AN EXAMINATION OF

RELATIVE SECURITY PRICING

AS A METHOD OF

SUPERIOR PORTFOLIO FORMATION

by

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ABSTRACT

An Examination of Relative Security Pricing as a Method of Superior Portfolio Formation

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Starting with the two-factor asset pricing model developed by Black, Jensen, and Scholes, this thesis examines the efficient markets hypothesis. In particular it addresses the question: Does relative strength, defined as the relative, risk-adjusted performance of securities beyond expectations, tend to persist for a period of months?

Evidence is presented by statistical tests that the efficient markets hypothesis is violated. Using the relative strength ranking of a security for the past six months a better estimate of its return for the next half year is possible than that obtained by using the pricing model alone.

Portfolio formation methods employing relative strength predictions are also tested by simulations over the period 1951 - 1970. Despite the superior predictive ability no "extra" profits net of transactions costs are realized. The apparent conclusion is that the observed violation is not large enough to produce arbitrage after considerations that include costs.

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CHAPTER I

There are two basic schools of financial analysis, the fundamental and the technical. Fundamentalists attempt to predict future corporate earnings and by capitalizing them arrive at an intrinsic estimate of value for the firm. Technicians on the other hand concern themselves primarily with the current market price and its movements in the past.[1] By looking at the past patterns the technicians contend that they can predict future prices.

For the most part, the fundamental school has not been challenged by the academicians.[2] In my opinion, this is primarily due to the difficulty of acquiring evidence rather than any obvious soundness of the theory. On the other hand, the technical school has been severely contested by the proponents of the "efficient capital markets" theory.

The latter theory is probably well known to the reader; however, the basis for the technicians' position may not be. They contend that the stock market is oligopolistic in nature not efficiently competitive. There is an unequal distribution of information among the market participants. As this information spreads throughout the market, the traders, in reacting to it, set up patterns in the prices. Therefore, merely by looking at individual price patterns, the nature of the underlying information can be learned before the information itself is wide-spread.

The first tests of the efficient markets hypothesis on the capital markets were "random walk" test of the simplest forms. Kendall /23/, Osborne, Moore, and Cootner[3] conducted tests to determine the properties of the distribution functions of changes in security prices. All of these tests

[1]Footnotes appear at the end of the paper.

were essentially statistical, rather than economic in nature; that is the concern was on correlations, runs analysis, distributional parameters, etc. rather than on returns or profits.

Perhaps the first economic test was the filter rule system of Alexander /1/. His trading rule for an x% filter was: If the price of a security moves up x% or more, buy and hold it until its price drops at least x% from a subsequent high. At this point the security was sold, and in some schemes a short sale was also effected. The short sale was later covered when the buy signal was again encountered. His conclusion and later that of Fama and Blume /12/, who duplicated and extended the study, was that net of transactions costs no profit could be made in excess of the profit earned by just buying and holding the security throughout the period.

Economic tests like the above tend to be simulations of trading rules using past market data. Simulations have the following definite advantages over statistical tests: (1) They are easier to interpret. Either the rule performed better than the control or it did not. No decision need to be made as to the proper level of significance. On the other hand, it may not be quite so easy to decide if this particular simulation result is typical for the rule in question. (2) Transactions costs can be explicitly included. As the filter rule demonstrated serial correlation in prices does not necessarily imply excess profits net of transactions costs. (3) Risk can also be explicitly considered. (4) Trading rules that technicians actually use can be tested.[4]

Fama and Blume introduced simulation tests; however, their filter rule was not one actually in use by technicians. Cootner /9/ performed the earliest test on a commonly used rule when he examined the buy-sell indications of a penetration of the 200 day moving average. The rule as generally used is: Whenever the current price of a security rises above the average price of the past 200 trading days, cover any short positions and buy the stock. When the price falls below the average close out the long position and sell short. Like the filter rule this strategy resulted in returns in excess of those generated by buying and holding the security only when the necessary transactions costs were ignored. Other authors have also tested technical indicators such as the advance-decline line /51/, other moving averages /18,50/, volume /40/, and odd-lot trading /47/.

The aforementioned technical tools are primarily used for the timing of transactions to buy securities at or near their local minimum price and to sell at the maximum. This paper will examine relative security pricing which is instead a selection scheme indicating which securities are the best to buy at any given time. A commonly heard recomendation is "be willing to take your losses but let your profits run." The appeal of this tactic seems intuitive. By getting out of the "bad" securities and maintaining positions in the "good" ones, one would expect to have a better than average performance. The flaw, of course, is that the "good" securities may not continue to do better than the "bad." Indeed the efficient markets hypothesis propounds just that exactly.

Robert Levy /27/ has studied this question and concludes that the securities that have had the highest returns over a six month period, will continue to have the highest returns over the next six months on the average.[5]
In two other studies /25,26/, he uses this result in an attempt to form superior performing portfolios. The two very similar methods of portfolio formation produce quite dissimilar results which leaves the practical

applications of relative strength nebulous. Jensen /21/ points out that the one method which is successful is very much dependent upon a few securities that are held in ever increasing proportions.

More doubt is cast on the value of relative strength upon examination of Levy's evaluation method. The period of his study, October 1960 to October 1965, was also a period of a very strong market. Except for the brief downturn in 1962, stock prices were continuously rising. The Standard and Poor Industrials rose from under 60 to near 100 during this period. Similarly the Dow Jones average also rose approximately 70%. From this knowledge of the performance of the market, we can deduce, ex-post, that the more volatile securities should have had higher returns than the less volatile. Furthermore, since the volatility of stocks is relatively constant over a short period such as six months, we can conclude that certain securities should have consistenly performed in a superior manner when judged by return alone.

This study will build from those of Levy with several changes to correct for the problems considered above. Every six months the securities will be ranked on their performance and ten portfolios will be formed containing an equal weight of each security from that decile. Since the portfolios will be continually rebalanced, a few securities will not become dominant to the overall return of any of the ten portfolios. The time period used will be January 1951 to December 1970. During this time there were several bear markets of different durations and severities. This and the use of a risk-adjusted return will serve to correct for the bias caused by a continuously rising market. The appropriate pricing modle is the subject of the next chapter.

CHAPTER II

From the normative portfolio model of Markowitz /31,32/, Sharpe /44,45/ and Lintner /30/ have developed capital market equilibrium models under the condition of risk. As Fama /14/ has shown both models are consistent and lead to a pricing of assets such that:

$$E(R_i) = R_f + \mathrm{Cov}(R_i, R_m)(E(R_m) - R_f)/\mathrm{Var}(R_m) \tag{2.1}$$

or:

$$E(R_i) - R_f = \beta_i(E(R_m) - R_f) \tag{2.2}$$

where R_i is the per-dollar return on security i, R_m is the per-dollar return on the market portfolio, a portfolio containing all assets in proportion to their value, and R_f is one plus the one-period risk-free interest rate.

The following assumptions underlie the model: (1) All investors are risk-adverse, one-period, expected utility of terminal wealth maximizers with a common horizon. (2) The investors find it possible to make portfolio decisions based solely on the meam and variance of their terminal wealth. (3) The capital markets are perfect in the sense that there are no transactions costs or differential taxes, and information is available to and processable by everyone at no cost differential.[6] (4) All investors may borrow or lend unlimited amounts at the exogenously given interest rate. (5) All investors have homogeneous expectations on the joint probability distribution of returns on all assets.

Objections have been raised to all the above assumptions, and most of them have been examined at one time or another.[7] Fama /13/, Merton /35, 36/, Samuelson /42/, and others have extended the work to solve multi-period portfolio problems. To develop a multi-period capital asset pricing model a valid myopic portfolio formation rule must be found. This cannot be achieved without restrictive assumptions. Merton /35,36/ shows that in the case of a portfolio opportunity set whose returns are lognormally distributed and the same, or changing deterministically, over time, the intertemporal problem reduces exactly, in the limit as continuous trading is allowed, to the one period mean-varianve model. The implied equilibrium compounding rate of return is now the variable given by R_i in the previous model (2.1). If the opportunity set is not deterministic, and it obviously is not since the interest rate at least, changes stochastically, then the pricing model breaks down. However, using the interest rate as an instrumental variable to represent shifts in the investment opportunity set, Merton /37/ has shown that a more complex pricing will hold:

$$(2.3) \qquad E(R_i) - R_f = \frac{S_i(r_{im} - r_{in}r_{nm})}{S_m(1 - r^2_{nm})}(E(R_m) - R_f) + \frac{S_i(r_{in} - r_{im}r_{nm})}{S_n(1 - r^2_{nm})}(E(R_n) - R_f)$$

where security n has perfect negative correlation with the interest rate, S_i is the standard deviation of security or portfolio i, and r_{ij} is the correlation coefficient between the returns on securities i and j.

The objections to the mena-variance approximation to general utility theory is dealt with by Samuelson /41/. He shows that in the context of the U. S. capital markets where trading is virtually continuous that the approximation is quite good. Lintner /28/ examines the question of heterogeneous expectations and concludes that removing this assumption does not change the pricing model in any significant way. Mayers /33/ addresses the problem of non-marketable assets. He shows that the only change in the pricing model is the replacement of β_i by $\beta_i' = Cov(R_i, R_mV_m+R_nV_n)/Cov,(R_m, R_mV_m+R_nV_n)$, where V_m and V_n are the dollar values of marketable and non-marketable assets.

In the abscence of a riskless asset, which is a description of the world in real rather than money terms, or with restrictions placed on borrowing and lending, the efficient portfolio frontier is no longer one straight line. In these cases it is a part of the semi-hyperbola in mean-standard deviation space /34/ and parts of zero, one, or two tangent lines.

Nevertheless, if there are no restrictions on short selling, Black /2/ has shown that in the abscence of a riskless asset or with riskless lending only, all investors' portfolios will be equivalent to a linear combination of two basic efficient portfolios. Brennan /5/ examines the case of differing lending and borrowing rates and shows that all investors will hold a linear combination of the two corner portfolios that he calls the "lending" and "borrowing" portfolios. However, Merton /34/ and Black /2/ have demonstrated that all efficient portfolios can be generated by linear combinations of any two distinct frontier portfolios in the abscence of short sales restrictions. Black then goes on to suggest that one portfolio be taken to be the market and the other to be the minimum-variance zero-beta portfolio. Black then proves that the expected equilibrium return on any risky asset or portfolio of only risky assets will be given by:

(2.4) $$E(R_i) = (1 - \beta_i)E(R_z) + \beta_i E(R_m)$$

(2.5) $$E(R_i) = E(R_z) + \beta_i E(R_m - R_z)$$

where all terms are defined as before and R_z is the return on the zero-beta portfolio with minimum variance. Equation 2.5 is identical to 2.2 with $E(R_z)$ taking the place of R_f.

