empirical study (1965-1976) includes a short-period of relative price stability (1967-1969), the average inflation rate remained consistently high. In fact, the geometric mean rate of inflation for the twelve year period, 15.7% per year, is sufficiently high to be taken into account in any empirical study.

A second striking phenomenon illustrated by Table 1 is the considerable weight of bonds in the Israel securities market. At the end of 1976, approximately 76% of the total market value of all securities listed on the Israeli exchange consisted of bonds. Though several types of bonds are traded in the Israeli market, it is long-term Government bonds linked (interest and principal) to the cost of living index which constitute the bulk of the bond market (69.7% of the total market value of all securities in 1976). The indexing of the Government bonds provides a riskless interest rate in real terms, which allows us to derive the Sharpe-Lintner equilibrium model in real terms. Obviously, most of these bonds are risky even in real terms due to possible fluctuation in their prices. However, investors with a given investment horizon, say, of one year, can buy indexed bonds maturing in one year, and these bonds can be considered as riskless in real terms. Since all the bonds are Government bonds, we can safely ignore bankruptcy risk.[2]

Inflation and the bond market are thus far from negligible factors in Israel. Therefore, an appropriate examination of the CAPM, as well as of the Beta estimates should be carried out in real terms, and the "market portfolio" should consist of both stocks and bonds.[3] We can examine the role of inflation and the bond market in the CAPM empirical studies by running the following four empirical tests:

(a) Analysis of the CAPM in nominal terms, when the proxy for the market portfolio is the index[4] of all stocks traded in the market.

(b) The same as (a) but carried out in real terms.[5]

---

2. While riskless bonds assure the possibility to lend at a real riskless interest rate, borrowing at a riskless interest rate is not readily available to all individuals.

3. Sharpe [18] analyzes the one-parameter performance index and the performance of bonds versus stocks in the American market. However, he does not analyze the impact of the inclusion of bonds on the estimate of the systematic risk or on the CAPM empirical studies.

4. Obviously, we adjust these indices for stock dividends, cash dividends, etc.

5. If R_{it} and g_t are the nominal rate of return on security i and the inflation rate in period t, respectively, the real rate of return on security i in this period, R^*_{it}, is calculated as follows:

$$R^*_{it} = \frac{1 + R_{it}}{1 + g_t} - 1.$$

(c) Analysis of the CAPM using as the market-portfolio proxy the weighted average of indices of stocks and bonds with weights reflecting the market value of each of these two components.

(d) The same as (c) but in real terms.

Before analyzing these alternative empirical tests, however, we believe that a brief description of the Israeli stock market is called for. There are only slightly more than 100 stocks listed in the Israeli market. Many of the companies listed in the stock market are owned totally, or partially, by the three large domestic commercial banks: Bank Leumi, Bank Hapoalim, and Discount Bank. These three banks virtually control the stock market, and there have been repeated complaints in the Israeli press that the banks fix the prices of stocks as they wish. The complete domination of the security market by the banks stems from several factors: A significant part of all stocks that are traded in the market (in terms of volume) are bank stocks; the banks are the underwriters of almost all stock issues; the banks are also the most active brokers in the stock exchange. Since the three big banks cooperate among themselves (e.g. there is almost complete agreement between the banks on the underwriting commissions), there is a strong tendency in Israel to believe that the stock market is highly inefficient, and that prices in the stock market do not represent potential earning power or any meaningful economic values. It is frequently claimed that the large fluctuations in stock price caused by a small random amount of excess demand or excess supply of a given stock indicate inefficiency in the market.[6] For example, a given

---

6. More details on the trading procedure and test for the thinness of the Israeli market can be found in Silber [19].

stock may appreciate by 20% as a result of a small random excess demand, and then in the next day depreciate dramatically as a result of a small (and random) excess supply. Thus, large price fulctuations not associated with any new information characterize the Israeli stock exchange.

The trading system in Israel differs from that in the U.S. The stock exchange officer collects all the "buy" and "sell" orders and checks if there is excess demand or excess supply. If there is, for example, excess supply, he announces a decline in the stock price, and this decline continues until someone is willing to buy the excess amount available (there is thus only one "call" price for all transactions in a given stock). However, there are no specialists in the Israeli stock exchange, and the price of a stock can drop on a particular day by 20% or even more because of an excess supply of few thousand dollars. The day after, an opposite change in price may occur. The market is inefficient in the sense that small excess demand or supply causes a big change in the daily prices. There are no specialists to smooth out these extreme fluctuations which may be caused by random orders placed on any given day.

In order to illustrate this phenomenon, we examined a sample of nine stocks traded on July 20, 1977 on the Israeli stock exchange. Obviously, this is not a random sample but a sample consisting of stocks with large fluctuations in their prices on that day. The first column in Table 2 shows the changes in stock prices on July 20, 1977, while the second column records the turnover on the same day. Although the trade obviously was in Israeli pounds, we translated it into dollars (about 10 Israeli pounds to the dollar at the time) in order to make it more understandable to the reader who is unfamiliar with the Israeli market.

At first glance, the data seem to confirm the popular claim. For example, the stock of Solel Boneh (which deals with construction and building) dropped in one day by about 41% while the turnover in this stock on that day was less than $5000! Furthermore, this was not even a day of a big crush in the stock market, and no new information with regards to this company became available.

On that same day the prices of stocks of other companies recorded a rise rather than a decline. For example, Table 2 shows that there were rises of 2-5 percent in the prices of several stocks, also coupled with a relatively small turnover. Similar relatively large daily price changes with small turnovers are the rule and not the exception in Israel. Bearing in mind this background on extreme price fluctuations and on the control of the financial securities markets by three large banks, we were inclined to believe that one would not find any strong relationship between average return and risk for Israeli stocks.

