**1: PREDICTING RANK ORDER STOCK PRICE PERFORMANCE USING A MULTI-FACTOR RELATIVE PRICE STRENGTH MODEL**

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| **INTRODUCTION**  One of the greatest challenges facing equity investors is predicting individual stocks’ relative future price performance in a manner that is disciplined, can be easily replicated and produces consistently accurate results over the investment time horizon of interest to the user.  As Research Director of a regional brokerage firm, I am continually asked to offer an opinion regarding the future price performance of specific stocks relative to a specific universe or specific portfolio. To meet this challenge, I have constructed and currently maintain and electronically distribute an extensive equity database. Updated weekly, this database includes a wide variety of technical and fundamental indicators and several forecasting models, including a short-term, technically-based, relative strength momentum model designed to provide relative performance guidance over a three to six-month time horizon.  Currently there is no shortage of proprietary and publicly available research tools attempting to accomplish this objective. In the author’s opinion, there does exist a noticeable absence of published data evaluating how well these tools work “after-the-fact,” assuming multiple start and end dates. We continue to observe that most published test results are derived from back-testing procedures assuming a single start and end date for the test. A potential user of the indicator is often at a loss to determine if encouraging results are the product of a model that has consistent forecasting ability or merely a coincidentally favorable test period.  Finally, the prospective user of a forecasting or relative ranking system often has no idea of how long the projected rankings will provide predictive value before deteriorating, or the consistency of a ranking methodology in accurately predicting the rank order of investment results for a significant equity universe under consideration. Results are often reported from universe subsets that will provide encouraging results. In summary, we have typically found the absence of data on the pervasiveness and consistency of test results generated by systems employed live or “after-the-fact” to be very troubling.  **OVERVIEW AND CONCLUSIONS**  This paper describes and presents the results of a technically based, multifactor stock selection and ranking index (momentum index) research methodology. The results presented are based on an ex post facto analysis of actual predicted and published rank performance suggested by the index. The rankings have been published weekly as part of the Branch Cabell Equity Advantage Database since June 25, 1999. The test analysis extends from the initial index publication date ofJune 25,1999 through November 26, 1999. The testing protocol considers the performance of the index assuming multiple overlapping start and end dates (of variable length holding periods) during this time period. As described below, the initial test results are encouraging, as the model appears to have provided positive predictive value over a wide variety of holding periods as determined using several rigorous academically acceptable evaluation criteria.  The momentum index in Chart 1 below shows the rank of an individual stock relative to its selection universe based on combining two ranked measures of cycle position for each stock and three ranked measures of price change.  Our investment hypothesis is that the Branch Cabell momentum index can demonstrate consistent predictive rank order performance results in excess of those generated from investing in a market (S&P 500) index fund over various weekly holding periods after making appropriate adjustments for historical price risk.  The momentum index was initially created to help investors assess probable three to six month rank order price for a 1,750 com pany equity universe including approximately 100 listed ADRs. The debut of this indicator was June 25,1999. As shown in Chart 1, the S&P 500 experienced two corrections and recoveries of at least five percent between July 1999 and November 26,1999. Looking back, this introductory five-month period was extremely trying for most investors as well as being a very diflicult period to test and evaluate any technically-based stock selection methodology due to the number and magnitude of the market and individual stock price directional changes. Over the entire time period, the S&P 500 was up 6.5% and the average price change of stocks included in the test universe was down 2%:  http://www.mta.org/eweb/docs/journal/2000/winter/Chart1-1.JPG  For testing purposes, we assumed an equal dollar-weighted investment in each name in the universe each week. We then divided the universe into deciles based on the ranking suggested by the momentum index and measured the performance of each ranking decile weekly over various holding periods during the test period. This procedure eliminated the possibility of favorable start and end dates impacting the test results. Although five months of test data is a very short time frame to evaluate an index and to conclude the validity of our investment hypothesis, we believe the following initial observations are noteworthy and justify continued publication of the index and the indefinite extension of the testing procedure.  