RELATIVE STRENGTH AS A CRITERION FOR INVESTMENT SELECTION

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I. INTRODUCTION

AN EXTENSIVE BODY of literature has recently emanated from scholarly sources stating that successive stock market price changes are statistically independent (i.e., that the study of past price trends and patterns—known in the trade as technical analysis—is no more useful in predicting future price movements than throwing a dart at the list of stocks in a daily newspaper). Most of the empirical tests to date of this random walk theory have employed some variation of serial correlation or runs analysis. The results have been both consistent and impressive. As stated by Eugene F. Fama:

> I know of no study in which standard statistical tools have produced evidence of *important* dependence in series of successive price changes. In general, these studies (and there are many of them) have tended to uphold the theory of random walks.[1]

There is, however, at least one important technique of technical analysis which has not been extensively tested—correction for the "co-movement" of stock prices. Benjamin F. King, Jr., in his unpublished Ph.D. dissertation, concluded that a large part of the movement of the price of a stock can be viewed as co-movement, not independent of what happens to the prices of other stocks.[2] King's conclusion was supported in a statement by John M. Birmingham, Jr.

> One . . . analysis, as yet only privately circulated, does indicate that the portfolio planning students are on the right track when they talk about intercorrelation of stock prices. It strongly suggests that the majority of individual stock price changes are controlled by more dominant "general market" and industry tendencies. In other words, successive changes in GM may be independent of previous changes for GM stock, but they are not independent of simultaneous changes in all other stocks or, in particular, other auto stocks.[3]

The intercorrelation or co-movement of stock prices could conceal existing dependencies in successive price changes. Perhaps an overly-simplified example will illustrate this phenomenon more clearly. The following table sets forth the prices of Stocks A and B at the beginning of four consecutive time periods.

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1. Eugene F. Fama, "Random Walks in Stock Market Prices," *Financial Analysts Journal,* XXI, No. 5 (September-October, 1965), 57.

2. Benjamin F. King, Jr., "The Latent Statistical Structure of Security Price Changes" (unpublished Ph.D. dissertation, University of Chicago, 1964). Cited by Lawrence Fisher, "Outcomes for 'Random' Investments in Common Stocks Listed on the New York Stock Exchange," *Journal of Business,* XXXVIII, No. 2 (April, 1965), 159.

3. John M. Birmingham, Jr., "Random and Rational: Stock Price Behavior and Investment Returns," *Financial Analysts Journal,* XXI, No. 5 (September-October, 1965), 53.

Stock	Price at Beginning of Time Period			
	1	2	3	4
A	$10.00	$12.00	$10.00	$11.00
B	10.00	15.00	14.00	18.00

A serial correlation study might attempt to measure the relationship between successive first differences for each stock.

Stock	Successive First Differences by Time Period		
	1-2	2-3	3-4
A	+$2.00	−$2.00	+$1.00
B	+ 5.00	− 1.00	+ 4.00

The limited data above certainly offer no preliminary indication that any significant degree of correlation exists between successive price changes.

Notice, however, that Stock B was relatively stronger than Stock A in all three periods. This fact might be revealed by computing the period-by-period percentage change in each stock's price and then ranking these percentage changes, assigning a rank of 1 to the stock with the greatest percentage appreciation (or least percentage depreciation) and a rank of 2 to the stock with the opposite characteristics. The outcome of this process is reported below.

Stock	Percentage Change in Price by Time Period		
	1-2	2-3	3-4
A	+20.0%	−16.7%	+10.0%
B	+50.0	− 6.7	+28.3

Stock	Performance Ranks by Time Period		
	1-2	2-3	3-4
A	2	2	2
B	1	1	1

Significantly, a serial correlation study of performance ranks offers far more promise of indicating a close relationship over time than would the same study using successive first differences.

By using ranks which measure *relative* strength, the co-movement of stocks is filtered out. This technique for eliminating the effects of the "general market" will be used for the empirical tests in this study.

