LENGTH OF SAMPLE PERIOD AND OPTIMAL PORTFOLIOS

BY

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ABSTRACT

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itle of Study: LENGTH OF SAMPLE PERIOD AND OPTIMAL PORTFOLIOS.

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cope and Method of Study: This study is designed to examine the effect of length of sample period on the selection of optimal portfolios which are derived by using the historical records as the sources of data. The major data are the S&P(500) Index and the prices of twenty-five securities which are selected from the 500 Largest Industries in 1980 ranked by FORTUNE. The sample periods in this study range from two years (1979-1980) to twenty years (1961-1980). The major models for the selection of optimal portfolios are the single index model and the constant correlation coefficient model. Also, the regression analysis methods are used for determining the significance of time effects on the selection of optimal portfolios.

indings and Conclusions: In general, there is no relationship between the length of the sample period and estimated security characteristics under the single index model and the constant correlation coefficient model. Moreover, the length of the sample period does not affect the composition of optimal portfolio.

)VISER'S APPROVAL Dale K Osborne

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* SIM=Single Index Model   SSA=Short Selling Allowed

CCCM=Const. Corr. Coef. Model   SSNA=Short Selling Not Allowed

CHAPTER I

INTRODUCTION

A portfolio is a set of securities that belong to an ıvestor. The investor's goal is to obtain the highest re- ırn for a given level of risk. He tries to accomplish this ›al by using the tools of portfolio management. Portfolio ınagement consists of the following steps (see, e.g., Smith .)):

1. Portfolio planning, which includes specifications of ıe investor's wealth and attitudes toward risks and the ;tablishment of investment criteria;
2. Investment analysis, which includes economic, indus- ·ial, and security analysis;
3. Portfolio selection, which includes selection models ıd criteria to determine the optimal portfolio;
4. Portfolio evaluation, which includes performance mea- ırement and performance comparison;
5. Revision of portfolio.

ıis study will concern the problems associated with the .ird of these steps--portfolio selection.

Modern portfolio-selection theory dates from Markoitz's (2)(3) pioneering articles published in 1952 and his ubsequent books. Expanded from Markowitz's theory, a large mount of theories and modeles were developed. But almost very approach to portfolio selection utilizes, more or less, he historical records of stock prices and dividends as the ases for forecasts. These historical data thus become the nportant sources of information in the portfolio-selection rocess. But there are some problems involved when an anayst is trying to apply the modern portfolio theory for the election of optimal portfolios. The major problems menioned by Elton, Gruber and Manfred (4)(5) are:

1. The difficulty in accurately estimating the types of nput data necessary;

2. The time and cost necessary to generate efficient ortfolios (solve the quadratic-programming problems); and

3. When analysts use the historical records such as stock rices and market indexes to determine the optimal portfolios nder different models, the preper length of the sample peril is hard to determine because its effect on the optimal ortfolio is unknown and may lead to erroneous results.

This study focusses on the third problem--that is, e effect of the sample period on the selection of optimal ortfolios. The basic data required for this study are stock ices of securities and Standard and Poor's(500) Index from

NYSE Daily Stock Prices Report. First, we use random-sampling procedures to selec twenty five companies from the 500 Largest Industries in 1980 ranked by FORTUNE (6) and assume that they are the securities included in the optimal portfolios. In order to get more data to test the effects of sample period on the seclection of optimal portfolios, we estimate the variables such as mean return, standard deviation, etc. of the twenty five selected securities in different sample periods which range from two years (1979-1980) to twenty years (1961-1980). Then under two different models with the option of short selling, we derive a set of optimal portfolios in each sample period. At the end of this study, we use the regression analysis methods to examine the relationship between length of sample period and optimal portfolio and the significance of this relationship.

The main models applied for the selection of optimal portfolios are the single index model developed by Sharpe (7) and the constant correlation coefficient model developed by Elton and Gruber (5). In both models, the simple criterion developed by Mao (8) is also used to decide which securities should be included in the optimal portfolios with the option of short selling. And the conditions applied for determining the optimality of portfolios were developed by Lintner (9) and Kuhn-Tucker (10).

The reasons to apply the single index model and the constant correlation coefficient model for the selection of optimal portfolios are: 1) The types of input data are easy to determine; 2) All the necessary variables can be easily computed by the SAS (Statistical Analysis System) package; 3) These two models can provide more accurate results than those from the linear programming approximations and those from the quadratic programming models.

This study will begin in Chapter II with a review of literature concerned with portfolio selection. Chapter III will discuss the methodology utilized in the examination of effect of length of sample period on the selection of optimal portfolios. The results will be covered in Chapter IV. Chapter V will show the conclusions of this study.

CHAPTER II

REVIEW OF LITERATURE

Risk is "the uncertainty of future outcomes" or "the progability of an adverse outcome." Almost any kind of investment involves different degrees of risk. One basic assumption of portfolio theory is that any investor wishes to maximize the returns from his investments. In order to adquately deal with such an assumption, certain ground rules must be laid. The first of these is that the portfolio being considered by an individual should include all of his assets and liabilities. Not just stocks or even just marketable securities, but also such items as cars, houses, coins, etc., should be included. We also normally assume that investors are risk averse, and it appears to be a reasonably accurate generalization. Any rational investor would prefer a higher return to a lesser return; unfortunately, a higher return normally involves a higher degree of risk and, as a result, an investor is continually faced with a compromise. Therefore, the continuous decision-making to derive the "optimal" trade-off between the expected return and expected risk become the "core" of the portfolio theory.

The pioneering article on portfolio selection was that of Markowitz (3), who provided the basic theoretical framework for the subsequent developments in portfolio-selection theory. Undoubtedly, his work gave us an "insight" and promoted later studies in this field. Therefore, we will use some space here to introduce Markowitz's model. Markowitz's model is based on several assumptions regarding investor behavior:

1. Investors consider each investment alternative as being represented by a probability distribution of expected returns over several holding periods.

2. Individuals estimate risk on the basis of the variability of expected returns.

3. Investors base decisions solely on ecpected return and risk, i.e., their utility curves are a function of expected return and variance (or standard deviation) of returns only.

4. For a given risk level, investors prefer higher returns to lower returns. Similarly, for a given level of expected return, investors prefer less risk to more risk.

Under above assumptions, a single asset or portfolio of assets is considered to be "efficient" if no other assets or portfolio of assets offers higher expected return with the same (or lower) risk or lower risk with the same (or higher) expected return. In order to derive the set of efficient portfolios, he developed the following formulae:

$$E = \sum_{i=1}^{n} X_i R_i \qquad \sum_{i=1}^{n} X_i = 1$$

$$V \quad \sum_{i=1}^{n} \sum_{j=1}^{n} X_i X_j \sigma_{ij}$$

where

σ_{ij} = correlation coefficient of security i, j

X_i = relative amount invested in security i

E = expected return from portfolio

V = variance of portfolio

R_i = expected return on security i

The maximum return portfolio and minimum variance portfolio became the "end points" of the efficient frontier. The optimal portfolio is the efficient portfolio with the highest utility. This will be found at the point of tangency between the efficient frontier and the curve with the highest possible utility for a given investor.

Martin (11), basen on Markowitz's E-V model, developed the quadratic programming for the portfolio selection. In his study, he used a real-world investment problem to formulate his model:

$$\underset{X_i}{\text{Min}} \left[\theta = V + \lambda_1 \left(\sum_{i=1}^{n} X_i R_i - E \right) + \lambda_2 \left(\sum_{i=1}^{n} X_i - 1 \right) \right]$$

Then did the partial derivatives $\partial\theta/\partial X_i$ and solved the equations with $E=\sum_{i=1}^{n} X_i R_i$ and $\sum_{i=1}^{n} X_i=1$. At the practical level, the formulation of precise probability beliefs about securities under consideration entails problems. Almost, any real-world applications of this theory would include a large number of securities. The cost of necessary clerical, processing, and analytical activities required in such an undertaking would preclude individuals and even large institutional investors from using this model.

There is little quwstion that the most significant and most popular developments in portfolio-selection theory since the Markowitz's mean-variance approach have been the diagonal model (also called single index model) introduced by Sharpe (7). The major characteristic of the diagonal model is the assumption that the returns of various securities are related only through common relationships with a basic underlying factor. Sharpe proposed the following model of the return from a risky security:

$$R_i = A_i + B_i + C_i \qquad (i = 1,\ldots,n)$$

$$I = A_{n+1} + C_{n+1}$$

where R_i is the return on a risky security i, A_{n+1} and the A_i are constants, and C_{n+1} and C_i are random variables with expected values of zero and variances Q_{n+1} and Q_i, respectively, and the covariances between C_i and C_j are zero for all values of i and j ($i \neq j$).

Helliwell and Mao (12) discussed the problems about uilding the simple criterion for selection of optimal port-olios. Before them, Latane and Young (13) tested four cri-eria: 1) the mean of all portfolios, 2) market elastici-y, 3) pure-risk yield, and 4) expected value of securi-y as the ranking rules to find out the optimal portfolios. atane and Young's conclusion solved the problem: If one's ptimal portfolio does not include all available securities, ow many securities should it include? Then, Evans and Ar-her (14), using the method of simulation, solved the pro-lem: Given that N securities are in the optimal portfolio, hich n of the available securities are to be included?

Finally, in 1970, Mao (8) assumed that the pairwise orrelation coefficient of all securities was a constant and sed Lintner's (9) conclusions as the conditions of optima-ity of portfolios to form a formula for the calculation of he number of securities to be included in the optimal port-olio. He also suggested a simple criterion--μ_i/b_i-- for electing the proper securities into optimal portfolios here μ_i is the expected return of security i and b_i (Beta) s an index of the nondiversifiable risk of security i.