With this rather pessimistic background in mind, we proceeded to test the CAPM on Israeli data. First we ran the first-pass regression using a time series of rates of return. With the estimates of $\hat{\beta}_i$ and the residual variance $\hat{S}^2_{e_i}$ from these time-series regressions, we ran the cross-secional (second-pass) regression in order to test the validity of the CAPM.

The empirical study covered 104 stocks which are listed on the Israeli stock exchange since 1965 and 4 representative bond groups. As with American data, we tested the CAPM by examining the relationship

$$\overline{R}_i = \hat{\gamma}_0 + \hat{\gamma}_1 \hat{\beta}_i \qquad (4)$$

and the relationship

$$\overline{R}_i = \hat{\gamma}_0 + \hat{\gamma}_1 \hat{\beta}_i + \hat{\gamma}_2 \hat{S}^2_{e_i} \qquad (5)$$

where $\overline{R}_i$ is the average rate of return on the ith security and $\hat{\beta}_i$ and $\hat{S}^2_{e_i}$ are the estimates taken from the first-pass regression. In order to obtain the first-pass regression estimates (i.e. $\hat{\beta}_i$) as well as the second-pass regression estimates, we used two alternative investment horizons, 3 months and one year, i.e. we used both quarterly data and annual data.[7] In order to analyze the impact of inflation on the empirical studies, we estimated the risk, $\hat{\beta}_i$, and the coefficients of the second-pass regression in nominal terms and in real (inflation-adjusted) terms. Finally, in order to examine the impact of the bond market on empirical results, we first used the stock market index as a proxy for the market portfolio, and then repeated the tests using as the market-portfolio proxy a weighted average of the stock and bond indices. We denote the proxy with stocks only as the "<u>All-Stock market portfolio</u>" while we call the second alternative (which includes bonds) the "<u>Stock-Bond market portfolio</u>".[8]

Testing the CAPM with quarterly data did not show great promise. In three out of the four alternative formulations discussed above, we obtained a very low R^2 ranging from nearly 1% to a maximum of 6%. Only in the formulation with the "stock-bond market portfolio" did the R^2 reach 15%. However, it is interesting to note that in the most relevant formulation, i.e., stock-bond market portfolio in real terms, the R^2 is only 6%. (See Tables 3 and 4).

---

7. There is no file of rates of return for Israeli stocks for a horizon shorter than three months.

8. All regressions involving the " all-stock market portfolio" were run using the 104 stocks; the regressions involving the "stock-bond market portfolio" were run using 108 securities - the 104 stocks and the 4 representative bonds.

The introduction of the residual variance ($\hat{S}^2_{e_i}$) as explanatory variable increases the R^2 to 19-22% depending on the formulation. However, in three out of the four formulations, after the introduction of $\hat{S}^2_{e_i}$, the coefficient of the systematic risk $\hat{\gamma}_1$ becomes insignificant. This result in itself casts doubts on the validity of the CAPM at least as can be concluded from tests with quarterly data. If we were to reach a conclusion solely on the basis of these empirical results, we would conclude that either one of the assumptions underlying the CAPM was wrong, or the Israel securities market was far from being efficient.[9]

In view of the thinness and the inefficiency of the Israel securities market, the results of Tables 3 and 4 indicating no relationship between average return and the systematic risk came as no surprise. Indeed, we almost decided to stop the research at this pessimistic point. However, knowing that the explanatory power of the CAPM is a function of the assumed investment horizon, we decided to try a longer horizon.[10] We thought that the results might be improved with annual data, but a priori, we did not expect to obtain much more meaningful results.

The results obtained with annual data, however, were startling. The explanatory power of the CAPM increased dramatically, we obtained a right direction for all coefficients, and over-all we would not hesitate to say that the empirical results were much stronger than in any empirical study

---

9. Obviously, there is the possibility of statistical errors. However, we do not believe that these possible errors can account for such extremely poor results.

10. For example, R^2 of the second-pass regression as observed in the American market is only about 5% with monthly data, about 13% with quarterly data and about 37% with annual data (all these figures are obtained when both $\hat{\beta}_i$ and $\hat{S}^2_{e_i}$ serve as explanatory variables).

which had been done with American data and was known to the author at the time of this writing.[11]

Tables 5 and 6 summarize the results of the second-pass regression with annual data. The conclusions from these tables are:

1) In all possible formulations the R^2 is quite high, varying in the range of 27% - 51%. By contrast, the R^2 obtained in previous studies (using American data and annual rates of return of individual stocks) has always been much lower. For example, the R^2 obtained by Miller and Scholes ranges from 19% to 34%. Even more important, when we test the CAPM in its pure formulation, namely with only $\hat{\beta}$ used as an explanatory variable, the R^2 with American data is below 20%, while with Israeli data it reached 41%. Thus in spite of the fact that the Israeli stock market is relatively small, in spite of the monopoly power of the large banks, and the extreme daily price fluctuations, it seems that, in the long run (annual data), the Israeli market may be even more efficient than the American market. At least, the return-risk relationship has a much greater explanatory power in the Israeli securities market than in the American securities market.

2) In virtually all empirical tests of the CAPM using American data it has been found that $\hat{\gamma}_0$ is much higher than the figure implied by the CAPM,[12]

---

11. Recall that we use in our cross-sectional regression individual stocks and not portfolios, exactly as required by the theoretical model. Hence in the comparison of the explanatory power of our results with those of other studies, we must confine ourselves to empirical tests which use individual stocks rather than portfolios (e.g., Lintner, Miller and Scholes, etc.)

