

Abstract

WEST, DONALD RAY. *Markov Model for Stock Market Buy and Sell Strategy*. (Under the direction of Dr. Russell E. King and Dr. Thom J. Hodgson.)

Approximately 50% of the households in America invest in the stock market. In many cases the investor's buy and hold strategy leads to negative returns. Given the stock market fluctuates up and down as time progresses, analysts examine stock prices, volumes traded and ratios to recommend buy and sell opportunities.

The pattern of price and volume changes provides input for the analysts' recommendations. Using these patterns in a Markov model, this dissertation contains an intensive analysis of 41 securities over a 13-year period. The model establishes states of change in price and volume and calculates the best investor action for an individual security.

The selection of the proper security enhances the investor's probability of achieving an exceptional return. The research examines the correlation of price and volume characteristics to overall return. With the proper correlation, higher yielding securities may be selected. Once selected, the dissertation's research recommends when to switch from one security to another security. Also, periods of staying in a cash position are recommended.

Overall this model outperforms the average yearly buy and hold return of eleven percent by about four additional percentage points. Even subtracting the cost of the transactions, the model buys and sells the securities to obtain the additional return.

MARKOV MODEL FOR STOCK MARKET BUY AND SELL STRATEGY

by
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Biography

Donald Ray West was born in Smithfield, North Carolina on August 13, 1947. In 1965, he enrolled at North Carolina State University. In 1969, he received his bachelor's degree in industrial engineering. Upon graduation, he began employment with Western Electric in Greensboro, North Carolina. During his employment, he completed his master's degree in industrial engineering from North Carolina State University and a minor in business administration from the University of North Carolina at Greensboro. These degrees were conferred in 1972. In 1973, he obtained his professional engineering license in the state of North Carolina.

Don served Western Electric, ATT and Lucent as an engineering manager in software development, quality and international consulting. In late 1997, Don again began an advanced degree in industrial engineering. In late 2001, after his retirement from Lucent, his research on the topic of market buy and sell strategies began.

Don is a Tau Beta Pi member and Certified Quality and Data Manager. He has served as a Baldrige examiner and Visiting Executive to the University of North Carolina at Greensboro.

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Chapter 1 Introduction

Presently, about 50% of the households in America are investing a very large amount of their personal wealth in the securities market. In 1998, stocks represent 34 percent of the average household's financial assets (Vogelheim, *et al.* 2001). Many of these investors rely on the services of a fund manager. The manager may invest in individual stocks for the investor or place the investor into a mutual fund. Other investors "play the market" and invest in individual securities.

Investors use different approaches to the interval in which they hold their stock. Some buy and hold the stock forever. Some purchase on an averaging technique – investing a fixed amount each month. While investors at the other extreme of buy and hold, use the Internet and electronic brokerage firms to trade on a daily basis. All groups tell their anecdotal stories of success and failure. All trade with their personalities and emotions in full gear helping or hindering their chance at success.

Regardless of approach or emotions, most investors are interested in achieving attractive returns with a minimum amount of risk. The purpose of this paper is to present an emotionless model to allow one to achieve superior returns in the stock market. The model does not force the investor to assume an inordinate amount of risk for success. The model attempts to place logic in a rather illogical world.

1.1 Problem Definition

To understand the problem, examine the graph on the following page that provides the average of price and volume of the S&P 500 since 1993. This index represents about 70% of the U.S. equities market. Members of the S&P may be found in Appendix A.



Figure 1.1 – Standard and Poor’s Daily Closing Price and Volume

The problem is both simple and complex. In the simple environment, one lives in the bull market of 1995 through 1999. During this period the U.S. stock market grows in excess of 20% per year. Most all strategies are successful during this period. For the complex, step into the year 2000 or 2001 or 2002. During these three years, the market loses 10%, 13% and 22%, respectively. Wise investors would be out of the market, investing in individual stocks whose direction differ from the market or be moving in and out of the market securities at the appropriate times during those periods to obtain a gain.

This paper’s approach is the latter – to determine buy and sell rules to enter and leave the market. This approach encounters both allies and opponents. A large part of the problem is to prove that this approach provides better than market returns and avoids placing the investor in a very risky situation. Fundamental to solving this problem is the impediment of an efficient market regarding market timing. If the market is strongly efficient, it has been theorized that only new information impacts the value of a stock and timing (buying and selling) does not work.

1.2 Proposal Overview

The approach is to first gather information regarding past research and achievements in this area. Special attention is paid to persons who generate superior results with a timing strategy using trading rules. This literature review also focuses on key issues to the obvious questions surrounding this paper's objective. Some of those issues included:

- 1) Market
- 2) Role of the Specialist
- 3) Risk and Return
- 4) Traditional Model of Security Value
- 5) Market Efficiency
- 6) Fundamental and Technical Analysts
- 7) Psychology and Behavior
- 8) Trading Rules
- 9) Buy and Hold
- 10) Results

The literature review is in Chapter 2.

Chapter 3 addresses market efficiency and the potential for large returns via a market timing strategy. Many recent academic studies support a non-efficient market. These studies leverage this inefficiency to trade in the market with superior results. This paper's approach to this area is to present a model that is thoroughly tested with real data producing real results. Although some broad observations with respect to market efficiency are addressed, the proof or disproof of strong market efficiency is not the intent of this research. Chapter 3 also contains examples of ideal returns for stock strategies based on trading rules. This paper only addresses the long position. Long positions buy the security and sell the held security. No short positions are ever assumed. Short positions would allow the investor to reap financial gain through a drop in price of the security. Short positions assuming a small commission would provide even better results than are presented in this research.

Chapter 4 explains the terms of the base model and the operation. In chapter 4, the model construction uses price change data. From changes in the price, a unique state is formed. Historical data on a given security is divided into two periods: a “learning” period to initially train the model and a “testing” period to determine the performance of the model. The model then uses the learning period to determine the proper action to be taken when this state is encountered in the testing period. If insufficient data is present, the model simplifies the state to obtain a reliable state from which to make a decision. Once a reliable state is obtained, the model examines the results of the following day and determines the best action to be taken. These actions are based upon the expected dollar return from the change in closing price. Then this action or policy is executed against the testing data. The policy is maintained for a weekly period and then the model is retrained and made available for the next week of testing data. From this learning and relearning, the policies are established to enter and leave the market. A table displays the recommended actions the model generates. Chapter 4 also provides a definition of the alternate strategies to which the model’s yearly returns are compared. These strategies include buy and hold, random trips, and two monthly fixed dollar-buying scenarios.

Chapter 4 addresses model results. Selection of securities to provide data for the model is the first step. Given the large number of securities (7,000) and mutual funds (8,300), the selection of data is a challenge. One technique to cover a wide band of securities is to use the S&P 500 index. This index contains the 500 largest U.S. publicly traded companies. The value of all of these stocks represents about 70% of the U.S. equity market and about 35% of the world equity market.

The results are analyzed with the data from a multitude of intervals for model training and model testing. That is, the data are analyzed with a variety of start and stop points. Both time spans used to train the model and to test the policies are varied. Policies are established during the training period. All transaction costs are considered in purchasing and selling the securities. Commissions and interest rates earned are from a popular on line brokerage firm. Data are obtained from a common source available to the average investor. For analysis, the daily closing price is used to enter and leave the market.

Chapter 4 compares the model's expected yearly returns with the returns of the competing strategies of buy and hold, random trips and monthly fixed dollar buying. The returns from the buying and selling are generated and converted to a percentage return for the year. The model also includes a modest return from funds when these funds are not in the market. Commissions are included. Whole numbers of shares are also required.

Chapter 5 repeats the analysis of chapter 4; however, the model is modified to use a change in volume. All of the tables, returns and possible correlations repeat for the original 21 selected securities.

Chapter 6 addresses additional research logically associated with the operation and expansion of the basic model to include a compound state form with both price and volume changes. At this point in the research, all of the securities examined had been forced to select one price / volume change pattern and use this pattern for the entire length of the experiment.

In chapter 7, a dynamic model examines variation of length and composition of pattern. This research allows the length and pattern composition to change as the experiment progresses. Questions relating to length of time to process before changing pattern, how to determine what is better, and how long to stay with the new pattern are examined for the 21 securities.

Chapter 8 involves a major investigation into a weaving process selecting the best security for investment for a series of 3-month time frames. This chapter's research combines the earlier dynamic compound results with price and volume characteristics of the stock. By examining the price and volume characteristics, the model is able to suggest the correct stock to follow for a time period. The model also recommends periods in which no stock is suitable and maintains a "cash only position" for those periods.

Chapter 9 regenerates a second set of securities for investigation. This set consists of 41 securities. This action updates the examination period to a more current date and provided a fresh set of securities for analysis. This chapter reexamines the previous model and produces good results.

Chapter 10 selects stocks that perform well with the model. This technique allows a smaller number of well-behaved stocks to generate returns better than a larger set of more random stocks. This technique involves correlation of stock price and volume characteristics with price changes.

Chapter 11 contains high-level conclusions. The chapter also recommends future research and improvements for the model.

Chapter 2 Literature Review

2.1 Introduction

Very few areas garner the amount of research that forecasting in the securities market captures. However, given the economic wealth obtained from success in this area, most of the successful findings are either not published or sequestered away in the research staffs of the more than 1000 brokerage/investment firms. Fadlalla and Lin (2001) in their research on the subject of trading rules comment that it is difficult to obtain information on actual applications. “Although a large number of actual systems may be in production, the sponsoring companies may not wish to divulge information on the successful applications,” (Fadlalla and Lin, 2001). Even with this slight disadvantage, they note that many large funds currently use modeling to improve their yields.

2.2 Market

Palmiero (2001) and The Salomon Smith Barney firm provide excellent insight into the world equity market. Presently, the U.S. stock exchanges represent about 50% of the total world financial markets. Basic logic contends that the many stockholders who invest into shares of the company control ownership of these publicly traded companies. With the exception of the smaller companies, one or two or even a small group of investors do not control the majority of shares of large capitalized companies. Many individual investors own the majority of the stock. These individual’s main measure of success is the growth in share value and the receipt of dividends. Ownership for ego or non-financial reasons is not considered in this document and in general is not prevalent in the stockholder universe.

However, this paper is not implying that stockowners including fund managers behave rationally. Shiller (2001) shows that individuals at all levels of the investment chain at times act very irrationally. Overconfidence, attention anomalies, self-esteem, and conformity pressures are forces that lead to speculative bubbles in the stock markets.

Stock ownership in America continues to grow tremendously. According to Darbonne and Read (2000) one-half of the US households own stock. Retail investors account for 75% of the Nasdaq trades. Stock accounts for 25-35% of all U.S. household wealth. The stockholders are investors taking an active or passive position in the market. The active investor purchases securities through a stockbroker. This purchase may be electronic, via the phone or made in person. The passive investor invests in mutual funds. The fund manager pools investments and buys and sells securities in the fund. Mutual funds are very popular in America with 7 trillion invested and over 8,300 funds being managed (Jones, 2000).

Although managed by professional fund managers, the average mutual fund actually underperforms the average of the market. To counter this problem, funds have been created that index the market and follow the overall of the stocks through the index. Pressure is tremendous on fund managers with the average tenure being about 4 years.

In the primary market, funds are initially raised for the company through initial program offerings. Future exchanges of shares are in the secondary market. The majority of the stock transactions are in this secondary market. That is, the company obtains the capital from the origination of the stock and now the security is “traded” in the open market. The U.S. secondary market consists of three major exchanges – New York, NASDAQ, and American.

Sofianos and Werner (2000) provide a window into the floor brokers world on the New York Stock Exchange. The New York Stock Exchange (NYSE) has been in existence for about 200 years. On the New York exchange, a specialist is assigned to a stock. The specialist assists in maintaining an orderly trade of the security. Of the public orders, 85% clear the market; however, on about 10-15% of the market trades, the specialist is required to remove stock from his/her inventory or place stock into his/her inventory to complete the transaction.

2.3 New York Stock Exchange Specialist

Specialists are obligated to maintain a “fair and orderly market.” In the purest form, root-cause scenario, the inventory level of the specialist determines the price of the security. As the inventory rises, the stock will drop in price. As the inventory wanes, the stock price will rise in price. Of course, the pressure on the inventory is created by the number of buy or sell

orders that must be executed. The pressure is relieved throughout the day with price changes and a larger adjustment is found in the following days' opening price. Madhavan and Panchapagesan (2002) provide further information about the opening day price. "Price continuity" is a major component of an orderly market. This may obligate the specialist to "lean against the wind" (Madhavan and Panchapagesan, 2002) with the opening price. The floor traders serve as a buffer to absorb some of the imbalance for clients and may take a position in the security after the book has been satisfied at the bid.

2.4 Market Risk/Return

Jones (2000) and other market experts show and confirm that return on investments must be coupled with the amount of assumable risk. Higher risks demand a higher return from the security. Variability in the stock price generates the measure of risks. Standard deviation in price is a normal measure. Beta, which scales the standard deviation with the market, is expressed as a ratio of stock variability with the overall market's variability. A beta of one for a stock implies the variability is the same as the market. A beta greater than one is more variable whereas less than one is less variable.

Although some may argue that the returns are completely random and stocks take a random walk in relation to their price, investors and money managers' actions do not logically follow this pattern (Shiller, 2001). History seems to support the non-randomness of the market with a 10-11% gain per year from 1920 through 2001 (Jones, 2000).

Along with the decline in inflation rates, 1995-1999 are the 5 greatest years in the US stock markets' history. Returns are 30% plus for 1995 through 1998 and 20% for 1999. The chart in the introduction of this paper presents this information in a graphical manner.

Markowitz (1952) best captured the balance between return and risks in the 50's in his analysis of portfolios. The portfolio has an efficient frontier built upon the standard deviation (risk), expected return, and investor's indifference curve.

Return on the security is the most difficult item to estimate. Return consists of change in price of the security plus dividends paid by the security. Dividends are becoming less

popular in the US stock market. Managers argue that dividends are taxed twice and that the company can better use the capital to expand the company. Another more sinister reason is that the earning's averages have dropped in relation to the stocks to the degree that many companies are now unable to meet dividend payments without borrowing funds. Borrowing to pay dividends is not as rare as one would surmise.

2.5 Security Value

Since much of the return is encapsulated in the price of the security, the ability to estimate this value is very important. Fundamentalists use basic measures to determine the “fair” price of a security. One of the basic methods involves dividends. Although during a majority of the time examined companies have increasingly abandoned paying dividends, purists still desire to measure the value of stocks based on the Dividend Discount Model. The DDM is simply

$$P = \sum D^t / (1 + k)^t$$

where “P” is the target price, “k” is the required rate of return, “D” is the expected dividend, and “t” is the time period.

Another fundamental technique is to multiply expected earnings by the expected price to earning ratio to generate an intrinsic value. (Farrell, 1997)

2.6 Market Efficiency

Efficiency is defined as to the relationship of the stock price to the current information pertaining to the stock. If the stock is priced correctly based on the information, then the market is said to be efficient. If the stock over reacts or under reacts or lags the information, the market is exhibiting inefficiency.

Skouras (2001) maintains that efficient markets are impossible to predict through the analysis of past price patterns as done by the technician. He does acknowledge that an artificially intelligent agent, one who learns from past success and failures, may be used to define the

degree of efficiency of the market. Furthermore, he continues and defines a “lack of inter-temporal arbitrage hypothesis” to explain the degree of efficiency of the market.

One of the most pervasive issues in the last 30 years is the answer to the question “Is the market efficient?” No one seems to know the degree of efficiency of the market; however, one’s answer to this question greatly determines how he/she will invest.

What is agreed is the definition of the degrees of market efficiency. Strong efficiency states that all information both public and private is reflected in the price of the stock.

Semi-strong efficiency states that only the public information is reflected in the price of the stock. Insiders still have information that is not available to the public.

Advocates of weak efficiency (the lowest level) believe only that any information gained from examining the security’s past trading history is reflected in the price. Leigh, Paz, and Purvis (2002) make the following observation about market efficiency. They contend that since past trading history is public information, the weak efficiency is a form of the semi-strong.

Even Lo and MacKinlay (1999), after rejecting the random walk hypotheses for weekly stock market returns, stop short of necessarily implying the inefficiency of stock price performance. They do imply that the standard Black-Sholes pricing formula (Black and Sholes, 1973) for stock index options is incorrectly specified.

Jones (2000) has identified at least five anomalies that discredit strong efficiency. They are:

- 1) Stock price changes from surprise earnings lag the announcement,
- 2) Low P/E stocks outperform high P/E stocks,
- 3) Small New York Stock Exchange issues outperform large issues,
- 4) Stocks rise in January, and
- 5) Timeliness recommendations in Value Line lead the market.

Haugen (1995) makes a strong case against an efficient market providing support for the ability to profit from these inefficiencies. In one example, he quotes Fama and French (1989) who published a 30-year study dealing with book value and present value of

securities. Their findings state that book value reflects historical cost and has no value in predicting the future value of a security.

Dreman (2001) makes an interesting observation in that the bursting of the market bubble has cost the investors \$4.6 billion to date. He concludes that the market's actions are a "mishmash of directions by fallible human beings."

2.7 Fundamentalist/Technicians

Depending on one's view of the market efficiency, analysts have two extremes for determining intrinsic and predicted equity value. One extreme is a pure fundamentalist and the other is the technician.

The fundamental analyst believes that the market exhibits strong efficiency and that every piece of information both good and bad is known and reflected in the current price. Positions of a fundamentalist will most likely be fairly low price/earnings ratio, low company debt, and low price to sales ratios. The fundamentalist will most likely follow heavy diversification and recommend a buy and hold strategy.

At the other end of the scale is the technical analyst or chartist. This analyst believes that by viewing the price movements and the volumes of a security, the future price can be estimated. These analysts are concerned solely with the daily dynamics of the markets. Bulkowski (2000) summarizes chart patterns in his recent work. Many articles and advice abound built around the price and volume charts of securities. In addition, many of the terms that have become standard jargon in the industry stem from basic technical analysis. Terms, such as, "price support at," "major breakout," and "head and shoulders pattern" all have derived from the tools of the technicians. Even the expression "the trend is your friend" is derived from graphs displaying the trend as a stock moves.

In fairness, perhaps 25% of the analysts fall in the extremes of fundamentalist or technician. The majority of analysts use a combination of the two strategies.

Walker and Hatfield (1996) share the following information concerning analysts. Despite much time and money being expended on fundamental and technical analysis, the average

investor does not benefit from the advice. The immediate impact, either up or down, on the security is experienced. That is, positive recommendations of strong buy or buy and repeat buy drive the stock price up about 4%. Negative recommendations (buy to hold and sell) drive the stock price down by 4% to 6%. However, these movements are short lived and the stocks settle back to normal levels before the average investor reaps the benefits.

This fact is not lost when the recommendations are examined in relation to the average investor's position. Cumby and Modest (1987) use the Henriksson-Merton test to examine the success of financial advisors. Although they support the ability to exploit market timing when all of the available data are used, they conclude that financial advisors do not demonstrate these better results. Identified potential shortcomings of fund managers are: they do not have superior information, are unable to capitalize on information they do possess, or management fees offset any gains.

These current findings about the strength of technical analysis merely reinforce what had been discovered many years ago. Treynor and Ferguson (1985) show that past prices when coupled with other valuable information could indeed be helpful in achieving unusual profit. They published in 1985 before the big bull market of the early 90's.

2.8 Psychology and Behavior

Market psychologies continue. Shiller (2001) publishes that investors are emotional and that the emotions have a major impact on their actions. The theory is that investors tend to hold stocks and avoid selling those that have gone down in order to avoid the pain and regret of having made a bad investment choice. Many investors find it easier to follow the crowd and buy a popular stock and rationalize in the event of a drop in price. Because money managers will most likely not be fired if a well know and touted stock underperforms, the money managers and advisors favor well know companies

Regardless of the degree, these emotions keep people from being totally rational with respect to the stock market. This irrationality introduces actions moving the market from a strong efficient state into a state allowing for profits to be gained from trading rules.

2.9 Trading Rules

In the late 1880's, Charles Dow developed the original theory of technical analysis and published his findings in a series of newspaper articles in the Wall Street Journal. From his earlier works, years of improvements and enhancements have been made. Edwards and Magee (1997) provide a modern explanation of the Dow analysis and charting trends in general.

Alexander (1961) generates one of the earlier computer assisted stock signal rules. The rule generates a buy signal when the stock moves at least $x\%$ from the past local low and a sell signal when the stock moves $x\%$ above the past local high.

Fama and Blume (1966) later reveal that with the addition of transactions cost, Alexander's (Alexander, 1961) technique would not perform better than the buy and hold strategy. However, their work is predicated on rather high transaction costs. Reexamination by Sweeny (1988) reveals that with lower transaction costs the " $x\%$ " signals would yield better results than the buy and hold strategy.

DeBondt and Thaler (1985) use trading rules in simulating the market. They attempt to prove that the market is overbought or oversold due to investor overreaction. They use a rule to build "winner" and "loser" portfolios and evaluate these against the market as a whole.

Viewing only the information about the stock prices, Bulkley and Tonks (1992) generate a switching rule moving from stocks into risk-free assets. Their research gives credibility and support to the notion that long-run volatility in the market produces excesses that allow for exploitation and performance exceeding the buy and hold strategy.

Brock, Lakonishod and LeBaron (1992) combine trading rules with a bootstrap simulation technique to produce positive results and challenge the equilibrium model of asset prices. They focus on moving average and trading range breakout to signal a change in market position. The sell signal in this model is fairly successful in predicting down turns in the market.

Zhang (2001) builds a stock-trading model around Brownian motion. He bounds the up and down movement of the stock to signal leaving and entering the market. Ten percent down and 50 percent up prove to be the best bounds. Using these simple rules of exit and entry generate favorable returns.

Pau (1991) provides price evolution descriptions by the use of context-sensitive terminal symbols to capture the price-evolution patterns of technical analysis. He comments on the difficulty of this task and provides a limited amount of real quantifiable results.

Although most of the models build policies on price alone, McMillan (2001) uses macro external data for his modeling. Financial and macro-economic data include 3-month Treasury bill (T-bill), 12 month T-bill, unemployment, industrial production, consumer price index and money supply (M1). Using these to construct states, he examines the S&P 500 on a monthly basis from 1970 through 1995. Using the Augmented Dickey-Fuller tests, he concludes nonlinear models provide a slightly better forecast gain than the linear model. Although not providing economic results, McMillan does endorse the ability to predict.

Leigh, Paz and Purvis (2002) provide forecasting results. They use hybrid neural network with pattern recognition to predict short-term gains on the New York Stock Exchange. They use Pattern Recognition Workbench to identify a flag breakout. Overall this technique provides a 60% success rate on buys. One weakness of the study is that the training data for the last five days of the 1000-day training period includes the first 5 days of the testing (out-of-sample) period. In fairness to the researchers, they conduct later studies with the “bull flag” and do not mention this overlapping period difficulty. This author assumes this slight problem no longer exists. See the “Articles in Press.”

Fadlalla and Lin (2001) expound the value of neural networks in forecasting in the financial markets. They survey firms and obtain the firm’s results. One large equipment company uses the neural network system to improve the performance of their pension fund. The company has beaten the S&P by about 3%.

Schierholt and Dagli (2000) also use neural networks against the S&P 500 index. Using the model’s recommendation, they are able to perform better than the index averages.

Coy (2000) also finds that Lo, Mamaysky and Wang at MIT have obtained 4% positive on the buy signal of an inversed head and shoulder pattern and a 6.2% decrease for broadening bottoms. These results mirror the up and down percentage occurring with analyst's recommendations observed by Walker and Hatfield (1996).

Breen, Hodrick and Korajczyk (2002) examine liquidity of a security based on size, historical relative trading volume, institutional holdings and the inverse of stock price. They also acknowledge the popularity of the S&P 500 index as a universal benchmark for the passive index funds. They state that liquidity improves with addition of a firm to the S&P 500 index. Market timing strategies are researched and successes achieved on non-U.S. exchanges. For the exchanges in Poland, Korea, Hong Kong, and Taiwan, the following studies have been performed.

Poland

Chrobak, Pacut, and Karbowski (2000) examine stocks on the Warsaw Stock Exchange for the period from 1994 through 1998. They examine with dynamic programming, ARMA, Markov and NARMA models against Q-learning. Best results are obtained from the ARMA model. The Q-learning provides the poorest results.

Korea

Oh and Kim (2002) examine tick data for short term day trading. They use chaotic analysis and back propagation neural networks. They found the results encouraging when measuring against the Korean KOSPI 200.

Kim and Han (2001) also investigate the KOSPI 200. Their findings encourage a do nothing policy when the signals are not clear. They use nine attributes – stochastic (%K and %D), RSI, momentum, rate of change, oscillator, commodity channel index, price oscillator and disparity (5 day).

Hong Kong

Li and Lam (2002) examine the impact of transaction costs on market timing strategies on the Hang Seng Index Futures market. They use the technical trading

rule called the momentum index-trading rule that uses two threshold values. In his model, the investor is either “in” or “out” of the market. While out of the market, a risk-free return is assumed. Given a portion of the time the model is operating in the risk free environment, Li devalues the risk penalty. His logic is the buy and hold investor is continuously exposed to the risk; however, with his model having only a portion of the time in the market and a portion of time in the risk free, his risk penalty is much less.

Taiwan

Wang (2002) proposes to use a fuzzy grey technique to reduce the amount of data reviewed for predictions. Wang states that speed is very important to the operation of a day trader.

Last, Klein and Kandel (2001) use “fuzzification” and aggregation to reduce the number of discovery rules. The discovery rules then drive the buy and sell decision. They use this technique to improve the performance of their market model.

Wulthrich, Cho, Leung, Permuntilleke, Sankaran, Zhange, and Lam (1998) examine textual web data from world news services on five major world indices. Their technique is to determine if the market will be strong for the day. Predictions using this technique are above random guessing and could be a tool for the direction of short-term investments. Only “word count” drives this model. Their predictions are not based on numeric information.

For a really long view of the trading rules, Gencay (1998) studies the Dow Jones Industrial index data from 1897 to 1988. He uses the moving average signal for entering and leaving the market. His model outperforms the index and provides a 10% forecast improvement in the most volatile years of the market.

2.10 Buy and Hold

A standard for stock investing is to buy and hold. Any serious trading rule model will be required to be examined against the basic buy and hold strategy. Dollar averaging is another popular method of stock accumulation that will need to be compared to the trading rules.