II. Construction of the Data File

Raw Data. The raw data for the tests which follow were the weekly closing prices of 200 stocks listed on the New York Stock Exchange for the 260-week period beginning on Monday, October 24, 1960 and ending on Friday, October

15, 1965.[4] The time period chosen was the most recent and lengthy period for which data were economically available in a form usable on the IBM 7090 and 7094 computers. The stocks were chosen according to the following criteria: (1) as previously mentioned, they had to have been listed on the New York Stock Exchange for the entire test period; (2) they must have been listed in the May 1965 edition of *Moody's Handbook of Widely Held Common Stocks;*[5] and (3) they must have been included as component stocks in Standard and Poor's Industry Stock Price Indexes as published in the 1964 *Security Price Index Record.*[6] In an effort to assure a representative sampling of the market, the stocks meeting the above three criteria were divided into industry groups, as determined by Standard and Poor's Industry Stock Price Indexes. The final selection of 200 stocks was then made in such a manner that the relative distribution of stocks by industry was approximately the same as in the Standard and Poor Industry Stock Price Indexes. (Although the sampling procedure was *ex post,* the author considers it unlikely that the test results have been materially biased.)

Price Ratios. All price series were adjusted for splits, stock dividends, and for the reinvestment of both cash dividends and proceeds received from the sale of rights.[7] It was then possible to compute various price relationships. Beginning with the 27th week (in order to allow for the compilation of 26 week's historical data), the following price ratios were computed weekly for each stock.

Ratio Designation	Description
C/A26	The price for the current week divided by the average of the series of prices ending with the price for the current week and including the prices for the 26 weeks immediately preceding. (Computed for weeks 27 through 260.)
4/C	The price for the current week divided into the price 4 weeks subsequent to the current week. (Computed for weeks 27 through 256 only.)
26/C	The price for the current week divided into the price 26 weeks subsequent to the current week. (Computed for weeks 27 through 234 only.)

4. Price data were supplied by Arnold E. Amstutz, Assistant Professor of Management at the Massachusetts Institute of Technology, and were checked extensively against the following sources: "Statistical Section," *Barron's,* October 1961 (Vol. XL, Nos. 44 through 52, and Vol. XLI, No. 1); *ISL Daily Stock Price Index: New York Stock Exchange* (Palo Alto, California: Investment Statistics Laboratory, Inc., 1961 annual edition and quarterly editions from 1962 through 3rd quarter 1965); "New York Stock Exchange Transactions," *The Wall Street Journal,* October 4, 11 and 18, 1965.

5. *Moody's Handbook of Widely Held Common Stocks* (New York: Moody's Investors Service, Inc., May 1965).

6. *Security Price Index Record* (New York: Standard and Poor's Corp., Inc., 1964). Of the 200 stocks, four were not included in the Industry Stock Price Indexes at the beginning of the test period.

7. Information on splits, stock dividends, cash dividends and rights offerings were obtained from the following sources: *ISL Daily Stock Price Index, op. cit.,* 1961 annual edition and quarterly editions from 1962 through 3rd quarter 1965; *Moody's Handbook, op. cit.,* quarterly editions, 4th quarter 1960 through third quarter 1965; *Stock Guide* (New York: Standard and Poor's Corp., Inc., monthly editions, October 1960 through November 1965). The adjustment for reinvestment of cash dividends and proceeds received from the sale of rights ignored income taxes and brokerage fees.

One of the above ratios (C/A26) is "historical" (i.e., it is based upon data originating prior to and including C) and so may be used for purposes of investment selection. The remaining two ratios, 4/C and 26/C, are "future" (i.e., they are based upon data originating subsequent to and including C), and so may be used for purposes of measuring the results of investment selection.

The specific time periods covered by the ratios were chosen because of their familiarity (i.e., approximately one month and one-half year), and in the case of 26/C, because of the possibility that there might be some measurable effect evolving from the six-month long-term capital gains provision of the Federal income tax law.

Moving averages were used for computation of the historical ratio because of their tendency to smooth over temporarily-exaggerated price movements, and because of their popularity with market practitioners. Moving averages were not used, however, for the future ratios since the future ratios are intended for the measurement of investment performance rather than for investment selection. Performance measures must be convertible into dollars and cents, and should express the relationship between cost of a given security and proceeds which would have been received upon sale of that security.

Relative Strength Ranks. As explained above, three price ratios were computed, as permitted by available data, for each of 200 stocks for each of 234 weeks (from week number 27 through week number 260). Next, on a week-by-week basis, each set of ratios was ranked by stock. The highest ratio was given a rank of 000 and the lowest a rank of 199. The following illustration, dealing with three stocks for one week, should facilitate an understanding of the ranking process. Price ratios for three stocks at week number 27 could have appeared as below.