The empirical evidence presented by Miller and Scholes /38/ seems to confirm other earlier evidence that equation 2.2 does not completely describe the available data. In particular when regressing R_i on β_i the slope was significantly less than $\overline{R_m - R_f}$. In a later test Black, Jensen, and Scholes /3/ constructed a time series for R_z thus they were able to test (2.5) explicitly. Their conclusion is that this two factor model is an adequate description of security returns. Since the B-J-S two factor model fits the theoretical work of Black and Brennan and seems to be empirically plausible as well, I have used it as the basic pricing model in this work.[8]

CHAPTER III

For this study the returns, R_{it}, are the the capital gains appreciations and dividends paid during each non-overlapping six month period from January 1951 to December 1970 by 483 corporations with stock listed continuously from July 1946 to the end of the period on the New York Stock Exchange.[9] The market return, R_{mt}, is a value-weighted average of the returns on all securities on the NYSE. It is similar to the NYSE composite index although it includes dividend returns unlike the index. The return on the zero-beta portfolio, R_{zt}, is figured as the product of the monthly R_z's as computed by B-J-S. The problem associated with this definition is considered later in this chapter. Estimates of each security's beta, β_i, are denoted by b_{it} and were obtained in the usual manner by regressing monthly $R_{it}-R_{zt}$ on $R_{mt}-R_{zt}$.

$$(3.1) \qquad R_{it} - R_{zt} = \alpha_i + \beta_i(R_{mt} - R_{zt}) + e_{it}$$

A different b_{it} was obtained for each six month period from the data covering the preceding fifty-four months.

Starting with (2.4), we are now able to evaluate relative pricing as a portfolio formation policy. Securities with "high relative strength" will be defined as those that have done the best beyond expectations. Thus, converting (2.4) from expectations to realizations:

$$(3.2) \qquad R_{it} = (1 - \beta_i)R_{zt} + \beta_i R_{mt} + u_{it}$$

$$(3.3) \qquad u_{it} = R_{it} - (1 - \beta_i)R_{zt} - \beta_i R_{mt}$$

Securities may now be ranked on their residuals, u_{it}. Those with the largest residuals will said to have the highest relative strength.[10] Portfolios of securities are now formed from each decile by investing an equal dollar amount in each security within that decile. Since (3.3) is linear in R_{it} and β_i, the residuals of each portfolio will merely be the average of the portfolio residuals.[11]

We can now look at the portfolio returns over the next six months and form residuals, $U_{p,t+1}$.[12] If portfolio upgrading is a good technical policy, we would expect $U_{1,t+1}$ to be the largest residual and $U_{10,t+1}$ to be the smallest. In general we would expect the correlation of u_{pt} and $U_{p,t+1}$ to be positive. If, on the other hand, the efficient markets hypothesis holds we would expect no significant correlation.

The above may seem quite straightforward; however, several matters require consideration before the test may proceed. β_i for each security is not known with certainty; we merely have an estimate, b_{it}, the regression coefficient. Although each b_{it} is an unbiased estimate of β_i, it is subject to error:

(3.4) $$\beta_i = b_{it} + e_{it}$$

The error in b_{it} leads to an error in our determination of the security residuals:

(3.5) $$u_{it} = R_{it} - R_{zt} - \beta_i(R_{mt} - R_{zt})$$

(3.6) $$= R_{it} - R_{zt} - b_{it}(R_{mt} - R_{zt}) - e_{it}(R_{mt} - R_{zt})$$

(3.7) $$= w_{it} - e_{it}(R_{mt} - R_{zt})$$

where w_{it} is the observed residual.

Since R_{mt} is in general greater than R_{zt}, if we have a positive error e_{it} in our measurement of β_i, our observed residuals w_{it} will tend to be larger than the true residuals and conversely. Because of this if we used the same estimate of β_i in forming both w_{it} and $w_{i,t+1}$, the residuals would tend to show a greater correlation over i than the true residuals actually had. This measurement error might lead us to an erroneous conclusion that relative strength tended to continue over time even if it had no such tendency. If different but non-independent estimates of β_i are used, the problem will be lessened but not corrected.

Another source of biased dependence between w_{it} and $w_{i,t+1}$ may come about indirectly. If the data used in forming the estimate $b_{i,t+1}$ comes partially from the period t, then $b_{i,t+1}$ and w_{it} will not be independent. Therefore the two residuals may show a greater or lesser correlation than they should. For example if $R_{mt} > \overline{R_m}$ and u_{it} is a positive residual, then an estimate for $b_{i,t+1}$ using data from the period t would tend to overestimate β_i (ie. $e_{it} < 0$). In this case $w_{i,t+1}$ will underestimate $u_{i,t+1}$ as shown above. This would lead to the residuals showing less correlation than the true residuals actually had.

To avoid the above two problems, b_{it} for each six month period was estimated using the monthly returns from the later two months of each sequence of four months during the four year period ending just prior to period t-1. For example, $b_{i,t+1}$ for the six month period covering months n+1 through n+6 was estimated using the returns from months n-6, n-7, n-10, n-11, n-14, . . . , n-46, n-47, n-50, n-51. Clearly $b_{i,t+1}$ will be independent of w_{it} which is derived from th returns in months n, n-1, . . . , n-5. Also it will be independent of b_{it} which is estimated using the returns in months n-12, n-13, n-16, . . . , n-48, n-49, a set disjoint from the previous one.

As mentioned earlier there is also a problem associated in the measurement of R_z. It is not in general true that the return on a six month zero-beta portfolio will equal the product of six monthly zero-beta returns. The proportions of securities in the monthly portfolios may not be constant for six months; however, the make-up of the six month portfolio can by definition only be figured and changed once every six months. Since the relative proportions may not be the same, it is obvious that the ex-post returns on the two can differ. The monthly zero-beta returns are those derived by Black, Jensen, and Scholes /3/ as follows:

(3.8) $$R_{zt} = k\sum(1 - \beta_j)^2 R_{zjt}$$

where $k = (\sum(1 - \beta_j)^2)^{-1}$, and R_{zjt} is an estimate of R_{zt} obtained from the jth portfolio by solving (3.2) for R_{zt} neglecting the error term:

(3.9) $$R_{zjt} = (R_{jt} - \beta_j R_{mt})/(1 - \beta_j)$$

Combining (3.8) and (3.9):

(3.10) $$R_{zt} = k(1 - \beta_j)(R_{jt} - \beta_j R_{mt})$$

The important thing to note in (3.10) is that the proportion of each of B-J-S's ten portfolios in the zero-beta portfolio depends only on the β_j's. In a study on the short term stationarity of beta coefficients, Levy /24/ formed portfolios in an identical manner and found that over a twenty-six week period beta coefficients for portfolios of greater than twenty-five stocks were extremely stable. During the time period of my study each of B-J-S's ten portfolios never had less than ninety-four securities. We may assume therefore that the proportions of each portfolio in the zero-beta portfolio remained approximately constant, and, therefore, that the six month ex-post zero-beta return may be closely approximated by the product of the monthly returns.

In measuring the holding period returns on each security an implicit assumption was made that the initial transaction would occur at the closing price for the previous period (ie. the price used to calculate the residuals for the previous six months) rather than at the next trade price. This assumption will not hurt in testing the random walk model since by assumption the opening price for the next say will be randomly distributed around the previous day's close. On the other hand, in testing the economic proposition that "excess" profits cannot be made by this method, we cannot assume that the closing price will be an unbiased estimate of the succeeding opening price. Several authors /17/, /1/, and /23/ have found evidence of positive serial correlation in successive closing prices. On the other hand, Niederhoffer /39/ has presented evidence that successive price changes tend to be opposite in sign. He has explained his results by examing the market making proceedure and the random arrival of market orders to buy and sell.

Therefore, during an overnight period, the former findings of positive serial correlation is probably the more serious problem. The noted dependence is not large enough to generate extra profits after transactions costs when used alone as a trading scheme, but it will tend to bias my results slightly in favor of continued relative strength. This bias should be very small, however, since it depends only on the implied correlation between the overnight change in price and the price change during the next six months.[13]

The problem with the non-normality of the data has been treated elsewhere. An important result is that the least squares estimate of beta is unbiased, although it is inefficient /3/. Distribution-free and non-parametric tests were used in this study when appropriate along with the standard, normal-assumption tests.

Objections could also be raised with the use of the residuals w_{it} for performance ranking. This scheme is analagous to using alpha from the Sharpe pricing model, a method known as Jensen predictability /20, 48/. Treynor /52/ has shown that this method is not theoretically correct for ranking portfolios relative to one another. A better measure would be the corrected residuals, w_{it}/b_{it}.[14] Nevertheless, Smith and Tito /48/ have shown that the two measures are very highly correlated. With this in mind, the former measure has been used throughout the body of this paper. For completeness all tests were also performed on the corrected residuals and the results are presented in appendix B. In keeping with the findings of Smith and Tito, the results are nearly identical.

CHAPTER IV

The preceding chapter described how residuals representing unexpected returns were calculated for each security in each period and how the securities were then partitioned on this measure into ten portfolios. The portfolio residuals were calculated for the last period, w_{pt}, and the next period, $W_{p,t+1}$.[15] Henceforth, period t will be called the "ranking period" and period t+1 the "evaluation period"; similarly, the residuals w_{pt} and $W_{p,t+1}$ will be referred to as the "ranking" and "evaluation" residuals respectfully. Appendix A presents the complete set of protfolio returns and residuals for each period.

For this ranking proceedure we know that:

$$(4.1) \qquad w_{1t} > w_{2t} > w_{3t} \cdot \cdot \cdot > w_{10t}$$

and would expect, if relative strength is persistent for some time to find:

$$(4.2) \qquad W_{1,t+1} > W_{2,t+1} > \cdot \cdot \cdot > W_{10,t+1}$$

Table 1 presents the average values of the evaluation and ranking residuals over the thirty-nine periods. The residuals do tend to fall in the order expected with only the third and seventh residuals lying far out of order. The correlation between these average residuals is .934 -- significant at the .1% level. Since these residuals are averages of thirty-nine separate period residuals which are, in turn, averages of forty-eight security residuals, we are certainly safe in assuming normality by the law of large numbers.

Turning our attention to the individual periods, we can perform a similar analysis. Now a distribution-free statistical test will be used.

TABLE 1

AVERAGE RANKING AND EVALUATION RESIDUALS

PORT. #	RANKING	EVALUATION
1	0.33872789	0.02639866
2	0.14360142	0.00198569
3	0.07944739	-0.00250820
4	0.03376356	0.00426252
5	-0.00312956	-0.00855196
6	-0.03536685	-0.00512385
7	-0.06745559	-0.00195579
8	-0.10428709	-0.00996118
9	-0.15268159	-0.01034950
10	-0.25391948	-0.02080797

Correlation coefficient 0.934

$R^2 = 0.872$

The test is known as the Kendall Tau test and can be outlined as follows /49/. Take two sets of paired random variables and order them from highest to lowest on one of the sets carrying the other along. Now in the second set count the number of permutations (ie. times that a lower value precedes a higher) and call this statistic I. Clearly I can range from 0, when the sets are identically ordered, to n(n-1)/2, when they are in the exact opposite order. If the two sets are independent, then a priori all of the n! orderins of the second variable are equally likely. If the two sets are positively correlated, we would expect I to be less than n(n-1)/4 and conversely. The expected distribution of I given independence can be evaluated by enumeration, and it is independent of the distribuitons of the underlying random variables. A statistic that has somewhat more intuitive feel than I is T = 1 - 4I/(n(n-1)). T ranges from +1 for perfect concordance to -1 for perfect negative concordance, thus it behaves qualitatively very much like the correlation coefficient although making no distributional assumptions.