El-Yaniv (1998) explains that a buy and hold strategy is also a market timing strategy. His logic is “sooner or later” owners of securities want to realize monetary value of the assets being held. Hence, whether a strategy is “buy and hold” or “market timing” is relative to the time horizon the stock is held. Further, he states market timing has the potential for tremendous returns. The Dow Jones Industrial Average has grown 11.2 percent compounded from 1946 through 1991. With a simple market timing strategy that allows one to be outside of the market for the 50 weakest months, the returns increase to 19% compounded annually.

Dollar averaging is examined in relation to buy and hold for stocks on the Taipei Stock Exchange (Chen, Kao, Lyuu, and Wong, 2001). In their findings, a recommended “phase purchase dollar averaging hold” proved stronger than the long-term buy and hold. Although their research targeted two very large companies, the sample of two is very small.

2.11 Articles in Press

Four unpublished articles add information to help direct and support actions of this paper’s investigation.

Leigh, Paz, and Purvis (2002) results support the validity of technical analysis for stock market price predictions and fail to confirm the efficient market hypothesis. Leigh and all expand and continue earlier work using the “bull flag.” Leigh (2002) examines data from the New York Stock Exchange Composite index for 4748 days from 1980 through 1999.

Two articles deal with forecasting accuracy.

Ashley (2001) examines the partitioning of data for the model estimation (training portion) and evaluation (out-of-sample/validation/testing) region. He maintains that a validation period of 100 observations is typically required for a 20% mean square forecast error.

Sullivan, Timmermann and White (2001) do an empirical example of predictions on technical trading rules and calendar rules. They caution against data sharing which is a common practice in forecasting situations. They use rules to attempt to discover repeated patterns in stock prices, for example by comparing short-term movements to long-term trends. They consider about 497 filter rules.

2.12 Results

The correctness of the results is very important. Schwager (1999) cautions against analysis that generates market-timing models that ignore transaction costs and limit the days examined to improve the reported results. He also encourages the modeler to compute a percent return for comparison, measure the risk, stabilize the model parameters and ascertain favorable performance for the total period rather than a reflection of a few isolated intervals of extraordinary performance.

Chapter 3 Market Timing/Efficiency

Many of the recent researchers affirm the inefficiency of the market. The literature review presented in chapter 2 provides many of the research discoveries. In addition, much success is being achieved through the use of technical analysis and the accompanying timing rules. For the technical analyst to be successful, a degree of non-randomness and repeatability must be present in the data.

Regardless of the degree of market inefficiency, this paper attempts to capture the patterns that occur and form policies that profit from those occurrences. Finding success here becomes further support for a market that is not strongly efficient.

The activity of buying or selling in our model depends upon the state of the security. The state is formed from the price and volume changes that have occurred before this day. At the close of each day, the model examines a finite number of days before this close and generates a state. The model's state consists of price and volume data for between two and fifteen days of history. Later in the analysis, the state consists of the combination of price change and volume change. It is assumed that the next state is based only on the immediately preceding state (Markov property). Thus, the present position of the security is the result of a series of Markovian steps from previous states, i.e. a Markov chain (Winston, 1994).

Chrobak et al. (2000) use the hidden Markov chain as part of their market characterization in forecasting market timing. They characterize the present state of the stock market as Markovian transitions relating to changes in past prices and volumes. These past states deliver the security to a present state.

As mentioned earlier, this paper examines the prices in a more direct manner. First, the paper briefly examines the "randomness" of the stock market.

A straightforward technique to examine a large portion of the U.S. stock market is to examine the movement of the S&P 500 index fund (symbol– SPY). The names of the U.S. firms in this index reside in Appendix A. Formed in 1993, this fund provides an economical method for one to diversify - simply and economically in the U.S. stock market. This

diversification is achieved with a smaller management fee than is usually incurred with a mutual fund. In addition, the index is “managed” in that companies are periodically removed (usually for financial reasons) and others placed in the index.

For an investor, to participate in the S&P 500 index is as simple as purchasing any stock. All of the benefits of tax profit and loss and their timing are in the investor’s control.

Furthermore, investor exposure to the wild cyclical activities, sometime experienced with an individual security, is reduced with the diversity of the S&P fund. The index consists of 400 industrial, 20 transportation, 40 utility, and 40 financial stocks. One last benefit of the S&P 500 – SPY is that the Beta value (volatility) is very reasonable with relation to overall market variability. Presently, the five-year Beta value is 0.98 (<http://www.quicken.com/>), which is almost equal to the market value of one as a whole. Beta is the standard deviation of the stock divided by the standard deviation of the market overall multiplied by the stocks correlation to the overall market. For a more complete definition of Beta see Appendix B.

For these reasons, the model examines SPY data first and assumes the SPY best emulates a typical stock.

3.1 Autocorrelation Analysis

The model uses our typical stock (SPY) to provide the graphical information for the following chart. The Internet YAHOO database (<http://finance.yahoo.com/>) is used to obtain data on prices, volumes and changes. This database access is free. Access provides a downloadable file to Excel for user analysis. The model selects a period from March 6, 1997 through March 5, 2002 for this analysis. The plot on the following page contains only the closing price (SPY), which is a composite of all of the S&P 500 stocks for the aforementioned period.

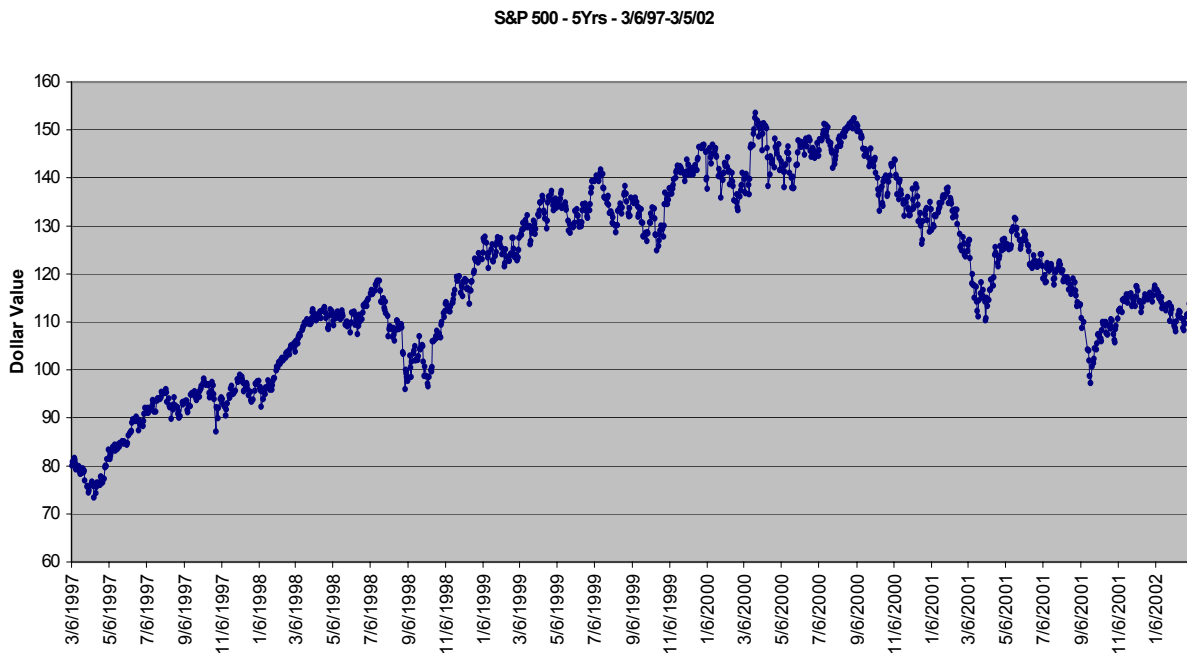


Figure 3.1 – Standard & Poor’s Closing Price

First examine the autocorrelation of the data. The autocorrelation is examined for a lag of 1 to 500 days. The formula used to estimate the autocorrelation is

$$r_k = \frac{\sum_{t=k+1}^n (y_t - \bar{y})(y_{t-k} - \bar{y})}{\sum_{t=1}^n (y_t - \bar{y})^2}$$

where the r_k is the autocorrelation for an assigned lag of k . The y_t represents the closing price of the S&P 500 on the t^{th} day.

When examining price of most any stock on the exchange, there is almost always a strong correlation between today’s price and tomorrow’s price. A naïve forecast for tomorrow’s price would be today’s price. One would have a reasonable value with that forecast. These values, today’s price and tomorrow’s price correlate strongly. Makridakis, Wheelwright, and Hyndman (1998) provide statistical methods showing this relationship.

The following chart reveals strong autocorrelation for the short lag periods for the SPY data.

Table 3.1 – Subset of Autocorrelations of Standard & Poor’s Closing Price

Autocorrelation all 5 years - 1-40 and 321-360 lag								
Lag	<i>r</i> value	Lag	<i>r</i> value	Lag	<i>r</i> value	Lag	<i>r</i> value	
1	0.9965	21	0.9481		321	0.0676	341	0.0314
2	0.9932	22	0.946		322	0.0643	342	0.0288
3	0.9903	23	0.9441		323	0.0613	343	0.0262
4	0.9877	24	0.9422		324	0.0592	344	0.0245
5	0.9851	25	0.9401		325	0.0577	345	0.0225
6	0.9826	26	0.938		326	0.0561	346	0.0207
7	0.9803	27	0.936		327	0.0546	347	0.0185
8	0.9783	28	0.9335		328	0.0532	348	0.0163
9	0.9764	29	0.9312		329	0.0514	349	0.0141
10	0.9745	30	0.9287		330	0.0499	350	0.0118
11	0.9724	31	0.9261		331	0.0483	351	0.0097
12	0.9705	32	0.9234		332	0.0467	352	0.0076
13	0.968	33	0.9212		333	0.045	353	0.005
14	0.9653	34	0.919		334	0.0431	354	0.0026
15	0.9629	35	0.9176		335	0.0413	355	-0.0004
16	0.9602	36	0.9163		336	0.0399	356	-0.0035
17	0.9577	37	0.9147		337	0.0387	357	-0.0072
18	0.9552	38	0.9133		338	0.0378	358	-0.0112
19	0.953	39	0.9117		339	0.0362	359	-0.0157
20	0.9505	40	0.9098		340	0.034	360	-0.0203

Plotting the data provides autocorrelation as shown in the graph that follows. The small lags of one and two days have very high correlation approaching 0.9965 and 0.9932, respectively. Notice that the autocorrelation drops below zero at about 354 days of lag. Do not confuse the 354 days with a calendar year. Remember, about 252 days generate one trading year on the stock market.

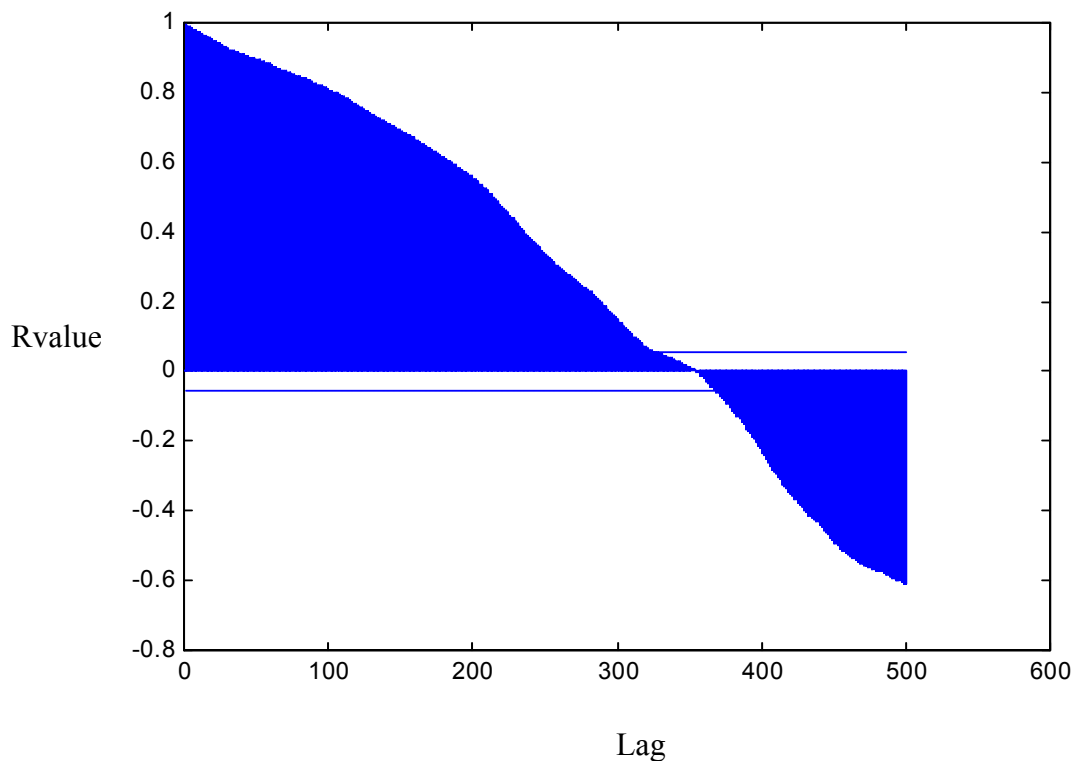


Figure 3.2 – Correlation for Closing Price in S&P for Lags

For the SPY, after one and one-half market years, there appears to be little relation in the closing price and today's closing price. However, the shorter time periods are autocorrelated.

For lags less than 50 days, the graphed autocorrelation data suggests a strong relationship between the data points. As stated, this is especially true for the low lag values of 10 days or

less. Some may conclude this supports the camp of theorists using technical analysis and its theories to predict future trends.

Taking the differences in the closing price from day to day converts the series into one approaching white noise. That is the daily change in closing price is almost a random amount uncorrelated with the previous days.

Also, in a buy and sell environment, one's wealth is not predicated on the price of the stock, but is determined by the change in the price of the stock while in one's possession. In reality, the change in stock value from day to day is the key to wealth obtainment and the driver for successful market timing strategies.

Examining the change in price from day to day for the S&P data yields the following chart.

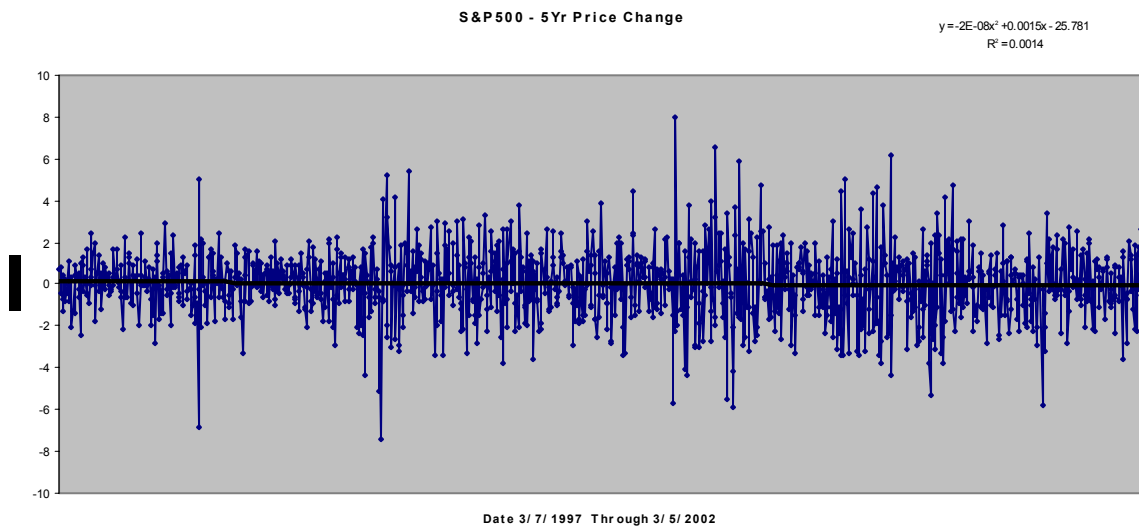


Figure 3.3 – Change in Daily Price in S&P Closing Price

The above chart provides the change in price for each of the 1,225 days of examination. These data appear to have no relationship between today's change and tomorrow's change. Indeed these data yield autocorrelations for the lags that imply random distribution. The following autocorrelation chart is generated for a lag of 1 to 500 days and is as follows.

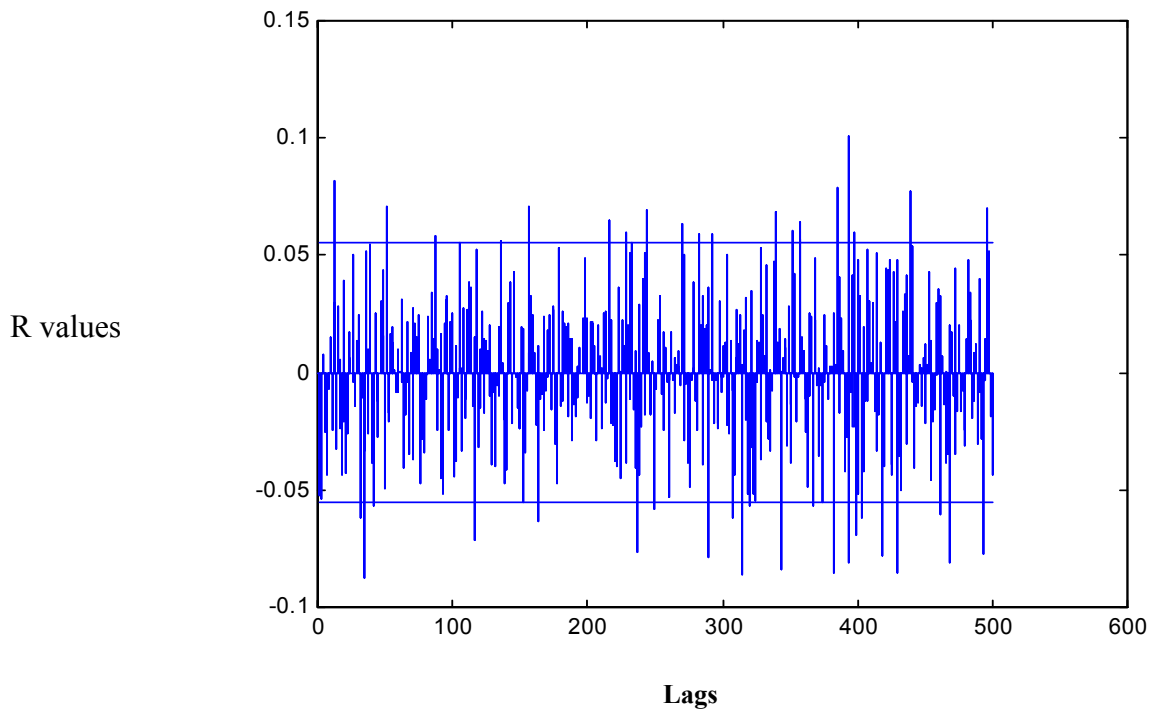


Figure 3.4 – Correlation for Closing Price Change in S&P for Lags

On the previous figure, notice these correlation values are 0.1 or less. Most of these values reside in the +/-0.025 range. Also, notice these correlations swing above and below the “0” line. Standard statistical tests may be used to examine these values. One test is the standard deviation of the estimator.

The standard deviation of the estimator is called its standard error and designated as S.E. (Bhattacharyya and Johnson, 1977). For the above changes in price, the mean should be zero and the standard deviation is computed as

$$S.E. = \frac{1}{\sqrt{n}}.$$

For the values to be white noise, 95% of all sample autocorrelation coefficients must lie within a range specified by the mean plus or minus 1.96 standard errors. If not the case, the series is probably not white noise (Madridakis, Wheelwright and Hyndman, 1998).

Given the values should statistically fall within the above bounds it is normal to plot lines at ± 1.96 divided by the square root of the number of values when plotting the autocorrelation function. Our data have 1225 points. The square root is 35. Since 1.96 divided by 35 yields 0.0553, the error bounds are ± 0.0553 . These limits are known as the critical values.

With these bounds although most points are within and support “white noise,” too many points violate the bounds. About 41 points are outside the upper and lower control points. Normally, only 5% or 25 points would be expected to reside outside of the limits.

These points indicate perhaps there is some slight internal autocorrelation of the points and justification to the technical analysis approach. This slight trend coupled with volume changes is exploited in the developed model in an attempt to profit from the market’s rise and fall.

3.2 White Noise

Looking forward in this paper in the middle stages, twenty securities and one index are examined. For each of these securities, the price change indicator for the days examined is compared with a Box-Pierce Q statistic for 15-day lags.

The Box-Pierce Q is calculated as

$$Q = n \sum_{k=1}^h r_k^2$$

where:

h =Maximum lag,

n =Number of observations in the series, and

r =Correlation coefficient.

The Box-Pierce Q statistic, namely a chi-square distribution, is then compared to the results. The statistic is compared to the chi-square with 15 degrees of freedom. For 15 degrees of

freedom, the probability p is taken from common chi-square tables and is given in the following table where df equals degrees of freedom.

Table 3.2 – Critical Values of Chi-square Statistic

		Probability p				
d.f.	0.1	0.05	0.025	0.01	0.005	0.001
15	22.30	24.99	27.48	30.57	32.80	37.70

For example, if the calculated $Q = 31.3$, data correlation would be significant at the $p = 0.01$. This means that for white noise data, there is less than a 1% chance of obtaining a value of Q as high as 31.3. The Chi-square value statistic is 30.57.

For the twenty stocks and the index, the next pages provide the Q values and possibility of the stocks' data being classified as white noise.

The twenty securities examined are as follows:

S&P 500 Index Fund	Cisco	AT&T
Tesoro Petroleum	Coca Cola	America On Line
Duke Power	SBC Corporation	IBM Corporation
Intel Corporation	I2 Technologies	Johnson and Johnson
OMI Corporation	Symbol Technologies	JP Morgan
General Electric	Bristol Myers	Exxon Corporation
Home Depot	Lucent Technologies	

In addition, the index examined is the Dow Jones Industrial Average.

Later in the paper, more is provided on the logic for selection of these 20 securities and the index. In chapter 9, the number of securities is increased to 41 and reanalyzed.

Table 3.3 – Significant Non-white Noise Examined Stocks

	Period	Start	End	Q Statistic	White Noise	Chi - Square / Probabilities					
						22.3	24.99	27.48	30.57	32.8	37.7
S&P	Apr 94- Apr 95	302	554	31.33		.100	.050	.025	.010		
	Apr 95- Apr 96	554	806	13.49	Yes						
	Apr 96- Apr 97	806	1058	9.45	Yes						
	Apr 97- Apr 98	1058	1310	16.71	Yes						
	Apr 98- Apr 99	1310	1562	14.99	Yes						
	Apr 99 - Apr 00	1562	1814	18.81	Yes						
	Apr 00 - Apr 01	1814	2066	19.63	Yes						
	Apr 01- Apr 02	2066	2318	8.92	Yes						
I Two	Apr 97- Apr 98	252	504	32.83		.100	.050	.025	.010	.005	
	Apr 98- Apr 99	504	756	8.29	Yes						
	Apr 99 - Apr 00	756	1008	13.18	Yes						
	Apr 00 - Apr 01	1008	1260	20.67	Yes						
	Apr 01- Apr 02	1260	1512	18.25	Yes						
Tesoro Oil	Apr 89- Apr 90	336	588	10.26	Yes						
	Apr 90- Apr 91	588	840	5.2	Yes						
	Apr 91- Apr 92	840	1092	11.96	Yes						
	Apr 92- Apr 93	1092	1344	33.06		.100	.050	.025	.010	.005	
	Apr 93- Apr 94	1344	1596	10.07	Yes						
	Apr 94- Apr 95	1596	1848	16.54	Yes						
	Apr 95- Apr 96	1848	2100	20.71	Yes						
	Apr 96- Apr 97	2100	2352	15.75	Yes						
	Apr 97- Apr 98	2352	2604	19.07	Yes						
	Apr 98- Apr 99	2604	2856	14.28	Yes						
	Apr 99 - Apr 00	2856	3108	12.71	Yes						
	Apr 00 - Apr 01	3108	3360	9.03	Yes						
	Apr 01- Apr 02	3360	3612	7.33	Yes						
Symbol Technologies	Apr 89- Apr 90	244	496	8.41	Yes						
	Apr 90- Apr 91	496	748	17.27	Yes						
	Apr 91- Apr 92	748	1000	9.38	Yes						
	Apr 92- Apr 93	1000	1252	21.4	Yes						
	Apr 93- Apr 94	1252	1504	8.63	Yes						
	Apr 94- Apr 95	1504	1756	15.54	Yes						
	Apr 95- Apr 96	1756	2008	26.68		.100	.050				
	Apr 96- Apr 97	2008	2260	22.98		.100					
	Apr 97- Apr 98	2260	2512	9.77	Yes						
	Apr 98- Apr 99	2512	2764	18.21	Yes						
	Apr 99 - Apr 00	2764	3016	23.82		.100					
	Apr 00 - Apr 01	3016	3268	10.07	Yes						
Apr 01- Apr 02	3268	3520	16.12	Yes							
Bristol Meyers	Apr 89- Apr 90	261	513	19.21	Yes						
	Apr 90- Apr 91	513	765	11.01	Yes						
	Apr 91- Apr 92	765	1017	19.71	Yes						
	Apr 92- Apr 93	1017	1269	5	Yes						
	Apr 93- Apr 94	1269	1521	17.16	Yes						
	Apr 94- Apr 95	1521	1773	9.48	Yes						
	Apr 95- Apr 96	1773	2025	10.28	Yes						
	Apr 96- Apr 97	2025	2277	4.31	Yes						
	Apr 97- Apr 98	2277	2529	13.98	Yes						
	Apr 98- Apr 99	2529	2781	14.88	Yes						
	Apr 99 - Apr 00	2781	3033	19.34	Yes						
	Apr 00 - Apr 01	3033	3285	10.75	Yes						
	Apr 01- Apr 02	3285	3537	10.91	Yes						
Duke Power	Apr 89- Apr 90	261	513	15.98	Yes						
	Apr 90- Apr 91	513	765	20.19	Yes						
	Apr 91- Apr 92	765	1017	16.73	Yes						
	Apr 92- Apr 93	1017	1269	15.4	Yes						
	Apr 93- Apr 94	1269	1521	8.57	Yes						
	Apr 94- Apr 95	1521	1773	18.78	Yes						
	Apr 95- Apr 96	1773	2025	12.59	Yes						
	Apr 96- Apr 97	2025	2277	21.36	Yes						
	Apr 97- Apr 98	2277	2529	14.23	Yes						
	Apr 98- Apr 99	2529	2781	12.89	Yes						
	Apr 99 - Apr 00	2781	3033	9.34	Yes						
	Apr 00 - Apr 01	3033	3285	11.05	Yes						
	Apr 01- Apr 02	3285	3537	31.18		.100	.050	.025	.010		