12. If $\bar{R}_i$ stands for the average rate of return of the i-th security in excess of the riskless interest rate then $\hat{\gamma}_0$ should not be significantly different from zero. In our empirical study, $\bar{R}_i$ is the average rate of return and not the excess return over the risk-free interest rate; hence $\hat{\gamma}_0$ is compared to the risk-free interest rate.

and $\hat{\gamma}_1$ is much lower than the observed average rate of return on the market portfolio in excess of the riskless interest rate. Once again, our Israeli findings are much more consistent with the CAPM on these points. Moreover, if we did have some deviations from the observed figures, they were certainly in the other direction. In order to examine these results more closely, let us mention the following figures: The observed average annual nominal and real rates of return on the "all-stock market portfolio" were 23.6% and 6.6%, respectively, in the years 1965-76 while the average annual rate of return on the "stock-bond market portfolio" (stocks and bonds) were 21.6% in nominal terms and 4.3% in real terms. The average inflation rate was 15.7% per year, and the average <u>real</u> rate of return on Government bonds was 4.6% a year. Since the bonds with average real rate of return of 4.6% include risky securities (i.e., bonds with long maturities), the real rate of return on bonds with one year maturity (which we considered as riskless in our test) was below 4.6%.

In all regressions, we obtained that $\hat{\gamma}_0$ was either below the riskless interest rate or not significantly different from it. Thus, this is the first study in which $\hat{\gamma}_0$ was below the observed riskless interest rate rather than above it. For example, in the two annual regressions in real terms $\hat{\gamma}_0 = -3.63$ and -3.85 (see Tables 5 and 6 respectively - note that here $\hat{\gamma}_0$ is not significantly different from zero). In both cases $\hat{\gamma}_0$ is below the average real riskless interest rate on Government bonds with a one-year maturity, which was about 3% for this period. Moreover, since our empirical study covering the period 1965-76 was written in 1979, we can benefit from an analysis of developments in the bond market during the years 1976-79. Although we used <u>ex-post</u> rather than <u>ex-ante</u> data in our empirical study, it is possible that the relatively low estimates we obtained for $\hat{\gamma}_0$ indicate the future trend in the real rate of return on bonds with one-year maturity. Indeed, the real yield to maturity on Government bonds with one-year maturity subsequently dropped to zero, and in 1976, even to -3%.[13] It thus appears that the estimates of $\hat{\gamma}_0$ are either very close to the (ex-ante) real rate of return on riskless assets or are below it.

An examination of the estimates of $\hat{\gamma}_0$ based on nominal rather than real rates of return does not change the previous analysis. The annual estimates of $\hat{\gamma}_0$ in nominal terms are 9.90% in one formulation and 12.63% in the other. (see Tables 5 and 6). In view of the fact that the mean annual inflation rate was about 16% over the period the estimates of $\hat{\gamma}_0$ adjusted for inflation yield almost the same results regardless of whether one uses nominal or real annual rates of return.

On the other hand, the estimates of $\hat{\gamma}_1$ seem to be higher than the observed return on the market portfolio in excess of the riskless interest rate. For example, in the regression using the "stock-bond market portfolio" and real annual rates of return (Table 6 (b)), we find that $\hat{\gamma}_1 = 3.67$, while the observed average real rate of return on this market portfolio was only 4.3% per year, and the excess return of this portfolio was much less than this figure. The same direction of bias in $\hat{\gamma}_1$ is obtained when we use the "all-stock market portfolio" as a proxy to the market portfolio.

In summary, we found that $\hat{\gamma}_0$ was below the observed riskless interest rate and that $\hat{\gamma}_1$ was above the average rate of return on the market portfolio (in excess of the riskless interest rate). These results were exactly

---

13. Recall that the principal and the interest of Government bonds are linked to the cost-of-living index. Thus, this yield to maturity actually measures the riskless interest rate for investors with a one-year investment horizon. The yield to maturity on short-term Government bonds fluctuated between +2% and -3% from 1976 through the first quarter of 1979.

the opposite of empirical results derived from American data. However, the deviations from the observed figures were much smaller in the Israeli market compared to the deviations obtained with American data (see Miller and Scholes [14]).

(3) In spite of the high inflation rate in Israel, and the great variability of this rate over time, the use of real rates of return rather than nominal rates of return did not improve the relationship between return and risk. On the contrary, the explanatory power of the CAPM was better with nominal rather than real returns.

(4) In Table 5 we used the "All-Stock portfolio" as a proxy to the market portfolio, while in Table 6 we used the "Stock-Bond market portfolio". The inclusion of bonds in the market portfolio tended to increase the R^2 slightly, but not dramatically, in all four cases. In addition, the estimate of $\hat{\gamma}_1$ was much lower when we included bonds in the market portfolio. This is consistent with the CAPM since the excess return of the "Stock-Bond portfolio market" is much smaller than the excess return of "All-Stock market portfolio".

It appears that the bond market, a non-negligible factor in the Israeli securities market, adds relatively little to the second-pass regressions which test the CAPM. There is no question that part (b) of Table 6 is the only relevant one on the normative ground, since bonds should be included in the market portfolio, and real, rather than nominal, rates of return are relevant for decision making. However, the results obtained with nominal returns are much stronger. It may be that investors make their investment decisions in nominal terms in spite of the fact that normatively real returns should be employed.

Can we, then, ignore the bond market in the empirical studies? Based on the preceding analyses, can we draw the conclusion that the bond market contributes very little to the CAPM empirical study? We will show below that, although the bond market has little impact on the CAPM empirical results, it does have a tremendous impact on the systematic risk estimates $(\hat{\beta}_i)$, and one therefore may commit a considerable error by ignoring this factor.

Table 7 shows the distribution of the estimate $\hat{\beta}_i$ for the 104 stocks included in the study with the "all-stock market portfolio" and for 104 stocks and 4 bond groups included in the tests with the "stock-bond market portfolio". The four bond groups are Index-linked, Dollar-linked, unlinked and bonds traded in foreign currency. However, the index-linked bonds are the bulk in terms of market value. These distributions were derived from estimates of β_i obtained with both nominal and real annual returns. If we limit ourselves to an examination of the "all-stock market portfolio" columns, we note that there are only small differences between the nominal and the real distributions of the Betas. Therefore, without the bond market, inflation does not affect significantly the distribution of the Betas. However, the inclusion of bonds in the market portfolio induces a significant change in the distribution of the Betas for both nominal and real returns. In nominal terms, the Betas tend to increase and this tendency becomes even stronger when the distribution is analyzed in real terms.