If we take the first set of ranking and evaluation residuals and order them on the former, we find six permutations: the second precedes the third, the fifth precedes the sixth, seventh, eighth, and ninth, and the eighth precedes the ninth. Hence I is six in this case and T = .733. A complete set of evaluation residual rankings appears in table 2a, and a list of values of T is given in table 3.

The evidence again seems to support the continuation of relative strength. Twenty-eight values of T are positive and only 11 negative. In addition seven (fouteen) are significantly positive and one (two) significantly negative ant the one (five) per cent level. The expected

TABLE 2a

PERIOD BY PERIOD EVALUATION RESIDUALS RANKINGS

Per. No.	Portfolio Number: 1	2	3	4	5	6	7	8	9	10
1	1	3	2	4	9	5	6	8	7	10
2	8	5	6	1	3	9	2	7	4	10
3	2	3	6	4	1	9	5	8	7	10
4	7	4	1	6	5	3	8	2	9	10
5	2	3	8	1	10	7	5	4	6	9
6	1	5	3	2	4	8	7	6	10	9
7	2	10	8	7	9	3	4	6	5	1
8	1	7	2	5	6	4	3	9	8	10
9	7	5	2	1	4	6	8	3	10	9
10	3	5	6	1	4	7	2	9	8	10
11	1	2	9	3	7	5	4	8	6	10
12	2	3	1	5	7	6	10	8	9	4
13	5	3	6	1	8	2	10	7	9	4
14	4	9	6	5	3	7	8	10	2	1
15	2	1	5	9	8	4	7	6	10	3
16	1	2	5	3	6	4	7	9	8	10
17	1	2	3	5	6	4	8	9	7	10
18	2	3	4	1	6	8	10	9	7	5
19	7	3	9	4	6	5	8	2	1	10
20	1	10	8	2	5	9	6	3	7	4
21	1	3	2	7	5	4	6	10	9	8
22	10	7	8	6	9	3	1	5	2	4
23	2	3	4	1	6	8	10	9	7	5
24	1	7	5	4	2	9	3	10	6	8
25	1	4	6	7	2	9	5	8	3	10
26	1	4	10	6	3	5	2	7	8	9
27	8	10	5	6	9	2	3	7	1	4
28	3	7	5	2	4	6	8	1	9	10
29	1	3	2	10	5	9	4	6	7	8
30	1	3	5	2	4	7	6	8	9	10
31	7	9	8	4	5	1	2	3	6	10
32	5	9	10	7	8	4	1	3	6	2
33	1	3	8	2	4	7	6	5	9	10
34	1	3	6	2	7	5	9	4	8	10
35	8	2	1	7	9	6	5	4	3	10
36	9	10	3	4	5	2	7	6	1	8
37	1	4	2	3	5	6	7	9	10	8
38	1	10	6	9	2	8	7	4	5	3
39	10	7	6	9	8	3	4	5	2	1

TABLE 2b

SUMMARY OF EVALUATION RESIDUALS RANKINGS

	Portfolio Number: 1	2	3	4	5	6	7	8	9	10
Times 1st	17	1	3	6	1	1	3	1	3	3
2nd	7	4	6	6	3	3	4	2	3	1
3rd	2	12	3	3	3	4	3	4	3	2
4th	1	5	1	6	6	6	4	4	1	5
5th	2	4	6	4	7	5	4	4	2	1
6th	0	0	9	4	5	6	5	5	5	0
7th	4	5	1	5	3	5	6	4	6	0
8th	3	0	6	1	4	3	6	6	5	5
9th	1	3	2	3	5	6	1	6	7	5
10th	2	5	2	1	2	0	3	3	4	17
1st half	29	26	19	25	20	19	18	15	12	12
2nd half	10	13	20	14	19	20	21	24	27	27
Mean	3.39	5.08	4.79	4.49	5.72	5.51	5.51	6.23	6.38	7.44

TABLE 3

PERIOD BY PERIOD CONCORDANCE FOR EVALUATION RESIDUALS

PERIOD	I (Permutations)	T (Kendall's Tau)	SIGNIFICANCE
1	6	0.7333	++
2	20	0.1111	
3	10	0.5556	+
4	16	0.2889	
5	16	0.2889	
6	8	0.6444	++
7	30	-0.3333	
8	11	0.5111	+
9	15	0.3444	
10	11	0.5111	+
11	11	0.5111	+
12	11	0.5111	+
13	17	0.2444	
14	26	-0.1556	
15	17	0.2444	
16	4	0.8222	++
17	4	0.8222	++
18	12	0.4667	
19	24	-0.0667	
20	23	-0.0222	
21	8	0.6444	++
22	35	-0.5556	-
23	20	0.1111	
24	15	0.3333	
25	13	0.4222	
26	14	0.3778	
27	32	-0.4222	
28	14	0.3778	
29	12	0.4667	
30	4	0.8222	++
31	25	-0.1111	
32	33	-0.4666	
33	9	0.6000	+
34	9	0.6000	+
35	22	0.0222	
36	26	-0.1556	
37	4	0.8222	++
38	27	-0.2000	
39	38	-0.6889	--

++,-- significant at 1% level
+,- significant at 5% level

number of occurences given independence would be .4 (2). The preponderance of positive correlations, therefore, cannot be looked upon as a mere chance occurence.

A two way analysis of variance was performed on the evaluation residuals to provide an overall view. The results, presented in table 4, once again seem to violate the random walk hypothesis. The two way test removes both the ex-ante differences in $E(R_m)$ and $E(R_z)$ from period to period and the ex-post differences in $R_m - E(R_m)$ and $R_z - E(R_z)$ before looking at the effects of the portfolio differences. The remaining variation, measured by its F value of 5.06 is highly significant.

The two previous tests have indicated that there does seem to be a noticeable difference in the evaluation residuals and that this difference indicates a tendency for relative strength to persist. To get a clearer picture of relative strength performance, we can compare two portfolios over time. The traditional method would be conduct a paired t-test; however, to avoid distributional dependence, a sign test was chosen. The null hypothesis is that neither portfolio is expected to out-perform the other. In this case, the probability in any given period that the portfolio with the higher ranking residual would also have the higher evaluation residual would be one-half. Therefore, if S is the number of times that this event occurs, then S should be binomially distributed with characteristic probability of .5.

Table 5 presents S as a proportion (ie. $S' = S/39$) for all forty-five two way comparisons. In general it will be noted that S' is greater than .5, and the five instances when it is less than one-half all occur in the case of "close" portfolios. Furthermore, S' is never significantly

TABLE 4

TWO-WAY ANALYSIS OF VARIANCE ON EVALUATION RESIDUALS

Source of Variation	D.F.	Sum Sq.	Mean Sq.	F-Stat
Between periods	38	1.83314	0.04824	40.35
Between portfolios	9	0.05448	0.00605	5.06
Deviations	342	0.40891	0.00120	
Total	389	2.29653		

	Avg. portfolio effect
1	0.0290593
2	0.0046466
3	0.0001530
4	0.0069238
5	-0.0058903
6	-0.0024629
7	0.0007063
8	-0.0072995
9	-0.0076885
10	-0.0181472

TABLE 5

RESULTS OF THE SIGN TEST ON THE EVALUATION RESIDUALS

Fraction of the time that portfolio i outperformed portfolio j.

Portfolio j	Portfolio i: 1	2	3	4	5	6	7	8	9
2	.770"								
3	.770"	.487							
4	.616	.410	.410						
5	.744"	.539	.590	.719"					
6	.719"	.642	.565	.565	.436				
7	.744"	.590	.539	.590	.565	.513			
8	.693'	.667'	.616	.667'	.539	.565	.590		
9	.770"	.616	.565	.667'	.667'	.565	.667'	.462	
10	.796"	.770"	.719"	.744"	.667'	.719"	.770"	.642	.642

" significant at 1% level
' significant at 5% level

less than one-half while it is significantly greater thirteen (twenty) times at the one (five) per cent level.

Th effect is most noticeable in the dominace of portfolio one and the inferiority of portfolio ten. There are two possible explanations for this. The first argues that since the observations for these two come from the tails of the distribution, their effects are more noticeable although no more real than those of the other portfolios. The second would explain that the performance of most securities is reasonably modeled by a random walk. Nevertheless, the market does not fully discount information that would require large price changes quickly; rather there is a lag of at least six months before the prices fully adjust. If the price has only begun to adjust during the ranking period, then extra profits can still be captured during the evaluation period. If the former were true, then more observations possibly would show the difference between the middle portfolios.

Unfortunately a more extensive test was not within the scope of this work; however, we can examine the middle portfolios more closely using just the available data. If we ignore portfolios one, two, nine, and ten, we will have excluded all of the securities experiencing unexpected large price changes. Now we can test the second hypothesis by using the same procedures as before.

In the upper right hand part of table 5 there are fifteen values for S'. Of these, thirteen are greater than one-half although only two are significantly so. Another analysis of variance performed on the excluding set resulted in an F value of 1.33 just missing the significant 25% level of 1.35. Kendall's Tau test resulted in four of thirty-nine values

FIGURE 1

DISTIBUTION OF THE STATISTIC "I" FROM THE KENDALL TAU TEST

All Portfolios				Middle Portfolios	
0 - 1				0	X
2 - 4	XXXX	(10)	(8)	1	
5 - 7	X			2	XXX
8 - 10	XXXXX			3	XXXX
11 - 13	XXXXXXX			4	XXXX
14 - 16	XXXXXX	(18)	(16)	5	XXX
17 - 19	XX			6	XXXX
20 - 22	XXX			7	XXXXX
23 - 25	XXX			8	XXX
26 - 28	XXX	(9)	(14)	9	XXX
29 - 31	X			10	XXXXX
32 - 34	XX			11	XXX
35 - 37	X			12	
38 - 40	X	(2)	(1)	13	X
41 - 43				14	
44 - 45				15	

significantly positive at the 5% level and seven at the 10% level. Figure 1 presents a histogram of I for this and the previous tests. The distribution again seems to be centered below the expected value although not by as much; nor is it as compact as before.

The above evidence is somewhat inconclusive, but it seems to point to the hypothesis that persistent relative strength is a factor in the performance of all securities and not just those experiencing large price changes due to new information.

CHAPTER V

The preceding chapter has presented evidence that stock prices, at least when considered jointly, violate the efficient market hypothesis. Equivalently we can conclude that the series of security prices is not a random walk derived from an underlying "fair game."[16] However, this is not the same as concluding that the securities market is not a fair game in the economic sense (ie. that excess profits can be extracted from the relative strength information). Using the notation from the preceding footnote, this may be written: If $\underline{a}(\emptyset) = (a_1, a_2, \ldots, a_n)$ indicating the fraction of wealth to be invested in each asset is the assumed "extra profit" strategy implied by the relative strength information, $\emptyset$, then $E_t(\sum a_i X_{it} - C_1(\emptyset) - C_2(\underline{a})) \leq 0$, where C_1 is the incremental cost of obtaining the information $\emptyset$, C_2 is the incremental cost of following policy $\underline{a}$, and E_t is the expectation operator as of time t. Certainly if all information were costlessly available and processable and furthermore, all trading schemes had no cost differential, then the two "fair games" would be equivalent assuming only that investors behaved rationally.