Table 3.3 (continued)

	Period	Start	End	Q Statistic	White Noise	Chi - Square / Probabilities					
						22.3	24.99	27.48	30.57	32.8	37.7
Intel Corporation	Apr 89- Apr 90	261	513	15.18	Yes						
	Apr 90- Apr 91	513	765	10.82	Yes						
	Apr 91- Apr 92	765	1017	24.81		.100					
	Apr 92- Apr 93	1017	1269	11.23	Yes						
	Apr 93- Apr 94	1269	1521	11.4	Yes						
	Apr 94- Apr 95	1521	1773	11.87	Yes						
	Apr 95- Apr 96	1773	2025	7.64	Yes						
	Apr 96- Apr 97	2025	2277	14.87	Yes						
	Apr 97- Apr 98	2277	2529	14.95	Yes						
	Apr 98- Apr 99	2529	2781	24.42		.100					
	Apr 99 - Apr 00	2781	3033	9.52	Yes						
	Apr 00 - Apr 01	3033	3285	16.25	Yes						
	Apr 01- Apr 02	3285	3537	16.28	Yes						
Lucent Technologies	Apr 97- Apr 98	252	504	15.48	Yes						
	Apr 98- Apr 99	504	756	13.4	Yes						
	Apr 99 - Apr 00	756	1008	13.21	Yes						
	Apr 00 - Apr 01	1008	1260	14.78	Yes						
	Apr 01- Apr 02	1260	1512	7.33	Yes						
OMI Corporation	Apr 93- Apr 94	274	526	23.09		.100					
	Apr 94- Apr 95	526	778	21.39	Yes						
	Apr 95- Apr 96	778	1030	15.02	Yes						
	Apr 96- Apr 97	1030	1282	7.18	Yes						
	Apr 97- Apr 98	1282	1534	7.42	Yes						
	Apr 98- Apr 99	1534	1786	15.28	Yes						
	Apr 99 - Apr 00	1786	2038	7.93	Yes						
	Apr 00 - Apr 01	2038	2290	15.77	Yes						
America On Line	Apr 94- Apr 95	519	771	19.95	Yes						
	Apr 95- Apr 96	771	1023	11.51	Yes						
	Apr 96- Apr 97	1023	1275	23.22		.100					
	Apr 97- Apr 98	1275	1527	12.48	Yes						
	Apr 98- Apr 99	1527	1779	8	Yes						
	Apr 99 - Apr 00	1779	2031	14.64	Yes						
	Apr 00 - Apr 01	2031	2283	18.67	Yes						
	Apr 01- Apr 02	2283	2535	18.6	Yes						
AT&T	Apr 89- Apr 90	261	513	12	Yes						
	Apr 90- Apr 91	513	765	15.86	Yes						
	Apr 91- Apr 92	765	1017	14.37	Yes						
	Apr 92- Apr 93	1017	1269	17.7	Yes						
	Apr 93- Apr 94	1269	1521	10.16	Yes						
	Apr 94- Apr 95	1521	1773	13.32	Yes						
	Apr 95- Apr 96	1773	2025	13.43	Yes						
	Apr 96- Apr 97	2025	2277	12.12	Yes						
	Apr 97- Apr 98	2277	2529	20.41	Yes						
	Apr 98- Apr 99	2529	2781	15.37	Yes						
	Apr 99 - Apr 00	2781	3033	19.13	Yes						
	Apr 00 - Apr 01	3033	3285	13.91	Yes						
	Apr 01- Apr 02	3285	3537	10.7	Yes						
General Electric	Apr 89- Apr 90	261	513	19.36	Yes						
	Apr 90- Apr 91	513	765	11.37	Yes						
	Apr 91- Apr 92	765	1017	19.28	Yes						
	Apr 92- Apr 93	1017	1269	7.67	Yes						
	Apr 93- Apr 94	1269	1521	19.93	Yes						
	Apr 94- Apr 95	1521	1773	12.31	Yes						
	Apr 95- Apr 96	1773	2025	19.75	Yes						
	Apr 96- Apr 97	2025	2277	25.92		.100	.050				
	Apr 97- Apr 98	2277	2529	7.63	Yes						
	Apr 98- Apr 99	2529	2781	21.42	Yes						
	Apr 99 - Apr 00	2781	3033	9.11	Yes						
	Apr 00 - Apr 01	3033	3285	18.5	Yes						
	Apr 01- Apr 02	3285	3537	10.55	Yes						

Table 3.3 – (continued)

	Period	Start	End	Q Statistic	White Noise	Chi - Square / Probabilities					
						22.3	24.99	27.48	30.57	32.8	37.7
Home Depot	Apr 89- Apr 90	259	511	15.73	Yes						
	Apr 90- Apr 91	511	763	19.99	Yes						
	Apr 91- Apr 92	763	1015	18.14	Yes						
	Apr 92- Apr 93	1015	1267	14.07	Yes						
	Apr 93- Apr 94	1267	1519	8.18	Yes						
	Apr 94- Apr 95	1519	1771	12.96	Yes						
	Apr 95- Apr 96	1771	2023	13.48	Yes						
	Apr 96- Apr 97	2023	2275	18.87	Yes						
	Apr 97- Apr 98	2275	2527	18.21	Yes						
	Apr 98- Apr 99	2527	2779	12.67	Yes						
	Apr 99 - Apr 00	2779	3031	12.73	Yes						
	Apr 00 - Apr 01	3031	3283	24.66		.100					
	Apr 01- Apr 02	3283	3535	25.55		.100	.050				
IBM Corporation	Apr 89- Apr 90	261	513	10.36	Yes						
	Apr 90- Apr 91	513	765	11.85	Yes						
	Apr 91- Apr 92	765	1017	26.47		.100	.050				
	Apr 92- Apr 93	1017	1269	17.94	Yes						
	Apr 93- Apr 94	1269	1521	15.33	Yes						
	Apr 94- Apr 95	1521	1773	13.35	Yes						
	Apr 95- Apr 96	1773	2025	11.44	Yes						
	Apr 96- Apr 97	2025	2277	19.39	Yes						
	Apr 97- Apr 98	2277	2529	17.38	Yes						
	Apr 98- Apr 99	2529	2781	19.81	Yes						
	Apr 99 - Apr 00	2781	3033	11.84	Yes						
	Apr 00 - Apr 01	3033	3285	18.44	Yes						
	Apr 01- Apr 02	3285	3537	3.9	Yes						
Johnson & Johnson	Apr 89- Apr 90	259	511	10.06	Yes						
	Apr 90- Apr 91	511	763	19.64	Yes						
	Apr 91- Apr 92	763	1015	10.47	Yes						
	Apr 92- Apr 93	1015	1267	11.22	Yes						
	Apr 93- Apr 94	1267	1519	11.85	Yes						
	Apr 94- Apr 95	1519	1771	12.71	Yes						
	Apr 95- Apr 96	1771	2023	14.96	Yes						
	Apr 96- Apr 97	2023	2275	15.73	Yes						
	Apr 97- Apr 98	2275	2527	18.66	Yes						
	Apr 98- Apr 99	2527	2779	13.8	Yes						
	Apr 99 - Apr 00	2779	3031	31.45		.100	.050	.025	.010		
	Apr 00 - Apr 01	3031	3283	21.82	Yes						
	Apr 01- Apr 02	3283	3535	12.14	Yes						
Cisco	Apr 92- Apr 93	517	769	12.48	Yes						
	Apr 93- Apr 94	769	1021	8.89	Yes						
	Apr 94- Apr 95	1021	1273	16.01	Yes						
	Apr 95- Apr 96	1273	1525	10.38	Yes						
	Apr 96- Apr 97	1525	1777	14	Yes						
	Apr 97- Apr 98	1777	2029	10.34	Yes						
	Apr 98- Apr 99	2029	2281	17.23	Yes						
	Apr 99 - Apr 00	2281	2533	11.41	Yes						
	Apr 00 - Apr 01	2533	2785	13.77	Yes						
Apr 01- Apr 02	2785	3037	10.81	Yes							
JP Morgan	Apr 89- Apr 90	259	511	10.44	Yes						
	Apr 90- Apr 91	511	763	34.3		.100	.050	.025	.010	.005	
	Apr 91- Apr 92	763	1015	43.21		.100	.050	.025	.010	.005	.001
	Apr 92- Apr 93	1015	1267	16.88	Yes						
	Apr 93- Apr 94	1267	1519	18.02	Yes						
	Apr 94- Apr 95	1519	1771	7.97	Yes						
	Apr 95- Apr 96	1771	2023	13.47	Yes						
	Apr 96- Apr 97	2023	2275	16.07	Yes						
	Apr 97- Apr 98	2275	2527	20.41	Yes						
	Apr 98- Apr 99	2527	2779	23.95		.100					
	Apr 99 - Apr 00	2779	3031	21.61	Yes						
	Apr 00 - Apr 01	3031	3283	11.9	Yes						
	Apr 01- Apr 02	3283	3535	12.54	Yes						

Table 3.3 (continued)

	Period	Start	End	Q Statistic	White Noise	Chi - Square / Probabilities					
						22.3	24.99	27.48	30.57	32.8	37.7
Coca Cola Corporation	Apr 89- Apr 90	261	513	23.2		.100					
	Apr 90- Apr 91	513	765	22.17	Yes						
	Apr 91- Apr 92	765	1017	16.36	Yes						
	Apr 92- Apr 93	1017	1269	15.61	Yes						
	Apr 93- Apr 94	1269	1521	19.07	Yes						
	Apr 94- Apr 95	1521	1773	12.12	Yes						
	Apr 95- Apr 96	1773	2025	22.49		.100					
	Apr 96- Apr 97	2025	2277	19.21	Yes						
	Apr 97- Apr 98	2277	2529	20.61	Yes						
	Apr 98- Apr 99	2529	2781	8.18	Yes						
	Apr 99 - Apr 00	2781	3033	13.92	Yes						
	Apr 00 - Apr 01	3033	3285	15.66	Yes						
	Apr 01- Apr 02	3285	3537	13.17	Yes						
SBC Corporation	Apr 89- Apr 90	261	513	23.29		.100					
	Apr 90- Apr 91	513	765	10.3	Yes						
	Apr 91- Apr 92	765	1017	16.2	Yes						
	Apr 92- Apr 93	1017	1269	14.17	Yes						
	Apr 93- Apr 94	1269	1521	19.67	Yes						
	Apr 94- Apr 95	1521	1773	9.71	Yes						
	Apr 95- Apr 96	1773	2025	24.67		.100					
	Apr 96- Apr 97	2025	2277	16.42	Yes						
	Apr 97- Apr 98	2277	2529	14.4	Yes						
	Apr 98- Apr 99	2529	2781	17.04	Yes						
	Apr 99 - Apr 00	2781	3033	10.94	Yes						
	Apr 00 - Apr 01	3033	3285	16.43	Yes						
	Apr 01- Apr 02	3285	3537	20.6	Yes						
Exxon Corporation	Apr 89- Apr 90	261	513	12.18	Yes						
	Apr 90- Apr 91	513	765	21	Yes						
	Apr 91- Apr 92	765	1017	13.35	Yes						
	Apr 92- Apr 93	1017	1269	12.03	Yes						
	Apr 93- Apr 94	1269	1521	17.9	Yes						
	Apr 94- Apr 95	1521	1773	18.86	Yes						
	Apr 95- Apr 96	1773	2025	16.97	Yes						
	Apr 96- Apr 97	2025	2277	10.47	Yes						
	Apr 97- Apr 98	2277	2529	16.3	Yes						
	Apr 98- Apr 99	2529	2781	12.54	Yes						
	Apr 99 - Apr 00	2781	3033	12.88	Yes						
	Apr 00 - Apr 01	3033	3285	19.25	Yes						
	Apr 01- Apr 02	3285	3537	12.7	Yes						
Dow Jones Index	Apr 89- Apr 90	261	513	20.45	Yes						
	Apr 90- Apr 91	513	765	18.31	Yes						
	Apr 91- Apr 92	765	1017	12.61	Yes						
	Apr 92- Apr 93	1017	1269	17.35	Yes						
	Apr 93- Apr 94	1269	1521	16.71	Yes						
	Apr 94- Apr 95	1521	1773	11.42	Yes						
	Apr 95- Apr 96	1773	2025	9.2	Yes						
	Apr 96- Apr 97	2025	2277	14.98	Yes						
	Apr 97- Apr 98	2277	2529	19.21	Yes						
	Apr 98- Apr 99	2529	2781	15.97	Yes						
	Apr 99 - Apr 00	2781	3033	11.03	Yes						
	Apr 00 - Apr 01	3033	3285	14.04	Yes						
	Apr 01- Apr 02	3285	3537	11.75	Yes						

The computations in the previous table represent the autocorrelations for the securities for yearly periods. Most all of the daily price changes appear to be white noise. With the exception of JP Morgan for the years of 1990 through 1992, any periods of non-white noise are rare. For most of the periods examined the stocks are in the white noise region.

Detail charts of each of the autocorrelation coefficients for each of the periods may be found in Appendix C.

This paper's intent is not to prove or disprove the non-randomness of the market and affront the strong market efficient proponents. Instead this paper's objective is to develop a model relying on past data to predict the future movement either up or down of an individual security in the market. Even with the large number of researchers who demonstrate success with market timing, the above quick look at our prime data source, SPY, and the twenty accompanying stocks is merely to verify that potential for timing is possible.

3.3 Theoretical Returns

In today's environment of greatly reduced commissions and fairly volatile markets, the potential return through market timing on most any stock is tremendous. No fund manager obtains even one-half of the theoretical potential return.

The following provides the technique to compute theoretical potential returns with market timing. The process outlined to evaluate this sample return is the same process that is used to evaluate the returns in the results section of this document.

For now, examine the process of perfect vision. Assume that the investor has perfect vision into the future. For the example that follows, with perfect vision the investor would buy at the three buy points and sell at the three sell points shown on the graph that follows.

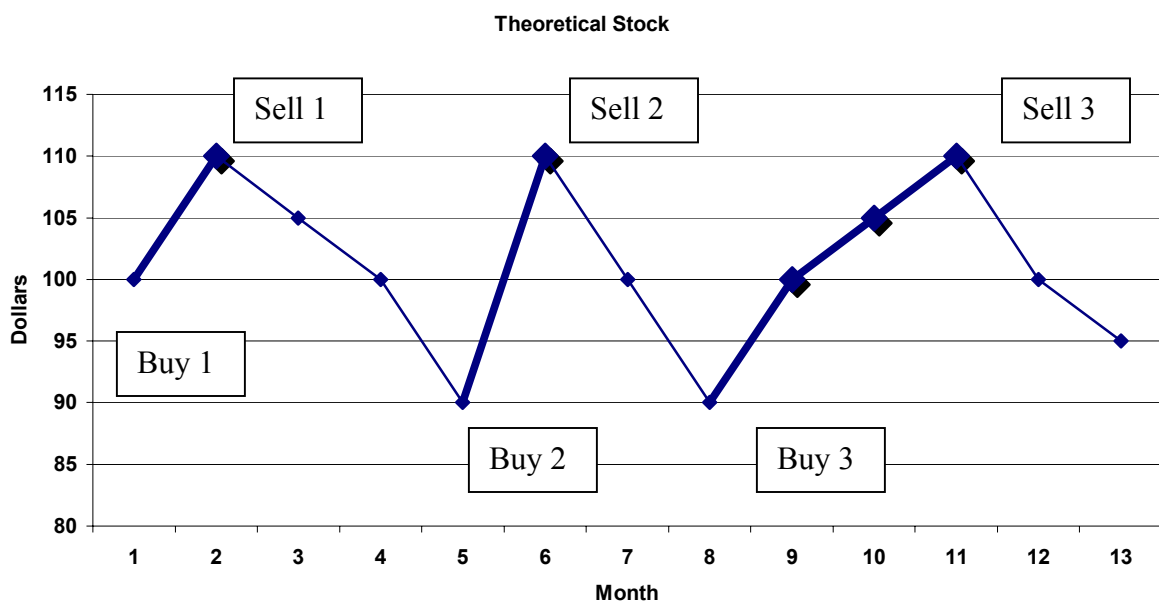


Figure 3.5 – Theoretical Stock Closing Price for One Year

Regardless of the length of time, these buy and sell points harvest the most return from the stock movement. Only if commission cost exceeds the gain would the buy and sell trips not be economical.

The model starts with a fixed amount of capital equal to the closing price on day one multiplied by a fixed number of shares (1,000).

$$IC = CP_1 \times 1000$$

where:

IC = Initial Capital and

CP_1 = Closing price on day one of the model “testing” period.

Based on the policies generated in the training section of the data, the model may suggest the investor enter the market. Assume the model suggested entry on day one. The investor will enter and purchase the following number of shares.

$$NS = \left\lceil \frac{IC - Comm}{CP_{ed}} \right\rceil$$

where:

NS = Number of shares initially purchased,

$Comm$ = Total commission paid, and

CP_{ed} = Closing price on the day market was entered (entry date).

Since fractional shares are not allowed, the number of shares purchased is rounded down to a whole number of shares.

The following is the cash not invested that draws interest.

$$CC = [CP_1 \times 1000] - Comm - [NS \times CP_{ed}]$$

where

CC = Cash Carried.

Including the interest yields

$$CCWI = CC \times [1 + (r / m)]^k$$

where:

$CCWI$ = Cash carried with interest,

CC = Cash carried or cash at the beginning of the period,

r = Interest rate for the year,

m = Number of periods (days), and

k = Number of periods (days) before the cash is reinvested in stock.

These calculations are consistent with formula in Luenberger (1998).

When the model recommends leaving the stock market, the cash position is increased by the number of shares times the share price less the commission.

$$CCAS = NS \times CP_{ex} - Comm + CCWI$$

where:

- CCAS* = Cash at sale date,
- NS* = Number of shares,
- CP_{ex}* = Closing price on the day of sale,
- Comm* = Total commission paid, and
- CCWI* = Cash remaining from previous transaction requiring even share purchase.

The cash at sale date accumulates interest until the cash is reinvested in stock.

$$CCN = CCAS \times [1 + (r / m)]^k$$

where:

- CCN* = New cash position,
- CCAS* = Cash after sale of stock,
- r* = Interest rate for the year,
- m* = Number of periods (days), and
- k* = Number of periods (days) before the cash is reinvested in stock.

Now the “new cash position,” *CCN*, assumes the position of the “initial capital” and the model repeats. Once again, in the repetition, if the model does not recommend entering the market the funds will accrue interest. If the model recommends entering the market, all of the money with the exception of the small amount that cannot be invested because of the requirement to purchase an even integer number of shares is invested. The small amount continues to draw the daily interest rate.

This process repeats until the end of the period is reached. For the model, the end of the period will be the end of the testing period.

At the end of the period, one of two situations exists.

- 1) Investor is in a cash position.
- 2) Investor is invested in stock with small amount of residual cash due to rounding of shares.

Situation 1

If investor is in situation one, the model will credit for the days until the end of the overall period.

That is,

$$CCN_f = CCN_{f-1} \times [1 + (r / m)]^k$$

where:

CCN_f = Final cash position on the final day of the overall (testing) period

CCN_{f-1} = Cash position on the sale of the security for the period before the last day,

and

k = Number of days from last exiting the market to the last day in the period.

The return is “final cash position” less the initial cash divided by the initial cash. The return is expressed as follows.

$$RET = 100 \times \left[\left[1 + \frac{CCN_f - IC}{IC} \right] - 1 \right]$$

where:

RET = Return expressed as a percentage,

IC = Initial capital or cash, and

CCN_f = Cash position on the final day of the testing period.

Situation 2

If investor has shares, these shares are sold, commission removed and the balance is combined with the residual cash. Calculation is as follows.

$$CCN_f = NS \times CP_f - Comm + CCWI$$

CCN_f = Final cash position on the final day of the overall (testing) period,
 CP_f = Closing price of the security on last day of the overall period, and
 $CCWI$ = Cash carried with interest for the small amount of cash not invested in stock.

Return is now calculated in the same manner as calculated for the cash position “*RET*” provided earlier.

For this simple example, the return may be compared to that of the buy and hold strategy. The buy and hold return is calculated as the final stock price minus the initial stock price divided by the initial stock price less one and converted to a percentage.

Equation is as follows.

$$RET = 100 \times \left[\left[1 + \frac{CP_f - CP_1}{CP_1} \right] - 1 \right]$$

where:

RET = Return expressed as a percentage,
 CP_f = Closing price on the last day of the overall period, and
 CP_1 = Closing price on day one.

For the example in figure 3.5 with perfect information, a return of approximately 65% is possible by buying and selling the security. For the same example, the return is negative 5% for buy and hold. The complete calculation of this example may be found in Appendix D.

Chapter 4 A Markov Decision Process Model Based on Price Change

Having established the method by which gains are converted into percent returns in the previous chapter, the technique to extract gains from the securities is now investigated. The basic operation of the model in this research uses a systematic method to predict entry and exit points for the investor. Among large variety of measures that can be used to determine entry and exit points is stock price and stock volume. This chapter examines the use of the daily change in the stock price to generate the entry and exit points to the market.

4.1 Basic Model Framework

First, the model establishes a general framework to profit from changes in the price of a security. The framework consists of purchasing one thousand shares of a security. All positions are “fully in the market” or “fully out of the market.” No partial buys or sells are permitted or examined in this document. To buy and sell a security constitutes a trip in the market.

All gains and losses are per one lot of approximately 1,000 shares of stock. At this stage of research, the model begins with capital equal to the purchase price of 1,000 shares of stock on the first day of the testing period. This initial money is used for the market trips.

All entry and exit points are at the closing prices. Making decisions to buy or sell during the last 5 minutes of each day assures obtainment and supports transactions at this price.

Once “in the market,” gain or loss is accumulated with the daily change in the price of the security. When “out of the market,” the daily interest is accrued in accordance with the earlier presentation in this document. Once more, any daily interest could be entered into the

model; however, $\frac{1}{2}\%$ compounded daily is used. Although the percent of interest on cash funds has been higher, at the time of this document, $\frac{1}{2}\%$ is the discount brokerage cash account rate for a year.

One other important factor needs to be considered in this model's strategy. This factor is commission. This model carefully considers commissions. Although any commission rate could be used, employing a discount brokerage firm rate greatly reduces the dollar amount of this burden. The model transactions assume the commission burden to be approximately one cent to buy and one cent to sell a share of stock. A ten-dollar trade generates this amount of commission per share of stock on a one thousand-share transaction. A number of Internet discount brokerage firms offer a ten-dollar or less trading schedule.

4.2 Markov Decision Process Model of Stock Price

As established earlier, past patterns in the price and volume changes are used to determine the expected future price direction of a security. The technical analysts consider a large number of patterns. Patterns include flags, pennants, gaps, triangles (symmetrical, ascending, descending and inverted), inverted saucer or dome, the triple top, the compound fulcrum, the rising and falling wedge, the broadening bottom, the duplex horizontal, rectangles, and the inverted V (Jones, 1998). All of these patterns are in use to predict future security prices. In some cases, two analysts view the same data and give two different predictions for the stock's future price movement.

In this research, an approach using Markov decision processes (MDPs) is used to develop a policy that directs the investor which decision to make on each trading day. The value of the Markov model implicitly determines and exploits "attractive" patterns in the data and thereby "side steps" the identification problem completely. Fundamental to the use of a Markov model in this environment is the assumption that future behavior of a market can be stochastically determined based upon some limited amount of historical behavior. In other

words, the probability associated with tomorrow's behavior is based solely on some specified number of days of history. The development of a Markov model requires the following:

1. Definition of the system states.
2. Determination of the state transition probability matrix, i.e., matrix of probabilities of transition from each system state to each other system state under each possible decision alternative.
3. Specification of the possible decisions for each system state.
4. Specification of the reward matrix, i.e., the value of a transition from each system state to each other system state under each possible decision alternative.
5. Determination of the optimal policy, i.e., set of decisions to make for each possible system state.

Each of these steps is addressed in the following pages.

4.2.1 State Definition

The model examines the security's pattern as a change in price from day-to-day. Each day the change in closing price from the previous day is associated with the day. Of course, since two days are needed to compute a difference in closing price, the size of the data set for the training period becomes one less than the original data set. The change in price from day $i-1$ to day i is simply defined as

$$\Delta P_i = CP_i - CP_{i-1}$$

where CP_i is the closing price of security on day i .

A state definition based on the actual changes in price can be intractably large. Therefore, in this research, on each day the change in price is classified as either being "up" or "down." Although this seems extremely simple, one complication arises. The change in price must

overcome the penalty of commissions to yield positive benefits. The absolute minimum acceptable change in price to be considered “up” becomes

$$\Delta P_i \geq 2 \times \text{commission} + 0.01 .$$

Therefore, with a commission of \$0.01 as defined in Section 4.1, three cents becomes the absolute minimum required to classify a price change as a positive movement. However, experimentation with the model found 5 cents to be a better indicator of positive returns. Five cents or higher change defines an “up” movement while less than 5 cents represents a “down” movement.

Next, the model combines the price change indicator for a group of days to form a pattern of “up” and “down” movements, referred to hence as a “snake pattern” or “snake.” A snake pattern corresponds to a state in traditional stochastic process jargon. The terms “snake” and “snake pattern” will be used interchangeably in the following development.

The number of days in the snake pattern defines the snake length. The concept of a snake may best be understood with a simple example. Assume the movement in some security for a five-day period is as in the following table.

Table 4.1 – Example of a 5 Length Snake

Day	Direction	Value
1	Up	1
2	Up	1
3	Down	0
4	Down	0
5	Down	0

The example snake from table 4.1 would be 5 in length and an “up-up-down-down-down” in shape.

In order to mathematically represent the pattern of “ups” and “downs,” an “up” is assigned a value of 1 and a “down” a value of zero. The pattern of 0’s and 1’s is then interpreted as a binary string where the oldest day in the pattern corresponds to the highest binary digit and the most recent day corresponds to the lowest digit. This value is referred to as the pattern identifier. For example, the snake length 5 state represented in the table above is the binary value “11000” which is equivalent to the value 24 in decimal. In this way, each unique pattern of “ups” and “downs” corresponds to a unique numerical value.

For the length snake of size n , there are 2^n different patterns. For example, for a snake length of 5, the pattern identifier, as defined above, could take on the values from 0 to 31.

However, in order to facilitate array indexing in the coding of the model, a one is added to the pattern identifier to yield values between 1 and 32.