Another important study is from Treynor and Black (15) he main viewpoint in their study is that of an individual nvestor who is attempting to trade profitably on the dif-erence between his expectations and those of a monolithic arket so large in relation to his own trading that market rices are unaffected by it. They also ignored the costs f buying and selling so that they could treat the portfolio election problem as a single-period problem (implicitly as-uming a one-period utility function as given), in the tra-ition of Markowitz, Sharpe, and others. The conclusions of heir study are abridged as follows:

1. It is useful in balancing portfolios to distiguish etween two sources of risk: market, or systematic risk on he one hand, and appraisal, or insurable risk on the other. n general, it is not correct to assume that optimal balanc-ng leads wither to negligible levels of appraisal risk or o negligible levels of market risk.

2. The overall portfolio can usually be improved by tak-ng a long or short position in the market as a whole.

3. The rate at which the portfolio earns risk premium epends only on the total amount of market risk undertaken nd is independent of the size of the investor's equity and f the composition of his active portfolio.

4. Optimal selection in the active portfolio depends only n appraisal risk and appraisal premiums.

5. The appraisal ratio depends only on 1) the quality of ecurity analysis and 2) how efficiently the active port-olio is balanced.

Another topic discussed in Lintner's (9) and Kuhnucker's (10) studies is the condition to deal with the pro-lem about short selling in the selection of optimal port-olio. From their studies, we obtain the useful condition hich can be applied in this study.

The studies which are summarized in the preceding pa-agraphs are the major references for this study. All the bove studies are the important articles in the field of ortfolio selection. In addition the others are:

1. Evans' study (16) to discuss the comparison between he Fixed-Investment-Proportion-Maintenance (FIRM) strategy nd Buy-and-Hold (B&H) strategy for portfolio management.

2. Fama's (17) Mean-Semivariance (E-S) approach for the election of portfolio.

3. Baumol (18) suggested the Expected-Gain-Confidence imit (E-L) Criterion for the selection of portfolio.

4. Roy (19) suggested the "Safety First" theory for the ortfolio management.

5. Jean (20) developed the Multidimensional-Portfolio-nalysis techniques for the selection of optimal portfolio.

In the next chapter, we will introduce the methodology f this study.

CHAPTER III

METHODOLOGY

(A) Sample and Data

The sample of securities comes from the 500 Largest ndustrials ranked by sales in 1980 by FORTUNE. The major ources of data are from the monthly stock prices of the wenty five selected securities and the market index which, n this study, is the Standard and Poor's(500) Index. The onthly stock prices and index are drawn from the close rices and the average S&P(500) index on the last trading ay of New York Stock Exchange (NYSE) in a month.

In order to examine the effect of length of sample eriod on the selection of optimal portfolios, different ample periods are taken. Table-1 shows the fourteen sample eriods.

Based on these stock prices and S&P(500) indexes in ach period, we can derive all the estimated variables appli- l in the single index model and the constant correlation efficient model for the selection of optimal portfolios. e variables are mean return (expected return) on security, andard deviation of return, beta coefficient, and residual

TABLE 1

Sample Periods

No.	Period	No. of Months
1	1979 - 1980	24
2	1978 - 1980	36
3	1977 - 1980	48
4	1976 - 1980	60
5	1975 - 1980	72
6	1974 - 1980	84
7	1973 - 1980	96
8	1972 - 1980	108
9	1971 - 1980	120
10	1969 - 1980	144
11	1967 - 1980	168
12	1965 - 1980	192
13	1963 - 1980	216
14	1961 - 1980	240

rror (residual risk) from the regression line which descri-es the relationship between security and market index. All ie computations of estimated varialbes of each stock have een derived with the use of the computer package--SAS.

Throughout, all the figures are on the monthly basis id we will assume the existence of a riskless asset. This iplies that the separation theorem holds and that the in-estor should maximize the ratio-excess return on a portfo-.o divided by the standard deviation of the portfolio. Also, iroughout this paper we will make the blanket assumption iat there is at least one security in the set of all in-estment opportunities whose expected return is strictly eater than the return on the riskless asset.

(B) The Single Index Model and the Construction of Optimal Portfolios

(i) The Standard Single Index Model

First, we shall assume that the standard single in-x model is an accurate description of reality. That is

1. $R_i = \alpha_i + \beta_i I + \epsilon_i$
2. $I = A_{n+1} + \epsilon_{n+1}$
3. $E(\epsilon_{n+1}\epsilon_i) = 0 \qquad i = 1,\ldots,n;$
4. $E(\epsilon_i \epsilon_j) = 0. \qquad i = 1,\ldots,n;\ j = 1,\ldots,n; i \neq j.$

here R_i = the return on security i

I = a market index

α_i = the return on security i that is independent of changes in the market index

β_i = a measure of the responsiveness of security i to changes in the market index (beta)

ϵ_i = variable with a mean of zero and variance (residual risk)

σ_m^2 = the variance of the market index

The last two equations characterize the approximation ? the standard single index model to the variance-covariance ;ructure. The assumption implied by these equations is that ıe only joint movement between securities comes about beıuse of a common response to a market index.

(ii) The Optimal Portfolio with Short Selling

The optimal portfolio in the single index model is e portfolio with the highest excess return to standard deation (θ). That is

$$\text{Max} \quad \theta = \frac{\overline{R}_p - R_f}{\sigma_p}$$

d

$$\overline{R}_p = \sum_{i=1}^{n} X_i(\overline{R}_i - R_f) + R_f$$

$$\sigma_p = \left(\sum_{i=1}^{n} X_i^2\beta_i^2\sigma_m^2 + \sum_{i=1}^{n}\sum_{j=1}^{n} X_i X_j \beta_i \beta_j + \sum_{i=1}^{n} X_i^2 \sigma_{\epsilon_i}^2\right)^{1/2}$$

here R_f = the riskless lending-borrowing rate

X_i = the relative weightw we place on each security ($X_i>0$ for a long position, $X<0$ for a short position)

R_p = return of the portfolio ($\overline{R}_p$ is the expected value of R_p)

σ_p = the standard deviation of the return on the portfolio.

About the way to treat short sellings, we are followng Lintner's (7) suggestion. This is that the short seller ays any dividends which accrue to the person who lends the tock to him and gets a capital gain (or loss) which is the egative of any price appreciation. In addition the short eller is assumed to receive interest at the riskless rate n both the money loaned to the owner of the borrowed stock nd the money placed in escort when the short selling is ade. To find the set of X_i's which satisfy the optimality f portfolio, we define $Z_i=(\overline{R}_p - R_f/\sigma_p^2)X_i$ and solve this exression for any Z_i. Then we get:

$$Z_i = \frac{\beta_i}{\sigma^2_{\epsilon_i}}\left[\frac{\overline{R}_i - R_f}{\beta_i} - C\right]$$

$$X_i = \frac{Z_i}{\sum_{i=1}^{25}|Z_i|}$$

ıere:

$$C = \frac{\sigma_m^2 \sum_{i=1}^{25} \left[\frac{\overline{R}_i - R_f}{\sigma_{\epsilon_i}^2} \beta_i \right]}{1 + \sigma_m^2 \sum_{i=1}^{25} \frac{\beta_i^2}{\sigma_{\epsilon_i}^2}}$$

ıd $\sum_{i=1}^{25} |X_i| = 1$ to assure that we have invested 100% of our ınd. In this model we can derive a set of X_i's for each ımple period and use the equation mentioned at the beginıg of this section to decide the expected return on optimal ›rtfolio ($\overline{R}_p$).

(iii) Optimal Portfolios when Short Sales are not Allowed

If short selling is not allowed then we must introce the constraints that all $X \geqslant 0$. This requires employing e Kuhn-Tucker conditions. That is:

$$Z_i = \frac{\beta_i}{\sigma_{\epsilon_i}} \left[\frac{\overline{R}_i - R_f}{\beta_i} - C \right] + \mu_i$$

ere:

$Z_i \geqslant 0$, $\mu_i \geqslant 0$, and $\mu_i Z_i = 0$ for all i

Since $\mu_i \geqslant 0$, including μ_i can only increase the value f Z_i. Thus, if Z_i is positive with $\mu_i = 0$, the including of i can never make it zero. Hence, if Z_i is positive when i 0, the security should be included. If $Z_i < 0$ when $\mu_i = 0$, ositive values of μ_i can increase Z_i. However, since the roduct of μ_i and Z_i must equal zero, positive values of μ_i nply $Z_i = 0$. Hence any security with $Z_i < 0$ when $\mu_i = 0$ must be ejected. In other words, we will reject the securities ıich can not satisfy the constraint--$X_i \geqslant 0$. In order to do ıese selection tests, we apply Mao's(11) simple criterion. ırst, let:

$$Q = \frac{\overline{R}_i - R_f}{\beta_i} \qquad\qquad CK = \frac{\overline{R}_i - R_f}{\beta_i} - C$$

ıen we rank all securities with β_i's$\geqslant 0$ by the value of Q ı decreasing order and test CK to see whether it is less ıan zero. This tests will start from the first security ich has the highest Q (i=1), then the first two securities =2), then the first three securities (i=3), etc. If i=k+1 ich makes CK<0 then the tests stop and we know that the rst k securities are included in the optimal portfolio. en no more positive or zero β stocks are included, stocks th negative β's should be tried in reverse order. Then, use the same formula in the last section to form the opmal portfolio. We repeat these procedures in each sample riod.

(C) The Constant Correlation Coefficient Model and Construction of Optimal Portfolios

(i) The Constant Correlation Coefficient Model

In this model, we assume that all pairwise correlation)efficients are equal. While this probably does not repres- ıt the true pattern one can find in the economy, it is very .fficult to obtain a better estimate. Elsewhere (4), we ıve known that this assumption produces better estimates of ıture correlation coefficients than those produced from o- ıer models. As mentioned earlier, the optimal portfolio is ıat maximizes the ratio of excess return on the portfolio ı its standard deviation of return. Letting:

1. σ_{ij} = covariance between security i and j
2. σ_i^2 = the variance of security i
3. π = the correlation coefficient between any two securities
4. all other as before.