The cost of obtaining security prices and processing them to obtain the relative strength rankings as described in the preceding chapters is negligible to institutions and many investors able to operate even on a moderate scale. C_2 has two components. The first is the utility cost associated with the degree of risk of the portfolio suggested by $\underline{a}$. For example, the standard deviation of the market portfolio was .116 over the entire period while those of the basic ten ranged from .129 to .182. We can deal with this cost by using the reward-to-variability ratio, θ, to measure portfolio performance rather than just the average return.[17]

The second component of C_2 is the transactions costs. For my purposes they were taken to be 1% on both sales and purchases.[18] The per-period transactions costs required to maintain a given portfolio then are approximatly:

$$C_j = .02(1 - f_{jj}) \tag{5.1}$$

where f_{jj} is the average fraction of securities to remain in portfolio j for the next period.[19] Since the fraction $1 - f_{jj}$ of portfolio j must be sold and the same fraction then re-invested in the new securities to be held in portfolio j, we must multiply by 2% the round trip transactions costs. The costs of rebalancing the fractional holdings on those securities remaining within a given portfolio were ignored. The costs of re-investing dividends was also neglected, but since this was done for both the individual and market portfolios no bias should have been introduced. The preceding derivation of transactions costs has been somewhat imprecise. Whenever necessary approximations were made to underestimate rather than overestimate the costs; therefore, we should have a lower limit on what these costs actually are.

Table 7 presents the average returns and reward-to-variability measure figured both with and without transactions costs included. The market performed better on a risk adjusted basis than all but portfolio one. In comparing the performance net of transactions costs it was clearly the best.

Obviously a rational investor would not choose to hold any of the ten portfolios singlely preferring instead the naive strategy of buying and

TABLE 6

SECURITY MOBILITY

f_{ij} = fraction of portfolio i transfered to portfolio j

i \ j	1	2	3	4	5	6	7	8	9	10
1	.165	.121	.094	.082	.079	.075	.075	.089	.103	.118
2	.115	.097	.114	.099	.088	.089	.091	.102	.096	.109
3	.093	.096	.114	.116	.100	.105	.092	.098	.104	.083
4	.105	.112	.107	.107	.097	.097	.110	.097	.088	.081
5	.081	.094	.103	.108	.104	.111	.123	.101	.090	.084
6	.079	.101	.099	.114	.105	.124	.106	.096	.107	.069
7	.075	.095	.104	.108	.128	.106	.116	.110	.085	.074
8	.078	.107	.099	.107	.096	.102	.111	.101	.090	.109
9	.098	.087	.089	.094	.110	.096	.102	.094	.111	.118
10	.016	.085	.071	.079	.087	.089	.089	.105	.120	.169

TABLE 7

PORTFOLIO RETURN MEASURES

Portfolio #	$\overline{R}_j$	$\overline{R}_j - C_j$	$\overline{R}_j/s_j$	$(R_j-C_j)/s_j$
1	0.0478	0.0311	0.2819	0.1834
2	0.0199	0.0018	0.1344	0.0122
3	0.0131	-0.0046	0.0971	-0.0338
4	0.0201	0.0022	0.1557	0.0173
5	0.0047	-0.0133	0.0358	-0.1022
6	0.0104	-0.0071	0.0793	-0.0537
7	0.0131	-0.0046	0.0875	-0.0310
8	0.0080	-0.0100	0.0547	-0.0686
9	0.0043	-0.0135	0.0282	-0.0882
10	-0.0028	-0.0194	-0.0154	-0.1069
Market	0.0316		0.2714	

holding the market or any other well diversified portfolio. However, by combining positions in the ten portfolios and the market it may well be possible to use the relative strength information and still achieve a well diversified holding that does outperform the market. Scholes /43/ has devised a method to combine both negative and positive information about securities into a complete portfolio system. As adapted to this problem it would consist of an active portfolio, with long positions in those securities with positive w_{it}'s and short positions in those with negative residuals such that on the average the active portfolio would be almost completely hedged against the market, and a passive portfolio that holds just the market levered by borrowing or lending if desired.

If we denote the return ration, $E(W_{p,t+1})/E(R_{m,t+1})$, by Q_{pt} and the variance ratio, $Var(W_p)/Var(R_m)$, by V_{pt}, then the proper holding of each of our ten basic portfolios in the active portfolio will be:

(5.2) $$X_{pt} = KQ_{pt}/V_{pt}$$

where K is a normalizing constant. The proportion of wealth held in the passive portfolio is:

(5.3) $$X_{mt} = (1 + \sum Q_{pt}/V_{pt})^{-1}$$

Then the proportion of wealth held in each of the basic portfolios is:

(5.4) $$X_{pt} = X_{mt}Q_{pt}/V_{pt}$$

Using hind-sight we can determine a proper set of values for the X's by using:

$$E(W_{p,t+1}) = \overline{W_p} \qquad Var(W_p) = s^2(W_p)$$

(5.5)

$$E(R_{m,t+1}) = \overline{R_m} \qquad Var(R_m) = s^2(R_m)$$

These choices are convenient ones; however, they do not represent a realizable portfolio formation strategy since they depend upon information unavailable at the times that the actual decisions would have had to have been made. Moreover, these estimates will be better (in the sense of being more efficient) than any possible by using only the intermediate data.[20] Consequently, by examining the return on this final portfolio we can set an upper limit on all feasible portfolio returns.

The above strategy realizes on average a gross excess return (ie. $\overline{R-R_f}$ not $\overline{R} - \overline{R_f}$) of 3.51% per six months with a variance of .0132. The reward-to-variability ratio of .3051 is, indeed, larger than that of any of the portfolios previously considered including the market portfolio, a necessary result of our "superior" predictions. To figure the return net of transactions costs an extension of the earlier approximation was used:

$$C = .013\sum f_{ij}|X_i - X_j| \qquad (5.6)$$

Now when a security moves from portfolio i to j, the desired holding changes from X_i to X_j. To achieve the correct holding in the active portfolio a quantity $X_i - X_j$ must be sold (bought) if the quantity is positive (negative). On the average we know that the fraction f_{ij} of portfolio i securities should be moved to portfolio j and that the average transactions costs of doing so will be 1.3%. The reward-to-variability ratio net of transactions costs is .2805 which is still somewhat larger than that of the market.

It is not surprising that by using "forbidden knowledge" superior profits are obtained. The important question is what returns are realizable using only the relative strength information currently available. To answer this question two possible prediction schemes were tested.

The first is similar in form to (5.5) although at each point it uses only historical data:

$$(5.7)\qquad \begin{aligned} E(W_{p,t+1}) &= \overline{W_p}(t) = (\sum W_{pi})/t \\ Var(W_p) &= \frac{1}{t-1}\sum(W_{pi} - \overline{W_p}(t))^2 \\ E(R_{m,t+1}) &= \overline{R_m}(t) = (\sum R_{mi})/t \\ Var(R_m) &= \frac{1}{t-1}\sum(R_{mi} - \overline{R_m}(t))^2 \end{aligned}$$

The second uses the same method (ie. (5.7)) for predicting the market return and variance and employs a regression equation for the portfolio residuals:

$$(5.8)\qquad W_{p,t+1} = \gamma_0 + \gamma_1 w_{pt} + e_t$$

$\gamma_0(t)$ and $\gamma_1(t)$ are estimated for each period using historical data. Then the expected value of the evaluation residuals are predicted using the estimated coefficients and the variation is predicted to be the residual variance:

$$(5.9)\qquad \begin{aligned} E(W_{p,t+1}) &= \hat{W}_{p,t+1} = \gamma_0(t) + \gamma_1(t)w_{pt} \\ Var(W_p) &= s_e^2(t) = \frac{1}{t-2}\sum(W_{p,t+1} - \hat{W}_{p,t+1})^2 \end{aligned}$$

Neither of these two formation policies were able to outperform the market over the period considered. The former had a reward-to-variability ratio of .1500 compared to the market's .2714. The latter acually had an average return net of transactions costs less than the average risk free rate during that period.

CHAPTER VI

The evidence presented indicates that security prices on the New York Stock Exchange cannot be modeled strictly as a random walk. However the violation is apparently not large enough to induce speculators to remove it due to the transactions costs they must incur in doing so. An unanswered question is do floor brokers or other traders with commission costs lower than the public's have this profit oppurtunity. Despite the advantage it is not obvious that they do. An implicit part of transactions costs is the specialist's spread to which even floor traders are subject. Specialists themselves could not take advantage of this scheme since it involves numerous securities and they possess their monopoly on only a few at most. Furthermore the trading schemes tested assumed a costless rebalancing of the portfolios every six months. If this were not done further diversification would probably be required. On the other hand, a basic time period of other than six months or improved prediction methods using the relative strength ranks could increase the profits realizable. These questions can only be answered by further simulation tests.

FOOTNOTES

1. They do consider other variables, most importantly volume; however, all of them like price are currently observable, non-random variables.

2. Performance evaluations of mutual funds can only indirectly be interpreted as tests of the fundamental theory.

3. For these and other early tests of the random walk theory see Cootner /8/.

4. The efficient market hypothesis cannot actually be proved since it would be impossible to test every conceivable technical strategy. However, by testing the strategies actually employed, the current state of the science of technical analysis canbe evaluated.

5. The measure that Levy actually used is the current price divided by the average price during the preceding twenty-six weeks.

6. Restrictions on short sales are allowable since, in this model, all investors will hold the market portfolio and hence all risky securities in positive amounts. In later models we will be forced to assume that there are no restrictions on short sales.

7. See /19/ for a general review.

8. It is the empirical reliability that is critical. If we used a pricing model that gave biased residuals, then as long as this bias persisted we would expect security residuals to show a higher degree of correlation than the residuals from an unbiased pricing model.

9. The data was taken from the CRSP tape as updated at the Sloan School of Management, MIT.

10. In general this ranking proceedure will obviously differ from ranking by R_{it}, the method employed by Levy /25,26,27/.

11.
$$\begin{aligned} u_{pt} &= R_{pt} - \beta_p(R_{mt} - R_{zt}) - R_{zt} \\ &= (1/n)\sum R_{it} - (1/n)\sum \beta_i(R_{mt} - R_{zt}) - R_{zt} \\ &= (1/n)\sum (R_{it} - \beta_i(R_{mt} - R_{zt}) - R_{zt}) \\ &= (1/n)\sum u_{it} \end{aligned}$$

The formation of portfolios serves to make the test more efficient since the estimates of β_p are more efficient than the individual estimates of β_i.

12. It should be noted that the evaluation residuals and the ranking

residuals of the ten basic portfolios are not the same set (ie. $u_{pt} \neq U_{pt}$). The difference is due to the restructuring of the portfolios at time t after U_{pt} but before u_{pt} have been calculated. The same oviously does not apply to the individual security residuals, and u_{it} is used for both sets.