After a new trading day is realized, the snake transitions to a new snake by dropping the oldest day’s price change indicator (“up” or “down”) and appending the price change indicator for the latest day. Notice that regardless of the length of the snake, since each new day is either “up” or “down,” each snake pattern can transition to one of two possible new snake patterns.

Using the example in the table above, on the sixth day, the pattern transitions to a new pattern by dropping the first direction indicator at the tail of the pattern and adding an "up" or "down" to the head of the pattern to form the new state. For our 5-length snake, the transition is to either an “up-down-down-down-up” pattern or to an “up-down-down-down-down” as shown as follows based upon the price change.

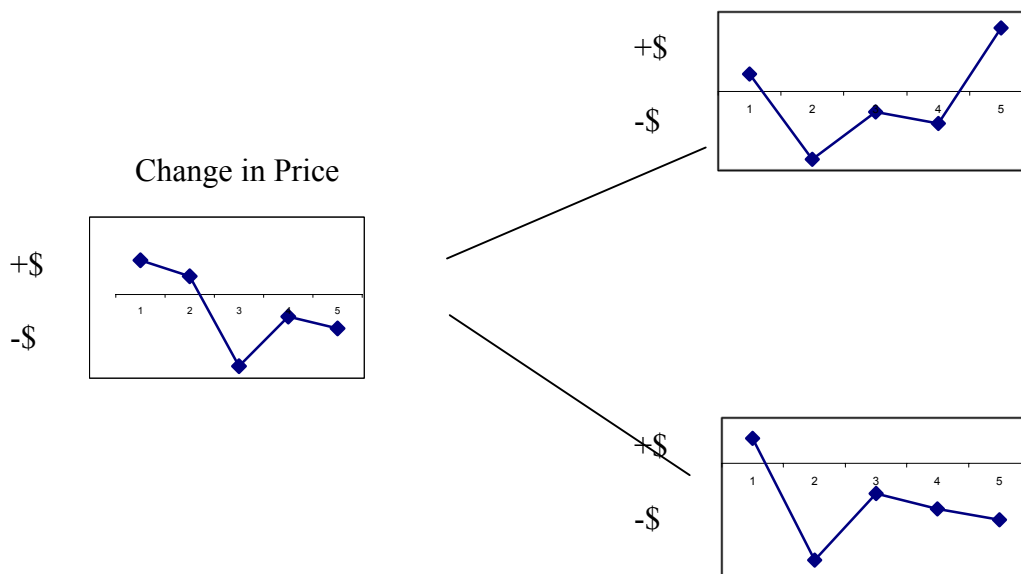


Figure 4.1 – Five Length Snake Transition

In the analysis of the model, different snake lengths from 2 to 15 are evaluated. In Section 4.2.3, the need to augment the snake pattern with additional state information is identified and the complete state definition determined.

4.2.2 State Transition Probabilities

In order to compute the optimal decision policy, the transition probabilities between the various snake patterns must be determined. In order to compute these transition probabilities, historical data is used. This process is referred subsequently as training. The most important underpinning of this model is the assurance that the model operates in a fair and correct manner. As mentioned, YAHOO, a public source, provides the closing prices. YAHOO data exports to an Excel spreadsheet. From Excel, the data are transferred into a “.dat” file that is later read and used by the Matlab programmed model.

The data for a given security is divided into a “training period” and a “testing” (out of sample - validation) period. (The use of the “testing” data is discussed in more detail in Section 4.4.) The training period data is analyzed and the differing snake patterns are identified.

The following excerpt provides snake patterns and raw data for a subset of the S&P 500 data. This table contains the first sixteen days and the snake patterns for snakes of length of two through five. Notice that the previously discussed pattern of “up-up-down-down-down” is highlighted in the table. This pattern is encountered on day thirteen. Also, notice for a snake length of four, the unique identifier for day thirteen is 9 and if the snake length was three or two, the unique identifier is 1. Also, notice that for these patterns the following day results in a negative 3-cent value for the delta price. The security moved from \$37.22 to \$37.19.

Table 4.2 – Snake Patterns for the S&P Closing Price for Lengths 2 Through 5

Day Number	Closing Price	Volume for Day	Delta Price	UP-DOWN Indicator	Pattern Identifier Snake Length =5	Pattern Identifier Snake Length =4	Pattern Identifier Snake Length =3	Pattern Identifier Snake Length =2
1	37.64	1003200	-	-	-	-	-	-
2	37.91	480500	0.27	1	-	-	-	-
3	37.99	201300	0.08	1	-	-	-	4
4	38.39	529400	0.40	1	-	-	8	4
5	38.55	531500	0.16	1	-	16	8	4
6	38.53	492100	-0.02	0	31	15	7	3
7	38.53	596100	0.00	0	29	13	5	1
8	38.26	122100	-0.27	0	25	9	1	1
9	38.31	379600	0.05	1	18	2	2	2
10	38.5	19500	0.19	1	4	4	4	4
11	38.21	42500	-0.29	0	7	7	7	3
12	37.24	374800	-0.97	0	13	13	5	1
13	37.22	210900	-0.02	0	25	9	1	1
14	37.19	378100	-0.03	0	17	1	1	1
15	37.32	34900	0.13	1	2	2	2	2
16	37.46	513600	0.14	1	4	4	4	4

Using this information from the complete training period, state transition probabilities can be computed. Recall that each pattern can transition to two patterns depending upon the outcome of the newest day (up or down). The probabilities of these transitions can be calculated by computing the fraction of time a given pattern transitions to each of its two “reachable” patterns in the training data.

4.2.3 Decision Specifications

Within the model, a decision must be made daily as to how best to manage the investment. Fundamentally, there are two choices. The investor may decide to “stay” (do nothing) remaining in their current position either “in” (invested) or “out” (not invested) of the market or alternatively the investor may decide to “change” either leaving the market if currently “in” or entering if currently “out” as shown in the following table.

Table 4.3 – Investor Decision Specification

Present Condition	Future Condition under “Do Nothing” Alternative	Future Condition under “Change” Alternative
In the Market	Stay in the Market	Sell and Leave the Market
Out of the Market	Stay out of the Market	Buy and enter the Market

Therefore, for each state, there are two alternatives: “Do Nothing” and “Change.” Since the action of the decision depends upon whether the investor is currently in or out of the market, the state definition must include this information. Therefore, the complete state definition is a combination of the snake pattern and the disposition relative to the market (in or out), i.e. for each possible snake pattern there are two states, one representing being “in” the market and one representing being “out.” The probabilities are computed using the approach described in section 4.2.2 in order to generate the complete state transition probability matrix.

For example, consider the pattern 11101 (identifier value 30). This pattern can transition to 11011 (28) or 11010 (27). Assume that in the training data, 4 times out of ten occurrences, the transition from 11101 is to 11011 (and thus six times to 11010). There are two states with the pattern 11101, i.e., one when “in” the market and one with “out” of the market. Therefore, if the investor is currently “in” the market, the pattern is 11101, and the decision is to “do nothing,” then the state will transition to “in” the market with the pattern 11011 with probability 0.4 and to “in” the market with the pattern 11010 with probability 0.6. The probabilities for the other combinations of being “in” or “out” under the possible decisions of “do nothing” or “change” are computed similarly.

4.2.4 State Reward Values

The next step is to determine the rewards associated with transitions between states under each of the two alternatives. The model is based on the assumption that the expected value of a transition is based upon the disposition of the investment (in or out of the market), closing price of the stock, the commission, and the decision made. For those states that correspond to being “out” of the market, under the “do nothing” alternative, the expected reward is set to \$0.00 while under the “change” alternative, the value is set to negative the commission. For the states corresponding to being “in” the market, the average dollar change in the share price of the security associated with each snake pattern is computed using the training data by summing the change in price for each occurrence of a given pattern and dividing by the number of occurrences (if any). For these states, under the “change” alternative, the commission is subtracted.

This set of values over all patterns and decision corresponds to the “ q_i^k ” values in the traditional development of an MDP, i.e. the expected reward for transitioning out of state i under decision alternative k .

In order to facilitate the computation of the rewards, the average change in price on the next day is computed for each snake pattern. An example of this is shown in the following table.

Table 4.4 – Average Price Change for Snake Patterns for Lengths 2 Through 5

Identifier	Snake Length = 5	Snake Length = 4	Snake Length = 3	Snake Length = 2
1	\$0.18	\$0.14	\$0.11	\$0.02
2	\$0.16	\$0.13	\$0.04	\$0.05
3	\$0.15	\$0.00	\$0.06	\$0.07
4	\$0.06	\$0.05	\$0.09	\$0.04
5	\$0.06	-\$0.03	-\$0.08	
6	\$0.09	\$0.06	\$0.06	
7	\$0.07	\$0.11	\$0.08	
8	-\$0.16	-\$0.03	-\$0.04	
9	\$0.05	\$0.08		
10	-\$0.15	-\$0.10		
11	\$0.20	\$0.11		
12	\$0.12	\$0.12		
13	-\$0.17	-\$0.12		
14	\$0.14	\$0.06		
15	\$0.05	\$0.04		
16	-\$0.01	-\$0.06		
17	\$0.11			
18	\$0.10			
19	-\$0.15			
20	\$0.03			
21	-\$0.12			
22	\$0.03			
23	\$0.15			
24	\$0.10			
25	\$0.12			
26	-\$0.05			
27	\$0.00			
28	\$0.12			
29	-\$0.07			
30	-\$0.02			
31	\$0.02			
32	-\$0.19			

For example, the expected reward for the next day if the security finds itself in an “up-up-down-down-down” pattern (pattern identifier = 25) is \$.12 or 12 cents.

It should be noted that not all patterns might occur in the training data, thus there will be no average price for those patterns. Snake pattern length reduction solves the lack of average price. This is discussed more in the next section.

4.2.5 Policy Optimization

The MDP model recommends a policy (“stay” or “change” decision for each possible state) for the investor based on the returns encountered in the training period. Typically with an MDP, this process involves the use of Howard’s two-phase algorithm (Howard, 1960).

However, in this case, the optimal policy is myopic since the security can be bought or sold every trading day. If the security is expected to go “up” and you are in the market, then “do nothing” is appropriate, while if out of the market, you should “change.” Similarly, if the price is expected to go “down” and you are in the market, then you should “change,” but if you are out of the market you should “do nothing.” The expected reward for each state, described in the previous section is used to determine the appropriate decision for each state.

The table on the following page summarizes the optimal policy.

Table 4.5 – Market Position and Optimal Actions

Current Position	Tomorrow's Expected Return	Recommendation	Comment
In Market	Positive	Do Nothing	Best situation in the market and expect to go up
In Market	Negative and greater than negative commission	Do Nothing	Appears security will drop tomorrow; however, the expected drop is less than the cost of the commission. Stay in the market
In Market	Negative and less than negative commission	Change	Tomorrow's expected drop is more than commission. Sell and leave the market
Out of Market	Positive and greater than twice the commission plus a penny	Change	Tomorrow's expected gain is sufficient to buy into the market. The twice covers investors cost to move from cash to stock and back to cash
Out of Market	Positive and less than twice the commission plus a penny	Do Nothing	Stay out of the market. The expected gain is not large enough to enter
Out of Market	Negative	Do Nothing	Stay out of the market. Tomorrow's expected value is negative

As mentioned before, particularly for long snake lengths, some possible snake patterns may not occur in the training data or may only occur a few times. If these patterns are not encountered in the testing data, then no problem exists. However, when one of these patterns is encountered, then the state either will have no defined decision or the policy's decision for this state may be based on only a few observations.

One solution is to define the decision for these states as “do nothing.” However, this may or may not be the best approach. An alternative approach is to reduce the snake length for these states by “throwing away” the older data at the tail of the snake until a state is reached for which adequate testing data exists. The decision for the original state is based on the expected price change for the shorter snake length pattern. A threshold parameter can be specified for the minimum number of occurrences (“hits”) of a given state in the training data below which the snake length would be reduced. The length of the snake pattern is reduced until an acceptable number of “hits” are found for the pattern. If the length of the snake reaches a specified minimum (two for this research) and the minimum threshold has still not been reached, then the “do nothing” decision is used. For longer length snakes, using a threshold of zero may result in many states with “do nothing” for their decision.

An example of how the change occurs would probably help clarify this activity. Suppose 3 years of training data are used and the following table contains the number of occurrences for the patterns. The model defines the number of occurrences as “hits.” The table on the following page represents the “Hit Array.”

Table 4.6 – Sample of Hits For Snake Patterns for Lengths 2 Through 5

Pattern Identifier	Snake Length = 5	Snake Length = 4	Snake Length = 3	Snake Length = 2
1	17	44	100	194
2	27	56	95	197
3	24	49	99	197
4	32	46	98	168
5	24	47	94	
6	25	52	102	
7	23	51	98	
8	23	47	70	
9	30	56		
10	18	39		
11	28	50		
12	24	52		
13	23	47		
14	27	50		
15	31	47		
16	16	23		
17	27			
18	29			
19	25			
20	14			
21	23			
22	27			
23	28			
24	24			
25	26			
26	21			
27	22			
28	28			
29	24			
30	23			
31	16			
32	7			
Total	756	756	756	756

For the previous table, notice that the pattern for a length five snake may take on values from one to thirty-two while there are 16 unique patterns for a length four snake, eight patterns for a length three snake and four patterns for a length two snake. In all cases, the total hits sum to 756 for the three-year period. Trading days of 252 times three years yield the 756 days.

Notice that the five-length snake of “up-up-up-up-up” (identifier thirty-two) occurs seven times in the data. If the threshold is set at seven or higher, then the model will shift back to the four-length snake and check for the occurrences of “up-up-up-up” (identifier sixteen). In the four-length arena, the “up-up-up-up” pattern occurs twenty-three times which exceeds the minimum threshold of more than seven. Therefore, the expected price change for identifier 16 for a snake of length four is used to define the policy for the two states that have pattern 32 for the original length five snake.

4.3 Comparative Strategies

In order to evaluate the performance of the proposed approach, the results of the model are compared to four different strategies of the investor: Buy and Hold, Random Buys, Dollar Averaging, and Dollar Averaging at Average Price. Each of these strategies is described below.

4.3.1 Buy and Hold

This is a very commonly used strategy where the investor buys the stock the first day of the testing period and holds it throughout the entire period. The value of the security on the final day of testing is subtracted from the initial value to determine the performance of this approach.

4.3.2 Random Buys

Under this strategy, the investor buys and sells the same number of times that the Markov model buys and sells. The model processes one hundred of these random “buy and sell” trips

and compares that to the model's buy and sell results. This technique best proves the value in the forecasting ability of the model.

4.3.3 Dollar Averaging

Under this strategy, a fixed dollar amount of a security is bought at the end of each month. This dollar averaging strategy purchases at the closing price at the end of the month. This is the recommended manner to invest in the stock market by many of the huge brokerage firms.

4.3.4 Dollar Averaging at Average Price

This is similar to the averaging technique above; however, instead of using the closing price at the end of the month for the purchasing price of the stock the average price of the stock is used. Many "company" plans for stock purchase use this technique. This technique is quite often used for dividend reinvestment plans.

4.4 Experimental Plan

In order to determine the performance of the proposed Markov-based strategy and the comparative strategies, they are tested using actual data from a variety of securities. As described in section 4.1, a portion of historical data, referred to as "testing" data is used for this purpose. Although, the length of "testing" period could be modified, in this research it is set to one year to compare to other strategies. On the stock exchange 252 trading days form a year.

In no instance is the model allowed to view future data to assist in making biased decisions. However, for the Markov-based model, it does make sense to update the policy based upon newly observed data. A moving window of data used for training is implementing in which, after some number of days of new data are observed, this new data is added to the training base and the corresponding number of days of the oldest data are removed. This updating is referred to as "sliding." For example, if the slide period is one week (represented by 5

trading days) then after a week of testing data is evaluated, the model is retrained with this data added to the existing training data and the oldest week removed. A new policy is generated using the new training data. When the model “slides” forward it has already made the “buy” and “sell” decisions and reaped the gain or loss for the 5-day period that moves into the training arena.

Operation of the model in this manner simulates recalculation of the policy on a weekly basis. The model could be executed on Sunday for a fresh weekly start on Monday. In this way, the model is continually trained using past data yielding a new policy, and then guides the investor with the recommended policy for entering and exiting the market.

For the Markov-based model and the comparative strategies, an initial capital position for the purchase of 1,000 shares of each security tested is assumed. The initial capital draws interest at $\frac{1}{2}\%$ per year until the policy recommends an entry into the market. At that point, any cash not invested in the security draws interest. Any purchase of stock is assumed to be for the largest integer number of shares that can be purchased with the available cash on hand. Cash from subsequent selling of the stock position is put into the cash account. This process continues until the testing period is complete. The timing of buys and sells are based upon the strategy being tested. At the completion of the testing period, the returns of each strategy are computed.

An overview of each of the companies represented by the securities used for testing is provided in section 4.4.1.

4.4.1 Securities Tested

The model, using the technique outlined earlier, examines 20 securities and one index. The securities selected are shown on the following page.

- 1) S&P 500 Index Fund
- 2) I2 Technologies
- 3) Tesoro Petroleum
- 4) Symbol Technologies
- 5) Duke Power
- 6) Bristol Myers
- 7) Intel Corporation
- 8) Lucent Technologies
- 9) OMI Corporation
- 10) AT&T
- 11) General Electric
- 12) America On Line
- 13) Home Depot
- 14) IBM Corporation
- 15) Cisco
- 16) Johnson and Johnson
- 17) Coca Cola
- 18) JP Morgan
- 19) SBC Corporation
- 20) Exxon Corporation

In addition, the index for the Dow Jones Industrial Average is examined.

These securities and index will be used to test the capability of the model to generate a favorable investment return on price only. Later, techniques to expand beyond price will be explored.

A brief characteristic description of each of the securities is as follows.

S&P 500 (SPY)

Details of this fund have been provided earlier in this paper. This index fund may be purchased as any other stock is purchased. The Beta volatility of the SPY is .98. This stock index resonates with the overall changes in the market. Furthermore, the SPY provides instant diversification and protection against an Enron type of fiasco destroying the stock value. One last point of strength is that the SPY represents a large portion of the entire U.S. equities market.

I2 Technologies (ITWO)

ITWO provides enterprise software applications and solutions for dynamic value chain management. This hot high tech stock is included because it carries extreme volatility. The ITWO has a five-year Beta of 3.67. On average when the market as a whole rises or falls by one percent, ITWO rises or falls by 3.67%. With the high volatility of the market ITWO experiences even higher volatility. This stock is a NASDAQ traded security. Preponderance of analysts recommends hold. Company's capitalization is over \$1 billion.

Tesoro Petroleum (TSO)

Old and conservative is the target of this selection. This stock has traded in the \$5 - \$20 range for the past 20 plus years. Tesoro did not see the explosion that ITWO experienced in go-go years of the Internet stock run up. Volatility is .85, which is less than the market. Traded on the New York Stock Exchange, the present price is about 40-50% of the book value. This San Antonio, Texas based company is composed of refineries, independent service stations and marine logistics services. Analyst recommendations are from strong buy to sell. TSO's capitalization is about \$375 million.

Symbol Technologies (SBL)

Symbol is a leader in the scanner business. The main reason for inclusion in this study is that SBL has a Beta of 1.47. Symbol is not as volatile as ITWO; however, still more volatile than the market in general. Another strength of SBL is that it has not experienced mergers and spin offs for many, many years. Data for Symbol covers about 14 years. Symbol describe themselves as a global provider of wireless networking and information systems that allow access, capture and transmission of information at the point of activity over local area networks (LANs), wide area networks (WANs) and the Internet. Analyst recommendations are split between buy and hold. SBL's capitalization is about \$2 billion.

Duke Energy (DUK)

Duke Energy is a large utility. Many investors purchase Duke Energy for the dividend yield. Still, the price of the stock does fluctuate. Duke Energy provides electric service to about 2 million customers in North and South Carolina, and is one of the largest U.S. transporters and marketers of natural gas. Duke Energy was formed in 1997 with the merger of Duke Power and PanEnergy. The beta is .03. The stock does not have the variation found in most stocks on the US exchanges. Analyst recommendations are hold. Data analyzed covers about 14 years.

Bristol Myers (BMY)

Bristol Myers Squibb is a leading global drug maker, with strength in both prescription and nonprescription products. Their beta is .51. Bristol Myers is a large company with a market capitalization of about \$41 billion. Prescription pharmaceuticals accounted for 80% of 2001 sales, nutritionals for 10%, consumer medications for 6%, and wound care and ostomy products for 4%. Most sales are within the US; however, sales outside the U.S. represent

32% of 2001 revenue. A Bristol Myers' well know consumer over-the-counter drug is Bufferin. Analyst recommendations are hold.

Intel Corporation (INTC)

Intel is the world's largest manufacture of microprocessors. Intel also produces other microelectronic devices serving the PC area. Sales are becoming more global. In 2001, revenues were derived 35% from North America, 31% from Asia-Pacific, 25% from Europe, and 9% from Japan. Intel has a very large market capitalization of about \$101 billion. Intel dominates the PC world with an 80% market share of processor chips. Analyst recommendations are hold. Beta for Intel is 1.73.

Lucent Technologies (LU)

Lucent is a very widely held stock. Lucent originated with a spin-off of the equipment-manufacturing arm of AT&T. Lucent is one of the world's leading developers and manufacturers of telecommunications equipment, software and products. With the slump in stock price, Lucent's market capitalization is about \$2 billion. Beta is 1.99. Lucent historical prices start in early 1996. Analyst recommendations are avoid.

OMI Corporation (OMM)

OMI, a major international tanker owner and operator, provides sea borne transportation services for crude oil and petroleum products in international shipping markets. Very few analysts follow this rather small company with a market capitalization of \$247 million. OMI is the smallest stock examined. OMI' customers include major independent and state-owned oil companies, major oil traders, government entities, and various other entities. Beta is .53. Book value exceeds the current price of the stock. About 10 years of stock data is analyzed on this security.

AT&T (T)

AT&T is a very widely held stock. AT&T is the largest U.S. long-distance provider and a leading provider of cable television and business communication services. The AT&T business division (54% of 2001 revenue) provides regular and custom voice services, data and Internet Protocol services, hosting, outsourcing and other consulting services to over four million domestic and multinational businesses. The Consumer unit (28%) is the largest U.S. provider of consumer long-distance services, with 60 million customers at the end of 2001. The division offers inbound and outbound domestic and international long distance, transaction-based long-distance services (operator assistance and prepaid phone cards), local calling offers, and dial-up Internet service. Beta is 1.23. Although 14 years of data are examined, mergers and spin-offs have impacted the stock volatility. Analysts recommend a hold on the stock.

General Electric (GE)

General Electric is a very widely held company. GE has interests in industrial equipment, media, insurance, and financing. GE's industrial portfolio comprises of seven operating segments: Power Systems, Industrial Products & Systems (locomotives/lighting products), Aircraft Engines, Technical Products and Services (medical diagnostics equipment), Materials (plastics), NBC (broadcasting & cable), and Appliances. GE's market capitalization is a staggering \$240 billion. Beta is 1.05. Fourteen years of data are examined for GE. Jack Welch, GE's CEO, has recently retired from the company. Analyst recommendations vary between hold and buy.

AOL Time Warner (AOL)

AOL is a leading media company with significant operations in areas that include online access and content, cable systems and networks, publishing, filmed entertainment, and music.

Beta is 2.75. AOL has been a very volatile stock. The Internet portion of the company as of December 2001 served 37 million subscribers. The media arm of AOL includes Warner Brothers, Time magazine (139 titles), Mad magazine, CNN, HBO and others. Recording artists Madonna, Faith Hill and others produce under AOL labels. The Time Warner cable division serves 10 million customers. Still analysts recommend a hold on AOL.

Home Depot (HD)

Home Depot is a very widely held stock. It operates a chain of more than 1,400 retail warehouse-type stores and sells a wide variety of home improvement products for the do-it-yourself and home remodeling markets. Home Depot is the largest home improvement retailer and the second largest retailer in America. Stock capitalization is approximately \$61 billion. Beta for Home Depot is 1.24. Based in Atlanta, Home Depot has moved from origination in 1978 to a member of the Dow Jones Industrial Average in a relatively short time period. Analysts recommend Home Depot as accumulate.

IBM Corporation (IBM)

IBM is the world's largest technology company. IBM offers a diversified line of computer hardware equipment, application and system software, and related services. No longer just a hardware company, software and services contributed 80% of 2001 pretax profits. Beta is 1.27. Analysts recommend for IBM as accumulate.

Cisco (CSCO)

Cisco offers a complete line of routers and switching products that connect and manage communications among local and wide area computer networks employing a variety of protocols. Cisco supplies the majority of networking gear used for the Internet and is the

world's largest supplier of high-performance computer internetworking systems. Cisco has growth through acquisitions. Beta is 1.35. Analysts recommend hold.

Johnson and Johnson (JNJ)

Johnson and Johnson is the world's largest and most comprehensive health care company. They offer a broad line of drugs, consumer products and other medical and dental items. Some of the consumer brands include Band-Aid and Tylenol. In addition, more than 90 different prescription drug, contraceptive and veterinary products are sold. Market capitalization of Johnson and Johnson is about \$168 billion. Beta is .45. Analysts recommend accumulate.

Coca Cola (KO)

Coca-Cola is the world's largest soft-drink company and has a sizable fruit juice business. Its bottling interests include a 40% stake in NYSE-listed Coca-Cola Enterprises. Market capitalization is \$127 billion. Sales in 2001 by geographic region were distributed as follows: North America (38%); Europe, Eurasia and Middle East (23%); Latin America (11%); Asia (25%); and Africa (3%). Beta is .50. Analysts recommend accumulate.

JP Morgan Chase & Co. (JPM)

JP Morgan Chase & Co., a bank holding company, offers a wide range of domestic and international financial services. J.P. Morgan Chase & Co. is now the second largest U.S. bank holding company. Beta is 1.66. Market capitalization is about \$34 billion. Analysts recommend avoid.

SBC Corporation (SBC)

SBC is the second largest U.S. provider of local telephone and wireless service. The company has grown considerably through mergers with fellow Bell companies Pacific Telesis and Ameritech. SBC now seeks to grow through its wireless, data and long-distance businesses. Cingular Wireless (CW) began operations through the merger of wireless operations at both SBC and BellSouth. SBC market capitalization is \$74 billion. Beta is .54. Analysts recommend avoid.