Week No.	Stock Number	Price Ratios		
		C/A26	4/C	26/C
027	001	1.306	0.906	1.101
027	002	1.212	0.990	0.802
027	003	1.269	1.023	0.918

Assuming that only three stocks were included in the study, the ranking process would have produced the following additional information:

Week No.	Stock Number	Relative Strength Ranks		
		C/A26	4/C	26/C
027	001	000	002	000
027	002	002	001	002
027	003	001	000	001

This same ranking process would have been extended to weeks number 28, 29, 30, etc. (each set of ratios for each week being ranked separately). Of course, 200 stocks were actually included in the study rather than only three, so that the ranks were inclusive over the range 000-199.

Volatility Ranks. Several of the tests which follow make reference to the comparative volatility of the price movements of the individual securities. A measure of volatility known as the coefficient of variation was utilized in this study. The coefficient of variation is the ratio of the standard deviation of a set of numbers to the arithmetic mean of the set. For purposes of price volatility measurement, the relevant "set of numbers" was taken to be the 27 consecutive weekly prices ending with C for any given security.

For each week separately beginning with week number 27, and for each of the 200 stocks, the coefficient of variation for the 27 latest weekly closing prices was determined. On a week-by-week basis, these coefficients were then ranked by stock from 000 to 199, with the highest ratio receiving the lowest rank (a ranking process identical to that used for the price ratios).

Market Ranks. In order to test certain techniques of market timing, long-term (i.e., 26-week) historical market ranks were included in the data file. The computation of these market ranks was relatively simple. The 200 stocks in total were considered to be representative of the entire market. Each week, the sum of the 200 C/A26 ratios was determined in order to indicate the market's performance over the preceding six months. There were 234 C/A26 sums computed (one for every week from week number 27 through week number 260). The long-term market ranks were then arrived at by ranking the C/A26 sums (i.e., the performance of the sample over 234 holding periods) from 001 through 234.

It may be correctly contended that the process described above resulted in the use of hindsight. For example, the rank for week number 27 was only determinable after the results for week number 260 were known. While this is true, it is considered unlikely that the dispersion of six-month market results would be significantly different over say one 234-week period of time as opposed to any other. In other words, the market ranks would probably be about the same no matter whether hindsight were used or whether some time period prior to the period of this study were adopted as a standard of dispersion of six-month market performance. Of course, the use of hindsight solved the critical problem of data availability.

Divergence Ranks. Whereas the market ranks described above measure the historical strength or weakness of the market as a whole, they do not permit a determination of the extent of "speculative excesses" prevalent in the market at any given point in time. To accomplish this purpose, additional market measures, to be called divergence ranks, were computed for each week of the test period.

A possible indicator of speculative excesses, employed by many practitioners, is the comparison of the price movements of the strongest and weakest stocks against the price movements of all stocks in total. The two divergence ranks (long-term strong divergence and long-term weak divergence) were designed respectively to detect exaggerated market conditions by measuring the difference between the performance of the strongest, or weakest, stocks and the performance of the average stock, over 26-week historical time periods.

To illustrate, the computation of the long-term strong divergence rank was

as follows: Each week, the average of the C/A26 ratios for the 20 strongest securities was compared to the average of the C/A26 ratios for all 200 securities. The absolute difference (divergence) between the two averages, week by week, was determined. These differences were then ranked, by week, from 001 through 234 with the largest difference receiving the lowest rank. Thus, a long-term strong divergence rank of 001 would indicate a wide divergence between the historical 26-week average price movements of the 20 strongest stocks and the historical 26-week average price movements of all 200 stocks. A rank of 234 would, of course, indicate just the opposite (i.e., a narrow spread between the two averages).

The long-term weak divergence ranks were computed in an identical manner except that the C/A26 ratios of the 20 weakest stocks were substituted for the C/A26 ratios of the 20 strongest stocks. Upon completion of these computations, every week from number 27 through number 260 was assigned two distinct divergence ranks, each ranging from 001 through 234.

The criticism of market ranks, as presented above, also applies to divergence measures. The method utilized for both computations involves hindsight. However, as explained earlier, this criticism is not considered to be of major importance.

III. Relative Strength Continuation: Empirical Results

(The reader should note that the word "historical," in the context used herein, refers to events occurring prior to the time at which a stock is considered for selection; the word "future" refers to events occurring subsequent to selection; the labels "long-term" and "short-term" refer respectively to 26-week and 4-week periods of time; and the words "strong" and "weak" refer to the trend of a stock's price movement relative to the movement of all other stock prices.)