It is now obvious that ignoring the bond market causes a decrease in the Beta estimates of most stocks. This, in turn, may cause a bias in the CAPM tests. For example, suppose that all Betas were biased downward by a given additive constant. This bias, of course, would not change the R^2 of the second-pass regression, and not even the estimate of the slope of the line.

However, if all Betas were biased downward by a given proportion, then, although the R^2 of the second-pass regression would remain unchanged, we would obtain a higher slope when using the CAPM test without bonds. This, indeed, describes our results (see Tables 5 and 6).

Though Table 7 shows a systematic shift in the distribution of the Betas with the inclusion of bonds in the market portfolios and adjustment for inflation, the figures of the table do not provide any information on individual stocks. We found that not all Betas increased by the same magnitude. The inclusion of bonds and inflation in the test actually caused a reduction in the Beta of some stocks although, in general, the Betas increased.

Table 8 illustrates this phenomenon. While most Betas increased when we took the bond market and inflation into account, we see from the table that the opposite was true for several stocks. The first two stocks in this table illustrate the typical result produced by taking inflation and the bond market into consideration; the transition from nominal to real returns did not have a dramatic impact on the Beta estimates as long as we restricted ourselves to the "all-stock market portfolio". On the other hand, the inclusion of bonds in the market portfolio generally caused an increase in the Betas which became even larger when the estimate was obtained with real rather than nominal returns. The greatest change in the Beta due to inflation was recorded for the stock of Alliance and Paper Mills: their Betas increased from 0.04 to 2.34 and from 0.22 to 3.90, respectively (see Table 8). The incorporation of inflation in our estimates thus induced an increase in the Beta of most stocks, but with some exceptions. For example, the Beta estimate of the Electric Corporation decreased from 1.52 to 1.12 and that of Chemicals and Phosphates decreased from 1.34 to 0.80.

Obviously, Table 8 only illustrates some of the extreme cases. However, by employing the Kolmogorov-Smirnov test and the Mann-Whitney test we find that the distribution of real Betas is stochastically larger than the distribution of the Betas obtained with "All-Stock market portfolio". This finding is significant at the $\alpha = 1\%$ level.

In summary, although the inclusion of bonds in the market portfolio did not change dramatically the empirical findings with regard to the CAPM, this factor as well as inflation cannot be ignored in estimating the systematic risk of securities.

The One-Parameter Performance Index

In a study which is not reported in this paper I have found, using American data, that, for a horizon of approximately one year, there is no systematic relationship between the one-parameter performance index and the securities' Betas. For other horizons $\hat{a}_1$ is negative and, in most cases, significantly different from zero (see eq. (3)). Using annual rates of return of Israeli stocks, we examined regression (3) using both nominal and real returns. We again used both the "all-stock market portfolio" and the "stock-bond market portfolio" as proxies to the market portfolio. Table 9 and Figures 1-4 summarize the results of regression (3) for these four formulations. It is obvious from these results that the inclusion of bonds in the market portfolio does not make much difference. Neither the R^2 nor the scatterdiagram change much when we use the two alternative proxies for the market portfolio. Similarly, inflation does not play an important role in the explanation of the one-parameter performance index. In all four alternative regressions we found that the R^2 was very close to zero (see Table 9). We also found that in all four cases the coefficient $\hat{a}_1$ was not significantly different from zero, as implied by the CAPM. Thus, in contrast to the results of most empirical studies based on data taken from the American market (see Friend and Blume [4]), we find no bias in the Israeli market in favor of risky securities. This is true with the regression carried out both in nominal and real return.

IV. Concluding Remarks.

We have examined empirically the CAPM and the one-parameter performance index with data taken from the Israeli market, a very thin market with only about 100 stocks of different companies listed on the exchange. We have found that the assumed investment horizon plays a central role, and that the regression coefficients of the CAPM, the coefficient of determination and the one-parameter performance index are all functions of the assumed investment horizon. This result is not peculiar to a small capital market, and the investment horizon plays a crucial role in the American market too.

The very thin Israeli stock market is characterized by large daily price fluctuations with small turnovers. Therefore, for short horizons, there is no meaningful relationship between return and risk. However, for annual rates of return, the CAPM explains about 40% of the variability of the average rates of return, the coefficients of the regression are not far from the observed variables and, in contrast to all other studies, there is no significant relationship between the reward-to-volatility index and the systematic risk.

There are two factors that may explain these surprising results obtained in the Israeli market.

(a) In the U.S. there is no riskless asset in real terms, whereas such an asset is essential to the derivation of the CAPM. In Israel, Government bonds linked to the cost-of-living index provide a riskless asset in real terms.

(b) From the point of view of the CAPM validity, the thinness of the market is a "two-edged sword." A thin market implies that a small excess demand or excess supply for a given stock may cause a large fluctuation in its price. This may induce a new and possibly meaningless price for the stock, implying that there is no meaningful relationship between return and risk. On the other hand, a small market may suit the CAPM better for the following reason: One of the properties of the CAPM is that all investors hold in their portfolios <u>all</u> the available risky securities. This, of course, is an unrealistic assumption that causes a deviation between the theoretical model and the empirical findings.[14] Indeed, in a recent study, Blume, Crockett and Friend [2] found that individuals hold highly undiversified portfolios, and that 50% of the investors who were included in the study held no more than two stocks. This finding implies that the bigger the market, the bigger will be the deviation between the assumption which underlies the theoretical model and the investors' actual behavior. The error induced by the fact that investors hold only 4-5 rather than 100 stocks (the Israeli market) will probably be much smaller than the error caused by the investors' holding only 4-5 rather than several thousand risky securities (the American market). Therefore, a thin and small market may show better

---

14. For more details on this issue, see Levy [8].

results than a larger market.[15] Obviously, this is true only if we eliminate other sources of error, e.g., by choosing an investment horizon as close as possible to the actual investment horizon.