Exxon Mobil Corporation (XOM)

Formed through the merger of Exxon and Mobil in late 1999, this is the world's largest publicly owned integrated oil company. Exxon Mobil serves customers in more than 200 countries worldwide, with the U.S. contributing 30% of 2001 sales, Japan 10%, the U.K. 9%, Canada 7%, and other areas 44%. Exxon market capitalization is \$233 billion. Beta is .39. Analysts recommend buy.

One reason for including AOL Time Warner, AT&T, Cisco, Exxon Mobil, General Electric, Home Depot, IBM, Intel, Johnson & Johnson and Lucent in our investigation is that these stocks are very widely held stocks.

Dow Jones Index

The Dow Jones Index consists of 30 of the largest industrial companies in the US. The companies are:

Alcoa Inc
American Express Co.
AT&T Corp.
Boeing Co.

Caterpillar Inc
Citigroup Inc.
Coca-Cola Co
DuPont Co.
Eastman Kodak Co.
Exxon Mobil Corp.
General Electric Co.
General Motors Corp.
Hewlett-Packard Co.
Home Depot
Honeywell International Inc
Intel Corp
International Business Machines Corp
International Paper Co.
JP Morgan Chase & Co.
Johnson & Johnson
McDonald's Corp.
Merck & Co.
Microsoft Corp.
Minnesota Mining & Manufacturing Co
Philip Morris Cos.
Procter & Gamble Co.
SBC Communications
United Technologies Corp.
Walt Disney Co.
Wal-Mart Stores Inc.

The Dow Jones Industrial Average consists of a composite of these stocks. The public gages the direction of the overall market movement most often with the DJIA and S&P 500 index.

4.4.2 Closing Price Plots

Regardless of the model or techniques used to enter and exit the market, the closing prices of the security will be of interest. To better understand these stocks, the closing price plots for each may be found below and on the next few pages. All chart dates are month, day, and year.

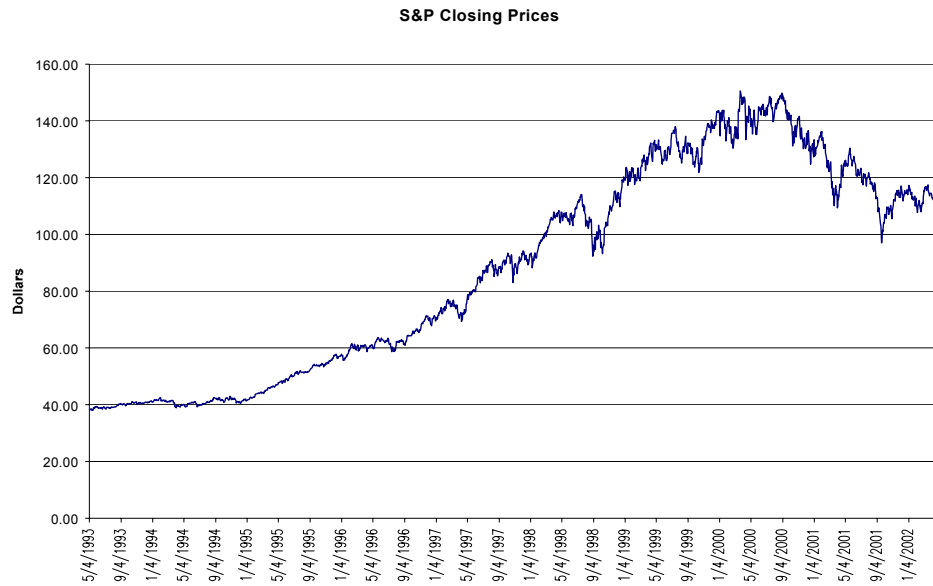


Figure 4.2 – Closing Price of S&P Index Fund (SPY)

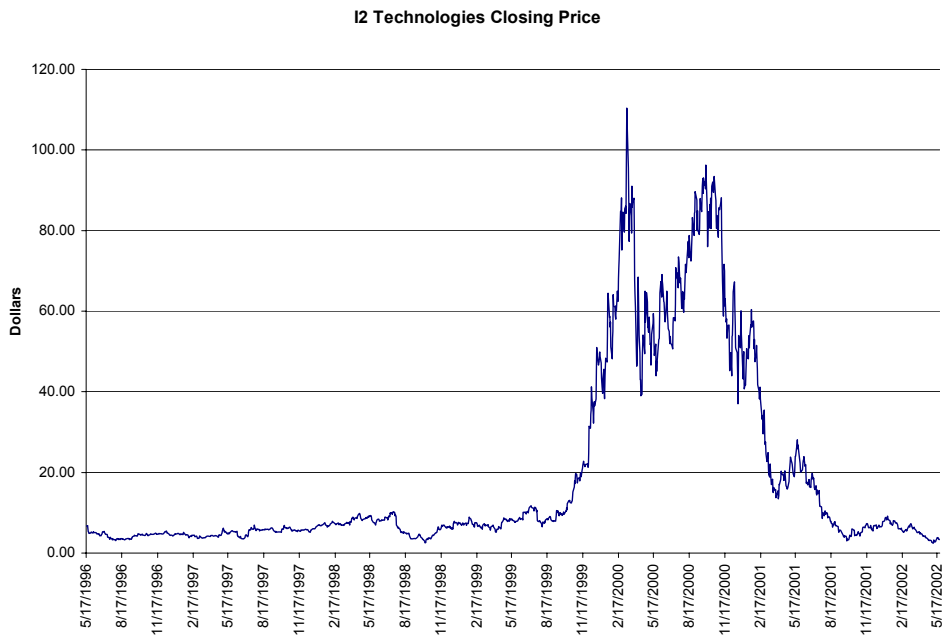


Figure 4.3 – Closing Price I2 Technologies (ITWO)



Figure 4.4 – Closing Price Tesoro Petroleum (TSO)

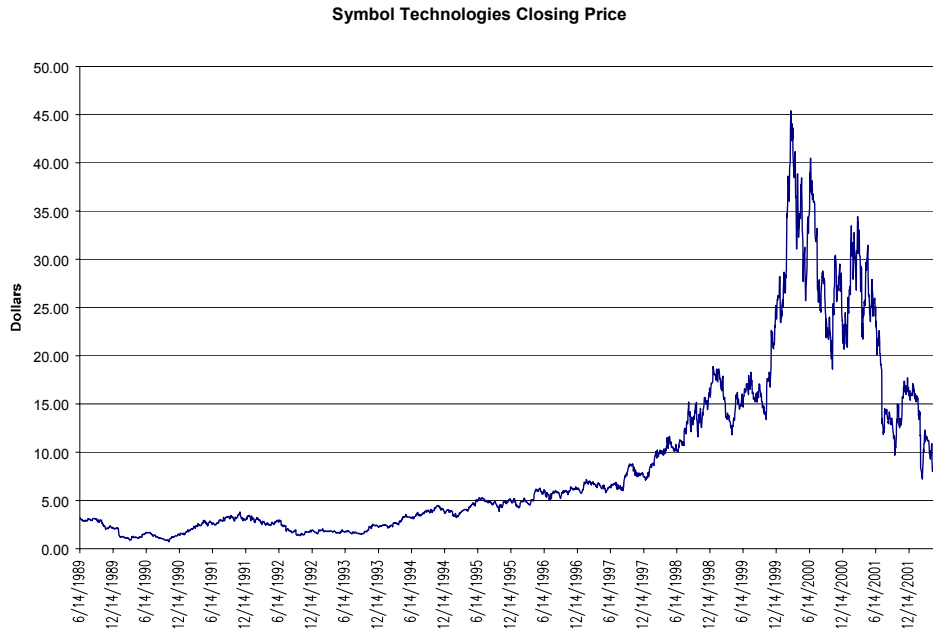


Figure 4.5 – Closing Price Symbol Technologies (SBL)



Figure 4.6 – Closing Price Duke (DUK)

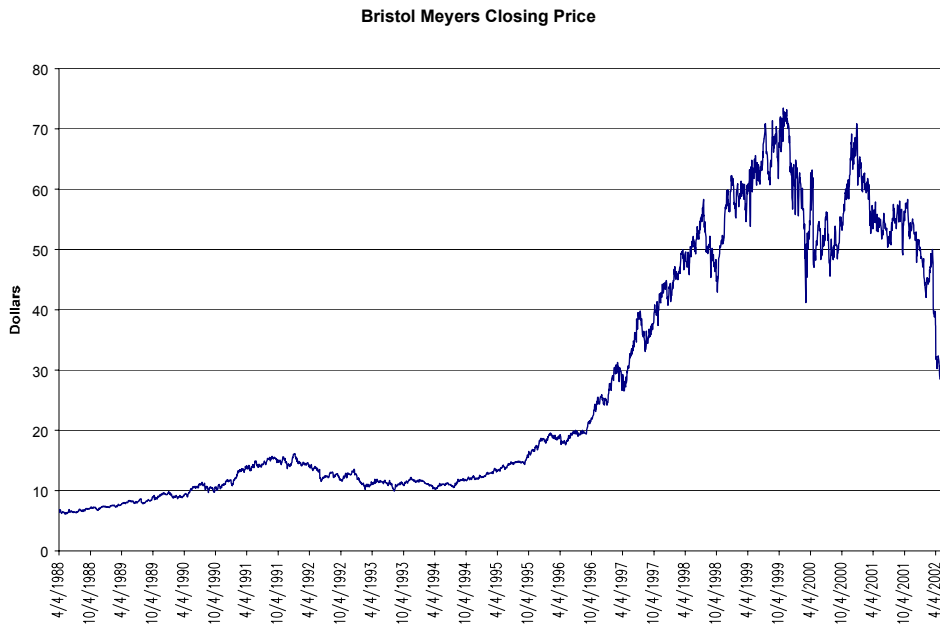


Figure 4.7 – Closing Price Bristol Myers (BM)

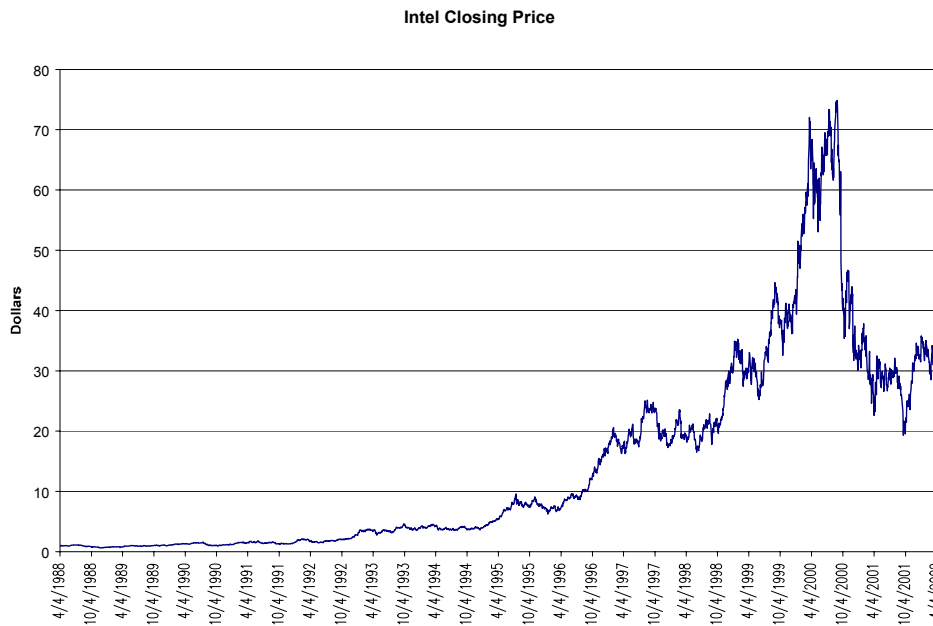


Figure 4.8 – Closing Price Intel (INTC)



Figure 4.9 – Closing Price Lucent (LU)

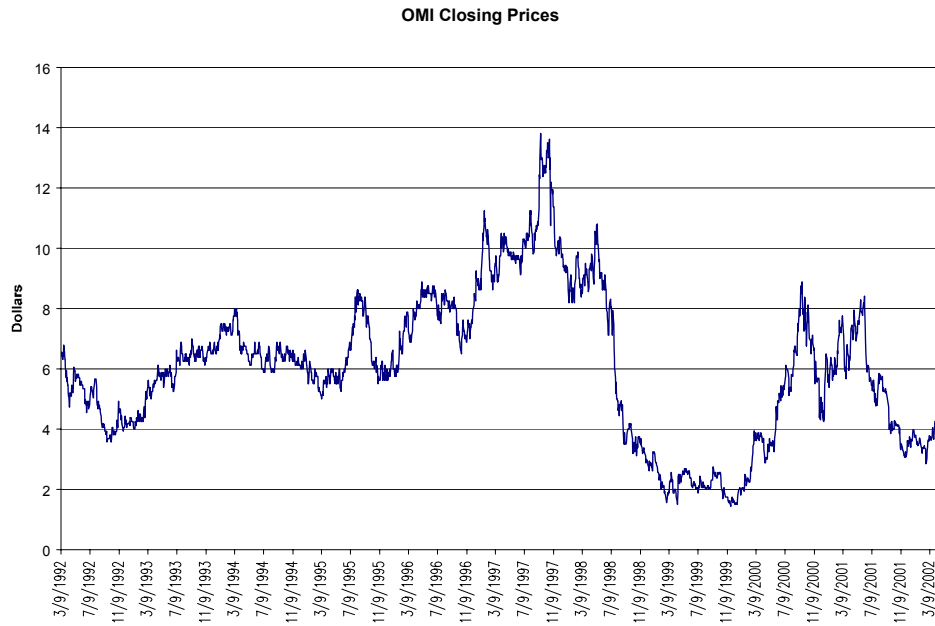


Figure 4.10 – Closing Price OMI Corporation (OMM)



Figure 4.11 – Closing Price AT&T (T)

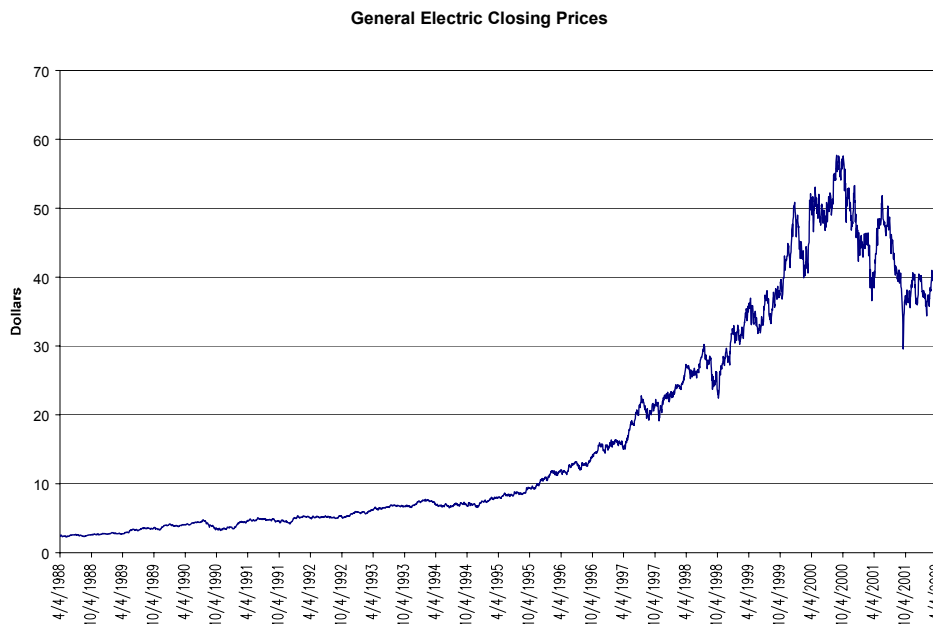


Figure 4.12 – Closing Price General Electric (GE)



Figure 4.13 – Closing Price AOL Time Warner (AOL)



Figure 4.14 – Closing Price Home Depot (HD)

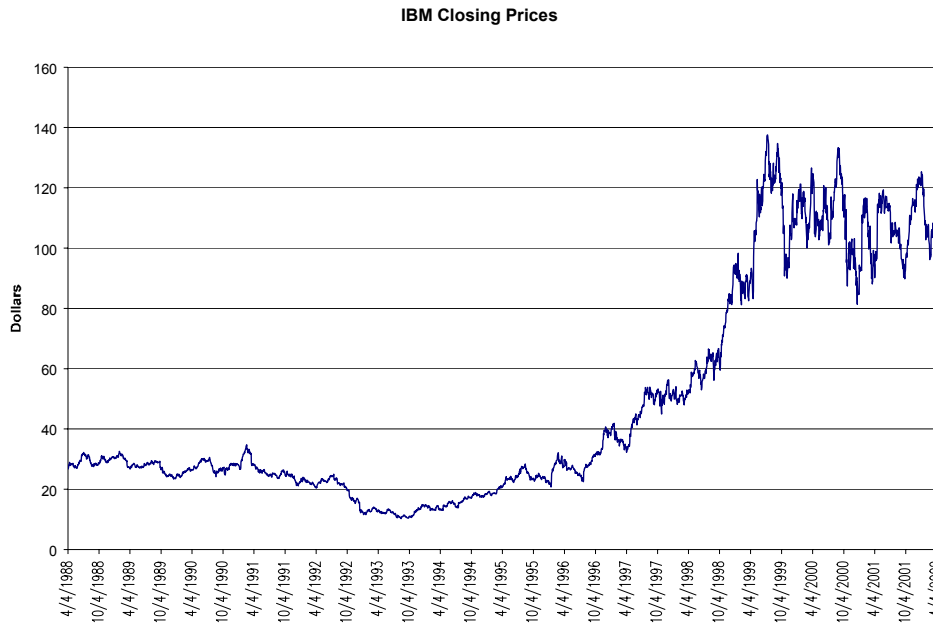


Figure 4.15 – Closing Price IBM (IBM)



Figure 4.16 – Closing Price Cisco (CSCO)

Johnson & Johnson Closing Price

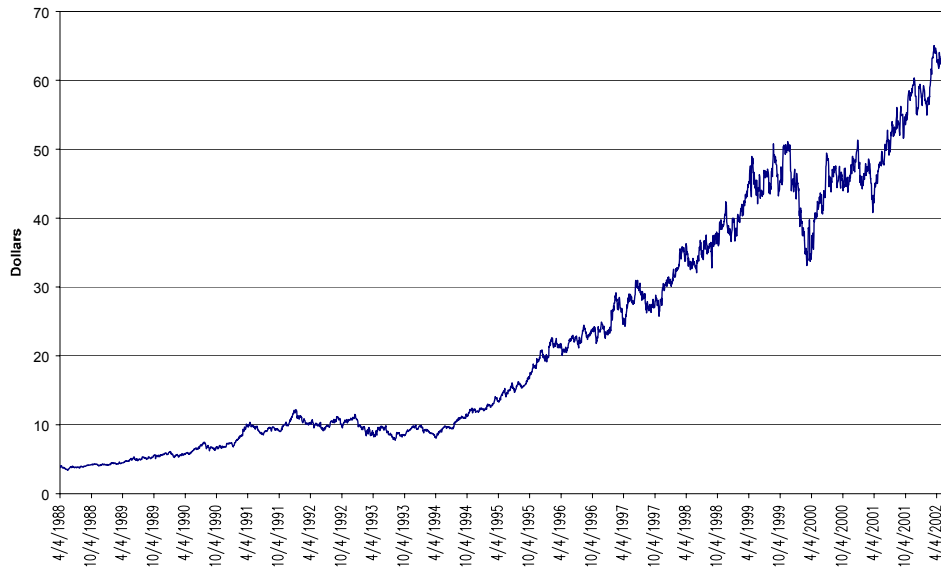


Figure 4.17 – Closing Price Johnson & Johnson (JNJ)

Coca Cola Closing Prices

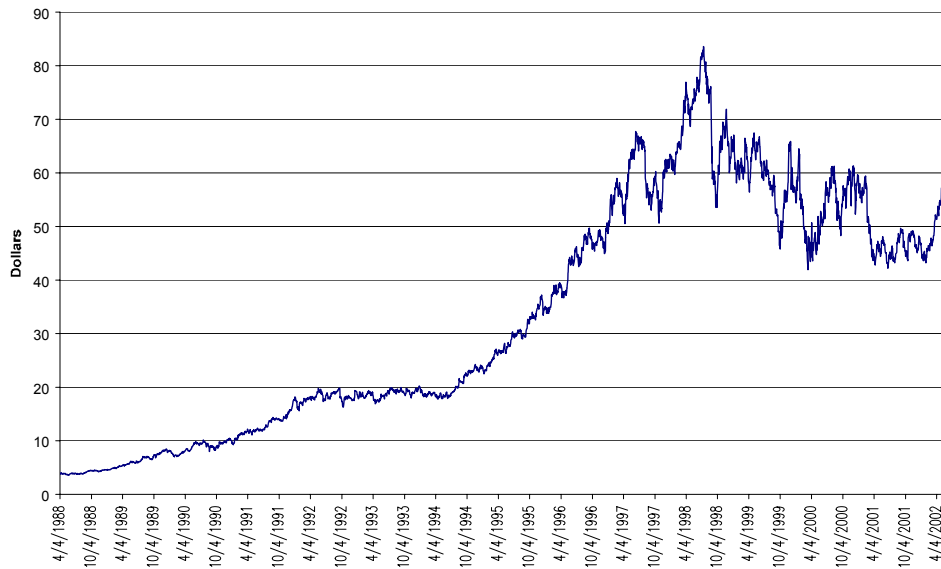


Figure 4.18 – Closing Price Coca Cola (KO)

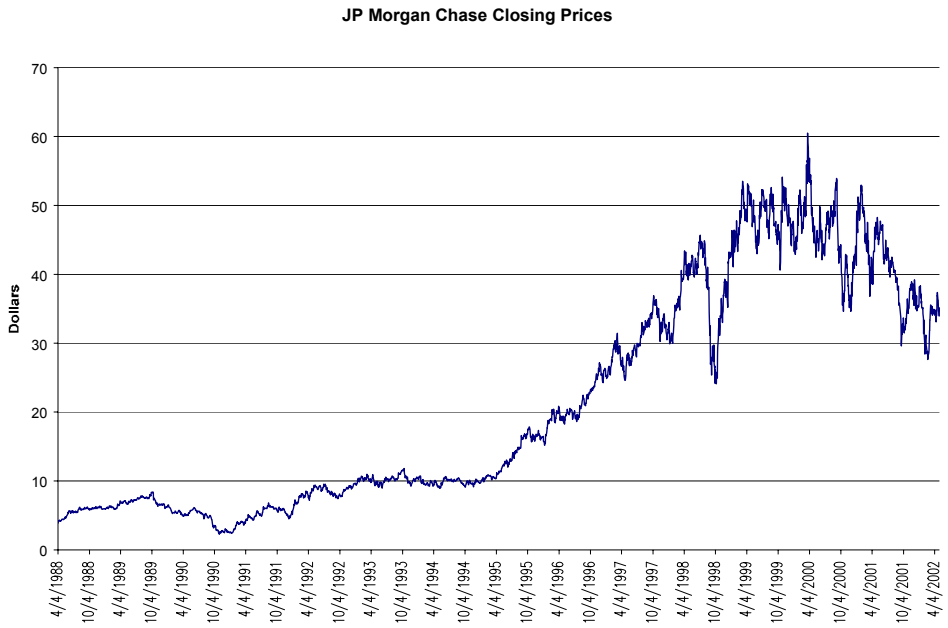


Figure 4.19 – Closing Price JP Morgan Chase (JPM)

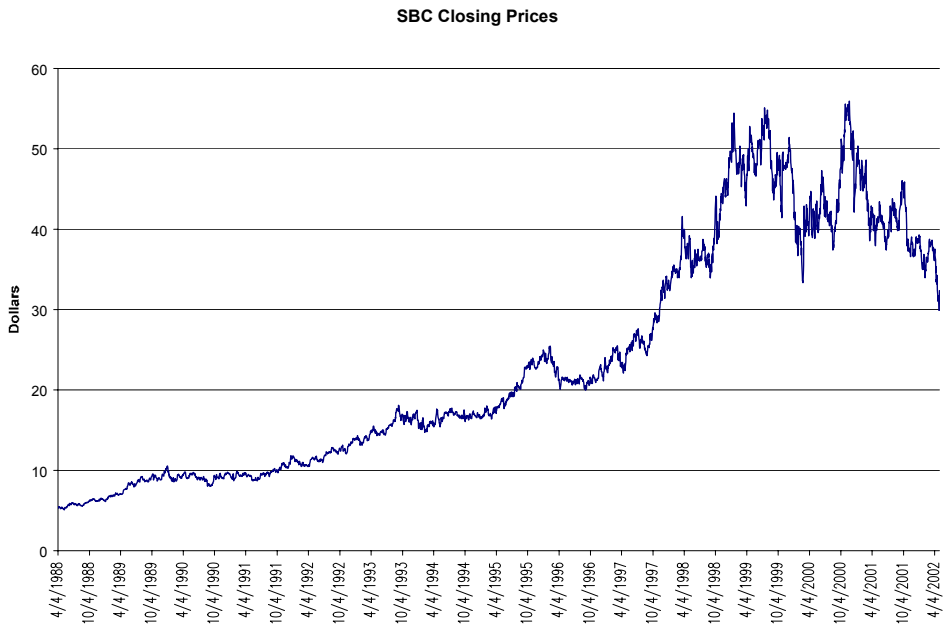


Figure 4.20 – Closing Price SBC (SBC)

Exxon Mobil Closing Prices



Figure 4.21 – Closing Price Exxon Mobil (XOM)

Dow Jones Index Close

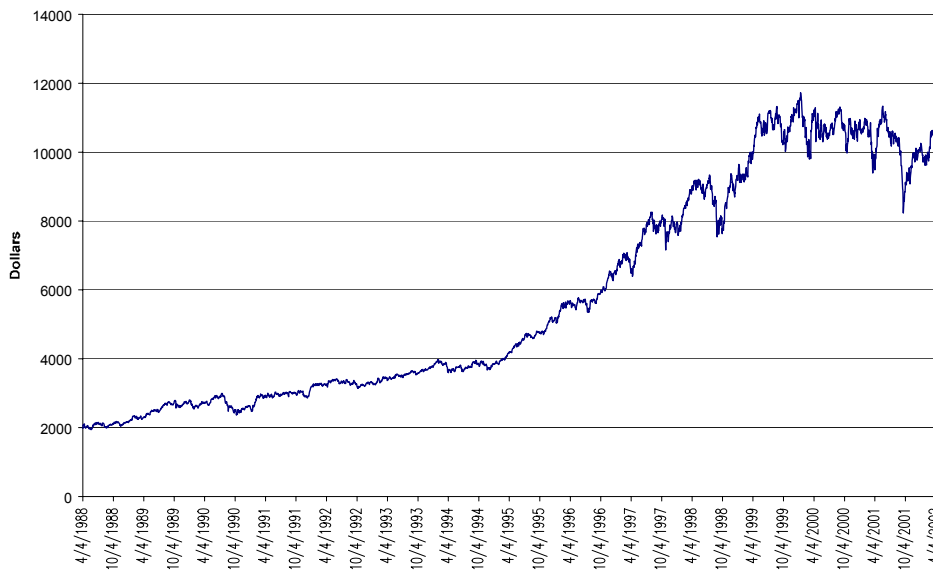


Figure 4.22 – Closing Price Dow Jones Index

The prices for the stocks are plotted for the data that are used in the analysis. That is, both training data and testing data are included in the plot. Notice that the historical closing prices of these stocks have been different. The S&P and Dow Jones Index have experienced a long slow climb with a recent fall back. Both indexes have tracked in similar manner. Both indexes peak in the 1999 and 2000 time periods.