.d

$$\bar{R}_p = \sum_{i=1}^{n} X_i(\bar{R}_i - R_f) + R_f$$

$$\sigma_p = \sum_{i=1}^{n} X_i^2\sigma_i^2 + \sum_{i=1}^{n}\sum_{j=1}^{n} X_iX_j\sigma_{ij}$$

(ii) The Optimal Policies when Short Sales Are Allowed

In this case, the optimal portfolio can be derive ithout restricting the sign of X_i and by using the follow- ng formulae:

$$Z_i = \frac{1}{\sigma_i} \frac{1}{1-\pi} \left[\frac{\overline{R}_i - R_f}{\sigma_i} - \frac{\pi}{1-\pi+25\pi} \sum_{j=1}^{25} \frac{\overline{R}_i - R_f}{\sigma_j} \right]$$

$$X_i = \frac{Z_i}{\sum_{j=1}^{25} |Z_j|}$$

(iii) The Optimal Policies When
Short Sales Are Not Allowed

Again, if short selling is not allowed, then we have rely on the Kuhn-Tucker conditions. These conditions ich maximizes θ are:

1. $\overline{R}_i - R_f - Z_i\sigma_i^2 - \sum_{\substack{j=1 \\ j\neq i}}^{n} Z_j\sigma_{ij} + \mu_i = 0$

2. Z_i 0, μ_i 0

3. $Z_i\mu_i=0$

lving for Z_i, we have:

$$Z_i = \frac{1}{1-\pi} \frac{1}{\sigma_i} \left[\frac{\overline{R}_i - R_f}{\sigma_i} - \frac{\pi}{1-\pi\ k\pi} \sum_{j=1}^{k} \frac{\overline{R}_j - R_f}{\sigma_j} \right]$$

$$X_i = \frac{Z_i}{\sum_{j=1}^{k} Z_i}$$

The sign of Z_i depends on the terms in the brackets. ince the last term in the brackets is a constant for any k f a security with a particular rate $(\overline{R}_i-R_f)/\sigma_i$ has a positive Z_i, then all securities with a higher ratio must also e included. Therefore, we can apply Mao's simple criterion gain to decide the securities which should be included in ne optimal portfolios and then derive the desired optimal ortfolios.

After reviewing all pairwise correlation coefficients twenty-five selected securities, we assume that the con- ant correlation coefficient is 0.4. Throughout, the month- riskless rate of return is also assumed to be 0.45 which near to the present interest rate for saving accounts for l the calculations in each model.

(D) The Examination in the Effect of the Length of Sample Period on the Optimal Portfolios

From section (B) and section (C), we derive four sets optimal portfolios. Each set consists of fourteen dif- rent optimal portfolios for each sample period.

First, we examine the relationship between sample riod and estimated variables--mean return, beta coeffici- t, and residual error of each security. Second, we exa- ne the relationship between length of sample period and timal portfolio in each model with the option of short

elling. These examinations will be done by regression me-
hod and F-test.

CHAPTER IV

RESULTS

(A) Estimated Variables

The major estimated variables used in the single in-
ɜx model and the constant correlation coefficient model in-
.ude mean or expected return on securities and on the S&P
;00) Index, variances of expected returns, beta coefficient,
ɜsidual errors for securities which are assumed to have a
sponse to the market index, and standard deviations of se-
ırities and the S&P(500) Index. Here we define the expect-
return of security i as:

$$\bar{R}_i = \left(\sum_{k=1}^{k} \frac{P_t - P_{t-1}}{P_{t-1}} \right) / k$$

ere: $\bar{R}_i$ = expected return on security i

P_t = stock price of security i in month t

k = length of sample period

In this study, we do not consider the dividends paid
any month. Also, all the estimated variables are calcu-
ted in fourteen sample periods. Table 2 shows the results
the calculations for the sample period 1979-1980.

TABLE 2

Estimated Variables

Period: 1980 - 1979

Company	$\overline{R}_i$	β_i	σ^2_ϵ	σ_i
A	0.991	0.702	86.928	9.669
B	2.217	1.214	58.458	9.327
C	5.617	1.957	57.806	11.635
D	2.242	1.303	53.200	9.827
E	1.970	1.373	38.430	8.733
F	1.425	1.272	66.927	9.889
G	-0.054	0.670	35.597	6.591
H	1.000	0.348	87.078	9.319
I	0.038	0.925	16.755	5.823
J	1.433	0.536	84.728	9.418
K	0.767	0.251	49.988	7.009
L	3.371	1.118	67.662	9.588
M	2.929	2.020	74.186	12.497
N	4.287	1.373	39.813	8.805
O	0.588	0.879	46.973	7.815
P	6.454	1.919	196.693	16.279
Q	0.913	1.214	140.781	12.848
R	4.304	1.075	39.807	7.896
S	4.863	1.277	77.090	10.335
T	1.100	1.502	69.150	10.646
U	0.242	0.658	31.443	6.255
V	-1.375	1.454	125.967	12.829
W	1.958	1.480	72.285	10.726
X	0.446	0.782	28.385	6.319
Y	0.513	0.976	26.208	6.707

(B) Optimal Portfolios

We have derived four sets of optimal portfolios. ach set consists of fourteen optimal portfolios which are rom the fourteen different sample periods. In the first ase that short selling is allowed, all the twenty-five seected securities are assumed to be included in the optimal ortfolio. All the securities with negative X's are those eld short. Table 3 and Table 4 are the results of the seection of optimal portfolios for the sample period 1979-980.

In the second case that short selling is not allowed, rejected some securities to make sure that all X's are eater than or equal to zero. In other words, all securies included in the optimal portfolios must be held long. ble 5 and Table 6 show the results for sample period 1979-80. Also, Table 7 shows the expected return on optimal rtfolio in each sample period.

From Table 7, we have found that the expected return optimal portfolio in the second case that short selling not allowed are higher than those in the first case. ese differences result from the use of Mao's criterion to the selection tests in the second case. These tests have jected some securities whose expected returns are low and stable (i.e. higher variance of return) and have resulted reallocation of weithts placed on remaining securities.

TABLE 3

Optimal Portfolio Under Single Index Model

(Short Selling Allowed)

Period: 1980 - 1979

Company	X_i (%)
A	-0.6
B	0.9
C	8.3
D	0.7
E	-0.5
F	-1.4
G	-6.2
H	0.3
I	-15.4
J	0.7
K	0.1
L	4.0
M	0.1
N	9.4
O	-3.3
P	3.2
Q	-1.2
R	11.0
S	6.4
T	-2.8
U	-5.4
V	-4.8
W	-0.6
X	-5.6
Y	-7.2
	$\Sigma\lvert X_i\rvert$ = 100.0

$\overline{R}_p$ = 2.418%

$\overline{R}_p$ = expected return on optimal portfolio

TABLE 4

Optimal Portfolio Under Constant Correlation Coefficients Model (Short Selling Allowed)

Period: 1980 - 1979

Company	X_i (%)
A	-2.0
B	1.5
C	6.6
D	1.2
E	1.2
F	-0.8
G	-7.8
H	-1.9
I	-8.6
J	-0.7
K	-3.1
L	4.4
M	1.3
N	8.5
O	-3.6
P	3.6
Q	-1.8
R	11.1
S	7.0
T	-1.7
U	-6.5
V	-5.3
W	0.2
X	-5.2
Y	-4.5
$\Sigma\|X_i\|$	= 100.0

$\bar{R}_p = 2.405\%$

TABLE 5

Optimal Portfolio Under Single Index Model

(Short Selling Not Allowed)

Period: 1980 - 1979

Company	X_i (%)
A	1.0
R	17.4
C	10.7
S	11.5
N	13.8
P	6.3
L	8.7
M	4.1
B	5.3
D	4.8
E	5.1
W	3.2
J	2.5
F	2.2
T	1.0
H	1.1
K	0.9
Q	0.3
ΣX_i	= 100.0

$\overline{R}_p$ = 3.817%

TABLE 6

Optimal Portfolio Under Constant Correlation Coefficients Model

(Short Selling Not Allowed)

Period: 1980 - 1979

Company	X_i (%)
R	21.8
S	12.7
P	6.5
N	19.7
C	17.7
L	8.5
J	1.8
H	0.8
B	3.5
D	3.5
K	0.6
M	2.7
	ΣX_i = 100.0

$\overline{R}_p = 4.384\%$

TABLE 7

Expected Returns on Optimal Portfolios

nit: %

	Simple Index Model		Const. Corr. Coef. Model	
Period	Case 1	Case 2	Case 1	Case 2
980-1979	2.418	3.817	2.405	4.384
980-1978	1.894	3.170	1.958	3.694
980-1977	1.699	2.619	1.750	2.811
980-1976	1.763	3.063	1.841	3.043
980-1975	1.792	3.121	1.762	2.874
980-1974	1.752	2.485	1.755	2.534
980-1973	1.426	1.905	1.420	1.873
980-1972	1.441	1.910	1.432	1.905
980-1971	1.448	2.017	1.405	1.960
980-1969	1.078	1.324	1.073	1.325
980-1967	1.037	1.384	1.036	1.369
980-1965	1.132	1.479	1.098	1.441
980-1963	1.099	1.279	1.043	1.384
980-1961	0.958	1.248	0.950	1.305

se 1 = Short selling is allowed.

se 2 = Short selling is not allowed.

(C) The Relationship between the Length of Sample Period and Estimated Variables

By regression analysis methods, we have examined the elationship between the length of sample period and the esimated variables. In addition, we have plotted all the ctual values of each variable against their predicted popuation values. These graphs are good references for deterining whether the regression lines are fit.

