TECHNICAL TRADING STRATEGIES AND WEAK FORM MARKET EFFICIENCY

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ABSTRACT

This paper expands on the work of Brock, Lakonishok, and LeBaron (1992) that studies whether a simple trading rule derived from technical analysis can outperform a "buy-and-hold" investment strategy. Their results provided statistically significant support for a technical trading strategy. This paper extends their technical strategy to a different and more recent data set to test the robustness of the trading rule. This paper finds that the technical trading rules studied by Brock *et al.* have lost some of their predictive power in recent years due a loss of statistical significance. The loss of statistical significance is likely precipitated by an increase in volatility.

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1.   INTRODUCTION

The concept that stock prices reflect a discounting of all information that is available to investors is referred to as the Efficient Market Hypothesis (EMH). The EMH is widely credited to the work of Eugene Fama (1965) in his publication "Random Walks in Stock Market Prices." According to the EMH, the stock market will respond so quickly to the development of new information that no investment technique can consistently outperform a buy-and-hold strategy of a diversified group of stocks. Malkiel (1989) notes that the market is said to be efficient with respect to some information set if security prices would be unaffected by revealing that information to all participants. Furthermore, Malkiel (2005) explains that equity prices adjust to new information immediately and, as a result, no arbitrage opportunities exist that would allow investors to achieve above-average returns without accepting above-average risk.

The EMH is usually divided into three different versions of the hypothesis. This is necessary because of the literal interpretation of the EMH. Fama (1970) was the first to make a distinction between the three forms of the EMH, which are:

1. The weak form hypothesis
2. The semi-strong form hypothesis
3. The strong form hypothesis

The weak form of the EMH is characterized by the suggestion that past stock prices or returns fully reflect all information contained in the historical sequence of prices. As a result of the weak form EMH, investors should not be able to develop an investment strategy that will outperform the market based on an analysis of historical price patterns (technical analysis). The weak form hypothesis suggests that if price patterns conveyed reliable signals about future performance, all investors would quickly learn to exploit the signals, thereby rendering useless any buy or sell signals. However, evidence of predictability, as presented in the following sections, provides an argument against weak form efficient markets.

The semi-strong form of the EMH implies that stock prices or returns reflect not only historical price information but also incorporate all publically available information pertaining to any individual stock or the entire market. Semi-strong EMH suggests that there are no underpriced or overpriced stocks and therefore any trading strategy would not be able to produce returns in excess of the market. This means that any trading strategy based on historical price data, financial statements, or news flow related to a particular stock or the entire market will not be able to generate returns in excess of the market.

The strong form of the EMH suggests that stock prices fully discount all available information, even privately held information, at all times. In other words, all information that is known by any market participant is fully recognized in the price of stocks and in the value of the market in general. It is difficult to fully accept strong form efficiency because it is a very drastic notion. For example, it is

not difficult to argue that senior management at a publically traded company often have access to sensitive information that is not incorporated into stock prices. As such, insider trading, although illegal, is a clear violation of strong form EMH.

Having considered the three forms of market efficiency, the remainder of this work is primarily interested in testing weak form market efficiency. Therefore, this study considers whether or not it is possible to generate returns in excess of a buy-and-hold strategy by implementing an active trading strategy based on historical price data. The trading strategy of interest for the following work is known as technical analysis, an investment technique whereby traders initiate positions on the premise that patterns in stock prices are assumed to recur in the future and that these patterns can therefore be used as a predictive indicator.

To test weak form market efficiency, it is necessary to first have a discussion in greater detail regarding technical analysis and to look at past studies in the literature that have looked at whether it is possible to implement a trading strategy based on buy/sell signals generated from the reoccurrence of historical price patterns.

Technical analysis is the study of historical price patterns in order to find recurring and predictable outcomes in the direction of stock prices. This is done in an effort to extract returns from the market that are in excess of the returns earned from a simple buy-and-hold strategy. The weak form EMH maintains that stock market trading rules based solely on historical prices cannot earn returns that are in excess of returns generated by holding the market portfolio. As such,

the EMH implies that technical analysis does not hold any value because stock prices move according to a random walk and therefore prices cannot be predicted.

After almost forty years of debate since Fama (1970) introduced the concept of weak form market efficiency, there have been many research studies dedicated to the concept of technical analysis and whether it holds predictive powers in the stock market. This review will look at both sides of the debate and will introduce several studies that claim to have identified technical trading strategies that have outperformed a buy-and-hold investment policy.

Early studies looking at the effectiveness of technical analysis concluded that no predictive power was observed for such trading strategies. Fama and Blume (1966) found that technical trading strategies were not able to outperform a simple buy-and-hold investment policy. Furthermore, the same study found that when commissions were taken into account for a mechanical trading system the largest profits are those of the broker.