http://www.mta.org/eweb/docs/journal/2000/winter/Chart1-2.JPG   1. The momentum index successfully projected rank-order performance over 20 overlapping time periods (extending from l-20 weeks) based on multiple start and end dates evaluated between June 25, 1999 and November 26, 1999 (Table 1). The results were pervasive and surprisingly consistent over the range of multi-week holding periods. The correlation coefficients of the momentum index ranked order performance ranged between 0.75 and 0.89 (1.0 marks perfect correlation, 0.0 marks zero correlation and -1.0 marks perfect negative correlation) for all time periods tested. 2. The absolute returns also initially suggest a high degree of rankorder forecasting ability. For all periods tested, the absolute return of stocks ranked in the top decile ranking was greater than the returns produced by stocks in the second decile (See Chart 3). Stocks ranked in the 2nd decile in turn outperformed stocks ranked in the 5th decile then in turn outperformed stocks ranked in the last (10th) decile. The degree of outperformance between the stocks in the top ranked decile and bottom ranked decile ranged from an average of 2.3% for a l-week holding period to 19.4% for a IO-week holding period and 40.3% for a 20-week holding period. The spread of rank order returns are highly significant when compared to the distribution of returns generated from a random selection of stocks made from the same universe tested in a similar manner over the same time period (Table 2). The top decile of stocks selected randomly underperformed the bottom ranked decile by 0.3% for one week, out erformed by 0.08% at 10 weeks and underperformed by 1.17 o at 20 weeks. ? 3. Stocks identified in the top two ranked deciles produced positive risk-adjusted excess returns for all time periods up to 17 weeks when evaluated using the Jensen Modified Capital Asset Pricing model (Table 3). The results were dramatically above what a rational investor would expect based on the risk profile of the stocks included in each decile category. Stocks included in the bottom two ranked deciles consistently produced the poorest negative excess returns over the entire spectrum of holding period. 4. The momentum rankings index produced excess returns consistent with their decile position rather than the average beta associated with each decile ranking position. These results were inconsistent with what one would expect based on the volatility assigned to each decile ranking class based on historical betas. This apparent market anomaly is worth noting and strongly suggests that future tests be conducted to determine the extent and pervasiveness of this anomaly over longer time periods including a full market and economic cycle.  http://www.mta.org/eweb/docs/journal/2000/winter/Chart1-3.JPG 5. We expected the average volatility, as measured by beta, for the stocks in each momentum index decile to decline proportionately by decile ranking category. We expected the highest momentum index ranked stocks to have the highest average historical beta and the lowest ranked stocks to have the lowest historical beta. In fact, the observed average beta declines sequentially as expected between decile ranks 1 and 5 but then unexpectedly rises sequentially between decile ranks 6 and 10 (Table 3). 6. The average beta measured over the entire 20-week time horizon within specific momentum ranking deciles was not stable (Table 4). During one period of sustained market weakness, (July 16July 30) the average beta of the top decile momentum ranked stocks fell from 1.38 to 1.15 while the beta of the lowest momentum ranked stocks rose from 1.04 to 1.20. The average beta of the middle-ranked decile remained very stable throughout the entire test period. The unusual variability could possibly be attributed to stocks eliminated from the universe during the testing period that were replaced by stocks with substantially different volatility characteristics. 7. We expected the momentum index to demonstrate proportionately reduced forecasting ability as the holding period lengthened. The test data suggests that the momentum index’s ability to produce returns consistent with the rankings persists much longer than we originally expected. Although we have only a few data points for holding periods beyond 15 weeks, the rank order correlation coefficients remain very high (0.80) with little noticeable deterioration beyond this time horizon. The positive spread of realized returns between performance ranks remains intact from the highest decile to the lowest decile for all periods up to 20 weeks. For this limited testing period, the momentum index met our initial objective of pervasiveness by maintaining its discrimination ability across the stock universe for time periods in excess of 13 weeks. 