Table 8 shows the regression statistics of mean reurn versus the sample period of each security. In the staistics, F Value is the ratio produced by dividing MS (Model) y MS (Error). It tests how well the model as a whole acounts for the dependent variable's behavior. If the signiicance probability, labeled PR>F, is small, it indicates ignificance. R-SQ measures how much variation in the deendent variable can be accounted for by the model. In eneral, the larger the value of R-SQ, the better the model's fit. We refer to the F Value, R-SQ, and PR>F to determine the relationship between mean return and the length f sample period. Not as might be expected, the regression esults show no evidence that mean returns of security are trongly correlated with the sample period. But we find hat some securities which have stable and growing returns re strongly correlated with sample period.

Also in Table 9 and Table 10, we do not find any po-

TABLE 8

Regression Analysis

Sample Period vs. Mean Return

Dependent Variable: Mean Return of Security i

Independent Variable: No. of Month

Company	SS.	R-SQ	C.V.	F-Value	PR > F
A	5.3	0.07	68	0.9	0.3622
B	4.4	0.52	57	12.9	0.0037
C	21.8	0.70	27	28.5	0.0002
D	4.7	0.66	22	23.5	0.0004
E	2.7	0.29	41	4.9	0.0464
F	13.0	0.39	30	7.7	0.0167
G	3.4	0.46	64	10.2	0.0076
H	3.0	0.36	41	6.8	0.0232
I	1.6	0.70	50	27.5	0.0002
J	1.6	0.12	37	1.6	0.2350
K	2.5	0.30	75	5.1	0.0440
L	6.2	0.28	48	4.7	0.0514
M	7.0	0.55	28	14.6	0.0024
N	12.6	0.57	31	16.2	0.0017
O	3.2	0.01	68	0.2	0.7039
P	28.2	0.65	38	22.4	0.0005
Q	6.2	0.10	708	1.3	0.2711
R	9.7	0.58	24	16.8	0.0015
S	16.3	0.63	31	20.1	0.0008
T	1.5	0.01	43	0.2	0.7056
U	1.4	0.04	43	0.6	0.4720
V	7.0	0.00	306	0.1	0.8131
W	1.7	0.44	19	9.5	0.0094
X	3.1	0.58	50	16.6	0.0016
Y	3.3	0.14	144	2.0	0.1881

TABLE 9

Regression Analysis

Sample Period vs. Beta

Dependent Variable: Beta
Independent Variable: No. of Month

Company	SS.	R-SQ	C.V.	F-Value	PR > F
A	0.32	0.14	15	1.9	0.1888
B	0.21	0.48	9	10.9	0.0063
C	0.13	0.07	5	0.9	0.3529
D	0.10	0.13	6	1.9	0.1966
E	0.12	0.12	8	1.7	0.2190
F	0.19	0.08	11	1.0	0.3420
G	0.25	0.62	10	19.5	0.0008
H	0.57	0.48	19	11.0	0.0062
I	0.20	0.31	11	5.5	0.0369
J	0.22	0.31	14	5.3	0.0394
K	0.36	0.45	21	9.8	0.0088
L	0.08	0.01	7	0.1	0.8090
M	2.17	0.42	22	8.6	0.0125
N	0.07	0.00	5	0.0	0.5714
O	0.18	0.61	8	18.9	0.0010
P	0.92	0.67	12	23.7	0.0004
Q	0.12	0.12	8	1.6	0.2242
R	0.46	0.55	9	14.7	0.0024
S	0.20	0.02	13	0.3	0.5944
T	0.53	0.23	17	3.6	0.0819
U	0.15	0.12	14	1.7	0.2214
V	0.98	0.69	13	27.1	0.0002
W	0.49	0.71	11	28.9	0.0002
X	0.46	0.45	14	9.8	0.0088
Y	0.12	0.00	9	0.0	0.9529

TABLE 10

Regression Analysis

Sample Period vs. Residual Error

Dependent Variable: Residual Error
Independent Variable: No. of Month

Company	SS.	R-SQ	C.V.	F-Value	PR > F
A	16435	0.02	30	0.2	0.6324
B	4193	0.21	32	3.3	0.0957
C	3519	0.61	13	19.0	0.0009
D	8205	0.69	21	27.1	0.0002
E	2878	0.51	23	12.6	0.0040
F	470	0.00	8	0.0	0.9919
G	6987	0.76	20	37.7	0.0001
H	2414	0.06	16	0.7	0.4155
I	3725	0.50	38	11.8	0.0049
J	2384	0.00	18	0.0	0.9615
K	3120	0.31	24	5.3	0.0403
L	1563	0.09	18	1.2	0.2904
M	5011	0.16	18	2.2	0.1603
N	2582	0.62	16	19.4	0.0009
O	1598	0.44	15	9.5	0.0095
P	12690	0.44	23	9.4	0.0098
Q	5975	0.57	14	15.7	0.0015
R	5483	0.60	20	18.1	0.0011
S	3042	0.25	19	4.0	0.0698
T	5788	0.25	25	4.1	0.0657
U	3801	0.00	27	0.1	0.7887
V	41491	0.55	24	14.7	0.0024
W	1389	0.52	13	12.8	0.0038
X	1222	0.42	20	8.7	0.0122
Y	1293	0.73	14	32.8	0.0001

sitive connection between the length of sample period and beta coefficient or residual error of security. In other words, all the results are opposite of what were expected and give no indication that a relationship between the length of sample period and each estimated variable exists.

(D) The Relationship between the Length of Sample Period and Optimal Portfolio

There are three factors that should be taken into consideration for determining the effect of the length of sample period on the optimal portfolio. These factors are:

1. The changes of securities included in the optimal portfolio. (It is not valid in the case that short selling is allowed because we have assumed that all twenty-five securities are included in the optimal portfolio.);
2. The changes of weights placed on the securities in the optimal portfolio; and
3. The changes of expected returns on the optimal portfolios.

After referring to the compositions of all the optimal portfolios in each sample period, we find:

1. No matter what sample period we choose, the securities selected for the optimal portfolios are almost the same.

2. In general, the weights placed on the securities in the optimal portfolio do not have significant changes when we alter sample periods.

We also regress the sample period against the expected return on the optimal portfolio. The results of regression statistics are shown from Table 11 to Table 14. From above tables, it appears that there is a strong correlation between the length of sample period and the expected return on the optimal portfolio.

In addition to the preceding results, the other thing we want to mention before we draw any conclusions is the limitations of this study. The limitations which may create some deviations from our conclusions are as follows:

1. The sample size in this study is small. Therefore, representation of this sample to the population may be incomplete.

2. The population considered in this study is narrowed to the 500 Largest Industries in 1980. This may limit the effects of diversification on optimal portfolios.

3. Only fourteen observations are available for all the regression analyses.

4. Dividends are not included in the calculation of expected return on each security.

TABLE 11

Regression Analysis

Sample Period vs. Return on Optimal Portfolio

Single Index Model

Short Selling Permitted

General Linear Models Procedure

Dependent Variable: $\overline{R}_p$

Source	DF	SS.	MS.	F Value	PR > F
Model	1	1.845	1,845	54.82	0.0001
Error	12	0.404	0.034		
Corrected Total	13	2.249			

TABLE 12

Regression Analysis

Sample Period vs. Return on Optimal Portfolio

Single Index Model

Short Selling Not Permitted

General Linear Models Procedure

Dependent Variable: $\bar{R}_p$

Source	DF	SS.	MS.	F Value	PR > F
Model	1	7.142	7.142	23.18	0.0004
Error	12	3.697	0.308		
Corrected Total	13	10.839			

TABLE 13

Regression Analysis

Sample Period vs. Return on Optimal Portfolio

Constant Correlation Coefficient Model

Short Selling Permitted

General Linear Models Procedure

Dependent Variable: $\overline{R}_p$

Source	DF	SS.	MS.	F Value	PR > F
Model	1	2.071	2.071	69.00	0.0001
Error	12	0.360	0.030		
Corrected Total	13	2.431			

TABLE 14

Regression Analysis

Sample Period vs. Return on Optimal Portfolio

Constant Correlation Coefficient Model

Short Selling Not Permitted

General Linear Models Procedure

Dependent Variable: $\bar{R}_p$

Source	DF	SS.	MS.	F Value	PR > F
Model	1	9.476	9.476	40.04	0.000
Error	12	2.840	0.237		
Corrected Total	13	12.316			

CHAPTER V

SUMMARY AND CONCLUSIONS

This study is designed to examine the effect of the length of sample period on the optimal portfolio which is derived by utilizing the historical records as the sources of information under the single index model and the constant correlation coefficient model. Our hypothesis is that this effect will be significant. In general, the results are opposite of what we expected.

The major findings and analyses can be summarized as follows:

1. There is no significant relationship between the length of sample period and beta coefficient or residual error of security. In every sample period, the fluctuation on the beta coefficient is very little. This implies that the beta coefficient of each security tends to be constant even when the sample period of the historical records change

2. Within the twenty-five selected securities, only a few securities which possess continuous, stable and increasing rates of growth (decline) in returns (i.e. stock prices --especially in this study) show a strong relationship be-

een their return and the length of sample period. The o-ers whose mean return is unstable does not show any con-ction between the length of sample period and their mean turn.

3. In the case that short selling is allowed and all twen--five securities are assumed to be included in the optimal rtfolio, over eighty percent of the fund is found to be vested in almost the same securities with continuous, sta-e, and increasing rates of growth (decline) in returns in ch sample period.

4. In the case that short selling is not allowed--that , all securities cncluded in the optimal portfolio are held ng, the optimal portfolio for each sample period always nsists of the same securities with continuous, stable, and creasing rates of <u>growth</u> in returns.

5. The regression statictics show a strong relationship tween the expected return on optimal portfolio and the ngth of sample period.

Based on the results shown above, we have reached the llowing conclusions. First, it is clear that the effect the length of sample period on the beta coefficient or sidual error of security is not significant when we use e historicalrecords as the bases for the selection of op-mal portfolio. Second, the effect of smaple period on the an return on securities vary from one security to another.