Table 1 lists the short-term (4/C) and long-term (26/C) average ratios, by groups of stocks, for the entire test period. The groups were determined by

TABLE 1

4-Week and 26-Week Average Investment Performance by Stock Group as Classified According to Historical Relative Strength Ranks

C/A26 Relative Strength Rank	4-Week Performance		26-Week Performance	
	Average 4/C Ratios	Average 4/C Ranks	Average 26/C Ratios	Average 26/C Ranks
000-019	1.009	102.0	1.096	90.8
020-039	1.009	99.6	1.074	94.2
040-059	1.010	98.0	1.066	97.2
060-079	1.009	99.8	1.060	99.3
080-099	1.009	99.1	1.062	98.5
100-119	1.010	99.4	1.057	101.4
120-139	1.009	99.4	1.061	99.2
140-159	1.010	97.9	1.061	99.5
160-179	1.010	98.0	1.057	101.6
180-199	1.008	101.8	1.029	113.3
All Stocks	1.009	99.5	1.062	99.5

classifying the stocks in accordance with their historical (C/A26) relative strength ranks. Also tabulated are the 4/C and 26/C ranks, listed in the same manner. The 4/C and 26/C average ranks are not affected by extreme price movements of one or more securities. This is not true, however, of the average ratios. Moreover, as discussed above, the computation of average ranks eliminates the sometimes-confusing effect which the trend of the general market has on measures of investment performance. Ranks, being a relative measure, are free of general market influence. This applies whether the ranks are historical (C/A26) or future (4/C and 26/C).

Technical analysts contend that stocks which historically have been relatively strong tend to remain relatively strong for some significant period of time. Analysis of the 4/C (short-term) average ranks and ratios in Table 1 provides no evidence that this contention is correct. There seems to be no discernible pattern to the results.

However, the 26/C average ranks and ratios clearly support the concept of continuation of relative strength. The stocks which historically were among the 10 per cent strongest (lowest ranked) appreciated in price by an average of 9.6 per cent over a 26-week future period. These same stocks had an average 26/C rank of 90.8. On the other hand, the stocks which historically were among the 10 per cent weakest (highest ranked) appreciated in price an average of only 2.9 per cent over a 26-week future period; and the average 26/C rank of these latter stocks was 113.3.

There appears to be good correlation between past performance groupings and future (26-week) performance groupings. This is easily discerned when the C/A26 relative strength rank group numbers are compared to performance indicators based upon 26/C average group ratios and ranks.

	Group Performance Indicator Based Upon	
C/A26 Relative Strength Rank Group Number	26/C Average Group Ratios	26/C Average Group Ranks
1	1	1
2	2	2
3	3	3
4	7	6
5	4	4
6	8	8
7	5	5
8	6	7
9	9	9
10	10	10

The correlation coefficient between the C/A26 rank group numbers (column 1) and the 26/C ratio group numbers (column 2) is .87. The correlation coefficient between the C/A26 rank group numbers and the 26/C rank group numbers (column 3) is .92.

The relationship tabulated above was not confirmed when weekly correlation coefficients between C/A26 and 26/C ranks were computed. The 208

correlation coefficients ranged from .37 to —.21, with an average of .08. (The corresponding range of 230 correlation coefficients between C/A26 and 4/C ranks was .51 to —.47, with an average of .00.) This minimal degree of relationship is not, however, inconsistent with dependence of the kind argued.

The conclusion to be drawn from Table I and the above table is that relative strength does, as technicians have claimed, tend to continue over the longer (26-week) period. This does not appear to be the case, however, for the shorter (4-week) period. The apparent unpredictability of the short-term (4/C) results seems to corroborate the results of the numerous serial correlation studies and runs analyses which have shown *short-term* price movements to be random.

The average price appreciation of the historically strongest securities (9.6% over 26 weeks, or approximately 20.1% per annum) provides some preliminary evidence of non-randomness in price changes. The annual price appreciation of all stocks, computed from the average 26/C ratio at Table 1, was 12.8%. Even allowing 4% per annum in brokerage fees (assuming a 1% one-way transaction cost, and two turnovers of the portfolio per year), the profits attainable by purchasing the historically strongest stocks are superior to the profits from random selection.

IV. The Effect of Stock Price Volatility

In an effort to delve deeper into the data presented in Table 1, and in order to improve the potential investment results, several subclassifications of Table 1 were made. One of these subclassifications was to first divide the securities each week into three groups based upon their historical volatility ranks. Those stocks with a volatility rank of 000 through 049 (the 25% most volatile stocks) were placed in the first group. Those stocks with a volatility rank of 150 through 199 (the 25% least volatile) were placed in the third group. All other stocks (50% of the total) were assigned to the middle group.