13. A significant correlation with a t-statistic of 2.00 in successive price changes explains about .0036 of the variation in the overnight price change and an even smaller fraction of the change during the next six months. See /11/.

14. Since we are not dealing with final portfolios in which one's entire wealth is to be held, we need only worry about the systematic risk and not about the variability of the portfolios in question; therefore the reward-to-volatility ratio, $\emptyset$, is appropriate.

$$\emptyset = (\overline{R-R_f})/\beta$$

Substituting for $R-R_f$ from the pricing model:

$$\emptyset = (\alpha + \beta(\overline{R_m-R_f}))/\beta$$

$$= \alpha/\beta + (\overline{R_m-R_f})$$

The second term will be the same for all portfolios hence α/β is equivalent to $\emptyset$.

15. $W_{p,t+1}$ denotes the observed evaluation residual. See note 12.

16. The fair game is $X_{jt} = R_{jt} - E(R_{jt}|\emptyset_{t-1})$, where $\emptyset$ is a generic representing all pertinent information as of time t-1. The fair game assumption is that $E(X_{jt}|\emptyset_{t-1}) = 0$. See /11/.

17. A portfolio of fifty securities is usually diversified enough that the non-systematic risk is negligible; hence the reward-to-volatility ration, $\emptyset$, could be used interchangeably with θ. In this case, however, the portfolio constituents were not chosen randomly. Securities with high returns over a period of time were separated from those with lower returns over the same period. This co-movement indicates that the securities within a given portfolio would tend to be positively correlated more than a random selection would be. This will result in less diversification. It may be remembered that I argued before, in footnote 14, for using $\emptyset$; however, the intent now is to consider these ten portfolios as alternate choices as a final portfolio.

18. Demsetz /10/ has found the average transaction cost to be 1.3% on the New York Stock Exchange.

19. The assumptions made in this approximation are: (1) that the

average value of f_{jj} is representative of all periods such that the discounted effects of off-average transactions costs will be immaterial, and (2) that the proportionate value of the traded securities will not have changed markedly from the initial equal proportions over the six month period.

20. This will be strictly true only if the distribution of the residuals is stable over time. An examination of moving averages, not presented here, suggests that this is the case.

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APPENDIX A

PERIOD NUMBER 1

	LAST PERIOD			NEXT PERIOD	
MARKET	1.0246			1.1370	
RZ	1.0873			1.0247	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.45866	1.15237	0.15656	1.23701	1.16329	-0.00037
1.46828	1.03055	0.03535	1.26468	1.15710	-0.00967
1.22970	1.00285	-0.00731	1.13169	1.14565	-0.00619
1.11108	0.97245	-0.04516	0.96504	1.10162	-0.03149
1.14970	0.94480	-0.07039	1.04852	1.08329	-0.05921
1.02188	0.92403	-0.09917	0.94193	1.09869	-0.03183
1.05758	0.89320	-0.12777	1.01880	1.10420	-0.03495
0.97594	0.87579	-0.15030	1.10547	1.09712	-0.05177
0.98380	0.84186	-0.18373	1.09360	1.10655	-0.04100
1.12798	0.75362	-0.26292	1.56752	1.11527	-0.08553

PERIOD NUMBER 2

	LAST PERIOD			NEXT PERIOD	
MARKET	1.1370			1.0545	
RZ	1.0247			1.0288	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.20905	1.36365	0.20313	1.14213	1.00421	-0.05389
0.93206	1.21723	0.08783	1.04668	1.01402	-0.04163
0.94706	1.16755	0.03647	1.10424	1.01126	-0.04587
1.03290	1.14488	0.00414	0.98273	1.02360	-0.03041
0.90173	1.10348	-0.02251	0.90763	1.01488	-0.03720
0.97177	1.08242	-0.05144	1.13247	0.99751	-0.06034
1.06151	1.06344	-0.08050	1.05093	1.02392	-0.03185
1.29260	1.05808	-0.11182	1.13444	1.01002	-0.04789
1.33401	1.02176	-0.15280	1.23806	1.02214	-0.03842
1.68681	0.95360	-0.26059	1.57724	0.99083	-0.07844

PERIOD NUMBER 3

	LAST PERIOD			NEXT PERIOD	
MARKET	1.0545			1.0460	
RZ	1.0288			1.0430	
BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.20469	1.22206	0.16235	1.13391	1.05350	0.00708
0.99047	1.11719	0.06298	1.00319	1.04750	0.00148
0.87455	1.07219	0.02096	0.80083	1.00670	-0.03872
1.02747	1.04315	-0.01200	0.98802	1.04491	-0.00106
1.02894	1.01636	-0.03884	0.90393	1.06154	0.01581
1.13276	0.99576	-0.06210	0.98576	0.99311	-0.05286
1.18906	0.97626	-0.08304	0.94598	1.04318	-0.00266
1.13672	0.94687	-0.11109	1.24354	0.99948	-0.04727
1.32872	0.90610	-0.15679	1.26889	1.00231	-0.04451
1.40298	0.82057	-0.24422	1.38710	0.96829	-0.07888

PERIOD NUMBER 4

	LAST PERIOD			NEXT PERIOD	
MARKET	1.0460			0.9428	
RZ	1.0430			1.0008	
BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.08896	1.23452	0.18824	1.15080	0.97590	0.04180
0.98388	1.12352	0.07756	1.01476	0.98634	0.04436
0.95232	1.08730	0.04144	1.27371	0.99362	0.06665
0.78594	1.05462	0.00926	0.96867	0.98748	0.04283
1.12866	1.02328	-0.02312	1.21155	0.97488	0.04431
0.92261	1.00056	-0.04522	0.99959	0.99589	0.05303
0.96257	0.97747	-0.06843	1.04057	0.95872	0.01824
1.15888	0.95001	-0.09648	1.21107	0.98668	0.05608
1.31777	0.91452	-0.13244	1.24395	0.92178	-0.00691
1.36392	0.85817	-0.188[illegible]4	1.32604	0.91422	-0.00972

PERIOD NUMBER 5

	LAST PERIOD			NEXT PERIOD	
MARKET	0.9428			1.0579	
RZ	1.0008			1.0924	
BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.50416	1.17539	0.26178	0.94330	0.94737	-0.11248
1.42479	1.06357	0.14537	1.04782	0.93917	-0.11707
1.22127	1.02375	0.09374	0.91093	0.91557	-0.14540
1.05708	1.00146	0.06194	0.93391	0.97236	-0.08782
1.19497	0.97469	0.04316	0.93141	0.90615	-0.15412
1.03811	0.95963	0.01900	0.87799	0.92276	-0.13935
1.04272	0.93436	-0.00600	0.95419	0.94088	-0.11860
0.92864	0.90602	-0.04095	0.79512	0.94735	-0.11761
1.07418	0.86493	-0.07361	1.05556	0.92178	-0.13420
0.96053	0.79442	-0.15070	1.31884	0.89290	-0.15400

PERIOD NUMBER 6

	LAST PERIOD			NEXT PERIOD	
MARKET	1.0579			1.2065	
RZ	1.0924			1.0417	
BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.19864	1.15235	0.10131	1.19244	1.24760	0.00940
0.79835	1.06913	0.00428	1.01089	1.14331	-0.06497
0.90818	1.02099	-0.04008	1.02079	1.16221	-0.04770
0.90811	0.97950	-0.08156	1.06108	1.17395	-0.04260
1.04198	0.94496	-0.11149	0.98647	1.14719	-0.05707
0.87405	0.92606	-0.13618	1.16216	1.13564	-0.09757
0.85564	0.89157	-0.17130	1.02206	1.12983	-0.08030
1.00410	0.84500	-0.21276	1.33342	1.18435	-0.07708
1.00531	0.79836	-0.25935	1.49685	1.15087	-0.13749
1.18017	0.68360	-0.36808	1.40186	1.14160	-0.13111

PERIOD NUMBER 7

	LAST PERIOD			NEXT PERIOD	
MARKET	1.2065			1.2392	
RZ	1.0417			1.0132	
BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.08869	1.45927	0.23818	1.16773	1.34834	0.07119
0.93356	1.26927	0.07374	1.09175	1.28284	0.02286
0.90578	1.20824	0.01728	0.85898	1.25362	0.04626
1.03617	1.19561	-0.01684	1.00426	1.28809	0.04789
0.89871	1.13568	-0.05412	0.73727	1.21450	0.03465
0.99654	1.11981	-0.08610	0.81897	1.26439	0.06608
1.28194	1.13465	-0.11829	1.06291	1.31468	0.06122
1.18773	1.07673	-0.16069	0.92131	1.26986	0.04841
1.47099	1.05565	-0.22845	1.04323	1.30080	0.05179
1.87319	0.96478	-0.38559	1.07932	1.37527	0.11810

PERIOD NUMBER 8

	LAST PERIOD			NEXT PERIOD	
MARKET	1.2392			1.1454	
RZ	1.0132			1.0141	
BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.07484	1.71580	0.45966	1.26937	1.16386	-0.01689
0.92523	1.45400	0.23167	1.27412	1.12851	-0.05286
0.84580	1.36274	0.15836	1.07914	1.13451	-0.02126
0.74698	1.28351	0.10146	1.01025	1.09883	-0.04790
0.70784	1.23117	0.05798	1.00663	1.09461	-0.05164
0.81077	1.20957	0.01311	0.98013	1.09913	-0.04364
0.91100	1.19568	-0.02344	1.01464	1.10927	-0.03804
1.05878	1.18557	-0.06695	1.05998	1.06742	-0.08584
1.14802	1.15779	-0.11490	1.22551	1.10509	-0.06990
1.55510	1.12438	-0.24033	1.38287	1.10784	-0.08781

PERIOD NUMBER 9

	LAST PERIOD			NEXT PERIOD	
MARKET	1.1454			1.0718	
RZ	1.0141			1.0040	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.03568	1.41488	0.26482	1.15616	1.06310	-0.01926
0.93419	1.21755	0.08082	0.93286	1.05770	-0.00952
0.98770	1.17775	0.03399	0.89478	1.07985	0.01521
0.88087	1.12554	-0.00420	0.91146	1.09722	0.03145
0.98049	1.10476	-0.03806	0.84793	1.05437	-0.00709
1.08821	1.08371	-0.07325	0.98707	1.05474	-0.01615
1.05312	1.04426	-0.10810	1.00532	1.04543	-0.02670
1.22596	1.02527	-0.14978	1.20722	1.08550	-0.00032
1.49797	1.00872	-0.20204	1.19881	1.02671	-0.05854
1.61553	0.91152	-0.31467	1.27073	1.05954	-0.03058