ı general, sample period does not have effect on most secu-
ities except those with long-term growths or declines in
:ices. Third, no matter what the length of sample period
choose, it will not change much the composition of the
ptimal portfolio. Fourth, statistically, it seems that the
ngth of sample period has an effect on the expected return
ı optimal portfolio. This implies that the shorter sample
riod we choose for the historical records, the higher ex-
cted return on optimal portfolio we would derive. Actual-
, this conclusion is in contradiction to the above con-
Lusions. Why does it happen? As we mentioned before, the
ptimal portfolio in each sample period always consists of
ıe securities with long-term increasing expected return.
ıe expected return on security is calculated on the average
asis. Therefore, the most recent expected return on a se-
urity always tends to be the highest one. Moreover, owing
the expected return on the optimal portfolio which is de-
rmined by the mean return of individual securities includ-
l in the optimal portfolio, it appears that the optimal
rtfolio which is from the shorter sample period would have
igher expected. Yet, in essence, the higher return does
t results from the choice of shorter sample period, but
rom the mean return of individual securities. Therefore,
can conclude that the effect of the length of smaple peri-
l on the optimal portfolio is also not significant.

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A P P E N D I X   A

COMPANY NAMES AND COMPUTER PROGRAMS

```
C     B    = AMERICAN CYANAMID
C     C    = AVNET ELECT
C     D    = BECKMAN INSTRUMENT
C     E    = BENDIX
C     F    = BOEING
C     G    = CBS
C     H    = DAN RIVER MILLS
C     I    = EMERSON ELECTRIC
C     J    = GRUMMAN AIRCRAFT
C     K    = HERSHEY FOODS
C     L    = JOY MANUFACTURING
C     M    = NORTHROP
C     N    = PERKIN ELMER
C     O    = REICHHOLD CHEMICALS
C     P    = SHELL OIL
C     Q    = SINGER
C     R    = SUNDSTRAND CORP.
C     S    = SUPERIOR OIL
C     T    = TEXTRON
C     U    = UNILEVER N.V.
C     V    = UNITED MERCHANTS & MANUF.
C     W    = UNIVERSAL LEAF TOBACCO
C     X    = WHIRLPOOL
C     Y    = XEROX
C     Z    = MARKET INDEX-STANDARD AND POOR'S-500
C                   PROGRAM
C     COMPUTE THE PORTFOLIOS AND ITS
C     EXPECTED RETURN UNDER THE SINGLE INDEX
C     MODEL (SHORT SELLING PERMITTED)
C     WRITTEN BY CHIANG-CHIEN HO 5/30/81
C                   VARIABLE
C     NAME= THE ALPHABETS FROM A TO Z STAND FOR THE NAME OF EACH SECURI-
C           TY
C     R    = MEAN RETURE ON SECURITY I
C     B    = BETA COEFFICIENT OF SECURITY I
C     E    = RESIDUAL ERROR OF RETURN OF SECURITY I
C     CR   = CONTRIBUTION TO TOTAL RETURN ON OPTIMAL PORTFOLIO FROM
C           SECURITY I
C     TR   = TOTAL RATE OF RETURN ON OPTIMAL PORTFOLIO
C     X    = RELATIVE WEIGHT OF SECURITY I IN OPTIMAL PORTFOLIO
C     N    = THE NUMBER OF INPUT SECURITY
C     Q    = TEMPERARY VARIABLE
C     Z    = TEMPERARY VARIABLE
C     Q1   = TEMPERARY VARIABLE
C     Q2   = TEMPERARY VARIABLE
C     TQ1  = TEMPERARY VARIABLE
C     TQ2  = TEMPERARY VARIABLE
C     TQR  = TEMPERARY VARIABLE
C                   CONSTANT
C     V    = STANDARD DEVIATION OF MARKET INDEX (S&P-500)
C     RF   = RISK-FREE RATE OF RETURN
      DIMENSION R(14,25),B(14,25),E(14,25),Z(14,25),X(14,25),
```

```
C          EXPECTED RETURN UNDER THE CONSTANT
C          CORRELATION COEFFICIENT MODEL (SHORT
C          SELLING IS PERMITTED)
C          WRITTEN BY CHIANG-CHIEN HO 5/30/81
C                           VARIABLE
C          R    = MEAN RETURN ON SECURITY I
C          SD   = SANDARD DEVIATION OF SECURITY I
C          X    = RELATIVE WEIGHT ON SECURITY I IN OPTIMAL PORTFOLIO
C          N    = THE NUMBER OF INPUT SECURITY
C          Q1   = TEMPERARY VARIABLE
C          TQ1  = TEMPERARY VARIABLE
C          Z    = TEMPERARY VARIABLE
C          TR   = TEMPERARY VARIABLE
C          CR   = SANDARD DEVIATION OF SECURITY I
C                           CONSTANT
C          RF   = RISK-FREE RATE
C          CC   = CORRELATION COEFFICIENT BETWEEN ANY TWO SECURITIES
C
C
      DIMENSION R(100),SD(100),Z(100),X(100),NAME(100),CR(100)
      WRITE(6,1)
    1 FORMAT(1H1,4X,'1980 - 1978')
      TQ1 = 0.0
      A = 0.0
      TCR = 0.0
      RF = 0.45
      CC = .4
  101 DO 110 I = 1,N
         READ(5,102) NAME(I),R(I),SD(I)
  102    FORMAT(A1,F8.3,F10.3)
  110 CONTINUE
      DO 120 I = 1,N
         Q1 = (R(I) - RF)/SD(I)
         TQ1 = TQ1 + Q1
  120 CONTINUE
  121 DO 130 I = 1,N
         Z(I) = ((R(I) - RF)/SD(I) - (CC*TQ1)/(1 - CC + N*CC))/
     1   (SD(I)*(1 - CC))
      A = A + Z(I)
  130 CONTINUE
      WRITE(6,131) A
  131 FORMAT(1H0,4X,'A',2X,'=',2X,F10.3)
      WRITE(6,132)
  132 FORMAT(1H0,4X,'NAME',6X,'X',6X,'CR')
  133 DO 140 I = 1,N
         X(I) = Z(I)/A
         CR(I) = (R(I) - RF)*X(I)
         WRITE(6,135) NAME(I),X(I),CR(I)
  135    FORMAT(1H0,6X,A1,4X,F6.3,2X,F6.3)
         TCR = TCR + CR(I)
  140 CONTINUE
      TR = TCR + RF
```

```
          A(M) = 0.0
          TCR(M) = 0.0
          TQ2(M) = 0.0
          TQ1(M) = 0.0
             READ(5,10) YE(I),YE(I)
    10       FORMAT(I4,I4)
             WRITE(6,15) YE(I),YE(I)
    15       FORMAT(1H1,4X,I4,1X,'-',1X,I4)
             READ(5,20) V(I)
    20       FORMAT(F7.3)
             WRITE(6,40)
    40       FORMAT(1H0,4X,'NAME',4X,'MEAN RETURN',5X,'BETA',8X,'RES. ERROR
         1   ')
             DO 110 J=1,N
                 READ(5,104) NAME(I,J),R(I,J),B(I,J),E(I,J)
   104           FORMAT(A1,F8.3,F6.3,F10.3)
                 WRITE(6,105) NAME(I,J),R(I,J),B(I,J),E(I,J)
   105           FORMAT(1H0,6X,A1,5X,F8.3,7X,F6.3,6X,F10.3)
   110       CONTINUE
             WRITE(6,121)
   121       FORMAT(1H1,6X,'NAME',6X,'BETA',7X,'Q')
             DO 130 J=1,N
                 Q(I,J) = (R(I,J) - RF)/B(I,J)