I2, Symbol Technologies, Intel, Lucent, AOL Time Warner, and Cisco all experience an explosion in their stock prices during late 1999 and year 2000. All also experience a very rapid fall in the 2001 and later time periods. These stocks appear to be on the “tech bubble.”

Tesoro Petroleum, OMI and AT&T did not experience the high growth and zigzag up and down over a time span from 1988 to 2002. All three of these stock prices end near the price for the stock in 1988. Tesoro and OMI are in the oil business. AT&T is a long distance provider.

Duke Energy, IBM, and Exxon Mobil track the indexes fairly closely. SBC, JP Morgan Chase, Home Depot and General Electric also track the indexes; however, these stocks have a slightly larger downturn in the latter months.

In the drug group, Johnson and Johnson continues to grow year over year. The other drug stock Bristol Myers Squibb; however, experiences a downturn in the latter months larger than any but the “tech stocks.”

The only common thread in most all of the 21 stocks is that they have experienced a decrease in price due to the 2002 entry into a bear market. One more small twist, not included in the earlier portions of this paper, is that many of the stocks pay a dividend. Duke, Bristol Myers, AT&T, General Electric, JP Morgan Chase, SBC and Exxon Mobile have paid dividends over the examined period that may have made these stocks “dividend” plays. The other stocks do not pay significant dividends.

Current dividends yields are provided in the following table.

Table 4.7 – Selected Dividends

Company	Year Percent Yield
Duke Power	5.7
Bristol Myers	4.9
AT&T	1.1
General Electric	2.7
JP Morgan Chase	7.3
SBC	4.5
Exxon Mobil	2.5

4.4.3 Experimental Design

In the experimentation that follows, the following parameters were varied as defined.

1. The “hit” threshold value is run at values of zero, three and six.
2. The snake length is ranged from 2 to 15.
3. The number of years of initial training data is run at values of 2-4.
4. Depending upon the security and the number of years of training data used, all feasible testing period years are evaluated.

For each of the securities, the model is executed for each combination of the above parameters.

4.5 Experimental Results

In this section, the performance of the Markov model is presented and compared to the performance of other strategies in order to determine the combination of parameters (threshold, years of training and snake length) that provides the best results for each testing year.

4.5.1 S&P 500

The S&P 500 (SPY) is the first security examined. The SPY data from the YAHOO database spans from January 29, 1993 through May 3, 2002. The days are numbered sequentially from 1 through 2334.

On the following page, table 4.8 shows the first set of runs.

Table 4.8 – Variables and Settings for S&P Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through fifteen
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	822, 1074, 1326,1578,1830,2082,2334
Year End Dates	Apr 30, 1996, Apr 29, 1997, Apr 29, 1998, Apr 29, 1999, Apr 27, 2000, Apr 27, 2001, May 3, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

In processing the model, the last 252 days are reserved as the testing period. The training occurs before the testing. The policy established in the training period is used as the buy and sell signal in the testing region. Given a testing period of one year for the earlier date, enough data is not present to examine a four-year training period. Only two years of training are used on the “year end” of 822 and only the two and three-year training periods are used for the 1074-year end position. The high level summaries of the yearly percent returns for the S&P 500 reside in the following tables.

Tables 4.9 – Percent Returns for SPY with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	14.81	13.54	12.95	2	14.81	13.54	12.95
3	10.79	15.95	15.96	3	10.79	15.95	15.96
4	11.65	10.34	10.30	4	11.65	10.35	10.30
5	11.35	14.25	9.14	5	11.35	14.25	9.14
6	5.39	12.19	13.47	6	6.20	12.18	13.47
7	15.52	14.79	11.34	7	13.06	11.74	10.05
8	8.63	10.58	16.82	8	10.57	9.25	13.35
9	11.21	14.62	18.81	9	10.65	10.40	14.56
10	8.61	13.34	11.08	10	10.56	9.66	14.13
11	8.71	5.66	6.04	11	10.56	9.68	14.61
12	8.92	5.15	4.29	12	10.56	9.75	14.82
13	5.46	2.59	2.50	13	10.56	9.75	14.82
14	5.28	2.41	1.47	14	10.56	9.75	14.82
15	4.71	4.10	3.86	15	10.56	9.75	14.82

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	14.81	13.54	12.95
3	10.79	15.95	15.96
4	11.65	10.34	10.30
5	11.14	14.25	9.14
6	8.21	13.04	13.60
7	9.91	10.58	9.74
8	10.13	11.81	13.88
9	10.13	11.71	13.60
10	10.13	11.71	13.60
11	10.13	11.71	13.60
12 - 15	10.13	11.71	13.60

Given the fact that fewer years are available for the four-year training period than the two-year training period, the first column consists of seven returns; the second of six and the final column has five returns.

These returns are based on the compounding nature of interest. That is, the overall return for the model is calculated as follows.

$$Total\ Return = \left[\left[\prod_{j=1}^n (1 + return_j / 100) \right] - 1 \right] \times 100$$

where:

- j = Model generated return for the year examined, and
 n = Number of years model generates data.

For the first column of Tables 4.9, “n” was equal to seven, for the second six and for the final column “n” equals five.

Now, the total return for the model must be expressed as a per year number for the previous tables. The formula for that conversion is as follows.

$$Yearly\ Return = \left[\left[\left[\left[Total\ Return / 100 \right] + 1 \right]^{1/n} \right] - 1 \right] \times 100$$

where

n = Number of years model generates data.

The yearly returns are given in the tables above and on the previous page. From these returns, candidates for the model are highlighted. Those candidates are:

- 1) Threshold of zero, training length of four years and snake length of nine – Yield estimated at 18.81% per year.
- 2) Threshold of three, training length of four years and snake length of three – Yield estimated at 15.96% per year.

The following table provides the returns for the first scenario compared to the buy and hold, random, average and average/average strategies explained in the previous chapter.

Tables 4.10 – Percent Returns for SPY (0,4,9) For Strategies

Price Change						Cumulative				
Summary for 0 Thresh, 4 Year Training, 9 Length Snake										
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
97-98	33.49	39.09	18.41	18.70	19.28	33.49	39.09	18.41	18.70	19.28
98-99	27.11	24.41	13.10	18.08	18.98	69.68	73.04	33.92	40.15	41.91
99-00	19.64	9.80	8.81	7.66	7.71	103.00	90.01	45.72	50.88	52.86
00-01	1.19	-12.96	-4.87	-7.34	-8.87	105.41	65.38	38.62	39.80	39.30
01-02	15.25	-13.66	-5.38	-6.61	-6.59	136.74	42.79	31.17	30.56	30.11

To convert to the overall gain of 136.74 percent in the previous table from the average model yearly return of 18.81 percent, raise 1.1881 to the fifth power subtract one and multiply by one hundred. This follows the formulas outlined earlier in the chapter. The following graphs the cumulative side of the table.

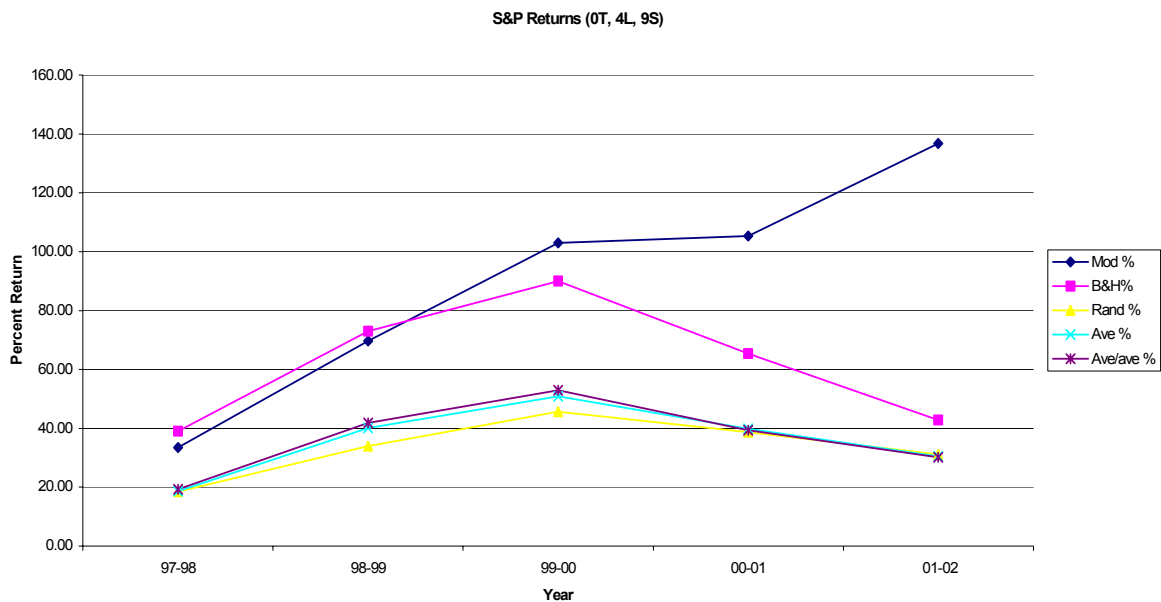


Figure 4.23 – SPY Returns for 0 Thresh, 4 Year Training & 9 Snake Length & Other Strategies

Another set of variables provides good results also. Those model variables yield about 15.96%. The following table provides the comparison to the other policies.

Table 4.11 – Percent Returns for SPY (3,4,3) For Strategies

Price Change						Cumulative				
Summary 3 Thresh, 4 Year Training and 3 Snake Length										
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
97-98	23.41	39.09	20.98	18.69	19.28	23.41	39.09	20.98	18.69	19.28
98-99	26.60	24.41	10.92	18.07	18.98	56.24	73.04	34.19	40.14	41.92
99-00	23.94	9.80	6.53	7.66	7.71	93.64	90.00	42.95	50.87	52.86
00-01	7.90	-12.96	-5.53	-7.34	-8.87	108.94	65.38	35.05	39.80	39.30
01-02	0.35	-13.66	-4.17	-6.61	-6.59	109.67	42.79	29.42	30.56	30.12

The following graphs the cumulative side of the above table for the second best set of variables for the S&P data.

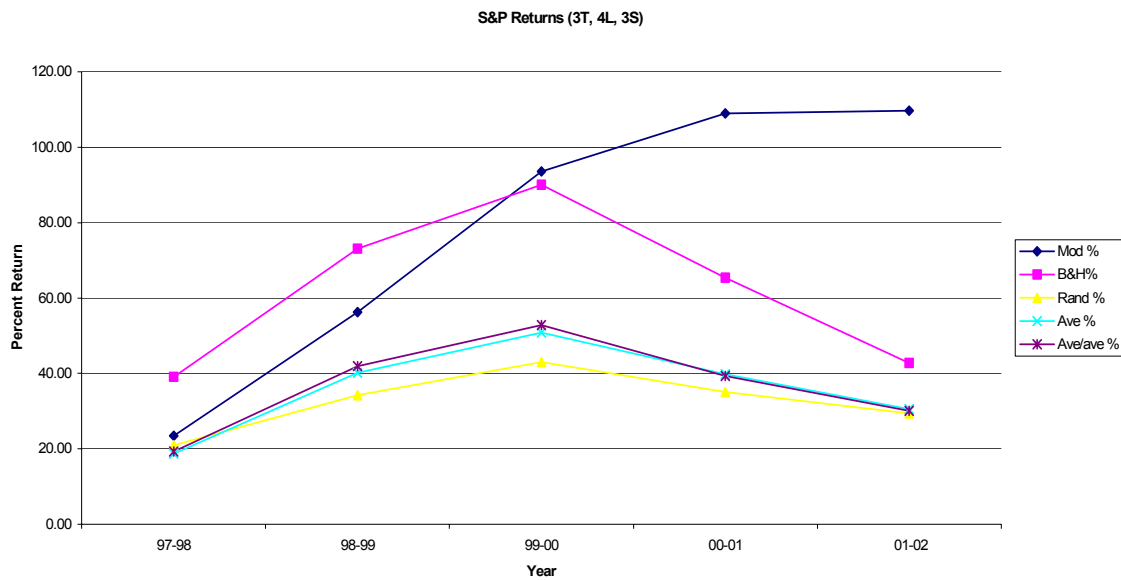


Figure 4.24 – SPY Returns for 3 Thresh, 4 Year Training & 3 Snake Length & Other Strategies

At 136% and 109% returns for the five year period, both of these models perform much better than the examined strategies of buy and hold, random buys, average and average of the average.

4.5.2 I2 Technologies

Next the model processes against a stock with much more variance than the overall S&P numbers. The model examines the data for I2 Technologies over the period from April 26, 1996 through May 23, 2002.

For the I2 Technologies runs, the model is set to examine the following.

Table 4.12 – Variables and Settings for ITWO Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through fifteen
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	772, 1024, 1276, 1528
Year End Dates	May 19, 1999, May 17, 2000, May 17, 2001, May 23, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

The high level summaries of yearly returns for I2 Technologies are as follows.

Tables 4.13 – Percent Returns for ITWO with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	1.41	-39.63	-61.13	2	1.41	-39.63	-61.13
3	14.42	-19.01	-53.88	3	14.42	-19.01	-53.88
4	-20.86	-34.51	-70.81	4	-20.86	-34.51	-70.81
5	-34.99	-25.61	-52.30	5	-34.99	-25.61	-52.30
6	-32.31	-34.63	-69.24	6	-30.32	-34.49	-69.24
7	-39.87	-28.28	-55.50	7	-41.79	-33.54	-58.24
8	4.57	34.90	-3.77	8	-34.31	-12.17	-44.25
9	-23.60	-6.32	-17.46	9	-27.08	-14.02	-28.82
10	-26.57	-10.75	-33.02	10	-27.79	-5.24	-38.00
11	18.74	-25.96	-45.50	11	-27.32	-5.41	-36.81
12	42.72	0.48	-55.40	12	-27.32	-5.41	-36.81
13	11.27	-13.42	-43.75	13	-27.32	-5.41	-36.81
14	-24.91	-16.34	-45.47	14	-27.32	-5.41	-36.81
15	-44.66	-40.69	-58.18	15	-27.32	-5.41	-36.81

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	1.41	-39.63	-61.14
3	14.41	-19.01	-53.88
4	-20.86	-34.50	-70.80
5	-35.84	-25.61	-52.31
6	-39.00	-39.25	-68.28
7	-49.54	-50.83	-68.57
8	-51.65	-53.27	-58.56
9 - 15	-50.59	-51.89	-58.77

The best return for the I2 Technologies is highlighted and is a zero threshold, two years of training, and a twelve-length snake (0T, 2L, 12S). The average yearly return is approximately 42%. This return is highlighted in the previous table.

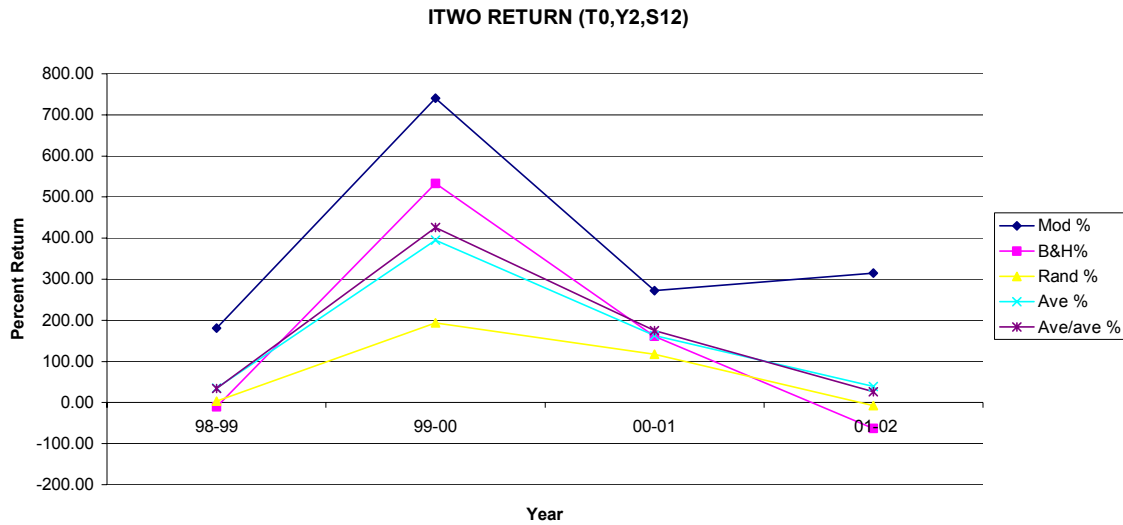
The chart comparing the model's return to the return of the strategies is given as follows.

Table 4.14 – Percent Returns for ITWO (0,2,12) For Strategies

Price Change										
Values for Thresh = 0, Years=2, Snake=12						Cumulative				
Data End	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
98-99	180.52	-10.46	3.79	35.29	33.82	180.52	-10.46	3.79	35.29	33.82
99-00	199.65	607.06	182.75	265.77	293.06	740.58	533.10	193.47	394.85	425.99
00-01	-55.69	-58.74	-26.05	-46.74	-47.8	272.46	161.22	117.02	163.56	174.57
01-02	11.39	-85.99	-57.25	-47.10	-53.88	314.88	-63.40	-7.22	39.42	26.63

Remember the

$$314.88 = \left[\left[1 + (42.72/100) \right]^4 - 1 \right] \times 100 .$$



The graph of the cumulative I2 data is shown on the following page.

Figure 4.25 – ITWO Returns for 0 Thresh, 2 Year Training & 12 Snake Length & Other Strategies

Once again for the I2 data, the model outperforms the other strategies. This volatile stock provides a very attractive return.

4.5.3 Tesoro Petroleum

The model examines a very old New York Stock Exchange company – Tesoro Petroleum. For the model, Tesoro's closing price data spans January 4, 1988 through May 22, 2002.

For Tesoro, the model is set to examine as shown on the following page.

Table 4.15 – Variables and Settings for Tesoro Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through fifteen
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	856, 1108, 1360, 1612, 1864, 2116, 2368, 2620, 2872, 3124, 3376, 3628
Year End Dates	May 21, 1991, May 20, 1992, May 21, 1993, May 20, 1994, May 19, 1995, May 17, 1996, May 16, 1997, May 18, 1998, May 18, 1999, May 16, 2000, May 16, 2001, May 22, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

Given the amount of data for Tesoro, the two-year training data executes on twelve years, the three-year training data executes on eleven years, and the four-year training data executes on ten years.

The high level summaries for yearly returns for Tesoro are as follows.

Tables 4.16 – Percent Returns for Tesoro with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	-5.50	-6.90	-4.60	2	-5.50	-6.90	-4.60
3	-1.43	3.62	-3.26	3	-1.43	3.62	-3.26
4	-3.30	-4.53	3.97	4	-3.30	-4.53	3.97
5	-16.33	-10.22	-0.13	5	-16.15	-10.22	-0.13
6	-9.77	-1.21	3.72	6	-8.57	-2.51	4.57
7	-4.47	-4.94	0.57	7	-5.39	-3.66	2.56
8	-12.41	-12.80	-13.49	8	-10.33	-12.19	-10.18
9	2.95	-7.16	4.99	9	-6.87	-8.27	-2.42
10	-3.80	-6.74	-4.52	10	-9.90	-12.52	-8.68
11	7.13	-6.49	-5.09	11	-8.59	-12.23	-11.76
12	1.90	4.58	7.39	12	-8.58	-12.42	-12.60
13	-10.48	-2.24	2.07	13	-8.69	-11.97	-12.00
14	-10.21	-6.96	1.97	14	-8.69	-12.75	-12.83
15	-10.72	-6.93	-4.54	15	-8.38	-12.75	-12.83

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	-5.50	-6.90	-4.60
3	-1.43	3.62	-3.26
4	-3.09	-4.53	3.97
5	-16.84	-8.93	-0.11
6	-7.88	-1.32	6.97
7	-5.53	-1.53	5.72
8	-7.51	-4.71	-3.58
9	-5.99	-1.58	2.63
10	-6.71	-3.41	-2.01
11	-5.36	-4.09	-5.00
12	-5.36	-4.09	-4.88
13 - 15	-5.36	-3.75	-4.49

A good return for Tesoro using the change in daily closing price Markov model appears to be the zero threshold, two years of training, and an eleven length snake (0T, 2L, 11S). This value of about 7.13% per year is highlighted in the table above.

The chart comparing the model's return on Tesoro to the return of the strategies is given below.

Table 4.17 – Percent Returns for Tesoro (0,2,11) For Strategies

Price Change										
Values for Thresh = 0, Years=2, Snake=11						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
90-91	-34.05	-4.28	1.54	7.86	6.67	-34.05	-4.28	1.54	7.86	6.67
91-92	-1.00	-47.06	-30.53	-26.75	-29.18	-34.71	-49.33	-29.46	-20.99	-24.46
92-93	32.38	38.89	5.26	53.00	51.13	-13.57	-29.62	-25.75	20.88	14.17
93-94	116.00	92.00	40.77	71.59	72.10	86.69	35.13	4.52	107.42	96.49
94-95	22.52	-7.33	-5.43	12.73	11.28	128.74	25.23	-1.15	133.83	118.65
95-96	27.76	1.17	-3.96	21.82	23.6	192.23	26.69	-5.07	184.85	170.25
96-97	12.69	15.56	3.24	5.15	3.71	229.32	46.41	-1.99	199.52	180.28
97-98	10.36	46.62	23.41	17.5	21.07	263.43	114.66	20.95	251.93	239.33
98-99	-33.21	-36.73	-16.15	-5.72	-8.6	142.74	35.82	1.42	231.80	210.15
99-00	11.01	-18.08	-5.69	-20.99	-22.19	169.46	11.26	-4.35	162.16	141.33
00-01	33.66	57.89	26.63	42.43	44.55	260.16	75.67	21.12	273.39	248.84
01-02	-36.56	-49.62	-25.08	-38.12	-40.06	128.49	-11.50	-9.26	131.05	109.09

By the eighth year, the model reaches a total return of 263 percent; however, as the stock moves down in price the final results are a gain of 128 percent for the twelve years.

The graph of the cumulative Tesoro data is as follows.

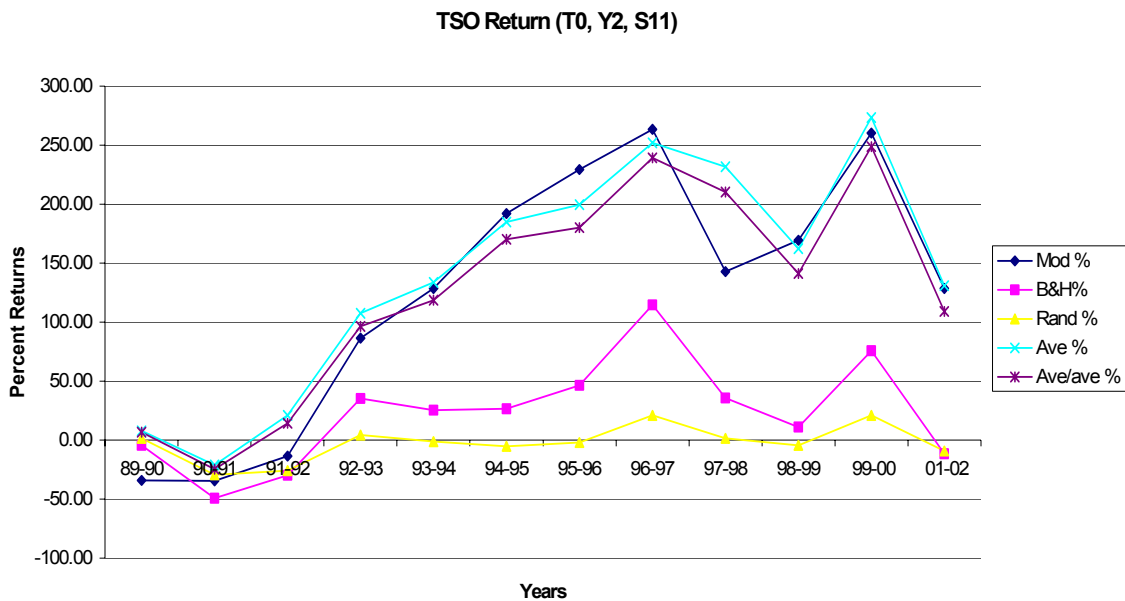


Figure 4.26 – Tesoro Returns for 0 Thresh, 2 Year Training & 11 Snake Length & Other Strategies

With the exception of the “average purchase technique,” for this security the model outperforms all of the strategies. For the investor purchasing a fixed dollar amount at the end of each month, the model is outperformed by about 2 ½% over a twelve year period (128.5%-131.0%). The yearly return of 7% is much lower than the I2 security; however, Tesoro spanned more years.

4.5.4 Symbol Technologies

Symbol Technologies is a high tech stock selected for examination by the Markov model using price change. Symbol’s data spans June 8, 1988 through June 10, 2002.

For the Symbol, the model is set to examine as shown on the following page.

Table 4.18 – Variables and Settings for Symbol Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through fifteen
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	1520, 1772, 2024, 2276, 2528, 2780, 3032, 3284, 3536
Year End Dates	June 8, 1994, June 7, 1995, June 5, 1996, June 4, 1997, June 4, 1998, June 4, 1999, June 2, 2000, June 4, 2001, June 10, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

Symbol is balanced with nine years' data for the two, three, and four year training periods. The high level summaries for Symbol yearly returns are as follows.