After subclassifying the stocks in this manner, computations identical to those reported in Table 1 were performed for each of the three volatility groups. The results are set forth at Table 2. (The 4/C results are omitted in Table 2 and in succeeding tables in this paper. There does not appear to be a discernible pattern in these short-term results.)

The best results were obtained when dealing with the most volatile stocks. The average 26-week price appreciation for the most volatile group ranged from 10.4% for those stocks with the 10% strongest C/A26 relative strength ranks, to 2.5% for those stocks with the 10% weakest C/A26 ranks; and the respective 26/C average ranks ranged from 85.7 to 117.3.

As shown in Table 2, the most volatile stock group shows a wider dispersion of both 26/C average ranks and 26/C average ratios than either of the less volatile groups. Clearly, the employment of the continuation of relative strength concept appears to be most effective with regard to the most volatile securities. Moreover, the historically strongest stocks in the most volatile group realized an implied average annual appreciation of 21.9% (based upon their average 26/C ratio). (Of course, the market practitioner interested in risk aversion may prefer not to invest in those stocks which historically have been most volatile.)

TABLE 2

26-WEEK AVERAGE INVESTMENT PERFORMANCE BY STOCK GROUP AS CLASSIFIED ACCORDING TO HISTORICAL RELATIVE STRENGTH RANKS AND SUBCLASSIFIED ACCORDING TO HISTORICAL VOLATILITY RANKS

	Volatility Ranks							
	000-049		050-149		150-199		All Stocks	
C/A26 Relative Strength Rank	Average 26/C Ratios	Average 26/C Ranks	Average 26/C Ratios	Average 26/C Ranks	Average 26/C Ratios	Average 26/C Ranks	Average 26/C Ratios	Average 26/C Ranks
000-019	1.104	85.7	1.063	103.7	1.100	110.3	1.096	90.8
020-039	1.078	90.7	1.063	97.4	1.107	93.9	1.074	94.2
040-059	1.081	93.2	1.057	99.0	1.078	96.8	1.066	97.2
060-079	1.060	99.4	1.064	99.1	1.046	100.1	1.060	99.3
080-099	1.073	96.1	1.071	98.3	1.038	99.7	1.062	98.5
100-119	1.069	103.4	1.069	99.1	1.035	104.3	1.057	101.4
120-139	1.076	105.6	1.071	97.3	1.046	100.3	1.061	99.2
140-159	1.090	103.5	1.064	98.0	1.048	100.4	1.060	99.5
160-179	1.068	111.1	1.050	98.6	1.061	101.3	1.057	101.6
180-199	1.025	117.3	1.030	109.1	1.036	115.4	1.029	113.3
All Stocks	1.076	97.2	1.061	99.6	1.051	101.7	1.062	99.5

Table 2 also indicates an excellent spread in 26/C average ratios as between the historically strong stocks and the historically weak stocks in the least volatile group. However, the 26/C average ranks for that group show no discernible pattern. In fact, the 10% historically strongest stocks in the least volatile group have both a high 26/C ratio (1.100) and a high 26/C rank (110.3), thus implying that the market was extraordinarily strong for the 26 weeks succeeding those time periods during which the strongest stocks were also the most stable.

The general conclusion to be drawn from Table 2 is that, over the entire test period, the selection of securities which historically had been both relatively strong and relatively volatile produced profits superior to those attainable from random selection.

V. Market Ranks: A First Attempt at Timing

The second subclassification of the results reported in Table 1 was by historical market ranks. All of the stocks at those weeks which had a market rank of 001 through 058 (the weeks at which the strongest historical market trends had been recorded) were placed in the first market group. The stocks at those weeks which had a market rank of 177 through 234 (the weeks at which the weakest historical market trends had been recorded) were placed in the third group. Remaining stocks (approximately 50% of the total) were assigned to the middle group.

The purpose of this subclassification was to indicate the extent to which historical market ranks could be used to facilitate market timing. The results of the subclassification by long-term historical market rank are presented in Table 3.

The stocks which had the 10% strongest C/A26 relative strength ranks, and which were in the strongest (lowest-ranked) long-term historical market rank group, recorded an average 26/C ratio of 1.150 and an average 26/C rank of 83.8. An average 26/C ratio of 1.150 implies an average annual price appreciation of 32.3%. However, the weeks included in this first market group covered only about 25% of the test period. The average annual rate of return for the entire test period would depend on the results achieved during the remaining 75% of the time (i.e., for the second and third market rank groups).