Jensen (1970) studied the ability to outperform the market using technical analysis and found that technical trading rules did not outperform the simple buy-and-hold strategy. Jensen also noted that the buy-and-hold strategy carried less risk for the trader and that efforts to refute the theory of random walks cannot be substantiated.

Because of these studies (and many others), discrediting the merits of technical analysis, most academics and many in the investment community had dismissed technical trading strategies as a means to outperform the standard

buy-and-hold strategy. However, there have been recent studies suggesting that technical analysis does hold predictive power. Brock, Lakonishok, and LeBaron (1992) (BLL) outlined technical trading strategies that provided statistically significant profitability which outperformed the buy-and-hold strategy. The BLL paper is considered a cornerstone of the field of research that looks at trading strategies employing technical analysis. The intriguing results of BLL were confirmed by Bessembinder and Chan (1995) in an article that extended the work to Asian stock markets. Their study found that the rules employed by BLL were successful at predicting stock price movement in Asian stock markets.

The remainder of this paper will be focused on expanding the work of BLL and their statistically significant trading strategies based on technical analysis. Their work will be extended beyond 1986 into the current period. This will shed light on whether their technical trading rules remain predictive. The following section, Methodology, describes the particular technical strategy employed by BLL, and used in this study. The findings of this study are described in the Results and Discussion section. Finally, the Summary and Conclusion section will summarize the purpose of the work and draw the final conclusions.

2. METHODOLOGY

There exists a wide variety of technical trading strategies utilizing a broad range of systems, indicators and price patterns that have been developed by technical analysts. The techniques popularized by BLL, and shown to produce statistically significant outperformance of the buy-and-hold policy, are known as moving average (MA) strategies. A moving average is a continuously updated value that provides an average of a historical set of numbers in a time series. A moving average is calculated by adding the stock's closing price for a number of time periods and then dividing the total by the number of periods. For example, a 150-day moving average is the sum of the closing price for the previous 150 days divided by the number of days (i.e. 150). Shorter-term moving averages respond quickly to changes in price while longer-term moving averages move much slower because of the larger data set.

The moving average strategy that is considered in this paper involves comparison of a shorter-term moving average versus a longer-term moving average. Specifically, a buy signal is generated when the shorter-term moving average crosses above the longer-term moving average. Likewise, a sell signal is generated when the shorter-term moving average crosses below the longer-term moving average. In theory, a variety of moving averages could be used for this strategy to be implemented.

The study in this paper builds on BLL's 1/150 strategy of trading the Dow Jones Industrial Average (DJIA). This implies that we are looking at a short moving average of 1 day (this is simply the closing price of the prior day) and a long moving average of 150 days. Hence, when the closing value of the index crosses above the 150-day moving average, a buy signal is triggered for the next day. As such, a sell signal is generated when the closing value of the index crosses below the 150-day moving average. Once a position is initiated, the rule requires the position to be held until a sell signal is generated by the crossing of the index below the longer moving average. Returns are then calculated based on the sum of 1-day returns. The results of this strategy for the entire study period of the DJIA (1897-1986), as reported by BLL, are provided in Table 1. As mentioned, note the high level of statistical significance attributed to their findings.

Key Results for the Full Sample Set as Reported by BLL

Results	1897 - 1986
Sample Mean Return	0.017%
Sample Std Deviation	1.080%
Sample Variance	0.00012
Total Buy Days	14866
Total Sell Days	9806
Mean Buy Day Returns	0.040%
Mean Sell Day Returns	-0.022%
Buy Day *t-stat*	2.049
Sell Day *t-stat*	-3.018

Table 1

The corresponding *t-statistics* are calculated along with daily returns. The *t-statistics* are calculated from the data as shown in Figure 1.

Calculation of *t-statistics*

$$t\text{-stat} = \frac{\mu_r - \mu}{\sqrt{\sigma^2/N + \sigma^2/N_r}}$$

Where: μ_r = mean return of buys (and sells)
μ = mean return of the sample
σ^2 = sample variance
N_r = number of signals of buys (and sells)
N = sample size

Figure 1

As noted, closing prices of the DJIA are used by BLL to conduct their analysis of the strategy. To continue their work, which concludes in December of 1986, this works extends BLL's 1/150 rule for the DJIA from January 1987 to October 2008. This will verify whether the strategy still holds predictive power. To implement the strategy it is necessary to calculate the 150-day MA for each day in the time series. The index value (recall this is the 1-day MA) is then compared to the 150-day MA to determine whether the closing price indicates a buy day or a sell day. This is done for the entire time series. Buy day returns and sell day returns are then calculated, *t-statistics* are determined, and overall returns are calculated. The techniques used for this study follow the methods employed in the original work by Brock, Lakonishok, and LeBaron (1992). Furthermore, their

results were replicated in this study in order to confirm that the calculations to determine returns were correct.

The results of the January 1987 – October 2008 data set, and comparison to the results of the July 1962 – December 1986 data set, are provided in the following section, Results and Discussion.