PERIOD NUMBER 10

	LAST PERIOD			NEXT PERIOD	
MARKET	1.0718			1.0665	
RZ	1.0040			1.0064	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.24424	1.34349	0.25517	0.99123	1.06568	-0.00028
0.92431	1.18145	0.11481	0.84793	1.04984	-0.00751
0.88905	1.12297	0.05872	0.74888	1.04103	-0.01036
0.92177	1.08865	0.02219	0.85999	1.10180	0.04373
0.97672	1.06405	-0.00614	0.84579	1.05206	-0.00515
0.89950	1.03266	-0.03230	0.70959	1.03151	-0.01752
0.89540	1.00195	-0.06273	0.79572	1.07602	0.02182
1.06132	0.97770	-0.09823	0.96341	1.02970	-0.03458
1.13127	0.93840	-0.14227	0.94992	1.03363	-0.02983
1.46677	0.87773	-0.22567	0.98624	0.99116	-0.07450

PERIOD NUMBER 11

	LAST PERIOD			NEXT PERIOD	
MARKET	1.0665			1.0076	
RZ	1.0064			0.9851	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
0.83908	1.36301	0.30620	1.17998	1.13559	0.12390
0.87390	1.17992	0.12102	1.15215	1.09368	0.08261
0.70370	1.11369	0.06501	0.87612	1.02948	0.02463
0.80805	1.07441	0.01947	0.93259	1.07191	0.06579
0.58960	1.03200	-0.00982	0.80934	1.03113	0.02779
0.79623	1.01797	-0.03627	0.89858	1.05849	0.05314
0.94538	0.99401	-0.06919	0.97642	1.07058	0.06347
0.91383	0.95366	-0.10764	1.00865	1.03525	0.02741
1.08144	0.91628	-0.15508	1.21287	1.04845	0.03601
1.14221	0.83306	-0.24196	1.19975	0.98792	-0.02423

PERIOD NUMBER 12

	LAST PERIOD			NEXT PERIOD	
MARKET	1.0076			1.0324	
RZ	0.9851			1.0447	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.27416	1.41088	0.39707	0.91429	1.00960	-0.02386
1.10491	1.20535	0.19535	0.90887	1.00485	-0.02868
0.90112	1.12140	0.11599	0.91148	1.01877	-0.01473
0.99099	1.07866	0.07123	0.81527	0.99588	-0.03880
0.93500	1.04700	0.04082	0.69165	0.99403	-0.04217
0.91062	1.02034	0.01471	0.86053	0.99282	-0.04130
0.87471	0.99113	-0.01369	0.72204	0.97756	-0.05826
0.90086	0.95674	-0.04867	0.81408	0.98513	-0.04957
1.12426	0.91629	-0.09415	0.94092	0.98312	-0.05002
1.23009	0.81971	-0.19311	1.07280	0.99699	-0.03452

PERIOD NUMBER 13

	LAST PERIOD			NEXT PERIOD	
MARKET	1.0324			0.8344	
RZ	1.0447			1.1075	
BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
0.96874	1.30591	0.27312	1.09944	0.73238	-0.07485
0.93671	1.12466	0.09148	1.04854	0.75746	-0.06367
0.76744	1.06078	0.02552	0.84766	0.79670	-0.07930
0.80960	1.02501	-0.00974	0.86795	0.81948	-0.05097
0.84560	0.99344	-0.04087	0.90183	0.77045	-0.09075
0.78850	0.96728	-0.06772	0.89829	0.80905	-0.05312
0.79858	0.94246	-0.09242	0.96171	0.73328	-0.11157
0.80811	0.91490	-0.11987	0.98761	0.74981	-0.08797
0.90579	0.86439	-0.16918	1.11801	0.70839	-0.09377
1.02243	0.76488	-0.26725	1.27724	0.68887	-0.06981

PERIOD NUMBER 14

	LAST PERIOD			NEXT PERIOD	
MARKET	0.8344			1.1584	
RZ	1.1075			1.0690	
BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.44464	0.92680	0.21385	0.81990	1.15027	0.00798
1.14682	0.86435	0.07006	0.90375	1.12539	-0.02439
1.00800	0.84578	0.01357	0.85335	1.13175	-0.01353
1.22896	0.74941	-0.02245	0.97950	1.14618	-0.01038
0.97682	0.77778	-0.06294	0.84403	1.15650	0.01206
0.96776	0.73829	-0.10490	0.80627	1.12574	-0.01533
0.95148	0.70542	-0.14222	0.76176	1.12035	-0.01674
0.83605	0.69915	-0.18002	0.87512	1.10022	-0.04700
0.79317	0.66371	-0.22717	0.66999	1.18544	0.05655
0.66012	0.59908	-0.32813	0.60758	1.26037	0.13706

PERIOD NUMBER 15

	LAST PERIOD		NEXT PERIOD		
MARKET	1.1584			1.2372	
RZ	1.0690			1.0552	
BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
0.66316	1.46661	0.33834	1.03444	1.30236	0.05887
0.68706	1.27798	0.14757	0.93381	1.30151	0.07634
0.63243	1.21520	0.08967	0.78708	1.17997	-0.01849
0.59940	1.16591	0.04333	0.89671	1.16936	-0.04906
0.84798	1.16039	0.01559	0.96356	1.18425	-0.04633
0.71568	1.11777	-0.01520	0.89282	1.21206	-0.00565
0.82922	1.09344	-0.04967	0.90290	1.17375	-0.04580
1.00664	1.06749	-0.09149	1.09685	1.21184	-0.04300
0.99747	1.01581	-0.14235	1.08122	1.18578	-0.06623
1.13767	0.92868	-0.24201	1.17604	1.26629	-0.00297

PERIOD NUMBER 16

	LAST PERIOD		NEXT PERIOD		
MARKET	1.2372			1.0706	
RZ	1.0552			1.0005	
BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
0.95732	1.67589	0.44645	0.96879	1.25419	0.18577
0.92024	1.37899	0.15630	0.96372	1.19093	0.12286
0.87570	1.28863	0.07404	0.86714	1.12446	0.06316
0.80592	1.22304	0.02115	0.79383	1.12985	0.07369
0.81297	1.18711	-0.01606	0.79079	1.11021	0.05427
0.94247	1.16611	-0.06063	0.82020	1.12412	0.06611
0.85934	1.11447	-0.09714	0.82245	1.09799	0.03983
1.03619	1.10063	-0.14317	0.89315	1.06196	-0.00117
1.13083	1.05580	-0.20523	0.94858	1.10083	0.03382
1.42211	1.00210	-0.31194	1.16745	1.07949	-0.00287

PERIOD NUMBER 17

	LAST PERIOD			NEXT PERIOD	
MARKET	1.0706			1.0310	
RZ	1.0005			1.0412	
BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
0.95103	1.54805	0.48087	0.93761	1.02567	-0.00601
0.99120	1.29570	0.22571	1.09436	1.00931	-0.02078
0.87972	1.20676	0.14458	1.00058	0.98931	-0.04172
0.79448	1.15237	0.09616	0.93764	0.96278	-0.04890
0.85871	1.11786	0.05715	0.83878	0.98202	-0.05066
0.89798	1.08570	0.02223	0.89009	0.98471	-0.04745
0.74081	1.04270	-0.00974	0.71275	0.97694	-0.05702
0.84250	1.00484	-0.05473	0.84733	0.97524	-0.05735
0.87773	0.94971	-0.11233	0.91763	0.97534	-0.05654
1.20290	0.87529	-0.20955	1.05775	0.94852	-0.08194

PERIOD NUMBER 18

	LAST PERIOD			NEXT PERIOD	
MARKET	1.0310			0.9483	
RZ	1.0412			1.1017	
BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
0.98235	1.29624	0.26502	1.02615	0.91250	-0.03181
0.97368	1.10443	0.07312	1.08376	0.89545	-0.04003
0.75725	1.04855	0.01504	0.82625	0.90683	-0.06814
0.86724	1.01103	-0.02136	1.01973	0.93167	-0.01362
0.79001	0.98108	-0.05210	0.89041	0.88311	-0.08202
0.94902	0.95228	-0.07928	0.96571	0.85365	-0.09994
0.89955	0.92361	-0.10845	0.86818	0.85940	-0.10914
1.06306	0.89456	-0.13584	1.04234	0.84188	-0.09995
0.98412	0.86151	-0.16969	1.05442	0.85483	-0.08515
0.96770	0.78056	-0.25081	1.03451	0.87175	-0.07128

PERIOD NUMBER 19

	LAST PERIOD			NEXT PERIOD	
MARKET	0.9483			1.0278	
RZ	1.1017			1.1089	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.08188	1.22575	0.28999	0.92753	0.91921	-0.11450
0.99335	1.02519	0.07585	0.83188	0.94651	-0.09495
1.02151	0.95304	0.00802	0.76978	0.91491	-0.13158
0.99546	0.90700	-0.04202	0.92242	0.93606	-0.09806
1.06192	0.85389	-0.08494	1.02652	0.91337	-0.11231
0.86043	0.85757	-0.11216	0.79807	0.93783	-0.10637
0.99138	0.81090	-0.13874	1.03603	0.90656	-0.11835
0.90684	0.79031	-0.17230	0.95714	0.95072	-0.08058
0.99021	0.73479	-0.21503	1.12894	0.94285	-0.07452
0.90902	0.65859	-0.30368	1.06676	0.88882	-0.13360

PERIOD NUMBER 20

	LAST PERIOD			NEXT PERIOD	
MARKET	1.0278			1.1089	
RZ	1.1089			1.0671	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
0.97891	1.19769	0.16815	0.97216	1.17329	0.06557
1.07444	1.05788	0.03608	0.94726	1.09693	-0.00974
0.93612	1.00458	-0.02843	0.90727	1.11206	0.00705
0.85927	0.96830	-0.07094	0.91748	1.15133	0.04589
0.92209	0.92902	-0.10512	0.90769	1.12540	0.02038
0.91219	0.90219	-0.13275	0.94154	1.09748	-0.00896
0.97659	0.86774	-0.16198	0.97721	1.12614	0.01821
1.07095	0.82926	-0.19281	1.20046	1.14604	0.02878
0.87355	0.80205	-0.23603	1.00531	1.12557	0.01647
0.86768	0.70215	-0.33640	1.08059	1.13564	0.02340

PERIOD NUMBER 21

	LAST PERIOD		NEXT PERIOD
MARKET	1.1089		1.0968
RZ	1.0671		1.1377

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.12319	1.52386	0.40984	1.13356	0.97379	-0.11754
0.93826	1.27712	0.17082	0.88864	0.97580	-0.12555
0.90203	1.20814	0.10335	1.03526	0.97529	-0.12006
0.96948	1.15977	0.05217	0.98365	0.94160	-0.15586
0.81454	1.10937	0.00824	0.81675	0.96750	-0.13679
0.91670	1.08212	-0.02328	0.89204	0.96966	-0.13155
0.96638	1.05296	-0.05452	1.01199	0.94680	-0.14951
1.03922	1.01911	-0.09141	1.04796	0.91295	-0.18188
1.10888	0.98076	-0.13266	1.12998	0.92403	-0.16744
1.07748	0.88330	-0.22882	1.02796	0.93606	-0.15959