The second long-term historical market rank group (covering approximately 50% of the time period) supported the continuation of relative strength concept as did the first group. The 10% historically strongest stocks in the second group yielded an average 26/C ratio of 1.086 and an average 26/C rank of 88.6.

The third long-term historical market rank group (covering the weeks at which the weakest historical 26-week market trends had been recorded) did *not* support the concept of relative strength continuation. The most profitable stocks (based on average 26/C ranks and ratios) in the third market group were those stocks with a C/A26 rank ranging from 020 through 159. The historically strongest stocks did not produce the most satisfactory 26/C results. It is noteworthy, however, that even during the 26-week period follow-

TABLE 3

26-WEEK AVERAGE INVESTMENT PERFORMANCE BY STOCK GROUP AS CLASSIFIED ACCORDING TO HISTORICAL RELATIVE STRENGTH RANKS AND SUBCLASSIFIED ACCORDING TO HISTORICAL LONG-TERM MARKET RANKS

	Long-Term Market Ranks							
	001-058		059-176		177-234		All Stocks	
C/A26 Relative Strength Rank	Average 26/C Ratios	Average 26/C Ranks	Average 26/C Ratios	Average 26/C Ranks	Average 26/C Ratios	Average 26/C Ranks	Average 26/C Ratios	Average 26/C Ranks
000-019	1.150	83.8	1.086	88.6	1.056	104.4	1.096	90.8
020-039	1.102	95.8	1.060	93.7	1.075	93.7	1.074	94.2
040-059	1.101	97.0	1.043	98.9	1.077	93.4	1.066	97.2
060-079	1.085	102.1	1.042	99.5	1.072	95.6	1.060	99.3
080-099	1.088	100.2	1.044	99.0	1.074	95.2	1.062	98.5
100-119	1.087	102.0	1.033	103.3	1.076	96.0	1.057	101.4
120-139	1.090	100.1	1.042	99.3	1.072	98.0	1.061	99.2
140-159	1.084	102.3	1.043	99.2	1.071	96.9	1.060	99.5
160-179	1.090	99.5	1.044	99.9	1.048	108.0	1.057	101.6
180-199	1.061	112.2	1.011	113.6	1.034	113.9	1.029	113.3
All Stocks	1.094	99.5	1.045	99.5	1.065	99.5	1.062	99.5

ing those weeks in the third market rank group, the stocks with the poorest C/A26 ranks (180-199) continued to produce the poorest C/A26 ranks and ratios.

Table 3 leads to the conclusion that the utilization of the continuation of relative strength concept produces superior profits during all periods except those periods immediately succeeding a comparatively weak market. Stocks with moderately strong C/A26 ranks seem to perform better during these latter periods.

It is also indicated by Table 3 that the best results are attainable by buying stocks in a market which historically had been comparatively strong. This implies that strength in the market tends to be followed by additional strength (i.e., continuation of relative strength seems to be applicable to the market as a whole as well as to individual securities).

VI. Divergence Ranks: A Second Attempt at Timing

The two divergence ranks described above also served as the basis for subclassifying the information presented at Table 1. The subclassifications were determined as follows: (1) all stocks at those weeks which had a divergence rank of 001-058 (the weeks at which the greatest historical divergence had been recorded) were placed in the first of three groups; (2) the stocks at those weeks which had a divergence rank of 177-234 (the weeks at which the least historical divergence had been recorded) were placed in the third group; and (3) remaining stocks (approximately 50% of the total) were assigned to the middle group. Table 4 sets forth the results of the subclassification by the long-term strong divergence ranks; and Table 5 presents the outcome of the subclassification by long-term weak divergence ranks.

Tables 4 and 5 indicate that the greatest 26-week rates of return are attained when selecting the 10% historically strongest stocks from the third divergence rank group; and the poorest returns (among the 10% historically strongest securities) arise from selecting those stocks in the first divergence rank group. With respect to Table 4, this principle is borne out by the average 26/C ratios (although not by the 26/C ranks); whereas, for Table 5 the average 26/C ranks are more indicative.

The stocks in the first divergence rank group do not appear to adhere very closely to the continuation of relative strength concept. Perhaps the historically strongest stocks which had shown the greatest divergence may have temporarily exhausted their upward momentum. On the other hand, those securities in the middle and third groups are quite consistent in following the patterns forecasted by their C/A26 relative strength ranks.