3. RESULTS AND DISCUSSION

The DJIA from January 1987 to October 2008 was studied in the same manner as described by BLL. The closing values of the index were obtained from Bloomberg and the 150-day MA was calculated for the data set. The sample mean return, standard deviation, and variance were calculated using Excel and following the method described by BLL. Finally, the *t-statistics* were calculated according to BLL.

Buy day returns and sell day returns were calculated in order to discern the value of the moving average strategy. The current study looked at BLL's 1/150 strategy as described earlier. The results of the moving average strategy, and comparison to the earlier period (replicated here), are provided in Table 2.

Key Results of the Moving Average Strategy

Results	1962 - 1986	1987 - 2008
Sample Mean Return	0.020%	0.029%
Sample Std Deviation	0.880%	1.144%
Sample Variance	0.00007	0.00013
Total Buy Days	3584	3520
Total Sell Days	2424	1554
Mean Buy Day Returns	0.037%	0.040%
Mean Sell Day Returns	-0.012%	-0.013%
Buy Day *t-stat*	0.940	0.466
Sell Day *t-stat*	-1.493	-1.264

Table 2

It is interesting to compare the results of this study to the July 1962 –

December 1986 period studied by BLL, and confirmed by my calculations. The

DJIA in the latter period was found to have similar return characteristics as the

earlier period studied by BLL. The mean buy day returns for the latter period

exceeded the earlier period by only 0.003%. This represents slightly higher return

characteristics in the latter period, when compared on a daily basis. More

interesting perhaps is the fact that the variance is significantly higher in the latter

period. This will have important ramifications for the value of the *t-statistic* and

consideration of the significance of results for this study.

With a *t-statistic* of 0.466 for buy days, it is difficult to argue for statistical

significance of the buy day returns. Therefore, it can be argued that, statistically

speaking, it is not clear that returns on buy days for the January 1987 – October

2008 period are different from zero. This has important consequences when

considering whether or not this moving average strategy still has predictive

power in today's market.

The *t-statistics* for the January 1987 – October 2008 time period are in

contrast to BLL's reported statistical significance of their data. The greater *t-statistics* for BLL's study are indicative of a more reliable trading strategy based

on the moving average rules. As noted earlier, the greater volatility in the latter

period has lead to the decrease in *t-statistics*, this can be rationalized by

considering the equation in Figure 1. A greater variance will lead to lower *t-statistics*, a natural interpretation of this is such that in a market with greater

volatility, it is harder to reliably determine if the technical trading strategy will hold

predictive power. That is, the greater volatility, coupled with the resulting decrease in statistical significance, has decreased the predictive abilities of BLL's technical trading rules.

The increased volatility has diminished the reliability of BLL's moving average crossover strategy. Regardless of positive buy day returns and negative sell day returns, the rules do not appear to be as successful during the latter timeframe compared to the earlier timeframe. The decrease in statistical significance has weakened the reliability of BLL's trading rules.

4. SUMMARY AND CONCLUSION

This work builds on the technical trading strategies of Brock, Lakonishok, and LeBaron (1992). Their work found statistically significant support for a profitable trading strategy based on technical analysis. Specifically, their trading strategy is based on a moving average crossover system that generates buy and sell signals based on the relative positioning of two different moving averages. They find that such a system outperformed the buy-and-hold strategy over a long time frame. This result is in sharp contrast to the weak form efficient market hypothesis. The weak form EMH states that past stock prices fully reflect all information contained in the current price of a stock and therefore technical analysis of past prices cannot be used to predict direction or outperform the market.

The work herein finds that BLL's technical trading rules still generate positive returns. However, as a result of increased volatility and the consequential decrease in statistical significance, their trading strategy does not hold the same predictive power as in the earlier period. With this in mind, it is recognized that a positive return was achieved for buy days and a negative return was achieved for sell days. The difficulty is in relation to the statistical significance of these values and whether or not they can conclusively be identified as non-zero (i.e. statistically significant).

In other words, the results imply that the rules originally studied by BLL in 1992, when applied to a more recent data set, do not necessarily outperform the buy-and-hold investment strategy because it is unclear whether the returns are different from zero. Strong statistical significance, as reported by BLL for the earlier period, must hold in order to conclude the strategy offers an improvement over buy-and-hold. As such, the technical trading rules discussed here, and originally laid out by BLL, do not appear to offer a viable investment strategy in the current market. Even though BLL found that the rules were sound in the market through 1986, market conditions have changed such that the rules do not hold the same effectiveness.

In conclusion, BLL's trading strategies that were found to be effective in the market through 1986 do not appear to be effective in today's market. Higher volatility leading to lower statistical significance makes it difficult to conclude the rules provide an edge to the trader. Even though the results appear to provide positive returns on buy days and negative returns on sell days, the results are not reliable due to a lack of statistical significance.

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