Our findings demonstrate that the inclusion of bonds in the market portfolio and adjustment for inflation have a significant impact on the return-risk relationship. In particular, disregard of the bond market causes considerable errors in the Beta estimates of individual stocks.

Finally, we would like to mention that all the results of this paper could be explained on technical grounds, namely by the relationship between the market portfolio proxy and the M-V efficient set.[16] However, we tried in this paper to explain how this relationship varies systematically with the assumed investment horizon, with the market size, with the weight of the bond market and with inflation.

---

15. Obviously, one would expect to find a stronger relationship between the security's Beta and its variance in a small rather than in a large market. Indeed the R^2 between β_i and σ_i^2 is 43% for the American stocks included in this study, and 48% - 55% for the Israeli stocks (for the various tests in this paper).

16. Analyzing the location of the market portfolio relative to the efficient set (for various horizons) is an impossible undertaking even in a small market. For example, with 100 stocks, one needs over 100 annual observations in order to derive the efficient set. Since we have less than 100 annual observations in the Israeli market (or in any stock market for that matter), the variance-covariance matrix is singular, and one cannot derive the efficient set. Since we do not have a file of Israeli rates of return for periods shorter than 3 months, this task is impossible with Israeli data. The author is currently engaged in a research of the impact of the investment horizon on the M-V efficient set using monthly American data, where such a test is possible.

References

[1] Black, F., Jensen, M.C., and Scholes, M., "The Capital Asset Pricing Model: Some Empirical Tests," in M.C. Jensen (ed.), Studies in the Theory of Capital Markets (New York: Praeger Publishers, 1972).

[2] Blume, M.E., Crockett, J., and Friend, I., "Stock Ownership in the United States: Characteristics and Trends," Survey of Current Business (November 1974).

[3] Douglas, G.W., "Risk in the Equity Markets: An Empirical Appraisal of Market Efficiency," Yale Economic Essays (Spr. 1969).

[4] Friend, I., and Blume, M., "Measurement of Portfolio Performance Under Uncertainty," American Economic Review (Sept. 1970).

[5] Friend, I., Westerfield, R., and Granito, M., "New Evidence on the Capital Asset Pricing Model," Journal of Finance (June 1978).

[6] Levhari, D., and Levy, H., "The Capital Asset Pricing Model and the Investment Horizon," Review of Economics and Statistics (Feb. 1977).

[7] Levy, H., "Portfolio Performance and the Investment Horizon," Management Science (August 1972).

[8] Levy, H., "Equilibrium in an Imperfect Market: A Constraint on the Number of Securities in the Portfolio," American Economic Review (September 1978).

[9] Lintner, J., "Security Prices, Risk, and Maximal Gains from Diversification," Journal of Finance (Dec. 1965).

[10] ———, "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolio and Capital Budgets," Review of Economics and Statistics (Feb. 1965).

[11] ———, "Security Prices and Risk: The Theory of Comparative Analysis of A.T.&T. and Leading Industrials," presented at the Conference on the Economics of Regulated Public Utilities, June 1965, Chicago.

[12] Markowitz, H.M., "Portfolio Selection," Journal of Finance (Mar. 1952).

[13] ———, Portfolio Selection (New York: John Wiley and Sons, 1959).

[14] Miller, H.M., and Scholes, M., "Rate of Return in Relation to Risk: A Re-Examination of Some Recent Findings," in M.C. Jensen (ed.), Studies in the Theory of Capital Markets (New York: Praeger Publishers, 1972).

[15] Roll, R., "A Critique of the Asset Pricing Theory's Tests. Part I: On Past and Potential Testability of the Theory," Journal of Financial Economics (March 1977).

[16] Sharpe, W.F., "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk," Journal of Finance (Sept. 1964).

[17] ——————, "Mutual Fund Performance," Journal of Business (Jan. 1966).

[18] ——————, "Bonds versus Stocks: Some Lessons from Capital Market Theory," Financial Analysts Journal (Nov. - Dec. 1973).

[19] Silber, W.L., "Thinness in Capital Markets: The Case of the Tel Aviv Stock Exchange," Journal of Financial and Quantitative Analysis (March 1975).

[20] Tobin, J., "Liquidity Preference as Behavior towards Risk," Review of Economic Studies (Feb. 1958).

[21] Treynor, J.L., "Toward a Theory of Market Value of Risky Assets," unpublished manuscript, 1961.

[22] ——————, "How to Rate Management of Investment Funds," Harvard Business Review (Jan. - Feb. 1965).

<u>Table 1</u>

<u>Some basic data on the Israeli market: Period 1965-76</u>

(in percent)

	Inflation rate[1]	Market values in the security market		
		Bonds[2]	Stocks	Total
1965	6.98	58.6	41.4	100.0
1966	7.81	68.1	31.9	100.0
1967	0.17	70.3	29.7	100.0
1968	1.93	75.9	24.1	100.0
1969	3.88	76.8	23.2	100.0
1970	10.17	80.2	19.8	100.0
1971	13.34	81.0	19.0	100.0
1972	12.34	70.9	29.1	100.0
1973	26.44	77.7	22.3	100.0
1974	56.16	82.3	17.7	100.0
1975	23.52	80.4	19.6	100.0
1976	38.03	76.1	23.9	100.0

1 Percentage changes over the calendar year.

2 There are four major categories of bonds in the Israeli market: unlinked bonds, bonds linked to the cost of living, bonds linked to the U.S. dollar, and bonds traded in foreign currency. However the dominant part of the bond market consists of Government bonds which are linked to the cost of living index.