As between the two tables, the long-term weak divergence ranks at Table 5 produce the most outstanding results. For the 26-week periods following those weeks which evidenced least historical divergence (the third group), the 26/C average ratios ranged from 1.156 for the 10% historically strongest stocks to 1.029 for the 10% historically weakest; and the 26/C average ranks had a corresponding range of 77.6 to 122.0. This represents the best of the results yet investigated. However, since they are only attainable for approximately 25%

TABLE 4

26-WEEK AVERAGE INVESTMENT PERFORMANCE BY STOCK GROUP AS CLASSIFIED ACCORDING TO HISTORICAL RELATIVE STRENGTH RANKS AND SUBCLASSIFIED ACCORDING TO HISTORICAL LONG-TERM STRONG DIVERGENCE RANKS

	Long-Term Strong Divergence Ranks							
	001-058		059-176		177-234		All Stocks	
C/A26 Relative Strength Rank	Average 26/C Ratios	Average 26/C Ranks	Average 26/C Ratios	Average 26/C Ranks	Average 26/C Ratios	Average 26/C Ranks	Average 26/C Ratios	Average 26/C Ranks
000-019	1.032	96.5	1.116	86.1	1.123	95.4	1.096	**90.8**
020-039	1.008	102.7	1.088	90.5	1.116	93.4	1.074	94.2
040-059	1.010	99.6	1.071	97.2	1.119	94.7	1.066	97.2
060-079	1.008	99.7	1.064	100.0	1.110	97.2	1.060	99.3
080-099	1.013	96.8	1.064	100.4	1.114	95.8	1.062	98.5
100-119	1.005	100.5	1.061	102.0	1.106	101.0	1.057	101.4
120-139	1.021	92.4	1.063	101.7	1.102	101.2	1.061	99.2
140-159	1.011	96.8	1.064	100.7	1.105	99.8	1.060	99.5
160-179	1.008	98.8	1.065	101.3	1.093	105.3	1.057	101.6
180-199	0.981	111.2	1.032	115.1	1.078	111.3	1.029	113.3
All Stocks	1.010	99.5	1.069	99.5	1.107	99.5	1.062	99.5

TABLE 5

26-WEEK AVERAGE INVESTMENT PERFORMANCE BY STOCK GROUP AS CLASSIFIED ACCORDING TO HISTORICAL RELATIVE STRENGTH RANKS AND SUBCLASSIFIED ACCORDING TO HISTORICAL LONG-TERM WEAK DIVERGENCE RANKS

	Long-Term Weak Divergence Ranks							
	001-058		059-176		177-234		All Stocks	
C/A26 Relative Strength Rank	Average 26/C Ratios	Average 26/C Ranks	Average 26/C Ratios	Average 26/C Ranks	Average 26/C Ratios	Average 26/C Ranks	Average 26/C Ratios	Average 26/C Ranks
000-019	1.086	104.7	1.080	88.3	1.156	77.6	1.096	90.8
020-039	1.081	101.4	1.062	91.7	1.097	91.0	1.074	94.2
040-059	1.080	100.7	1.049	96.4	1.092	94.6	1.066	97.2
060-079	1.077	101.8	1.046	97.9	1.074	99.8	1.060	99.3
080-099	1.088	96.7	1.044	99.0	1.075	99.4	1.062	98.5
100-119	1.080	100.9	1.039	101.4	1.071	101.9	1.057	101.4
120-139	1.090	95.8	1.046	99.0	1.062	104.7	1.061	99.2
140-159	1.092	94.2	1.038	101.7	1.073	101.0	1.060	99.5
160-179	1.093	95.3	1.034	104.3	1.068	102.8	1.057	101.6
180-199	1.076	103.5	1.008	115.2	1.023	122.0	1.029	113.3
All Stocks	1.084	99.5	1.045	99.5	1.079	99.5	1.062	99.5

of the time, the over-all rate of return would depend upon the profits achieved for the remaining 75%.

Also of significance, the sum total of all securities in the first divergence rank group at Table 4 yields an average 26/C ratio as low as 1.010. This implies that long-term strong divergence ranks might be an effective means of forecasting long-term (26-week) market weakness. The 1% average return over a six-month period, for all stocks in the first group, is quite low when compared to the over-all averages at Tables 3 and 5. Yet this was the return achieved for the 26 weeks immediately following those periods during which performance of the historically strongest stocks diverged by a relatively large amount from the performance of all 200 stocks. The possibility that long-term strong divergence ranks may possess forecasting significance is a familiar one to the many market practitioners who regularly advise caution whenever the market becomes "speculative" (i.e., whenever a few "high-flyers" or "glamor" issues begin to record extraordinary gains relative to other securities). Of course, these market practitioners do not think in terms of divergence ranks; but they do express conceptually what the long-term strong divergence ranks seek to measure quantitatively.