PERIOD NUMBER 22

	LAST PERIOD		NEXT PERIOD
MARKET	1.0968		0.7613
RZ	1.1377		0.9404

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
0.98725	1.22765	0.13034	1.08694	0.80179	0.05601
0.89346	1.09564	-0.00551	1.09840	0.82141	0.07768
0.99410	1.03716	-0.05987	0.97757	0.83068	0.06531
1.04112	0.99402	-0.10108	1.00786	0.84591	0.08597
0.87032	0.96398	-0.13811	0.99082	0.82497	0.06198
0.94592	0.93093	-0.16807	1.15156	0.83845	0.10424
0.93799	0.89827	-0.20106	0.93576	0.88244	0.10959
1.11745	0.84965	-0.24234	1.12643	0.83493	0.09622
1.13186	0.80404	-0.28736	1.27689	0.82007	0.10830
1.04825	0.72641	-0.36841	1.50105	0.77536	0.10372

PERIOD NUMBER 23

	LAST PERIOD			NEXT PERIOD	
MARKET	0.7613			1.1049	
RZ	0.9404			1.0539	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.71073	0.97710	0.34301	1.32222	1.10998	-0.01141
1.22271	0.95721	0.23574	1.05620	1.09062	-0.01719
1.31252	0.89147	0.18608	0.99155	1.06273	-0.04179
1.22553	0.87070	0.14974	1.16115	1.05390	-0.05927
1.16334	0.83903	0.10694	1.06481	1.02335	-0.08491
1.03015	0.82440	0.06845	1.03065	1.07236	-0.03414
1.06178	0.77619	0.02590	0.98756	1.09663	-0.00768
0.86013	0.77053	-0.01586	0.90100	1.08200	-0.01789
0.78714	0.73265	-0.06681	0.73419	1.07437	-0.01701
0.78693	0.64123	-0.15827	C 84818	1.01791	-0.07928

PERIOD NUMBER 24

	LAST PERIOD			NEXT PERIOD	
MARKET	1.1049			1.0999	
RZ	1.0539			1.0315	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
0.93961	1.36896	0.26710	1.13076	1.18069	0.07188
0.88107	1.20200	0.10313	0.94711	1.08842	-0.00783
0.95197	1.15333	0.05084	0.96168	1.11057	0.01332
0.92576	1.10839	0.00724	1.05609	1.11752	0.01382
1.00927	1.07647	-0.02895	1.00615	1.16420	0.06392
0.86526	1.03738	-0.06068	1.05935	1.09475	-0.00917
1.02215	1.01153	-0.09455	0.96789	1.11207	0.01440
1.30672	0.98510	-0.13550	1.29624	1.10578	-0.01434
1.08159	0.92172	-0.18739	1.15654	1.12226	0.01169
1.11281	0.82366	-0.28705	1.12813	1.10062	-0.00801

PERIOD NUMBER 25

	LAST PERIOD			NEXT PERIOD	
MARKET	1.0999			1.0655	
RZ	1.0315			0.9812	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.11296	1.46241	0.35482	1.27495	1.17265	0.08394
0.99893	1.26770	0.16792	1.15425	1.09810	0.01957
0.98473	1.19408	0.09526	0.96761	1.05957	-0.00322
0.80940	1.13278	0.04595	1.06806	1.05968	-0.01158
1.07216	1.11243	0.00763	1.10651	1.11471	0.04020
1.11193	1.08649	-0.02103	1.17438	1.06141	-0.01882
1.04509	1.05298	-0.04997	0.98826	1.06928	0.00475
1.00587	1.01605	-0.08421	1.07224	1.05971	-0.01190
1.23421	0.98950	-0.12638	1.13486	1.10800	0.03111
1.33389	0.88782	-0.23487	1.32324	1.02960	-0.06317

PERIOD NUMBER 26

	LAST PERIOD			NEXT PERIOD	
MARKET	1.0655			1.0284	
RZ	0.9812			1.0016	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.19682	1.41048	0.32837	1.29486	1.17313	0.13684
1.08840	1.20761	0.13464	1.15661	1.12461	0.09202
1.01007	1.14722	0.08085	1.03312	1.10731	0.07804
0.95035	1.10352	0.04219	1.04691	1.11779	0.08815
0.95049	1.07598	0.01464	1.00969	1.12269	0.09405
0.99574	1.05161	-0.01355	1.09585	1.11989	0.08893
0.94729	1.01418	-0.04690	1.06840	1.16032	0.13010
1.12762	0.99162	-0.08466	1.08606	1.11497	0.08428
1.33606	0.95299	-0.14087	1.27349	1.11790	0.08219
1.65786	0.88083	-0.24016	1.33327	1.11545	0.07814

PERIOD NUMBER 27

	LAST PERIOD			NEXT PERIOD	
MARKET	1.0284			1.0236	
RZ	1.0016			1.0532	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.31548	1.50948	0.47265	1.38138	1.00745	-0.00491
1.05202	1.26877	0.23899	1.02594	0.97601	-0.04686
1.10570	1.21422	0.18301	1.09647	1.01967	-0.00112
1.03727	1.15868	0.12929	1.06805	1.01870	-0.00293
1.19599	1.12558	0.09195	1.16658	0.97703	-0.04168
1.06984	1.09116	0.06091	1.13420	1.03123	0.01157
1.01932	1.05762	0.02872	0.96575	1.02764	0.00299
1.03661	1.01863	-0.01074	0.97117	1.02029	-0.00420
1.18008	0.97119	-0.06202	1.13334	1.05988	0.04018
1.38608	0.86523	-0.17349	1.15351	1.02141	0.00231

PERIOD NUMBER 28

	LAST PERIOD			NEXT PERIOD	
MARKET	1.0236			0.9974	
RZ	1.0532			0.9718	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.16597	1.31216	0.29344	1.27907	1.07868	0.07410
1.12941	1.14863	0.12882	1.07332	1.05625	0.05695
0.95578	1.08710	0.06216	1.01493	1.06572	0.06792
1.07851	1.04214	0.02083	1.18118	1.07823	0.07617
1.05111	1.01632	-0.00580	1.12100	1.07345	0.07292
1.09657	0.99288	-0.02790	1.10828	1.06680	0.06660
1.11807	0.96210	-0.05804	1.10538	1.05240	0.05228
1.05385	0.92496	-0.09708	1.18205	1.10226	0.10017
1.15386	0.87971	-0.13938	1.19184	1.05220	0.04986
1.28708	0.79880	-0.21635	1.35700	1.04884	0.04227

PERIOD NUMBER 29

	LAST PERIOD			NEXT PERIOD	
MARKET	0.9974			1.1220	
RZ	0.9718			0.9210	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.46045	1.34342	0.33420	1.29747	1.45713	0.27536
1.08682	1.17469	0.17505	1.12455	1.35816	0.21115
1.18207	1.12808	0.12599	1.19567	1.40811	0.24681
1.10654	1.09101	0.09086	1.09445	1.27192	0.13096
1.10198	1.06190	0.06186	0.92824	1.28326	0.17570
1.07993	1.03818	0.03871	1.02489	1.26536	0.13838
1.13266	1.01839	0.01757	1.14698	1.34369	0.19217
1.02650	0.98910	-0.00900	1.02878	1.28001	0.15225
1.05298	0.95643	-0.04235	1.18666	1.31128	0.15178
1.38453	0.87764	-0.12963	1.35536	1.33204	0.13864

PERIOD NUMBER 30

	LAST PERIOD			NEXT PERIOD	
MARKET	1.1220			0.9331	
RZ	0.9210			0.9017	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.02267	1.90554	0.77901	1.53002	1.20171	0.25191
1.27052	1.55107	0.37473	1.41081	1.13073	0.18468
1.04285	1.41687	0.28628	1.26126	1.06198	0.12063
1.03518	1.35223	0.22318	1.14655	1.12306	0.18532
0.97033	1.27716	0.16115	1.11892	1.06232	0.12545
1.18129	1.27633	0.11792	1.16352	1.03225	0.09397
0.90742	1.17504	0.07167	1.03816	1.05221	0.11788
1.16765	1.17520	0.01953	1.16549	1.02437	0.08603
1.15560	1.10370	-0.04955	0.99921	1.01703	0.08392
1.63002	1.08482	-0.16378	1.18685	1.01743	0.07842

PERIOD NUMBER 31

	LAST PERIOD			NEXT PERIOD	
MARKET	0.9331			0.9600	
RZ	0.9017			1.0039	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.43150	1.45451	0.50781	1.33304	0.92360	-0.02181
1.26887	1.21668	0.27509	1.14546	0.90155	-0.05209
1.16658	1.15637	0.21800	1.17654	0.90987	-0.04241
1.17694	1.10434	0.16564	0.99403	0.94620	-0.01408
1.13079	1.05116	0.11391	1.00999	0.94060	-0.01898
0.99583	1.01235	0.07934	0.89495	0.98806	0.02345
0.96007	0.98345	0.05157	1.06554	0.95680	-0.00034
1.17782	0.95866	0.01993	1.08497	0.94697	-0.00932
1.25122	0.92386	-0.01717	1.24946	0.92877	-0.02030
1.45653	0.86669	-0.08080	1.33191	0.87517	-0.07028

PERIOD NUMBER 32

	LAST PERIOD			NEXT PERIOD	
MARKET	0.9600			1.1485	
RZ	1.0039			0.9968	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.34010	1.20225	0.25716	1.30978	1.32486	0.12941
1.12194	1.08348	0.12881	1.06542	1.16317	0.00477
1.02748	1.02084	0.06203	1.09198	1.15697	-0.00545
1.06451	0.97635	0.01916	1.06296	1.22902	0.07100
1.06641	0.94014	-0.01696	1.22663	1.21408	0.03124
1.18157	0.90242	-0.04963	1.26558	1.33347	0.14472
1.06838	0.88066	-0.07635	1.11865	1.40267	0.23620
1.08691	0.84437	-0.11184	1.36747	1.40604	0.20183
1.12678	0.79402	-0.16043	1.47373	1.31332	0.09300
1.20298	0.67813	-0.27298	1.65469	1.45087	0.20310

PERIOD NUMBER 33

	LAST PERIOD			NEXT PERIOD	
MARKET	1.1485			1.0941	
RZ	0.9968			0.9918	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.46693	2.07788	0.85860	1.10461	1.24404	0.13920
1.42283	1.53470	0.32210	1.11487	1.17068	0.06479
1.25918	1.39792	0.21015	1.12420	1.11635	0.00951
1.04788	1.28598	0.13025	1.90447	1.18821	0.10386
1.13995	1.24185	0.07215	0.97050	1.11901	0.02790
1.12650	1.19362	0.02597	1.01044	1.11350	0.01830
1.07702	1.13741	-0.02274	0.89738	1.10745	0.02382
1.20337	1.11158	-0.06773	1.05504	1.12386	0.02409
1.24739	1.06203	-0.12396	0.98860	1.10079	0.00783
1.64720	0.96595	-0.28068	1.48202	1.07362	-0.06984