Table 2

Price changes and turnover in a sample of stocks on July 20, 1977

Stocks	Price Change (in %)	Turnover (in $)
Solel Boneh	-40.9%	$4,800
I.C.P. Citrus	+ 2.1	471
Pri-Or	+ 4.2	4,970
Ata	-28.3	22,895
Lewin-Epstein	-26.9	8,625
Wolfson-Clore Mayer	+ 4.8	3,200
Jordan (options)	+ 5.5	10,500
Mortgages and Building Bank	-28.3	1,472
Alliance	+ 3.9	2,500

Table 3

Israel Stock Market 1965-1976:
The Second Pass Regression with Quarterly data and the "All-stock market portfolio"

$\bar{R}_i =$ $\hat{\gamma}_0$	+ $\hat{\gamma}_1 \beta_i$	+ $\hat{\gamma}_2 S^2_{e_i}$	R^2
	(a) Nominal returns		
3.92	1.01		0.04
(0.54)	(0.50)		
t = 7.23	t = 2.01		
3.94	-0.012	0.00014	0.22
(0.49)	(0.502)	0.00003	
t = 8.04	t = -0.02	t = 4.87	
	(b) Real returns		
0.57	0.56		0.01
(0.53)	(0.49)		
t = 1.08	t = 1.15		
0.43	-0.23	0.00014	0.21
(0.47)	(0.47)	(0.00003)	
t = 0.90	t = -0.50	t = 5.11	

Table 4

Israel Securities Market 1965-1976: The second pass regression with quarterly data and the "stock bond market portfolio"

$\bar{R}_i$ = $\hat{\gamma}_0$	+ $\hat{\gamma}_1\beta_i$	+ $\gamma_2 S^2_{e_i}$	R^2
c) Nominal returns			
3.23	1.19		0.15
(0.42)	(0.27)		
t = 7.68	t = 4.33		
3.19	0.70	0.00007	0.19
(0.41)	(0.35)	(0.00003)	
t = 7.72	t = 2.03	t = 2.25	
d) Real returns			
0.02	0.42		0.06
(0.45)	(0.16)		
t = 0.04	t = 2.59		
-0.03	0.05	0.00011	0.18
(0.42)	(018)	(0.00003)	
t = -0.06	t = 0.30	t = 3.85	

Table 5

Israel Stock Market 1965-1976:
The Second-Pass Regression With Annual
Data and the "All-Stock market portfolio"

$\bar{R}_i =$	$\hat{\gamma}_0 +$	$\hat{\gamma}_1\beta_i +$	$\hat{\gamma}_2 S^2_{e_i}$	R^2
		(a) Nominal returns		
	9.90	14.19		0.35
	(2.12)	(1.90)		
	t = 4.67	t = 7.46		
	13.70	7.62	0.00020	0.50
	(2.01)	(2.09)	(0.00004)	
	t = 6.81	t = 3.65	t = 5.36	
		(b) Real returns		
	-3.63	10.70		0.22
	(2.13)	(1.97)		
	t = -1.70	t = 5.43		
	-1.87	6.49	0.00025	0.44
	(1.84)	(1.81)	(0.00004)	
	t = -1.02	t = 3.58	t = 6.23	

Table 7

The distribution of the estimates of β_i of Israeli securities: 1965-76
(annual returns)

Range of Betas	"All-stock Market Portfolio"		"Stock-bond Market Portfolio	
	Real	Nominal	Real	Nominal
0.001 - 0.250	5	4	2	7
0.251 - 0.500	8	9	2	3
0.501 - 0.750	12	16	2	8
0.751 - 1.000	31	23	4	11
1.001 - 1.250	18	25	3	19
1.251 - 1.500	22	19	3	24
1.501 - 1.750	4	4	5	8
1.751 - 2.000	2	1	5	5
2.001 - 2.250	0	0	5	12
2.251 - 2.500	1	1	12	5
2.501 - 2.750	0	0	12	2
2.751 - 3.000	1	1	4	1
3.001 - 3.250	0	0	10	0
3.251 - 3.500	1	1	8	0
3.501 - 3.750			1	0
3.751 - 4.000			0	0
4.001 - 4.250			6	0
4.251 - 4.500			4	1
4.501 - 4.750			12	0
4.751 - 5.000			4	0
5.001 - 5.250			0	0
5.251 - 5.500			1	0
5.501 - 5.750			0	0
5.751 - 6.000			1	0
> 6.000			2	2
TOTAL	104	104	108	108

Table 8

A sample of Beta estimates with different market portfolios in Nominal and Real terms (annual returns)

	"All-Stock Market Portfolio"		"Stock-Bond Market Portfolio"	
	Nominal	Real	Nominal	Real
Otzar Hashilton	0.51	0.56	0.56	1.47
Mizrahi Bank	0.51	0.47	1.1	1.40
Paper Mills	0.87	1.34	0.22	3.90
Alliance	0.51	0.79	0.04	2.34
Bank Leumi	0.84	0.88	1.29	2.92
Electric Corp.	0.36	0.26	1.52	1.12
Chemicals and Phosphates	0.28	0.21	1.34	0.80

Table 9

Regression of the One-Parameter Performance Index on Beta*:
Annual Returns 1965-1976

	I_j =	$\hat{a}_0$ +	$\hat{a}_1 \hat{\beta}_i$	R^2
"Stock-Bond Market Portfolio"				
	Nominal	19.82 (8.87)	-6.19 (5.06)	0.014
	Real	3.45 (1.44)	-0.12 (0.45)	0.001
"All-Stock Market Portfolio"				
	Nominal	4.82 (3.76)	4.26 (3.37)	0.015
	Real	5.72 (3.23)	2.85 (2.99)	0.009

* In brackets the standard error of the estimates.