                 WRITE(6,122) NAME(I,J),B(I,J),Q(I,J)
   122           FORMAT(1H0,7X,A1,6X,F6.3,4X,F6.3)
   130       CONTINUE
             DO 150 J = 1,N
                 Q1(I,J) = B(I,J)*(R(I,J) - RF)/E(I,J)
                 TQ1(I) = TQ1(I) + Q1(I,J)
                 Q2(I,J) =  (B(I,J)**2)/E(I,J)
                 TQ2(I) = TQ2(I) + Q2(I,J)
   150       CONTINUE
             C(I) = ((V(I)**2)*TQ1(I))/((V(I)**2)*TQ2(I) + 1)
             DO 180 J=1,N
                 Z(I,J) = (R(I,J) - RF - B(I,J)*C(I))/E(I,J)
                 A(I) = A(I) + ABS(Z(I,J))
   180       CONTINUE
             WRITE(6,191) A(I)
   191       FORMAT(1H0,4X,'A',2X,'=',2X,F10.3)
             WRITE(6,192)
   192       FORMAT(1H1,6X,'NAME',5X,'X',7X,'CR')
             DO 200 J=1,N
                 X(I,J) = Z(I,J)/A(I)
                 CR(I,J) = (R(I,J) - RF)*X(I,J)
                 WRITE(6,193) NAME(I,J),X(I,J),CR(I,J)
   193           FORMAT(1H0,7X,A1,4X,F6.3,3X,F6.3)
                 TCR(I) = TCR(I) + CR(I,J)
   200       CONTINUE
             TR(I) = TCR(I) + RF
             WRITE(6,211) TR(I)
   211       FORMAT(1H0,////,7X,'TOTAL RETURN ON OPTIMAL PORTFOLIO',2X,'=',
         1       2X,F8.3)
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A P P E N D I X B

VARIABLES

BS	MO	R1	R2	R3	R4	AM	AB	AE	BM	BB	BE	CM	CB	CE
1	24	2.418	3.817	2.405	4.384	0.991	0.702	86.928	2.217	1.214	58.458	5.617	1.957	57.806
2	36	1.894	3.170	1.958	3.694	0.325	1.000	74.510	1.428	1.306	41.138	3.981	1.965	74.278
3	48	1.699	2.619	1.750	2.811	0.481	0.847	63.504	1.135	1.244	36.699	2.817	1.886	61.836
4	60	1.763	3.063	1.841	3.043	0.713	0.948	52.995	0.872	1.029	38.698	3.478	2.133	69.373
5	72	1.792	3.121	1.762	2.874	2.626	1.410	87.098	1.013	1.014	33.895	4.335	2.102	76.342
6	84	1.752	2.485	1.755	2.534	2.048	1.010	145.658	1.019	0.908	37.317	3.125	1.726	86.495
7	96	1.426	1.905	1.420	1.873	1.119	0.976	142.905	0.316	0.971	37.814	2.376	1.862	94.301
8	108	1.441	1.910	1.432	1.905	0.851	0.958	129.421	0.215	0.986	47.182	2.190	1.883	94.307
9	120	1.448	2.017	1.405	1.960	0.833	1.018	120.379	0.245	0.996	49.377	2.278	1.926	96.947
10	144	1.078	1.324	1.073	1.325	0.588	1.129	108.799	0.285	0.953	73.452	1.232	1.936	94.766
11	168	1.037	1.384	1.036	1.369	0.929	1.118	95.900	0.388	0.946	76.821	1.762	1.951	89.077
12	192	1.132	1.479	1.098	1.441	0.643	1.087	86.789	0.276	0.942	76.107	1.736	1.915	88.066
13	216	1.099	1.279	1.043	1.384	0.669	1.083	78.282	0.403	0.958	79.091	1.323	1.856	87.001
14	240	0.958	1.248	0.950	1.305	0.412	1.033	102.023	0.438	0.949	30.419	1.378	1.901	121.968

BS	DM	CB	DE	EM	EB	EE	FM	FB	FE	GM	GB	GE	HM	HB
1	2.242	1.303	53.200	1.970	1.373	38.430	1.425	1.272	66.927	-0.054	0.670	35.597	1.000	0.348
2	2.183	1.341	44.685	1.364	1.241	31.179	3.847	1.261	90.299	0.075	0.797	28.261	0.947	0.718
3	2.010	1.188	40.191	0.625	1.191	25.910	3.542	1.107	72.510	-0.283	0.813	25.794	1.213	0.503
4	1.843	1.041	38.095	0.773	1.190	33.408	3.943	1.062	69.967	0.228	0.930	26.310	1.580	0.916
5	3.049	1.258	46.308	1.726	1.215	36.330	3.985	1.047	69.487	1.106	0.755	53.378	2.167	1.043
6	2.099	1.246	48.337	1.312	0.957	38.392	3.798	0.870	71.204	1.273	0.653	54.316	1.245	0.738
7	1.465	1.290	61.207	0.546	1.082	45.830	2.689	1.049	80.765	0.483	0.773	55.720	0.704	0.828
8	1.434	1.306	69.315	0.639	1.081	46.188	2.732	1.086	79.099	0.522	0.782	66.977	0.983	0.841
9	1.748	1.307	74.471	0.998	1.087	55.239	2.853	1.185	75.059	0.848	0.793	81.724	0.949	0.879
10	1.189	1.394	87.001	0.517	1.148	61.120	1.724	1.297	73.934	0.422	0.919	83.422	0.372	1.038
11	1.250	1.298	104.623	0.792	1.182	66.981	1.458	1.230	77.512	0.635	1.070	80.639	0.539	0.983
12	1.168	1.282	102.270	0.918	1.159	65.902	1.736	1.264	71.433	0.808	1.022	82.569	0.497	1.025
13	0.911	1.254	111.892	0.739	1.149	72.409	1.906	1.236	71.130	1.262	1.031	83.811	0.664	1.019
14	0.942	1.377	72.954	0.575	1.117	38.890	1.738	1.150	78.145	1.299	1.013	80.331	0.633	0.962

BS	HE	IM	IB	IE	JM	JB	JE	KM	KB	KE	LM	LB	LE
1	87.078	0.038	0.925	16.755	1.433	0.536	84.728	0.767	0.251	49.988	3.371	1.118	67.662
2	73.340	0.236	0.851	16.953	0.892	0.971	74.889	0.675	0.397	41.651	1.933	1.122	53.745
3	74.042	0.131	0.780	14.611	0.542	0.905	60.470	0.265	0.397	34.245	0.683	1.142	42.147
4	83.352	0.125	0.756	13.788	0.785	0.679	60.494	0.763	0.395	39.126	1.232	1.298	45.480
5	82.375	0.658	0.961	19.930	1.288	0.806	64.438	1.631	0.663	52.935	1.319	1.178	48.954
6	96.058	0.060	1.148	25.636	1.592	0.673	95.927	1.131	0.679	49.601	1.002	1.076	65.045
7	91.090	0.027	1.099	27.560	1.334	0.747	103.206	0.384	0.751	52.704	1.413	0.980	77.101
8	84.495	0.119	1.081	41.244	0.879	0.724	92.724	0.222	0.754	67.823	0.787	1.038	75.767
9	80.926	0.285	1.087	45.577	0.783	0.825	85.500	0.283	0.714	69.875	0.975	1.093	72.408
10	80.101	0.491	1.064	54.236	0.386	0.852	79.701	0.259	0.686	66.634	1.131	1.048	65.708
11	109.408	0.724	1.007	54.627	0.571	0.898	72.493	0.249	0.687	77.107	1.058	1.065	64.003

BS	MM	MB	ME	NM	NE	NE	OM	OB	OE	PM	PB	PE	QM
1	2.929	2.020	74.186	4.287	1.373	39.813	0.588	0.879	46.973	6.454	1.919	196.693	0.913
2	3.536	2.119	77.141	3.914	1.351	46.882	-0.003	0.795	40.741	4.222	1.736	138.826	-0.097
3	1.246	2.073	80.925	2.865	1.218	42.345	-0.281	0.723	32.707	2.917	1.682	108.666	-0.050
4	2.348	1.953	85.294	2.543	1.452	48.126	0.765	0.883	46.150	3.168	1.421	97.134	1.633
5	2.221	1.549	104.543	2.636	1.586	52.857	1.279	0.975	48.401	2.707	1.112	98.101	1.229
6	2.330	0.995	113.618	1.748	1.475	51.417	1.619	0.709	64.879	2.131	1.425	102.097	-0.157
7	1.864	1.113	120.084	1.424	1.494	52.815	0.994	0.855	64.008	2.109	1.327	97.269	-0.690
8	1.771	1.103	136.186	1.512	1.506	54.307	1.274	0.854	68.727	2.038	1.349	99.051	-0.662
9	1.601	1.108	127.878	1.894	1.506	58.680	0.973	0.869	63.181	1.843	1.296	96.171	-0.402
10	1.059	1.265	119.666	1.116	1.461	70.531	0.626	0.980	61.307	1.400	1.206	94.936	-0.368
11	1.330	1.284	113.810	1.404	1.438	75.145	0.870	1.036	63.361	1.279	1.080	97.735	0.014