It might also be expected that, if significant divergence (as measured by the long-term strong divergence rank) precedes a weak market, then a small degree of divergence (measured in the same manner) should forecast a comparatively bullish market. In fact, this supposition is borne out by Table 4, where the average 26/C ratio for all stocks in the third divergence rank group is 1.107—higher than any of the over-all averages at Tables 3 and 5.

To summarize, the utilization of divergence ranks appears to facilitate market timing. Tables 4 and 5 (subclassifications of the information presented at Table 1) indicate that return on investment can be significantly improved by selecting the 10% historically strongest securities in the third divergence rank group (i.e., the group covering those weeks for which comparatively little divergence was noted). In the case of the long-term weak divergence ranks (Table 5), the results of following this strategy were superior to any results yet investigated. And in the case of the long-term strong divergence ranks (Table 4), it was discovered that comparatively weak market periods usually followed those weeks included in the first divergence rank group; and comparatively strong market periods tended to follow those weeks included in the third divergence rank group.

Any conclusions regarding the validity of using market ranks or divergence ranks to facilitate market timing must, however, be of a tentative nature. The studies in this paper fail to relate the various average 26/C ratios to the number of dollars which would be available for investment at various times in the market.

VII. Limitations

Although it appears that superior profits can be achieved by investing in securities which historically have been relatively strong in price movement, the random walk hypothesis is not thereby refuted. To the extent that the superior profits are attributable to the incurrence of extraordinary risk, the

prices of individual securities could still be said to fluctuate randomly about a trend which is related to the opportunity cost of capital (a function of risk). Thus, only when a technical investment strategy can produce profits which are superior to those attainable by random selection, at risk which is less than that of random selection, can the random walk hypothesis be disproven.[8]

It is therefore necessary to determine the riskiness of the various technical measures tested above. Volatility ranks, while indicative of price stability, are unsatisfactory measures of risk for two reasons. First, since they are based upon the coefficient of variation of *prices* rather than *price changes,* they are more properly related to price action than to risk. While price action is an important variable for technicians to determine, it is not equivalent to risk. For example, stock prices rising sharply and rapidly would have a large coefficient of variation. But if the price series adhered closely to a linear trend, this coefficient of variation would bear no relationship to any common definition of risk. The relevant measure in this case would be either the coefficient of variation of *price changes* or the coefficient of alienation of price regressed on time. However, even these two measures would share with the volatility ranks a second weakness if applied to risk determination. Namely, prospective risk may not be a function of historical risk. It is the realized variance of the resultant rates of return rather than the predictability of past prices which better reflects risk.

Why, then, have the realized variances of the future returns and ranks not been computed? The answer is that there is no satisfactory method of doing so. To illustrate, comparisons of C/A26 ranks and 26/C ranks were made over 208 holding periods, each one commencing and terminating one week later than the previous one. Thus, it is clear that there are only eight non-overlapping 26-week periods analyzed. Consequently, the results are extensively intercorrelated; and the use of standard statistical measures becomes suspect. Only if each holding period were treated independently could the variances be relied upon; and under these circumstances, we would have 208 variances for each historical rank grouping, with no satisfactory method of combining them for analysis.

As a result, this study is limited by omission of statistical tests of significance, and omission of measures of return variability among individual securities and individual holding periods. However, as Paul Cootner commented in discussing his work on the random walk model:

> . . . my own tests . . . suffer from lack of a good statistical test of significance; on the other hand, they come closer to testing for the kind of non-randomness which stock market traders claim exists. It is a foolish sort of statistical reasoning which would suggest we limit our investigations to those hypotheses which are easy to investigate.[9]

8. For a further discussion by the author of the theory of random walks, see "The Principle of Portfolio Upgrading," *Industrial Management Review,* IX, No. 1 (Fall, 1967); and "Random Walks: Reality or Myth," *Financial Analysts Journal,* XXIII, No. 6 (November-December 1967).

9 Paul H. Cootner, "Stock Prices: Random vs. Systematic Changes," *Industrial Management Review,* III, No. 2 (Spring, 1962), 43.