FIGURE 1

ALL-STOCK PORTFOLIO, NOMINAL RETURNS

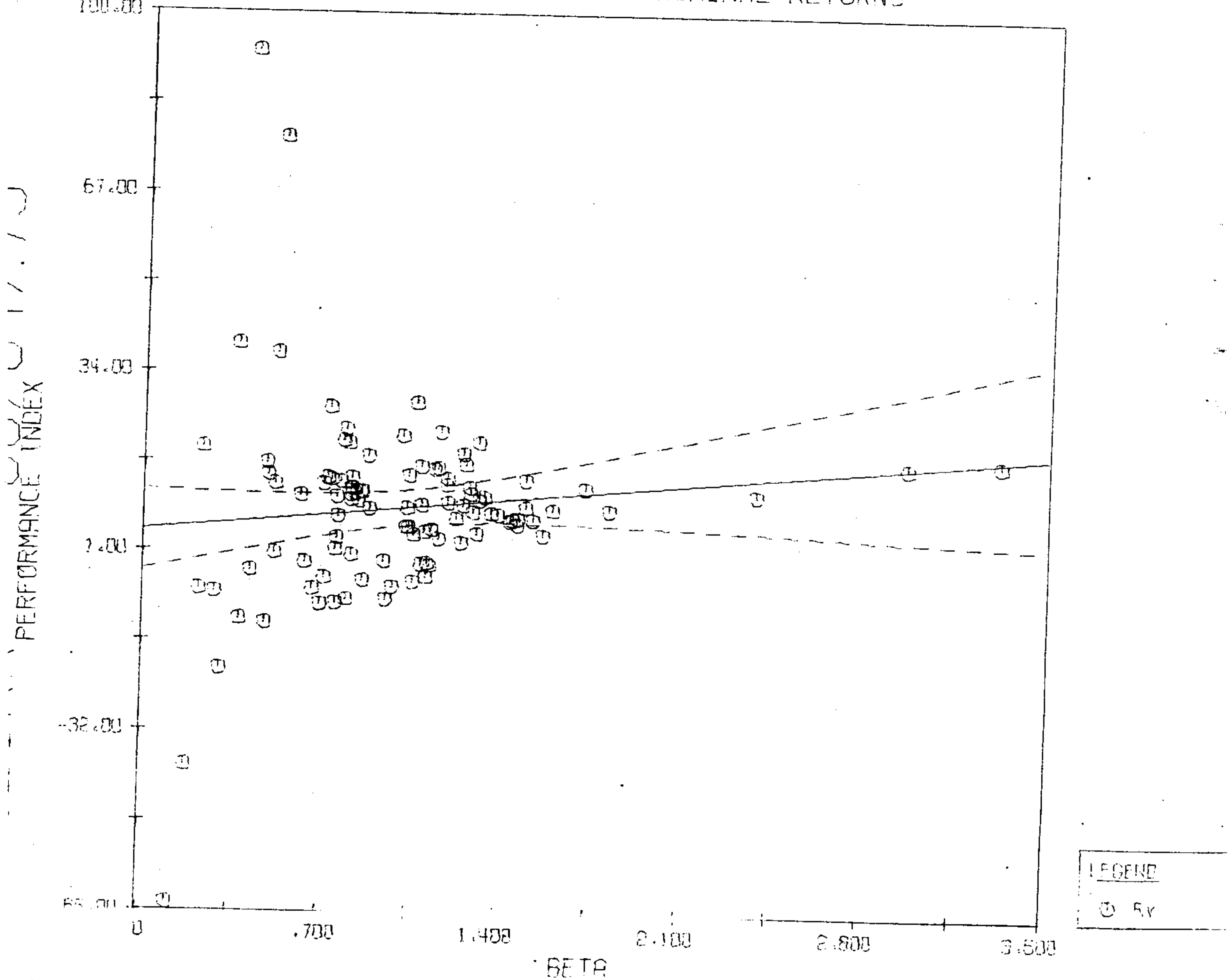
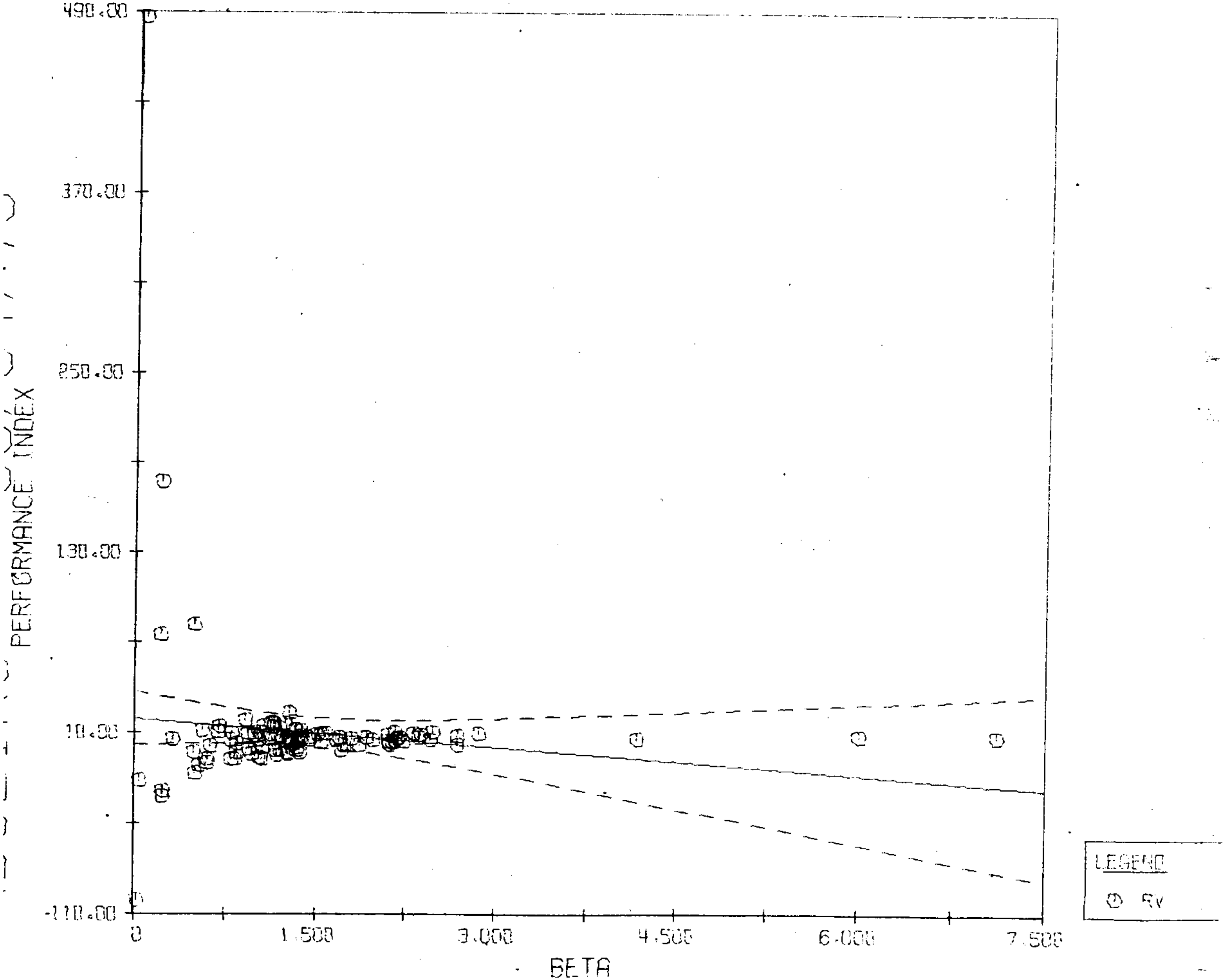