12	1.383	1.308	112.487	1.588	1.395	76.615	0.753	1.051	61.935	1.143	1.123	95.890	-0.198
13	1.203	1.245	106.798	1.497	1.354	87.328	0.746	1.045	65.771	1.242	1.117	101.455	-0.059
14	1.195	1.197	90.862	1.435	1.411	53.928	0.438	1.060	60.693	1.085	1.087	54.118	0.246

BS	QB	QE	RM	RB	RE	SM	SB	SE	TM	TB	TE	UM	UB	UE
1	1.214	140.781	4.304	1.075	39.807	4.863	1.277	77.090	1.100	1.502	69.150	0.242	0.658	31.443
2	1.238	101.095	3.356	1.343	39.827	4.022	0.981	66.562	0.722	1.368	54.033	0.181	0.582	31.122
3	1.085	82.570	2.565	1.268	35.722	3.213	1.014	56.691	0.473	1.243	43.405	0.965	0.566	91.163
4	1.487	114.714	3.418	1.328	47.977	3.247	0.911	56.107	0.950	1.225	40.825	0.995	0.687	79.081
5	1.212	129.167	3.579	1.450	62.908	2.676	0.759	58.500	1.433	1.312	52.035	1.446	0.850	75.716
6	1.103	122.554	2.308	1.342	63.882	1.713	0.858	57.578	0.995	0.758	92.322	0.599	0.888	70.966
7	1.190	113.324	2.027	1.531	91.854	1.398	0.879	69.557	0.403	0.909	95.764	0.500	0.840	71.315
8	1.155	110.717	2.050	1.571	88.885	1.863	0.909	74.753	0.495	0.925	94.571	0.817	0.858	70.665
9	1.153	102.134	2.210	1.665	82.609	1.807	0.992	81.581	0.656	0.957	93.570	1.100	0.879	67.940
10	1.174	99.305	1.386	1.675	78.858	1.503	1.060	90.476	0.258	1.082	96.555	0.775	0.877	73.318
11	1.126	89.624	1.623	1.678	76.415	1.689	1.023	94.398	0.643	1.061	92.631	0.996	0.766	69.785
12	1.125	83.146	2.053	1.682	83.025	1.488	1.036	90.927	0.973	1.066	90.563	0.858	0.753	68.781
13	1.134	78.546	1.826	1.629	79.381	1.506	1.034	96.630	1.121	1.081	87.040	0.794	0.753	66.851
14	1.173	63.191	1.799	1.493	93.648	1.289	1.080	57.034	1.149	1.017	69.275	0.682	0.762	47.498

BS	VM	VB	VE	WM	WB	WE	XM	XB	XE	YM	YB	YE
1	-1.375	1.454	125.967	1.958	1.480	72.285	0.446	0.782	28.385	0.513	0.976	26.208
2	1.900	1.712	195.924	1.461	1.198	77.698	0.215	0.771	24.063	0.789	1.074	23.826
3	-0.263	1.508	287.037	1.298	1.080	61.308	-0.243	0.753	20.144	0.142	1.007	21.466
4	-0.460	1.581	238.986	1.957	1.026	63.264	-0.061	0.695	25.070	0.543	1.148	30.752
5	-0.164	1.448	205.926	2.146	1.034	55.302	1.181	1.028	36.160	0.550	1.305	33.559
6	-0.444	1.058	191.414	1.860	0.926	50.978	0.702	1.126	45.314	-0.331	1.269	38.224
7	-0.674	1.058	171.908	1.328	0.968	48.766	0.291	1.184	43.808	-0.471	1.203	40.700
8	-0.756	1.088	155.743	1.302	0.934	51.427	0.486	1.190	45.777	-0.249	1.183	41.886
9	-0.645	1.056	142.157	1.190	0.966	50.590	0.752	1.185	45.468	0.106	1.191	39.771
10	-0.641	1.100	132.612	1.053	0.906	59.116	0.754	1.178	47.678	0.151	1.054	35.311
11	-0.074	0.925	119.815	1.267	0.756	58.957	1.145	1.102	48.146	0.148	1.050	36.032

: FOR APPENDIX B:

MO = Number of Months

R1 = Expected Returns on Optimal Portfolios under Single Index Model (Short Selling Allowed)

R2 = Expected Returns on Optimal Portfolios under Single Index Model (Short Selling Not Allowed)

R3 = Expected Returns on Optimal Portfolios under Constant Correlation Coefficient Model (Short Selling Allowed)

R4 = Expected Returns on Optimal Portfolios under Constant Correlation Coefficient Model (Short Selling Not Allowed)

AM = Mean Return of Company A

AB = Beta Coefficient of Company A

AE = Residual Error of Company A

A P P E N D I X   C

OPTIMAL PORTFOLIOS

(Short Selling Allowed)

Unit: %

1980-1978		1980-1977		1980-1976		1980-1975		1980-1974		1980-1973		1980-1972	
Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i
A	-2.7	A	-1.2	A	-2.0	A	2.2	A	2.0	A	0.9	A	0.1
B	-1.1	B	0.3	B	-2.1	B	-5.0	B	-0.6	B	-4.7	B	-5.7
C	4.4	C	4.3	C	4.4	C	6.2	C	5.4	C	5.3	C	4.7
D	2.1	D	4.5	D	3.4	D	7.9	D	5.1	D	3.6	D	3.0
E	-1.5	E	-3.1	E	-3.9	E	-0.5	E	1.6	E	-2.2	E	-2.2
F	4.7	F	6.5	F	8.5	F	10.4	F	12.4	F	8.9	F	10.4
G	-7.6	G	-8.3	G	-7.9	G	-1.0	G	2.2	G	-1.6	G	-1.5
H	-0.5	H	1.3	H	1.1	H	2.1	H	0.9	H	-0.1	H	1.1
I	-11.4	I	-9.1	I	-14.6	I	-12.9	I	-15.1	I	-11.0	I	-8.0
J	-1.2	J	-1.1	J	-0.7	J	-0.2	J	2.2	J	2.3	J	0.7
K	-0.7	K	-2.1	K	0.1	K	2.6	K	1.3	K	-2.3	K	-3.4
L	1.5	L	-1.5	L	-1.1	L	-2.7	L	-1.0	L	3.1	L	-0.4
M	2.7	M	-0.6	M	1.0	M	0.2	M	3.3	M	3.3	M	2.9
N	9.0	N	7.7	N	4.5	N	2.5	N	1.6	N	3.4	N	3.9
O	-5.6	O	-6.2	O	-1.8	O	-1.5	O	3.3	O	1.5	O	3.2
P	3.0	P	2.8	P	3.7	P	3.2	P	2.1	P	4.8	P	4.7
Q	-3.2	Q	-2.4	Q	0.1	Q	-1.3	Q	-3.6	Q	-5.2	Q	-6.2
R	7.9	R	7.7	R	9.0	R	7.4	R	4.6	R	4.4	R	4.9
S	7.6	S	7.4	S	8.3	S	7.2	S	3.7	S	3.6	S	6.3
T	-3.5	T	-2.6	T	-2.4	T	-2.7	T	0.0	T	-1.4	T	-1.5
U	-5.0	U	0.5	U	0.0	U	0.2	U	-2.2	U	-1.2	U	0.2
V	-0.1	V	-1.0	V	-2.0	V	-3.3	V	-2.8	V	-3.3	V	-4.6
W	-0.3	W	0.9	W	2.5	W	3.0	W	4.8	W	4.3	W	4.2
X	-7.6	X	-10.0	X	-9.3	X	-3.4	X	-3.9	X	-4.9	X	-4.1
Y	-5.3	Y	-7.1	Y	-5.7	Y	-10.5	Y	-14.2	Y	-12.5	Y	-12.2
ΣX_i	100.0		100.0		100.0		100.0		100.0		100.0		100.0

Unit: %

1980-1971		1980-1969		1980-1967		1980-1965		1980-1963		1980-1961	
Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i
A	-0.5	A	-0.8	A	0.4	A	-2.5	A	-3.2	A	-3.1
B	-7.3	B	-3.8	B	-4.8	B	-6.2	B	-5.5	B	-8.9
C	4.6	C	2.5	C	4.8	C	4.6	C	0.2	C	1.0
D	4.4	D	3.4	D	2.2	D	1.5	D	-0.9	D	-0.5
E	0.0	E	-2.4	E	-1.3	E	-0.2	E	-2.9	E	-5.7
F	12.3	F	9.5	F	5.3	F	8.8	F	11.0	F	7.5
G	0.0	G	-2.1	G	-2.2	G	-0.7	G	3.6	G	3.9
H	0.4	H	-2.9	H	-2.0	H	-3.1	H	-2.1	H	-2.3
I	-7.9	I	-2.7	I	-1.6	I	-0.1	I	0.2	I	0.3
J	-0.5	J	-2.4	J	-2.4	J	-0.7	J	-0.5	J	0.9
K	-3.8	K	-3.8	K	-4.6	K	-7.2	K	-7.8	K	-6.2
L	-0.1	L	4.8	L	2.4	L	-1.7	L	2.3	L	-1.2
M	2.4	M	1.9	M	2.6	M	2.8	M	1.5	M	2.1
N	6.0	N	3.3	N	4.1	N	6.0	N	4.3	N	5.6
O	0.7	O	-0.6	O	0.2	O	-1.9	O	-2.5	O	-5.0
P	4.0	P	5.2	P	3.2	P	1.9	P	2.4	P	2.7
Q	-7.1	Q	-8.0	Q	-7.4	Q	-11.2	Q	-11.6	Q	-7.4
R	5.7	R	5.0	R	5.3	R	9.0	R	7.0	R	5.7
S	5.4	S	6.4	S	6.9	S	5.5	S	5.3	S	5.1
T	-1.5	T	-3.3	T	-1.8	T	0.7	T	1.8	T	3.0
U	1.6	U	1.2	U	2.7	U	1.1	U	-0.0	U	-1.0
V	-5.8	V	-7.4	V	-5.6	V	-6.9	V	-7.0	V	-5.7
W	2.6	W	4.8	W	6.8	W	6.8	W	7.8	W	5.4
X	-3.3	X	0.4	X	4.3	X	2.2	X	5.7	X	6.2
Y	-12.0	Y	-11.2	Y	-15.1	Y	-6.9	Y	2.9	Y	3.6
$\Sigma\lvert X_i\rvert =$	100.0		100.0		100.0		100.0		100.0		100.0

(Short Selling Not Allowed)

Unit: %

1980-1978		1980-1977		1980-1976		1980-1975		1980-1974		1980-1973		1980-1972	
Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i
S	14.3	F	14.6	F	17.2	F	15.9	F	22.1	F	19.1	F	17.5