8. We observed significant deviation of returns for the individual stocks included within each of the decile rankings. The performance statistics of individual stocks suggest the widest dispersion of individual stock returns at the highest and lowest decile ranking levels. Therefore, one needs to look at the decile performance rankings as only an indication of central tendency for the stocks included in each decile rather than an absolute predictor of future individual stock performance. The performance ranks suggest probability of performance rather than serving as an explicit predictor of performance on a stock-by-stock basis. 9. We conclude that for the time period tested, the momentum index provided valuable forecasting information about the future risk-adjusted excess returns that could be profitably exploited by investors after considering reasonable transaction costs. An investor could have begun to employ the published momentum index rankings several weeks after the testing period began and would have received approximately the same benefit as an investor who employed the model from the start of the test period over the entire array of holding periods. The results appear to be consistent and pervasive during the test period across holding periods ranging from one to twenty weeks.   **METHODOLOGY The Momentum Ranking Index**  Background. The genesis of the author’s interest in relative strength analysis dates back over 30 years. In his 1967 doctoral thesis, Dr. Robert A. Levy scientifically explored and tested a 26 week relative strength ranking system that he claimed invalidated the widely accepted “weak efftcient market thesis.” Several academic researchers at the time concluded that Dr. Levy’s ability to demonstrate exceptional performance results was a direct function of the volatility inherent in the stocks selected rather than a persistent market anomaly. Thus, Dr. Levy’s claim of refuting the efficient market hypothesis was widely discredited. On a practical basis, we have found the original 26week rate of change indicator to be helpful in establishing probabilities of future results, but lacking persistence and consistency when applied across a wide universe of stocks.  Index definition and construction. The momentum ranking index is constructed using only historical price behavior of individual stocks. Thus, it is a pure “technical” index. Conceptually, the index attempts to quantify a stock’s position within a 52-week price cycle and its momentum or rate of change as measured over 4week, 13-week and 52-week periods. The momentum ranking index subcomponents, cycle position and velocity (percent price change) appear to be greatly impacted by overall market factors. The ability of the stock to respond to changing market factors is hypothesized to be a critical variable in determining near-term price changes. This index has been continuously constructed on a weekly basis since June 25,1999. No changes were made in construction methodology during the test period.  Each week every stock in the 1,750 company universe is ranked relative to the entire universe based on its respective Price/52-week high and Price/52-week low to determine relative cycle position. Then each stock is separately ranked on the basis of its 4week, 13 week and 26week price change relative to the same universe. Each stock’s ranked position based on each of these five criteria are then summed and ranked relative to each stock in the universe to determine the final technical momentum ranking index. A stock ranking number 1 in each category would have a composite score of 5. This score would be compared to the scores of all other companies in the universe to determine a final momentum index rank. The stock with the lowest cross-ranked score is projected to have the highest probability of outperforming all other stocks in the universe going forward (See Chart 1).  During the testing period, approximately 75 companies from the original starting universe were eliminated from the universe due to mergers or acquisitions. New companies were introduced into the universe during the test period at the request of our retail clients, our institutional brokerage clients or to include IPOs of technical or fundamental interest when data became available on the StockVal database. For companies with less than 52 weeks of pricing data, we calculated comparable cycle position statistics using Price/Life of Company high price in place of the Price/52 week high ratio and Price/Life of Company low price in place of the Price/52-week low ratio. For companies with fewer than 13 weeks of pricing data, we substituted the price change from the company’s IPO to the calculation date for the index in the velocity indicators. We have not identified the impact of these changes on the test results shown in this paper.  The momentum index is calculated based on Friday closing prices (4:30 PM EST/EDT) and does not recognize prices posted in Friday aftermarket trading on electronic exchanges such as Instinet. The historical prices in the database are adjusted when a stock split or meaningful stock dividend occurs. Companies that have been acquired during the test period are purged from the universe to preserve comparability of companies from each weekly starting point. This adjustment might add a small positive or negative bias to the test results.  **Testing Procedure**  Test period. The test period was conducted between June 25, 1999 and November 26, 1999 using the technical momentum index published weekly in the Branch Cabell Equity Advantage Database between June 25,1999 and November 5,1999. June 25,1999 marked the first date the Technical Momentum Index was pub lished and distributed to clients.  Stock Universe. The Equity Advantage Stock universe was originally constructed in October 1998. It includes members of the S&P 500, the Russell 1000, selected holdings or stocks of special interest to clients of Branch Cabell, and stocks covered by CS First Boston and Prudential Research (research correspondents of Branch Cabell). Stocks not otherwise identified with at least $1 billion in market capitalization are also included in the database. The performance of the Branch Cabell Equity Universe versus the S&P 500 is shown in Chart 2. The stocks included in the universe are included in the StockVal” database which is used as the basic information source for all data. Friday night closing prices are downloaded from the StockVal” database and loaded into the Branch Cabell Equity Advantage database every Saturday. StockVal’” provides component calculations for the five variables included in the Technical Momentum Index.  Testing Protocol. Each week the technical momentum ranks and individual equity betas were loaded into an Excel spreadsheet along with the model ranking algorithms. Historical weekly prices were retrieved from the StockVal” database for each worksheet, providing the necessary data to calculate cumulative weekly returns from the initial date of the holding period to the last date included in the test (November 26, 1999). The stock prices were split-adjusted but were not adjusted for spinoffs that may have negatively impacted the performance of a specific stock. Each weekly database was then sorted in ascending order of technical momentum rank, with most favorable momentum rank at the top of the list and least favorable at the bottom of the list. The universe was then divided into deciles, and average performance returns were calculated for each performance decile. The data were ordered so that the average performance of comparable weekly holding periods could be determined. The procedure was repeated for each of the twenty weeks included in the test. The results were averaged for each ranking decile by comparable holding periods. Thus one could easily evaluate the returns for all l-week, 5-week, lo-week, etc. holding periods on a common basis.  This procedure allows us to draw conclusions about the persistence and consistency of the performance ranking results without assuming specific starting and ending test period dates. We view this as a very rigorous but fair testing protocol. The results of this protocol are shown in Table 1. Chart 3 presents a graph of the test results over the test period. After 20 weeks, initial signs of conver gence between the performance of the bottom decile and the middle decile ranking position were beginning to appear, although the number of data points observed remain very small (3). The spread between the top decile ranking position and the middle decile ranking position continued to widen.  Mindful of the “weak efficient market hypothesis” which suggests that purely historical stock price behavior has no predictive power, we decided to construct a benchmark test assigning random numbers as a pseudo technical momentum rank, or “pseudo ranks.” Using the Excel worksheet’s random number function, a number between 0 and 1 was generated and multiplied by the universe size to determine a stock’s pseudo rank. Stock performance tests were then conducted in a manner consistent with the test procedure used to determine the performance of the technical momentum ranks. The data from this test is shown in Table 2. The randomly generated performance ranks produced apparently random results within very tight performance boundaries. The re sults of the “pseudo ranking” test provide a benchmark in order to evaluate whether our technical momentum model was the product of a random process or identified a market anomaly that can be exploited by investors. Performance that substantially exceeded the randomly generated results, particularly at the decile rank ex tremes, added confidence in the validity of the momentum index test results.  A comparison of the performance of the technical momentum ranks versus the “pseudo ranks” strongly suggests that the predictive performance of the technical momentum rank was the result of a process other than chance. We draw the same conclusion evaluating the average rank order correlation coefftcients of the technical momentum ranks (consistently above 0.75 with 99% of the observed individual cell rankings above 0.1) versus the correlation coefficients produced by the “pseudo ranks.” As expected and shown in Chart 3, the performance spread between the decile rankings for the “pseudo ranks” was very narrow and the decile performance showed a high tendency for convergence.  Cognizant of the academic arguments raised in the challenge of Dr. Levy’s study, we then constructed a matrix that identified the betas associated with the stocks grouped into the decile categories by their technical momentum rank. Table Four presents this data. The betas shown were calculated as of September 30, 1999. It was not practical to recreate the betas for June 25, 1999. Our assumption is that the change in betas on a stock-by-stock basis would be minor, as the beta calculation was made based on five years of weekly price data for each stock and for the S&P 500.  