FIGURE 2

STOCK-BOND PORTFOLIO, NOMINAL RETURNS



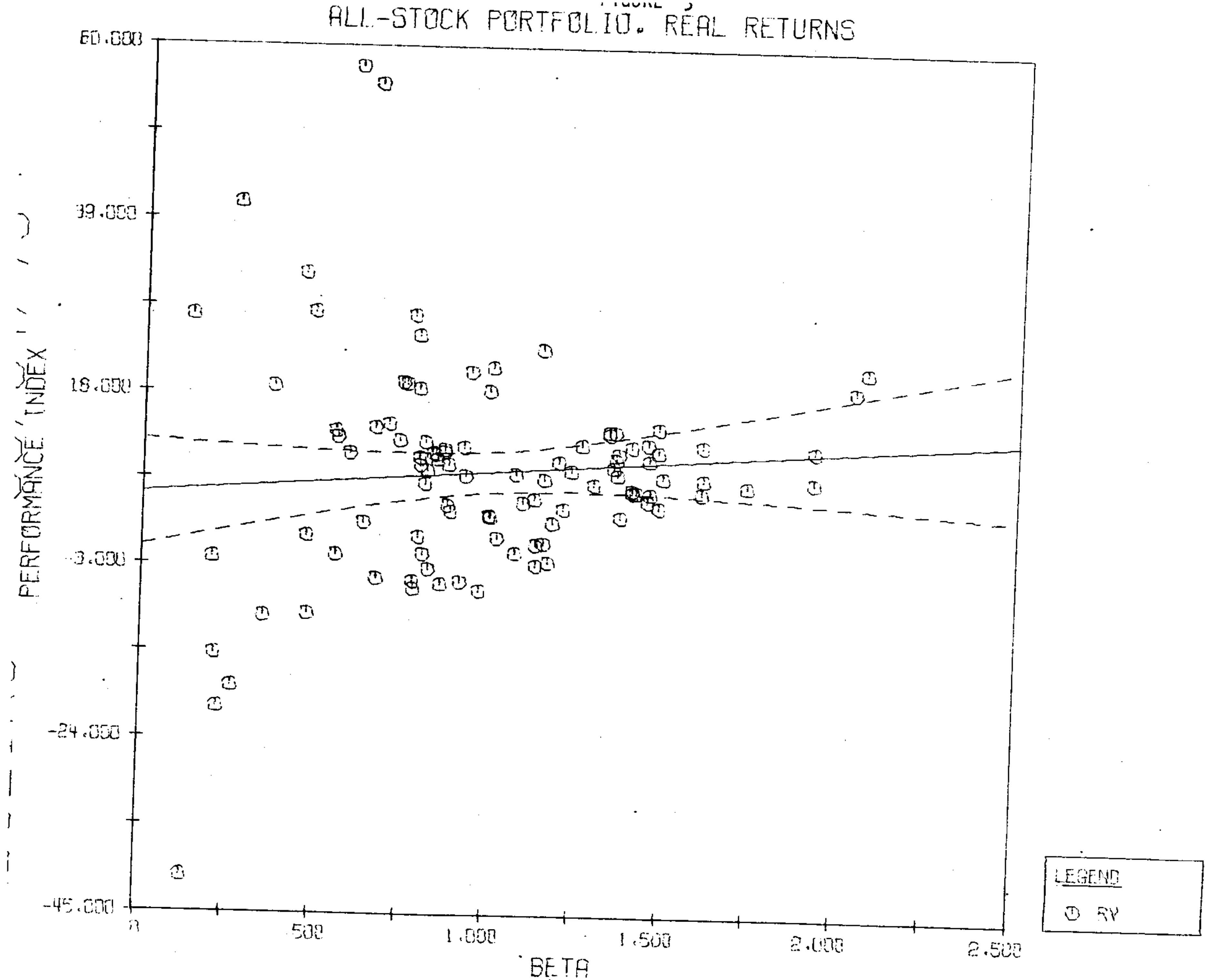

ALL-STOCK PORTFOLIO, REAL RETURNS
60.000
39.000
18.000
-3.000
-24.000
-45.000
PERFORMANCE INDEX
0
.500
1.000
1.500
2.000
2.500
BETA
LEGEND
RY

FIGURE 4

STOCK-BOND PORTFOLIO, REAL RETURNS