Tables 4.19 – Percent Returns for Symbol with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	18.82	16.92	19.91	2	18.83	16.92	19.91
3	6.86	11.09	13.29	3	7.34	11.09	13.29
4	8.44	19.41	16.63	4	8.62	19.41	16.63
5	18.00	15.84	11.36	5	16.40	15.25	12.57
6	1.55	1.65	2.74	6	5.81	4.40	5.05
7	-3.49	-0.05	1.71	7	2.41	3.99	3.95
8	-4.71	1.61	0.95	8	-5.25	6.46	2.24
9	0.09	0.92	-3.70	9	-4.31	7.01	7.41
10	-3.92	1.15	-1.66	10	-6.14	7.54	6.50
11	-3.75	6.04	4.51	11	-6.01	7.02	2.70
12	-1.04	-8.63	-3.27	12	-4.54	3.43	1.28
13	4.42	-5.16	-1.82	13	-4.33	1.65	-0.46
14	12.87	7.56	14.71	14	-4.72	1.51	-1.78
15	6.15	5.29	12.37	15	-5.14	0.02	-1.37

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	18.83	16.92	19.91
3	7.34	11.83	13.29
4	7.91	19.54	16.63
5	14.90	14.80	12.09
6	5.66	4.28	6.05
7	7.10	7.84	4.44
8	3.33	7.44	5.97
9	4.14	7.30	8.79
10	4.49	9.49	7.82
11	2.41	4.99	5.88
12	3.91	4.63	4.72
13	4.93	3.06	3.91
14	4.44	2.31	2.22
15	3.24	2.12	3.81

The best return for Symbol appears to be the zero thresholds, four years of training data, and a two-length snake (0T, 4L, 2S). Expected yearly return would be 19.91%.

The chart comparing the model's return to the return of the strategies is as follows.

Table 4.20 – Percent Returns for Symbol (0,4,2) For Strategies

Price Change										
Values for Thresh = 0, Years=4, Snake=2						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
93-94	0.50	81.92	0.50	45.30	46.51	0.50	81.92	0.50	45.30	46.51
94-95	-11.99	52.48	14.64	24.69	26.34	-11.55	177.39	15.21	81.17	85.10
95-96	16.26	18.74	4.62	15.71	18.07	2.83	229.37	20.54	109.64	118.55
96-97	7.02	8.06	-0.15	0.65	1.30	10.05	255.92	20.36	111.00	121.39
97-98	19.85	63.97	17.74	27.53	30.72	31.90	483.61	41.71	169.09	189.40
98-99	107.37	45.30	18.02	8.18	10.28	173.51	747.98	67.24	191.10	219.15
99-00	183.55	123.72	49.66	60.05	63.21	675.54	1797.10	150.29	365.90	420.89
00-01	-39.47	-24.12	-10.90	-7.99	-7.74	369.44	1339.52	123.01	328.68	380.57
01-02	0.59	-64.99	-40.08	-35.58	-35.62	372.21	403.98	33.63	176.15	209.39

For the Symbol security, the model built on price change snakes underperforms the buy and hold strategy. The graph of the cumulative Symbol data is as follows.

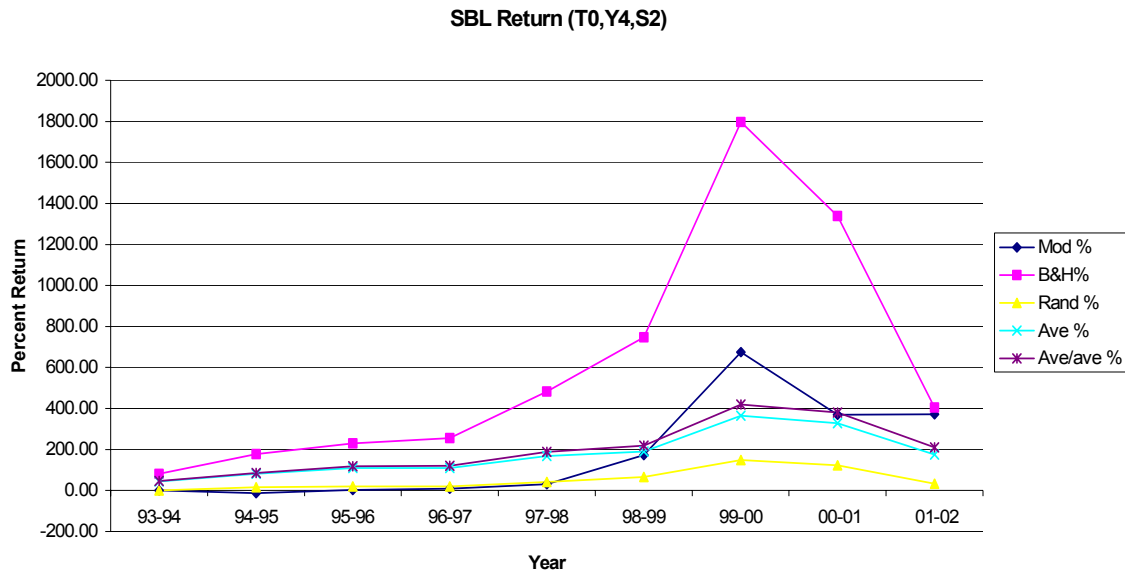


Figure 4.27 – Symbol Returns for 0 Thresh, 4 Year Training & 2 Snake Length & Other Strategies

For the Symbol security, the buy and hold shows the best returns; however, the model closes the gap as the price of Symbol stock deteriorates.

4.5.5 Duke Energy

Duke Energy is a major utility. The data examined spans from April 4, 1988 through May 1, 2002. For Duke Energy, the model is set to examine the following table’s contents.

Table 4.21 – Variables and Settings for Duke Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through twelve
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	781,1033,1285,1537,1789,2041,2293,2545,2797,3049,3301,3553
Year End Dates	May 3, 1991, May 1, 1992, April 30, 1993, April 29, 1994, April 28, 1995, April 26, 1996, April 25, 1997, April 27, 1998, April 27, 1999, April 25, 2000, April 25, 2001, May 1, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

Duke Energy has twelve, eleven, and ten years' data for the two, three, and four year training periods.

The high level summaries for Duke Energy yearly returns are as follows.

Tables 4.22 – Percent Returns for Duke Energy with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	2.50	7.52	4.19	2	2.50	7.52	4.19
3	1.53	1.87	2.47	3	1.53	1.87	2.47
4	7.25	9.61	7.69	4	7.25	9.61	7.69
5	4.68	3.78	2.00	5	4.68	3.78	2.00
6	5.04	2.12	2.04	6	5.04	2.12	2.04
7	6.67	2.75	3.28	7	6.67	2.75	3.28
8	3.76	6.34	7.03	8	3.76	6.34	7.03
9	1.83	5.04	6.62	9	1.83	5.04	6.62
10	2.04	10.47	11.89	10	2.04	10.47	11.89
11	4.19	8.89	8.49	11	4.19	8.89	8.49
12	-0.28	3.15	3.94	12	4.34	9.10	8.76

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	2.50	7.52	4.19
3	1.53	1.87	2.47
4	7.25	9.61	7.69
5	4.68	3.78	2.00
6	5.04	2.12	2.04
7	6.67	2.75	3.28
8	3.76	6.34	7.03
9	1.83	5.04	6.62
10	2.04	10.47	11.89
11	4.19	8.89	8.49
12	4.00	9.00	8.45

The best return for Duke Energy appears to be the zero thresholds, four years of training data and a ten-length snake (0T, 4L, 10S). Expected yearly return would be 11.89%.

The chart comparing the model's return to the return of the strategies is given below.

Table 4.23 – Percent Returns for Duke Energy (0,4,10) For Strategies

Price Change										
Values for Thresh = 0, Years=4, Snake=10						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
92-93	5.73	22.25	3.39	10.58	11.79	5.73	22.25	3.39	10.58	11.79
93-94	-6.18	-2.32	1.72	-9.64	-9.17	-0.81	19.41	5.17	-0.09	1.54
94-95	1.03	13.50	-6.28	5.01	6.15	0.21	35.53	-1.43	4.92	7.78
95-96	26.93	23.65	-0.72	6.74	8.63	27.19	67.58	-2.14	11.99	17.09
96-97	-2.17	-5.63	1.69	-9.37	-9.19	24.44	58.15	-0.49	1.50	6.33
97-98	34.51	39.84	3.36	14.42	15.44	67.37	121.16	2.85	16.13	22.75
98-99	-2.47	-0.33	0.02	-8.53	-9.14	63.23	120.42	2.88	6.22	11.53
99-00	28.44	12.67	9.56	10.56	10.57	109.66	148.35	12.71	17.44	23.32
00-01	57.30	61.17	41.20	29.04	31.29	229.79	300.28	59.15	51.54	61.91
01-02	-6.73	-14.92	-7.52	-1.18	-1.48	207.60	240.57	47.19	49.76	59.52

For the Duke Energy security, the model built on price change snakes underperforms the buy and hold strategy. The graph of the cumulative Duke Energy data is as follows.

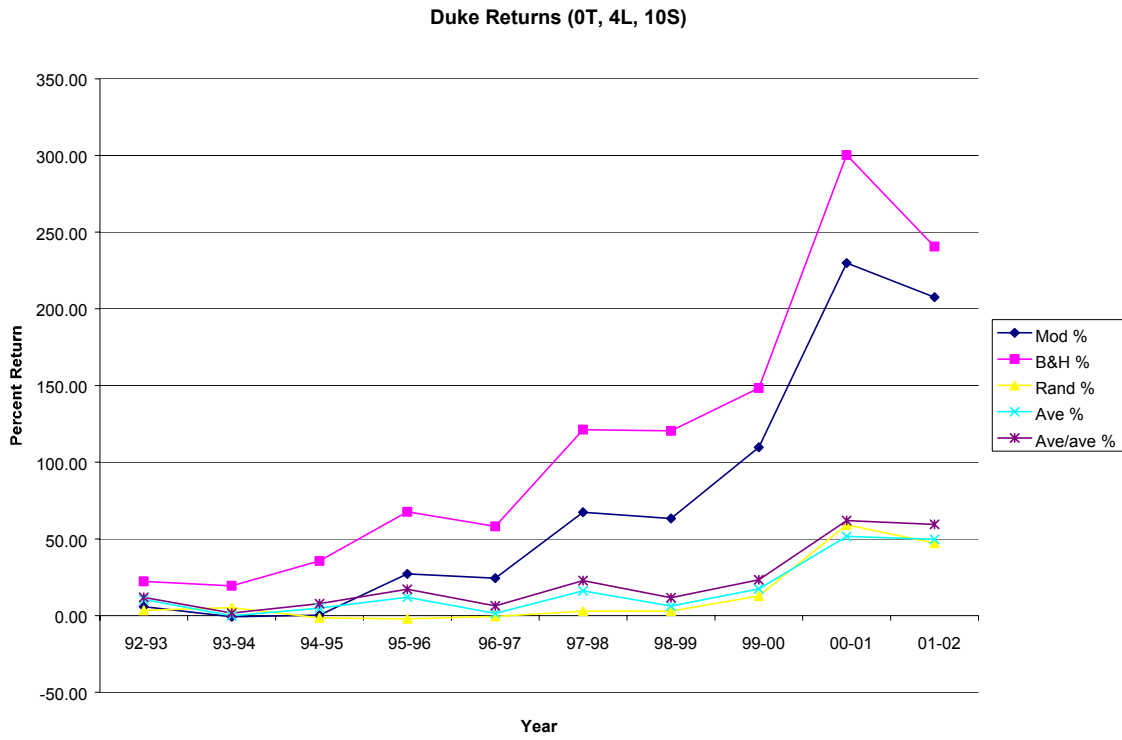


Figure 4.28 – Duke Energy Returns for 0 Thresh, 4 Year Training & 10 Snake Length & Other Strategies

4.5.6 Bristol Myers Squibb

The data examined spans from April 4, 1988 through May 1, 2002. For Bristol Myers Squibb, the model is set to examine the following.

Table 4.24 – Variables and Settings for Bristol Myers Squibb Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through fifteen
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	781,1033,1285,1537,1789,2041,2293,2545,2797,3049,3301,3553
Year End Dates	May 3, 1991, May 1, 1992, April 30, 1993, April 29, 1994, April 28, 1995, April 26, 1996, April 25, 1997, April 27, 1998, April 27, 1999, April 25, 2000, April 25, 2001, May 1, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

Bristol Myers Squibb has twelve, eleven, and ten years' data for the two, three, and four year training periods. The high level summaries for Bristol Myers Squibb yearly returns are as follows.

Tables 4.25 – Percent Returns for Bristol Myers Squibb with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	11.85	11.10	6.02	2	11.85	11.10	6.02
3	17.50	14.47	12.61	3	17.50	14.47	12.61
4	12.89	9.33	12.62	4	12.89	9.33	12.62
5	9.31	9.70	8.21	5	9.31	9.70	8.21
6	7.86	3.54	3.00	6	7.86	3.54	3.00
7	3.61	2.14	-0.18	7	3.61	2.14	-0.18
8	3.27	-0.96	-2.43	8	3.27	-0.96	-2.43
9	8.43	0.48	2.55	9	8.43	0.48	2.55
10	6.16	6.24	6.43	10	6.16	6.24	6.43
11	5.25	4.27	0.39	11	5.25	4.27	0.39
12	3.19	5.31	1.67	12	3.19	5.31	1.67
13	-3.42	-4.71	-2.64	13	-3.42	-4.71	-2.64
14	-4.51	-4.17	-3.17	14	-4.51	-4.17	-3.17
15	-5.62	-6.64	-5.60	15	-4.51	-4.17	-3.17

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	11.85	11.10	6.02
3	17.50	14.47	12.61
4	12.89	9.33	12.62
5	9.31	9.70	8.21
6	7.86	3.54	3.00
7	3.61	2.14	-0.18
8	3.27	-0.96	-2.43
9	8.43	0.48	2.55
10	6.16	6.24	6.43
11	5.25	4.27	0.39
12	3.19	5.31	1.67
13	-3.42	-4.71	-2.64
14 - 15	-4.51	-4.17	-3.17

The best return for Bristol Myers Squibb appears to be the zero thresholds, two years of training data and a three-length snake (0T, 2L, 3S). Expected yearly return would be 17.5%.

The chart comparing the model's return to the return of the strategies is given below.

Table 4.26 – Percent Returns for Bristol Myers Squibb (0,2,3) For Strategies

Price Change										
Values for Thresh = 0, Years=4, Snake=10						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
90-91	15.17	44.98	41.81	24.10	26.00	15.17	44.98	41.81	24.10	26.00
91-92	-8.50	-2.28	1.53	-7.88	-7.09	5.38	41.68	43.97	14.33	17.07
92-93	-9.73	-15.91	-10.90	-6.28	-6.81	-4.87	19.13	28.27	7.14	9.10
93-94	-3.05	-5.64	6.60	-3.52	-4.24	-7.77	12.41	36.74	3.38	4.47
94-95	3.65	27.14	14.11	16.19	16.99	-4.41	42.92	56.03	20.12	22.22
95-96	33.57	30.83	23.46	11.51	12.84	27.69	86.97	92.63	33.94	37.92
96-97	62.09	54.15	13.15	23.05	25.64	106.97	188.21	117.96	64.82	73.28
97-98	87.98	64.44	27.00	18.38	20.79	289.08	373.94	176.81	95.11	109.31
98-99	35.26	41.44	87.87	22.22	22.47	426.24	570.33	420.04	138.45	156.34
99-00	56.58	-25.61	-27.80	-22.98	-23.05	723.97	398.66	275.45	83.65	97.27
00-01	6.77	14.02	-9.23	-1.35	-1.82	779.79	468.57	240.80	81.18	93.67
01-02	-21.32	-46.60	-19.00	-41.46	-43.00	592.26	203.62	176.06	6.07	10.40

For the Bristol Myers Squibb security, the model built on price change snakes outperforms all other strategies. The graph of the cumulative Bristol Myers Squibb data is as follows.

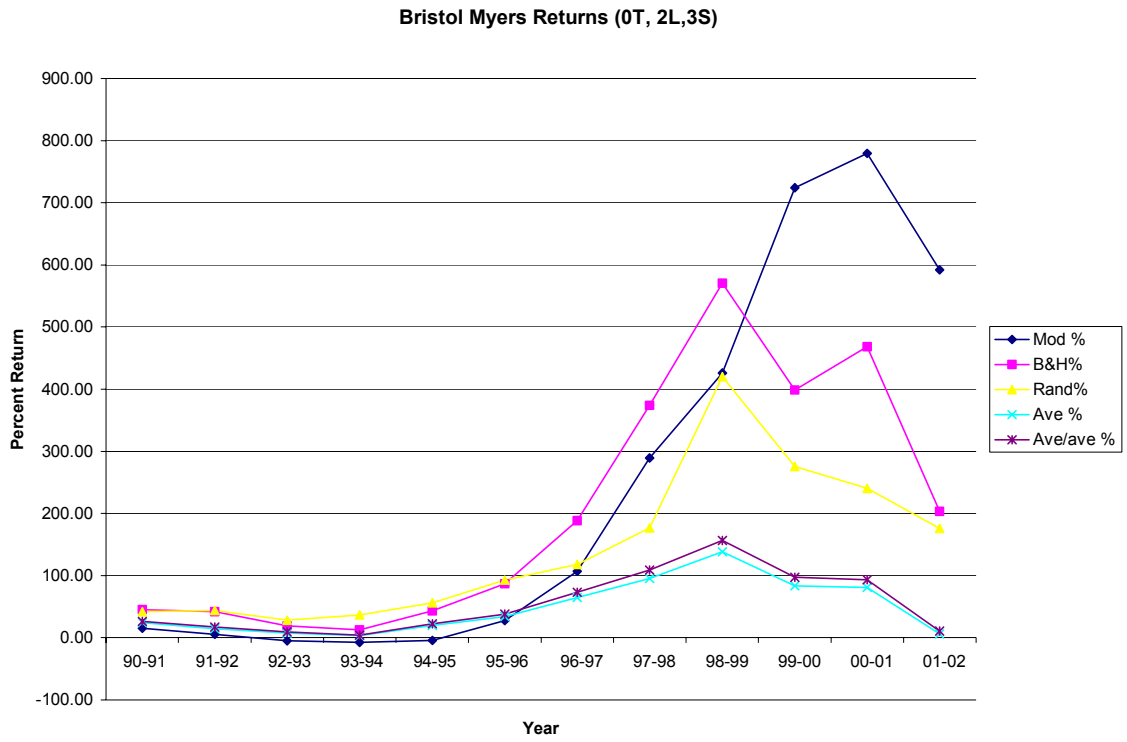


Figure 4.29 – Bristol Myers Squibb Returns for 0 Thresh, 2 Year Training & 3 Snake Length & Other Strategies

4.5.7 Intel Corporation

The data examined spans from April 4, 1988 through May 1, 2002. For Intel, the model is set to examine the following.

Table 4.27 – Variables and Settings for Intel Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through twelve
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	781,1033,1285,1537,1789,2041,2293,2545,2797,3049,3301,3553
Year End Dates	May 3, 1991, May 1, 1992, April 30, 1993, April 29, 1994, April 28, 1995, April 26, 1996, April 25, 1997, April 27, 1998, April 27, 1999, April 25, 2000, April 25, 2001, May 1, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

Intel has twelve, eleven, and ten years' data for the two, three, and four year training periods.

The high level summaries for Intel yearly returns are as follows.

Tables 4.28 – Percent Returns for Intel with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length			
2	3.98	12.47	13.16	2	3.98	12.47	13.16
3	14.46	10.21	15.10	3	14.46	10.21	15.10
4	12.19	14.86	17.39	4	12.19	14.86	17.39
5	9.14	7.98	6.47	5	9.14	7.98	6.47
6	8.54	7.12	4.77	6	8.54	7.12	4.77
7	4.16	6.65	4.28	7	4.16	6.65	4.28
8	15.22	17.05	16.79	8	15.22	17.05	16.79
9	11.64	17.09	22.71	9	11.64	17.09	22.71
10	7.58	18.08	12.12	10	7.58	18.08	12.12
11	8.01	15.36	16.35	11	8.01	15.36	16.35
12	4.39	5.03	8.44	12	8.12	11.39	13.89

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	3.98	12.47	13.16
3	14.46	10.21	15.10
4	12.19	14.86	17.39
5	9.14	7.98	6.47
6	8.54	7.12	4.77
7	4.16	6.65	4.28
8	15.22	17.05	16.79
9	11.64	17.09	22.71
10	7.58	18.08	12.12
11	8.01	15.36	16.35
12	8.45	12.34	16.37

The best return for Intel, appears to be the zero thresholds, four years of training data and a nine-length snake (0T, 4L, 9S). Expected yearly return would be 22.71%.

The chart comparing the model's return to the return of the strategies is given below.

Table 4.29 – Percent Returns for Intel (0,4,9) For Strategies

Price Change										
Values for Thresh = 0, Years=4, Snake=9						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
92-93	22.97	81.10	-7.58	26.42	30.00	22.97	81.10	-7.58	26.42	30.00
93-94	2.55	28.28	10.60	-3.07	-2.19	26.10	132.32	2.21	22.54	27.16
94-95	30.54	67.98	-0.46	51.88	54.41	64.60	290.25	1.74	86.11	96.35
95-96	-14.21	35.31	-9.61	15.46	15.49	41.21	428.05	-8.03	114.88	126.76
96-97	96.86	107.74	37.28	46.17	51.90	177.99	996.95	26.25	214.09	244.44
97-98	68.67	11.17	-14.46	-2.53	-1.01	368.89	1119.52	8.00	206.16	240.96
98-99	13.87	55.60	37.23	30.50	34.89	433.91	1797.57	48.20	299.52	359.91
99-00	13.67	100.84	6.30	64.15	66.45	506.88	3710.98	57.53	555.83	665.51
00-01	46.52	-53.55	46.83	-34.72	-36.41	789.21	1670.12	131.31	328.14	386.81
01-02	-12.94	-1.38	-25.05	0.42	-1.51	674.19	1645.73	73.37	329.96	379.44

For the Intel security the model built on price change snakes underperforms the buy and hold strategy. The graph of the cumulative Intel data is as follows.

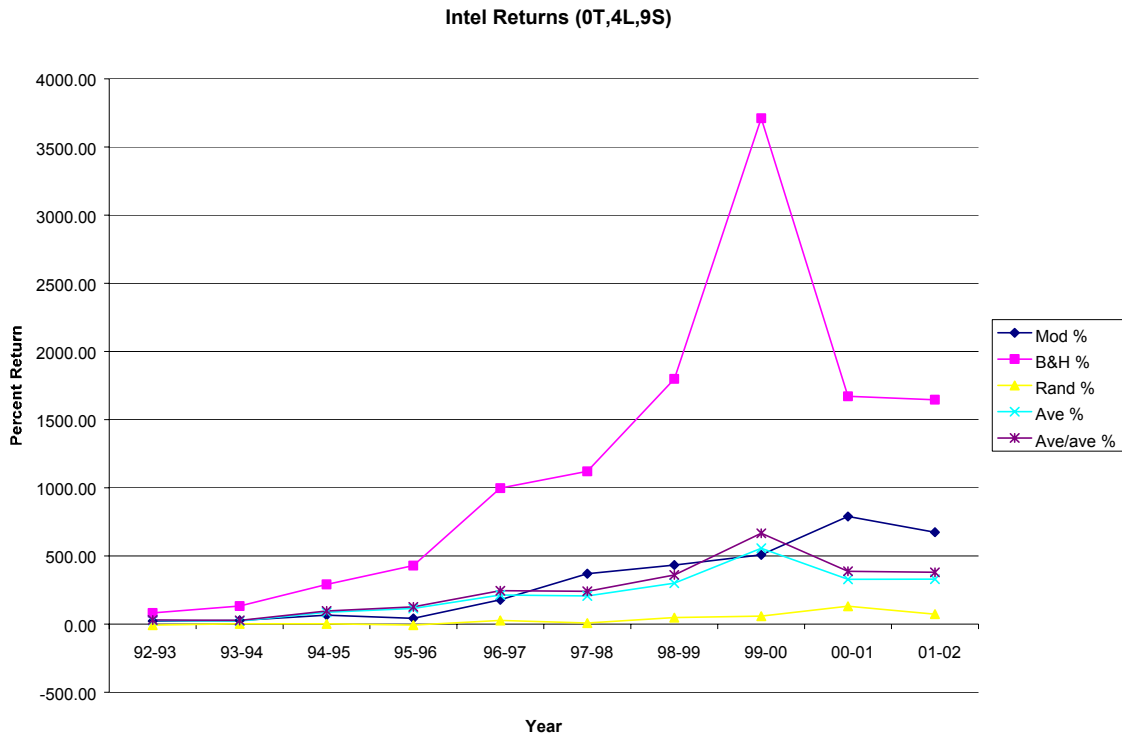


Figure 4.30 – Intel Returns for 0 Thresh, 4 Year Training & 9 Snake Length & Other Strategies

4.5.8 Lucent Technologies

The data examined spans from April 4, 1996 through May 1, 2002. For Lucent, the model is set to examine the table’s content on the following page.

Table 4.30 – Variables and Settings for Lucent Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through twelve
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	772,1024,1276,1528
Year End Dates	April 27, 1999, April 25, 2000, April 25, 2001, May 1, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

Lucent has four, three, and two years’ data for the two, three, and four year training periods.

The high level summaries for Lucent yearly returns are as follows.

Tables 4.31 – Percent Returns for Lucent with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave	2Yr Ave	3Yr Ave	4	Thresh=3	Yr Ave	2Yr Ave	3Yr Ave	4
Snake Length=					Snake Length=				
2	-16.82	-48.86	-56.13		2	-16.82	-48.86	-56.13	
3	-8.19	-33.35	-53.01		3	-8.19	-33.35	-53.01	
4	-11.41	-38.22	-61.18		4	-11.41	-38.22	-61.18	
5	-15.63	-29.99	-47.94		5	-15.63	-29.99	-47.94	
6	-33.06	-37.64	-47.83		6	-33.06	-37.64	-47.83	
7	-46.13	-47.60	-58.33		7	-46.13	-47.60	-58.33	
8	-29.09	-33.80	-47.62		8	-29.09	-33.80	-47.62	
9	-23.58	-34.48	-55.80		9	-23.58	-34.48	-55.80	
10	-25.11	-10.01	-43.10		10	-25.11	-10.01	-43.10	
11	-27.90	-43.62	-55.02		11	-27.90	-43.62	-55.02	
12	-21.36	-45.45	-70.06		12	-27.90	-43.62	-55.02	

Tables 4.31 (continued)

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	-16.82	-48.86	-56.13
3	-8.19	-33.35	-53.01
4	-11.41	-38.22	-61.18
5	-15.63	-29.99	-47.94
6	-33.06	-37.64	-47.83
7	-46.13	-47.60	-58.33
8	-29.09	-33.80	-47.62
9	-23.58	-34.48	-55.80
10	-25.11	-10.01	-43.10
11	-27.90	-43.62	-55.02
12	-27.90	-43.62	-55.02

The best return for Lucent appears to be the zero thresholds, two years of training data and a three-length snake (0T, 2L, 3S). Expected yearly return would be negative 8.19%.