The data provided an interesting twist. We expected to see rank order correlation between the betas for each decile and the momentum index decile rankings. This would indicate that the stocks with the highest estimated technical momentum would have the highest betas and those with the lowest technical momentum would have the lowest betas. The data did not confirm this hypothesis. In fact, the data suggest a bi-modal distribution with the betas accelerating as one approaches the upper and lower decile ranking levels. We did not expect the worst performers to have the second highest decile beta rankings in the universe during the test period.  As a final test, we decided to compare the performance results produced by the technical momentum rankings to those predicted by the Jensen Modified Capital Asset Pricing Model (MCPM), a benchmark test used to determine rational asset pricing. MCPM states that an asset’s return is related to the risk free rate of return plus the difference between market rate of return (S&P 500) and the risk free rate of return times the beta of the specific security. (Expected Individual Security Return = Risk Free Rate t (Market Return - Risk Free Rate)\* Individual Security Beta). If the differential is positive, an unexplained “excess return” is generated. Investors are being compensated for their unusual investment knowledge.  Table 3 presents the excess returns generated using the momentum rankings by decile over the test period, assuming various holding periods and starting dates. The theory behind the MCPM assumes that the return of the asset category will be a direct function of the asset category’s volatility as measured by beta. The data shown below contradict that conclusion. The excess returns systematically decreased in direct proportion to the rank ordered position of the index in contradiction to the directional movement of the average beta by decile position. This anomaly is certainly worth exploring in more depth in the future as the momentum index gains more ex post facto history.  Our hunch is that the anomaly partially reflects the fact that the measurement period of the performance data is far shorter than the time period used to calculate each individual stock’s beta. We believe betas calculated for a time period consistent in length with the test period could have produced far different and more predictable results consistent with that expected using the MCPM. Thus, we cannot make a strong assertion about the validity of the Capital Asset Pricing Model when evaluated from the perspective of this test protocol. The data do suggest that the technical price momentum model successfully discriminated future price performance on a rank-order risk-adjusted basis during the test period.  **FINAL OBSFRVATIONS**  The findings of this study are highly encouraging. The results suggest that momentum as a market behavior force was much more pervasive than we previously expected. Clearly, this is an investment style employed by enough participants in the market place to impact security pricing behavior. We will continue to capture, test and evaluate future results using the ability of the momentum index rankings to predict rank order stock performance behavior over varying time horizons. In the future, we plan to evaluate the performance of the technical momentum performance ranks on the basis of market capitalization to determine if there is any small or large cap bias and in combination with our fundamentally based indicators. Our goal is to understand how well our published indicators work, why they work, to identify forecasting problems if and when they occur and to encourage other practicing technical analysts to adapt a similar rigorous approach to testing the validity of their model forecast on an ex-post-facto basis.    http://www.mta.org/eweb/docs/journal/2000/winter/Table1-1.JPG  http://www.mta.org/eweb/docs/journal/2000/winter/Table1-2.JPG  **REFERENCES**   * Robert A. Levy, “Random Walks, Realty or Myth,” Financial AnalystsJouma1 (November-December 1967a). * Michael C. Jensen and George A. Bennington, “Random Walks and Technical Theories: Some Additional Evidence,” The Journal ofFinance, XXV, No. 2 (May 1970).       http://www.mta.org/eweb/docs/journal/2000/winter/Table1-3.JPG  http://www.mta.org/eweb/docs/journal/2000/winter/Table1-4.JPG  **BIOGRAPHY**  Frederic H. Dickson, CMT is Managing Director of Research at Branch Cabell & Co., Inc., in Richmond, VA. Fred is a past President of the Market Technicians Association (1983 1984), served for many years as the Educational Committee Chairman of the MTA and authored the first set of test questions selected for use in the CMT Level I examination. Fred has served as an Adjunct Assistant Professor of Finance at the University of Richmond and as an Instructor at the New York Institute of Finance. He has contributed several articles in the past to the MTA Journal. He presently publishes a daily and weekly market comment and the Branch Cabell Equity Advantage Database for an institutional audience. |