PERIOD NUMBER 34

	LAST PERIOD			NEXT PERIOD	
MARKET	1.0941			1.0564	
RZ	0.9918			1.0507	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.10117	1.65942	0.55495	1.55011	1.08669	0.02723
0.89048	1.32562	0.24270	1.36898	1.08136	0.02292
0.97692	1.23986	0.14810	1.24887	1.06506	0.00730
0.73977	1.14456	0.07706	1.03702	1.08042	0.02386
0.95355	1.11104	0.02167	1.07299	1.05525	-0.00151
0.89681	1.05702	-0.02655	1.12291	1.06838	0.01134
1.05061	1.03209	-0.06722	0.97051	1.02123	-0.03495
1.05121	0.99216	-0.10721	1.25068	1.07456	0.01679
1.21524	0.94832	-0.16784	1.29382	1.05557	-0.00245
1.77060	0.85447	-0.31852	1.77893	1.00789	-0.05287

PERIOD NUMBER 35

	LAST PERIOD			NEXT PERIOD	
MARKET	1.0564			1.0690	
RZ	1.0507			1.0383	
BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.43131	1.45686	0.39808	1.22556	1.07949	0.00355
1.26178	1.22667	0.16884	1.02408	1.11943	0.04968
1.30367	1.15763	0.09957	1.11786	1.13505	0.06242
1.25281	1.09571	0.03793	1.05816	1.07602	0.00522
1.04564	1.05595	-0.00065	0.99702	1.07084	0.00192
1.11889	1.01728	-0.03975	1.07152	1.07905	0.00784
1.09504	0.98054	-0.07635	1.03352	1.08239	0.01236
1.12002	0.94296	-0.11407	0.97784	1.09494	0.02662
1.39472	0.88982	-0.16876	1.09818	1.10553	0.03351
1.66620	0.77830	-0.28181	1.48032	1.06994	-0.01382

PERIOD NUMBER 36

	LAST PERIOD			NEXT PERIOD	
MARKET	1.0690			0.9293	
RZ	1.0383			1.0187	
BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.11983	1.50537	0.43269	1.28010	0.82824	-0.07606
1.02430	1.24347	0.17372	1.14524	0.82073	-0.09562
1.11905	1.16832	0.09566	1.12796	0.87652	-0.04138
0.97559	1.11788	0.04963	1.00515	0.88102	-0.04785
0.87106	1.07763	0.01258	0.98435	0.87276	-0.05797
0.84768	1.04581	-0.01852	1.02416	0.89119	-0.03599
1.17674	1.01795	-0.05648	1.20782	0.84634	-0.06443
1.18899	0.98106	-0.09375	1.22033	0.84966	-0.05998
1.31325	0.92755	-0.15108	1.48083	0.86777	-0.01860
1.44698	0.83304	-0.24969	1.63993	0.80357	-0.06858

PERIOD NUMBER 37

	LAST PERIOD			NEXT PERIOD	
MARKET	0.9293			0.9506	
RZ	1.0187			0.9858	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.66359	1.14158	0.27155	1.19519	1.00443	0.06074
1.31809	0.99486	0.09395	1.12146	0.93618	-0.01010
1.15461	0.93981	0.02429	1.10651	0.97301	0.02620
1.02846	0.90322	-0.02357	1.07508	0.96955	0.02163
1.03645	0.86501	-0.06107	0.90356	0.93591	-0.01805
1.07525	0.83135	-0.09126	0.94856	0.91620	-0.03618
1.23393	0.78791	-0.12052	1.07621	0.91046	-0.03741
1.26416	0.75540	-0.15033	1.11845	0.89666	-0.04973
1.27883	0.70407	-0.20035	1.09524	0.88159	-0.06561
1.07328	0.61919	-0.30359	1.29039	0.89225	-0.04808

PERIOD NUMBER 38

	LAST PERIOD			NEXT PERIOD	
MARKET	0.9506			0.7732	
RZ	0.9858			1.0934	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
1.18977	1.27997	0.33610	1.34490	0.71164	0.04890
1.19717	1.11603	0.17242	1.15479	0.69314	-0.03047
1.12050	1.03071	0.08439	1.18538	0.71050	-0.00331
1.15772	0.97069	0.02568	1.15573	0.69373	-0.02958
0.95103	0.93296	-0.01932	1.25683	0.71755	0.02662
1.04913	0.88652	-0.06231	1.08589	0.73086	-0.01481
0.94738	0.86098	-0.09144	1.17069	0.71362	-0.00489
1.00077	0.82154	-0.12899	1.20686	0.71898	0.01204
1.10830	0.76529	-0.18146	1.39270	0.65586	0.00843
1.21150	0.65745	-0.28566	1.56024	0.61641	0.02264

PERIOD NUMBER 39

	LAST PERIOD			NEXT PERIOD	
MARKET	0.7732			1.2668	
RZ	1.0934			1.0601	

BETA	RETURN	RESIDUAL	BETA	RETURN	RESIDUAL
2.34397	0.75323	0.41043	1.46324	1.14736	-0.21517
1.57863	0.77945	0.19157	1.24971	1.23229	-0.08611
1.40061	0.75063	0.10574	1.10586	1.21215	-0.07651
1.20839	0.75701	0.05057	1.04251	1.15680	-0.11877
1.19996	0.70705	-0.00209	1.11070	1.18060	-0.10907
1.04628	0.71590	-0.04245	1.00190	1.23768	-0.02950
1.12546	0.65574	-0.07725	1.04731	1.23018	-0.04638
0.98719	0.66089	-0.11639	1.11398	1.21906	-0.07128
0.81731	0.65551	-0.17616	0.98604	1.24226	-0.02164
0.82141	0.52859	-0.30177	1.12162	1.31790	0.02598

APPENDIX B

TABLE B-2a

PERIOD BY PERIOD CORRECTED EVALUATION RESIDUALS RANKINGS

Per. No.	Portfolio Number: 1	2	3	4	5	6	7	8	9	10
1	1	3	2	4	10	5	6	8	7	9
2	8	4	6	2	5	10	1	7	3	9
3	2	3	8	4	1	9	5	7	6	10
4	7	5	2	4	6	1	8	3	9	10
5	4	2	9	1	10	8	5	7	6	3
6	1	6	3	2	5	8	7	4	9	10
7	3	10	5	8	9	2	4	6	7	1
8	1	4	2	6	7	5	3	10	8	9
9	7	5	2	1	4	6	9	3	10	8
10	3	5	6	1	4	7	2	9	8	10
11	1	2	8	3	6	5	4	9	7	10
12	2	3	1	5	9	6	10	8	7	4
13	5	4	8	2	9	3	10	7	6	1
14	4	9	6	5	3	7	8	10	2	1
15	2	1	5	9	7	4	8	6	10	3
16	1	2	5	3	6	4	7	9	8	10
17	1	2	3	4	6	5	10	8	7	9
18	2	3	6	1	7	9	10	8	5	4
19	7	5	10	3	4	9	6	2	1	8
20	1	10	8	2	4	9	6	3	7	5
21	1	3	2	8	9	4	5	10	6	7
22	10	6	8	4	9	2	1	3	5	7
23	2	3	7	8	9	6	1	4	5	10
24	1	8	4	5	2	9	3	10	6	7
25	1	4	6	7	2	9	5	8	3	10
26	2	6	8	4	3	5	1	7	9	10
27	7	10	5	6	9	2	3	8	1	4
28	6	7	2	4	3	5	8	1	9	10
29	1	4	2	9	3	7	5	6	8	10
30	1	3	6	2	5	8	4	9	7	10
31	6	9	8	4	7	1	2	3	5	10
32	5	9	10	6	8	4	1	2	7	3
33	1	3	8	2	4	7	5	6	9	10
34	2	3	6	1	7	5	10	4	8	9
35	8	2	1	7	9	6	5	4	3	10
36	9	10	3	5	8	2	7	6	1	4
37	1	4	2	3	5	8	6	9	10	7
38	1	10	6	9	2	8	7	4	5	3
39	10	6.	7	9	8	3	4	5	2	1

TABLE B-2b

SUMMARY OF CORRECTED EVALUATION RESIDUALS RANKINGS

	Portfolio Number:									
	1	2	3	4	5	6	7	8	9	10
Times 1st	15	1	2	5	1	2	5	1	3	4
2nd	7	5	8	6	3	4	2	2	2	0
3rd	2	9	3	4	4	2	3	5	3	4
4th	2	6	1	8	5	4	4	5	0	4
5th	2	4	4	4	4	7	7	1	5	1
6th	2	4	8	3	4	4	4	5	5	0
7th	4	1	2	2	5	4	4	5	8	4
8th	2	1	8	3	3	5	4	6	5	2
9th	1	3	1	4	8	6	1	5	5	5
10th	2	5	2	0	2	1	5	4	3	15
1st half	28	25	18	27	17	19	21	14	13	13
2nd half	11	14	21	12	22	20	18	25	26	26
Mean	3.64	5.10	4.81	4.44	5.99	5.66	5.44	6.23	6.26	7.07

TABLE B-3

PERIOD BY PERIOD CONCORDANCE FOR CORRECTED EVALUATION RESIDUALS

PERIOD	I (Permutations)	T (Kendall's Tau)	SIGNIFICANCE
1	7	0.6889	++
2	22	0.0222	
3	12	0.4667	
4	16	0.2889	
5	23	-0.0222	
6	9	0.6000	+
7	27	-0.2000	
8	9	0.6000	+
9	16	0.2889	
10	11	0.5111	+
11	9	0.6000	+
12	14	0.3778	
13	24	-0.0667	
14	26	-0.1556	
15	16	0.2889	
16	4	0.8222	++
17	5	0.7778	++
18	16	0.2889	
19	28	-0.2444	
20	22	0.0222	
21	11	0.5111	+
22	29	-0.2889	
23	17	0.2444	
24	15	0.3333	
25	13	0.4222	
26	14	0.3778	
27	31	-0.3778	
28	16	0.2889	
29	9	0.6000	++
30	8	0.6444	++
31	25	-0.1111	
32	31	-0.3778	
33	8	0.6444	++
34	11	0.5111	+
35	22	0.0222	
36	32	-0.4222	
37	6	0.7333	++
38	27	-0.2000	
39	37	-0.6444	--

++,-- significant at 1% level
+,- significant at 5% level

TABLE B-4

TWO-WAY ANALYSIS OF VARIANCE ON CORRECTED EVALUATION RESIDUALS

Source of Variation	D.F.	Sum Sq.	Mean Sq.	F-Stat
Between periods	38	1.60472	0.04223	40.45
Between portfolios	9	0.03763	0.00418	4.01
Deviations	342	0.35705	0.00104	
Total	389	1.99940		

TABLE B-5

RESULTS OF THE SIGN TEST ON THE CORRECTED EVALUATION RESIDUALS

Fraction of the time that portfolio i outperformed portfolio j.

Portfolio j	Portfolio i: 1	2	3	4	5	6	7	8	9
2	.744"								
3	.744"	.513							
4	.590	.354	.487						
5	.744"	.539	.616	.744"					
6	.693'	.642	.539	.616	.462				
7	.693'	.590	.513	.565	.539	.462			
8	.719"	.642	.616	.667'	.462	.565	.616		
9	.770"	.642	.539	.693'	.539	.590	.667'	.436	
10	.770"	.744"	.667'	.719"	.642	.616	.642	.616	.667'

" significant at 1% level
' significant at 5% level