N	14.0	S	16.4	R	16.3	R	12.2	C	9.5	C	9.8	S	14.3
R	12.7	N	14.4	S	17.3	C	9.6	R	9.6	P	10.3	P	10.0
F	9.4	R	14.3	C	8.5	D	13.2	D	10.4	R	9.0	C	8.8
C	7.7	C	8.1	P	8.7	S	12.6	W	10.9	M	8.1	R	8.8
P	6.3	P	6.6	N	10.3	N	8.3	M	7.6	S	9.8	M	7.7
M	6.0	D	9.5	D	9.4	P	7.1	S	9.1	W	10.4	N	8.2
D	6.3	W	4.0	W	7.4	W	8.5	P	6.0	D	7.8	W	10.1
L	5.8	H	3.7	M	4.9	A	6.6	O	8.2	L	7.9	D	7.4
E	4.3	B	4.0			H	6.2	N	6.6	N	7.8	O	7.4
B	3.8	M	1.7										
W	2.7	U	1.7										
V	1.6	L	0.7										
H	1.4	E	0.5										
Y	1.5												
J	1.0												
K	0.8												
T	0.3												
$\Sigma X_i =$	100.0		100.0		100.0		100.0		100.0		100.0		100.0

(Short Selling Not Allowed)

Unit: %

1980-1971		1980-1969		1980-1967		1980-1965		1980-1963		1980-1961	
Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i
F	18.0	F	14.3	S	14.8	R	11.1	F	8.6	F	9.2
S	13.7	S	16.5	W	13.8	N	13.4	S	8.7	R	7.3
N	12.7	P	11.4	N	10.3	F	11.2	R	6.3	N	7.8
C	9.5	W	12.4	F	8.6	S	12.9	N	8.0	X	9.0
R	9.6	R	7.7	C	6.4	W	14.5	W	8.7	S	7.6
P	9.9	D	8.6	R	7.1	C	7.0	X	7.6	W	8.5
D	10.4	N	9.5	P	8.2	M	7.0	P	6.2	G	6.1
M	7.1	L	8.3	X	9.6	P	7.7	G	4.7	Y	6.4
W	9.1	C	5.7	D	7.1	D	6.9	Y	5.6	T	5.5
		M	5.5	M	6.3	X	8.3	I	7.0	P	5.8
				U	7.9			L	4.4	M	4.4
								T	4.4	C	3.4
								M	3.7	I	6.6
								C	3.1	J	3.1
								D	2.6	D	3.0
								U	3.2	L	2.1
								J	2.0	U	2.3
								E	2.4	H	1.1
								O	1.8	E	0.8
								H	1.1		
ΣX_i =	100.0		100.0		100.0		100.0		100.0		100.0

(Short Selling Allowed)

Unit: %

1980-1978		1980-1977		1980-1976		1980-1975		1980-1974		1980-1973		1980-1972	
Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i
A	-3.6	A	-1.9	A	-3.2	A	2.1	A	1.4	A	0.5	A	-0.5
B	0.1	B	0.8	B	-2.3	B	-4.3	B	-1.1	B	-4.4	B	-5.8
C	4.1	C	3.8	C	4.2	C	6.0	C	5.3	C	4.7	C	4.4
D	2.4	D	4.3	D	3.5	D	7.9	D	5.0	D	3.1	D	3.1
E	0.2	E	-1.5	E	-2.9	E	0.9	E	1.5	E	-2.1	E	-1.5
F	5.2	F	7.6	F	10.2	F	11.4	F	15.2	F	10.0	F	9.8
G	-7.5	G	-8.5	G	-7.8	G	-3.7	G	0.9	G	-2.6	G	-2.5
H	-1.7	H	0.8	H	0.4	H	1.2	H	-0.7	H	-1.0	H	0.5
I	-7.4	I	-7.1	I	-0.0	I	-8.5	I	-10.1	I	-7.7	I	-7.6
J	-1.9	J	-1.7	J	-2.8	J	-2.6	J	1.1	J	2.1	J	-0.3
K	-3.2	K	-4.4	K	-3.1	K	0.4	K	-0.2	K	-3.5	K	-5.4
L	1.8	L	-1.2	L	-0.6	L	-2.4	L	-1.8	L	3.1	L	-0.7
M	2.8	M	0.0	M	1.4	M	0.0	M	3.3	M	3.5	M	3.5
N	8.4	N	7.3	N	4.8	N	3.4	N	2.0	N	3.1	N	3.6
O	-6.7	O	-7.7	O	-3.0	O	-2.4	O	2.7	O	1.2	O	2.9
P	3.2	P	3.0	P	4.2	P	2.6	P	2.1	P	4.9	P	5.0
Q	-3.9	Q	-3.1	Q	-0.2	Q	-3.1	Q	-6.2	Q	-6.5	Q	-7.1
R	7.3	R	7.1	R	9.3	R	7.6	R	4.7	R	4.1	R	4.3
S	8.7	S	8.5	S	9.9	S	7.0	S	3.5	S	4.1	S	7.4
T	-2.4	T	-2.0	T	-1.9	T	-1.9	T	-1.9	T	-2.4	T	-2.2
U	-7.2	U	-0.3	U	-1.8	U	-1.9	U	-4.3	U	-2.3	U	-0.1
V	-0.3	V	-1.6	V	-3.4	V	-5.5	V	-5.6	V	-4.9	V	-5.7
W	-0.3	W	1.0	W	2.5	W	2.8	W	4.9	W	4.3	W	4.4
X	-7.1	X	-9.7	X	-12.0	X	-2.9	X	-3.8	X	-3.9	X	-2.6
Y	-2.5	Y	-5.0	Y	-4.5	Y	-7.4	Y	-11.0	Y	-10.1	Y	-9.1
$\Sigma\lvert X_i\rvert$ =	100.0		100.0		100.0		100.0		100.0		100.0		100.0

(Short Selling Allowed)

Unit: %

1980-1971		1980-1969		1980-1967		1980-1965		1980-1963		1980-1961	
Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i
A	-1.2	A	-0.8	A	-0.3	A	-2.1	A	-2.5	A	-4.3
B	-7.1	B	-5.4	B	-6.9	B	-8.2	B	-7.2	B	-6.7
C	4.5	C	2.3	C	3.2	C	3.2	C	1.0	C	1.3
D	4.6	D	3.8	D	3.9	D	2.3	D	-0.5	D	-0.0
E	1.1	E	-1.6	E	-0.2	E	1.3	E	-1.7	E	-3.8
F	10.0	F	7.3	F	4.3	F	5.8	F	7.1	F	7.2
G	-0.4	G	-2.8	G	-2.1	G	-0.8	G	2.3	G	3.5
H	-0.3	H	-2.6	H	-3.0	H	-3.5	H	-2.7	H	-2.8
I	-7.4	I	-2.2	I	-0.2	I	2.4	I	3.0	I	2.3
J	-1.4	J	-2.4	J	-2.6	J	-1.0	J	-1.2	J	-0.0
K	-6.4	K	-5.8	K	-8.6	K	-11.8	K	-13.5	K	-7.9
L	-0.3	L	3.6	L	1.6	L	-0.8	L	1.6	L	-1.3
M	2.6	M	2.1	M	2.6	M	2.7	M	1.2	M	1.8
N	6.1	N	4.2	N	5.3	N	7.0	N	5.9	N	5.4
O	0.3	O	-0.4	O	0.2	O	-1.1	O	-1.8	O	-5.0
P	4.4	P	5.5	P	3.7	P	2.7	P	3.5	P	2.7
Q	-7.6	Q	-8.1	Q	-7.3	Q	-9.5	Q	-9.6	Q	-6.8
R	4.5	R	3.5	R	3.5	R	6.0	R	4.7	R	5.4
S	6.6	S	8.4	S	9.0	S	6.5	S	6.6	S	4.9
T	-2.2	T	-3.5	T	-2.0	T	0.7	T	1.6	T	2.6
U	1.7	U	1.6	U	2.8	U	0.7	U	-0.8	U	-2.1
V	-7.0	V	-7.9	V	-6.5	V	-7.1	V	-6.7	V	-7.4
W	3.0	W	5.6	W	7.5	W	7.0	W	5.7	W	5.0
X	-1.4	X	1.5	X	4.4	X	2.6	X	5.9	X	6.1
Y	-7.7	Y	-7.0	Y	-9.2	Y	-3.4	Y	2.7	Y	3.5
ΣX_i	100.0		100.0		100.0		100.0		100.0		100.0

Unit: %

1980-1978		1980-1977		1980-1976		1980-1975		1980-1974		1980-1973		1980-1972	
Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i
S	17.1	F	15.8	F	16.6	F	12.4	F	18.3	F	18.2	F	19.7
F	11.2	S	18.0	S	16.3	S	9.0	M	5.7	M	6.7	S	12.0
N	21.7	N	18.0	R	18.2	R	10.6	J	4.0	P	9.6	M	5.6
P	7.6	R	17.8	P	7.7	D	11.8	O	6.0	J	4.7	R	9.7
R	20.3	H	2.9	W	5.6	P	4.8	A	3.6	S	7.2	P	9.2
O	8.5	P	6.3	N	10.0	C	10.2	C	10.1	C	10.6	O	6.3
M	9.2	D	9.8	C	9.9	K	4.4	W	9.0	R	8.9	C	9.4
L	5.9	C	9.2	D	7.9	H	3.9	S	7.0	L	6.3	W	8.4
D	8.1	U	0.9	H	2.7	W	5.8	R	9.1	W	8.7	D	6.3
V	0.9	W	1.4	M	3.1	A	4.5	D	10.5	D	7.3	N	8.1
W	1.6			Q	0.8	N	6.9	G	4.6	A	1.8	H	2.3
B	2.1			U	0.6	U	1.9	P	4.8	N	6.8	J	1.6
E	2.4			K	0.6	M	2.4	H	2.3	O	3.0	U	0.8
H	0.4					E	4.4	K	3.7			A	0.4
						J	1.6	E	5.6				
						G	1.1	N	6.2				
						O	1.5	I	3.9				
						T	1.1	B	2.6				
						L	0.9	L	0.9				
						X	0.9						
$\Sigma X_i =$	100.0		100.0		100.0		100.0		100.0		100.0		100.0

(Short Selling Not Allowed)

Unit: %

1980-1971		1980-1969		1980-1967		1980-1965		1980-1963		1980-1961	
Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i	Co.	X_i
F	20.0	S	12.7	S	10.7	F	13.1	F	14.0	F	10.8
S	9.3	F	18.8	W	10.9	W	10.1	S	7.1	R	8.8
P	7.4	P	10.2	F	9.3	S	8.2	W	11.1	G	6.2
R	10.7	W	9.7	P	5.9	R	13.7	R	10.5	W	8.8
M	4.5	L	9.8	U	5.2	N	9.9	G	5.6	S	8.4
D	8.5	R	10.3	R	10.2	M	5.2	N	6.9	X	10.8
N	11.8	D	7.2	M	5.1	C	8.9	P	4.3	N	9.9
C	9.0	M	4.1	C	9.6	P	4.2	X	10.4	T	5.4
W	6.0	N	7.2	N	8.2	D	3.8	T	3.8	Y	6.7
U	3.8	C	5.6	X	9.0	U	3.1	Y	6.4	M	4.1
O	2.6	U	2.7	D	4.7	X	6.8	M	3.4	P	5.7
H	1.8	X	1.8	L	5.5	T	2.8	L	5.6	J	2.4
E	2.2			A	2.2	I	3.1	I	3.3	C	3.1
G	1.1			O	2.7	E	2.7	C	3.7	I	5.9
L	1.4			E	0.8	J	1.5	U	1.8	D	1.7
						G	1.2	J	1.8	U	0.7
						L	1.2			L	0.5
						O	0.7				
	ΣX_i=100.0		100.0		100.0		100.0		100.0		100.0

VITA

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Master of Business Administration

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