The chart comparing the model's return to the return of the strategies is given below.

Table 4.32 – Percent Returns for Lucent (0,2,3) For Strategies

Price Change										
Values for Thresh = 0, Years=2, Snake=3						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
98-99	80.84	70.15	43.10	39.82	44.55	80.84	70.15	43.10	39.82	44.55
99-00	18.52	4.59	6.73	0.63	-0.06	114.33	77.96	52.72	40.69	44.46
00-01	-62.55	-82.96	-81.84	-55.37	-59.34	-19.73	-69.67	-72.26	-37.21	-41.27
01-02	-11.49	-55.48	-54.73	-31.74	-34.11	-28.96	-86.50	-87.44	-57.14	-61.30

For the Lucent security, the model built on price change snakes out performs all of the other strategies; however, the model still returns negative results. This potential problem is addressed later in this research. In later chapters, a “weaver” routine facilitates choosing securities with positive yields.

The cumulative graph for Lucent is on the following page.

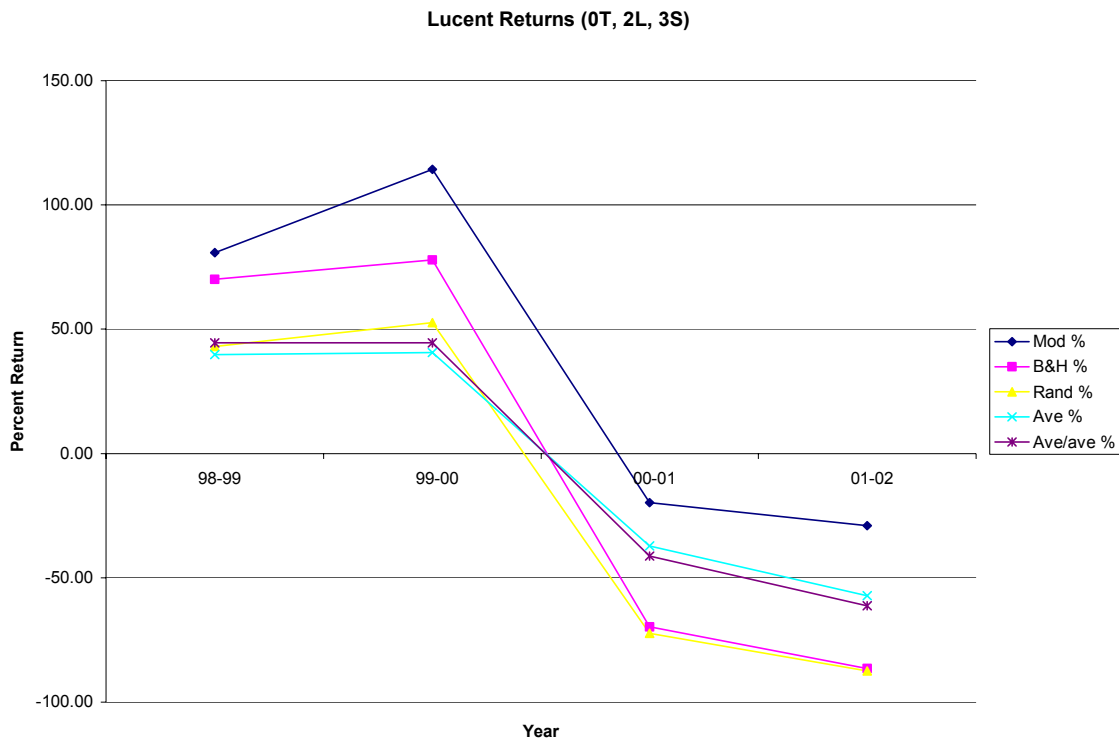


Figure 4.31 – Lucent Returns for 0 Thresh, 2 Year Training & 3 Snake Length & Other Strategies

4.5.9 OMI Corporation

The data examined spans from March 9, 1992 through May 1, 2002. For OMI, the model is set to examine the table’s contents on the following.

Table 4.33 – Variables and Settings for OMI Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through twelve
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	794,1046,1298,1550,1802,2054,2306,2558
Year End Dates	April 28, 1995, April 26, 1996, April 25, 1997, April 27, 1998, April 27, 1999, April 25, 2000, April 25, 2001, May 1, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

OMI has eight, seven, and six years' data for the two, three, and four year training periods.

The high level summaries for OMI yearly returns are as follows.

Tables 4.34 – Percent Returns for OMI with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=	Snake Length						
2	-6.26	-18.49	-17.46	2	-6.26	-18.49	-17.46
3	-16.05	-13.87	-28.88	3	-16.05	-13.87	-28.88
4	-12.83	-11.80	-23.99	4	-12.83	-11.80	-23.99
5	-11.41	-4.32	-20.49	5	-11.41	-4.32	-20.49
6	-12.98	-10.03	-15.42	6	-12.98	-10.03	-15.42
7	-7.18	-12.62	-24.97	7	-7.18	-12.62	-24.97
8	-16.54	-19.93	-22.95	8	-16.54	-19.93	-22.95
9	-21.08	-30.20	-41.18	9	-21.08	-30.20	-41.18
10	-20.08	-24.52	-24.22	10	-20.08	-24.52	-24.22
11	-21.43	-23.10	-21.66	11	-21.43	-23.10	-21.66
12	3.74	-11.25	-14.92	12	-26.77	-24.08	-27.45

Tables 4.34 (continued)

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	-6.26	-18.49	-17.46
3	-16.05	-13.87	-28.88
4	-12.83	-11.80	-23.99
5	-11.41	-4.32	-20.49
6	-12.98	-10.03	-15.42
7	-7.18	-12.62	-24.97
8	-16.54	-19.93	-22.95
9	-21.08	-30.20	-41.18
10	-20.08	-24.52	-24.22
11	-21.43	-23.10	-21.66
12	-21.26	-22.63	-21.55

The best return for OMI appears to be the zero thresholds, two years of training data and a twelve-length snake (0T, 2L, 12S). Expected yearly return would be 3.74%.

The chart comparing the model's return to the return of the strategies is given below.

Table 4.35 – Percent Returns for OMI (0,2,12) For Strategies

Price Change						Cumulative				
Values for Thresh = 0, Years=2, Snake=12										
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
94-95	3.38	-11.54	-8.78	-7.67	-8.46	3.38	-11.54	-8.78	-7.67	-8.46
95-96	-0.76	41.22	18.31	21.76	22.76	2.59	24.92	7.92	12.42	12.38
96-97	25.88	24.63	4.99	18.11	20.19	29.14	55.69	13.31	32.77	35.07
97-98	35.04	-12.95	-1.17	-12.33	-13.75	74.39	35.54	11.98	16.40	16.50
98-99	-45.16	-72.99	-52.55	-31.10	-38.21	-4.36	-63.38	-46.86	-19.80	-28.01
99-00	19.81	28.57	12.14	31.54	33.27	14.59	-52.92	-40.41	5.50	-4.06
00-01	193.25	156.54	50.89	44.77	40.97	236.03	20.77	-10.09	52.73	35.24
01-02	-60.08	-38.22	-28.90	6.34	5.82	34.13	-25.38	-36.07	62.42	43.11

For the OMI security, the model built on price change snakes underperforms the two averaging techniques. The graph of the cumulative OMI data is as follows.

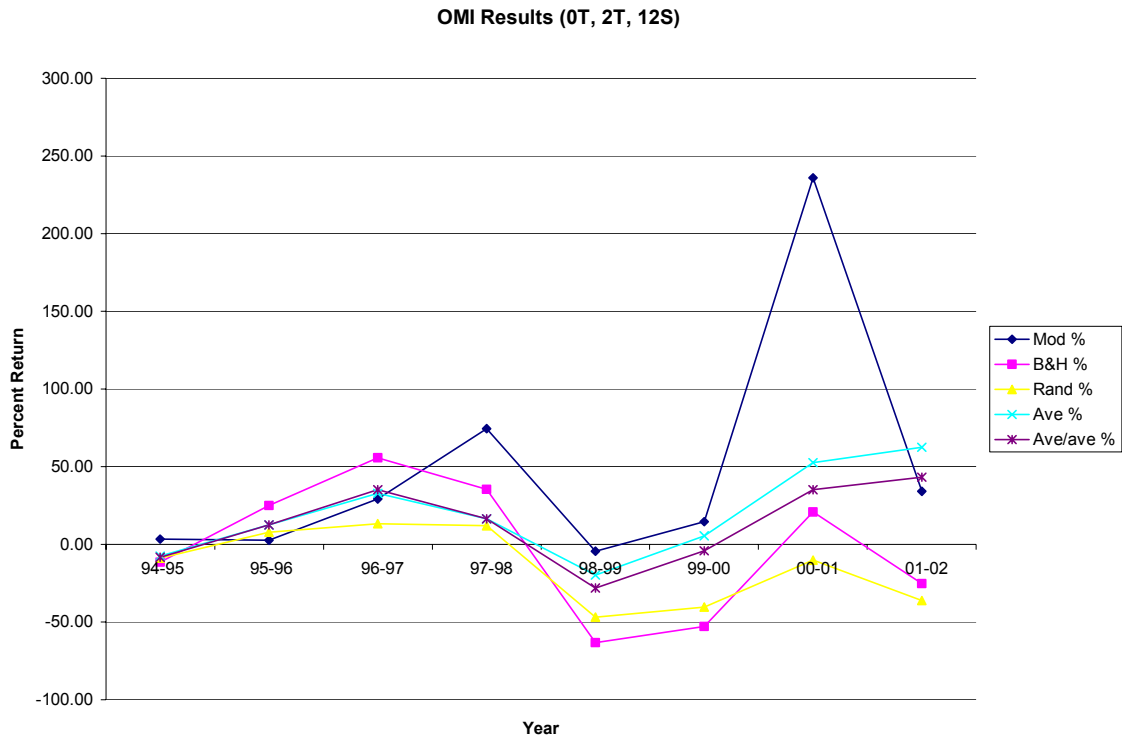


Figure 4.32 – OMI Returns for 0 Thresh, 2 Year Training & 12 Snake Length & Other Strategies

4.5.10 AT&T

The data examined spans from April 4, 1988 through May 1, 2002. For AT&T, the model is set to examine the following.

Table 4.36 – Variables and Settings for AT&T Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through twelve
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	781,1033,1285,1537,1789,2041,2293,2545,2797,3049,3301,3553
Year End Dates	May 3, 1991, May 1, 1992, April 30, 1993, April 29, 1994, April 28, 1995, April 26, 1996, April 25, 1997, April 27, 1998, April 27, 1999, April 25, 2000, April 25, 2001, May 1, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

AT&T has twelve, eleven, and ten years' data for the two, three, and four year training periods.

The high level summaries for AT&T yearly returns are as follows.

Tables 4.37 – Percent Returns for AT&T with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	8.07	13.63	14.41	2	8.07	13.63	14.41
3	5.42	12.13	10.69	3	5.42	12.13	10.69
4	4.34	6.78	3.95	4	4.34	6.78	3.95
5	1.13	4.90	8.89	5	1.13	4.90	8.89
6	2.08	4.93	8.24	6	2.08	4.93	8.24
7	3.15	0.79	-3.47	7	3.15	0.79	-3.47
8	3.62	0.73	-2.27	8	3.62	0.73	-2.27
9	2.64	-4.51	-9.29	9	2.64	-4.51	-9.29
10	-4.46	-7.14	-8.53	10	-4.46	-7.14	-8.53
11	-4.85	-8.96	-12.67	11	-4.85	-8.96	-12.67
12	3.30	-2.79	-8.43	12	-4.85	-9.02	-12.67

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	8.07	13.63	14.41
3	5.42	12.13	10.69
4	4.34	6.78	3.95
5	1.13	4.90	8.89
6	2.08	4.93	8.24
7	3.15	0.79	-3.47
8	3.62	0.73	-2.27
9	2.64	-4.51	-9.29
10	-4.46	-7.14	-8.53
11	-4.85	-8.96	-12.67
12	-4.85	-8.96	-12.67

The best return for AT&T appears to be the zero thresholds, four years of training data and a two-length snake (0T, 4L, 2S). Expected yearly return would be 14.41%.

The chart comparing the model's return to the return of the strategies is given below.

Table 4.38 – Percent Returns for AT&T (0,4,2) For Strategies

Price Change										
Values for Thresh = 0, Years=4, Snake=2						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
92-93	20.72	29.57	4.01	19.45	20.73	20.72	29.57	4.01	19.45	20.73
93-94	-5.00	-8.30	9.72	-10.86	-11.13	14.68	18.82	14.12	6.48	7.29
94-95	7.19	-0.97	-4.41	-3.72	-3.57	22.93	17.67	9.08	2.52	3.46
95-96	34.45	20.95	26.70	4.69	5.40	65.27	42.32	38.20	7.33	9.04
96-97	-24.75	-49.07	-25.47	-31.67	-32.60	24.38	-27.51	3.00	-26.66	-26.50
97-98	55.32	93.59	25.90	31.78	36.01	93.18	40.33	29.68	-3.35	-0.04
98-99	37.75	31.43	26.86	19.91	21.90	166.11	84.43	64.50	15.89	21.85
99-00	13.33	-2.12	-7.61	2.23	1.12	201.59	80.52	51.98	18.47	23.22
00-01	35.46	-58.01	-42.84	-17.62	-20.98	308.54	-24.20	-13.12	-2.41	-2.64
01-02	-5.95	-35.88	-34.24	-23.83	-25.07	284.24	-51.40	-42.87	-25.66	-27.05

For the AT&T security, the model built on price change snakes outperforms the other strategies. As a stock, AT&T performed well. The graph of the cumulative AT&T data is on the following page.

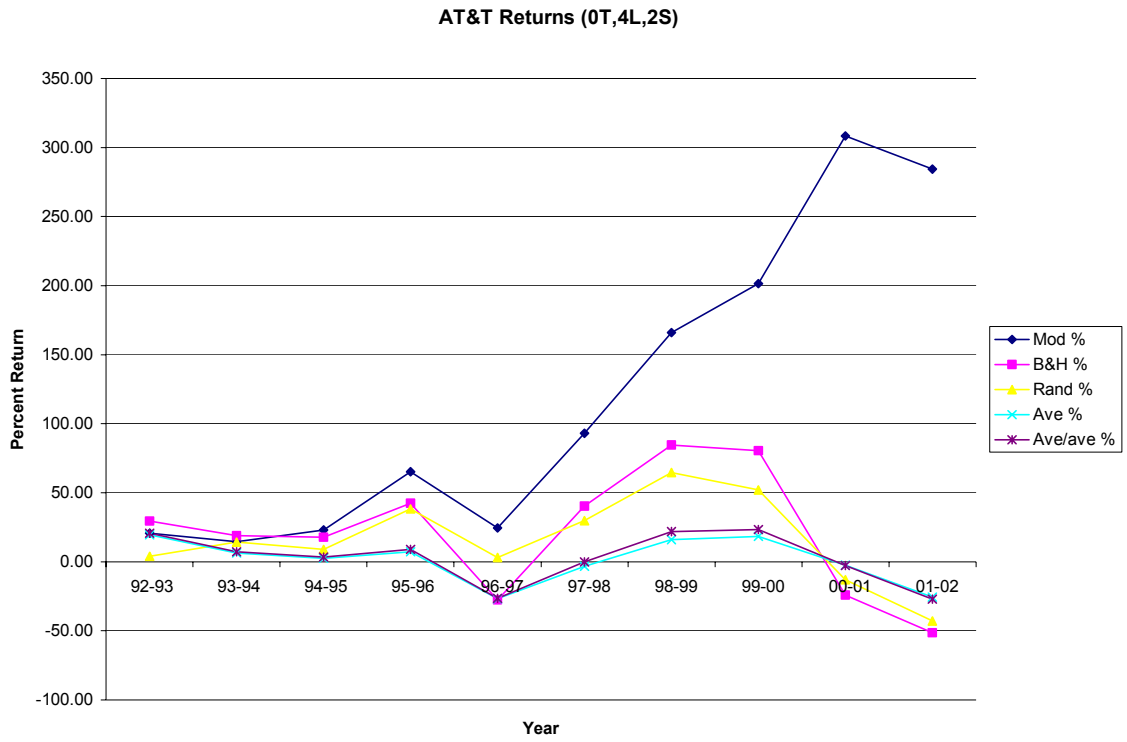


Figure 4.33 – AT&T Returns for 0 Thresh, 4 Year Training & 2 Snake Length & Other Strategies

4.5.11 General Electric

The data examined spans from April 4, 1988 through May 1, 2002. For General Electric, the model is set to examine the following.

Table 4.39 – Variables and Settings for General Electric Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through twelve
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	781,1033,1285,1537,1789,2041,2293,2545,2797,3049,3301,3553
Year End Dates	May 3, 1991, May 1, 1992, April 30, 1993, April 29, 1994, April 28, 1995, April 26, 1996, April 25, 1997, April 27, 1998, April 27, 1999, April 25, 2000, April 25, 2001, May 1, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

General Electric has twelve, eleven, and ten years' data for the two, three, and four year training periods.

The high level summaries for General Electric yearly returns are as follows.

Tables 4.40 – Percent Returns for General Electric with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	4.64	9.04	11.80	2	4.64	9.04	11.80
3	8.32	10.96	11.38	3	8.32	10.96	11.38
4	17.36	16.17	17.72	4	17.36	16.17	17.72
5	5.32	9.20	12.43	5	5.32	9.20	12.43
6	9.48	10.26	10.97	6	9.48	10.26	10.97
7	0.99	-0.29	4.75	7	0.99	-0.29	4.75
8	3.73	5.08	7.02	8	3.73	5.08	7.02
9	4.58	4.45	5.87	9	4.58	4.45	5.87
10	9.79	12.07	14.15	10	9.79	12.07	14.15
11	4.71	3.99	6.40	11	4.71	3.99	6.40
12	4.64	7.50	5.55	12	5.50	5.99	6.50

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	4.64	9.04	11.80
3	8.32	10.96	11.38
4	17.36	16.17	17.72
5	5.32	9.20	12.43
6	9.48	10.26	10.97
7	0.99	-0.29	4.75
8	3.73	5.08	7.02
9	4.58	4.45	5.87
10	9.79	12.07	14.15
11	4.71	3.99	6.40
12	5.57	4.62	6.32

The best return for General Electric appears to be the zero thresholds, four years of training data, and a four-length snake (0T, 4L, 4S). Expected yearly return would be 17.72%.

The chart comparing the model's return to the return of the strategies is given below.

Table 4.41 – Percent Returns for General Electric (0,4,4) For Strategies

Price Change										
Values for Thresh = 0, Years=4, Snake=4						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
92-93	12.89	23.23	-4.24	12.25	13.46	12.89	23.23	-4.24	12.25	13.46
93-94	6.00	7.99	-8.18	-3.87	-3.52	19.66	33.07	-12.07	7.91	9.47
94-95	-1.43	21.30	0.78	12.24	13.66	17.94	61.42	-11.38	21.12	24.42
95-96	11.74	42.68	7.97	21.63	22.90	31.79	130.31	-4.32	47.31	52.91
96-97	10.41	39.57	19.78	16.19	17.66	45.51	221.46	14.61	71.17	79.91
97-98	39.34	57.32	18.72	21.25	23.00	102.75	405.71	36.06	107.54	121.29
98-99	56.71	38.38	25.87	23.01	26.11	217.73	599.81	71.26	155.28	179.08
99-00	40.42	49.26	10.72	34.02	36.59	346.15	944.49	89.61	242.13	281.18
00-01	41.71	-12.57	-8.51	-3.68	-5.89	532.25	813.19	73.48	229.55	258.74
01-02	-19.18	-32.57	-6.55	-22.56	-22.63	410.98	515.75	62.12	155.22	177.55

For the General Electric security, the model built on price change snakes underperforms the buy and hold strategy. The graph of the cumulative General Electric data is as follows.

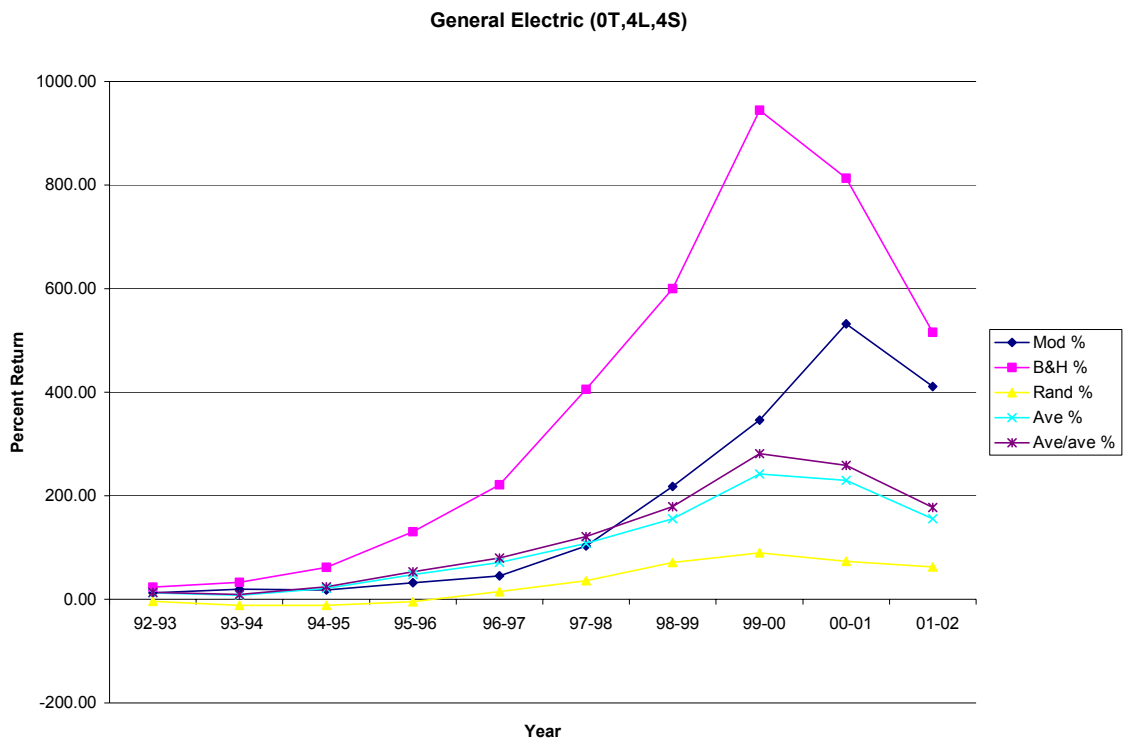


Figure 4.34 – General Electric Returns for 0 Thresh, 4 Year Training & 4 Snake Length & Other Strategies

4.5.12 AOL Time Warner

The data examined spans from March 19, 1992 through May 1, 2002. For AOL Time Warner, the model is set to examine the following.

Table 4.42 – Variables and Settings for AOL Time Warner Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through twelve
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	787,1039,1291,1543,1795,2047,2299,2551
Year End Dates	April 28, 1995, April 26, 1996, April 25, 1997, April 27, 1998, April 27, 1999, April 25, 2000, April 25, 2001, May 1, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

AOL Time Warner has eight, seven and six years' data for the two, three, and four year training periods.

The high level summaries for AOL Time Warner yearly returns are as follows.

Tables 4.43 – Percent Returns for AOL Time Warner with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	32.57	49.38	41.13	2	32.57	49.38	41.13
3	24.74	26.17	19.07	3	24.74	26.17	19.07
4	45.81	43.35	36.86	4	45.81	43.35	36.86
5	52.43	51.81	46.29	5	52.43	51.81	46.29
6	22.93	31.19	19.54	6	22.93	31.19	19.54
7	16.65	18.15	10.77	7	16.65	18.15	10.77
8	32.50	28.75	17.59	8	32.50	28.75	17.59
9	22.80	25.75	19.22	9	22.80	25.75	19.22
10	24.63	27.54	30.47	10	24.63	27.54	30.47
11	13.23	1.49	7.24	11	13.23	1.49	7.24
12	6.20	13.64	16.42	12	13.82	2.30	4.26

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	32.57	49.38	41.13
3	24.74	26.17	19.07
4	45.81	43.35	36.86
5	52.43	51.81	46.29
6	22.93	31.19	19.54
7	16.65	18.15	10.77
8	32.50	28.75	17.59
9	22.80	25.75	19.22
10	24.63	27.54	30.47
11	13.23	1.49	7.24
12	13.72	1.72	7.01

The best return for AOL Time Warner appears to be the zero thresholds, two years of training data and a five-length snake (0T, 2L, 5S). Expected yearly return would be 52.43%.

The chart comparing the model's return to the return of the strategies is given below.

Table 4.44 – Percent Returns for AOL Time Warner (0,2,5) For Strategies

Price Change										
Values for Thresh = 0, Years=2, Snake=5						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
94-95	9.37	163.64	30.33	81.32	86.13	9.37	163.64	30.33	81.32	86.13
95-96	52.67	184.83	16.51	96.51	102.91	66.97	650.91	51.85	256.32	277.68
96-97	-1.96	-35.35	-38.04	13.78	13.76	63.71	385.46	-5.91	305.42	329.64
97-98	37.78	241.20	-2.44	92.05	96.99	125.56	1556.37	-8.20	678.61	746.34
98-99	495.32	739.74	315.15	340.91	378.51	1242.79	13809.14	281.11	3332.94	3949.86
99-00	54.57	-20.26	-11.01	0.35	1.22	1975.60	10991.01	239.13	3344.81	3999.23
00-01	27.35	-18.85	40.60	0.67	-3.24	2543.32	8900.13	376.82	3367.82	3866.62
01-02	10.24	-60.83	-22.78	-44.37	-45.70	2813.97	3425.53	268.20	1829.22	2054.07

For the AOL Time Warner security, the model built on price change snakes underperforms the buy and hold strategy. The graph of the cumulative AOL Time Warner data is given on the following page.

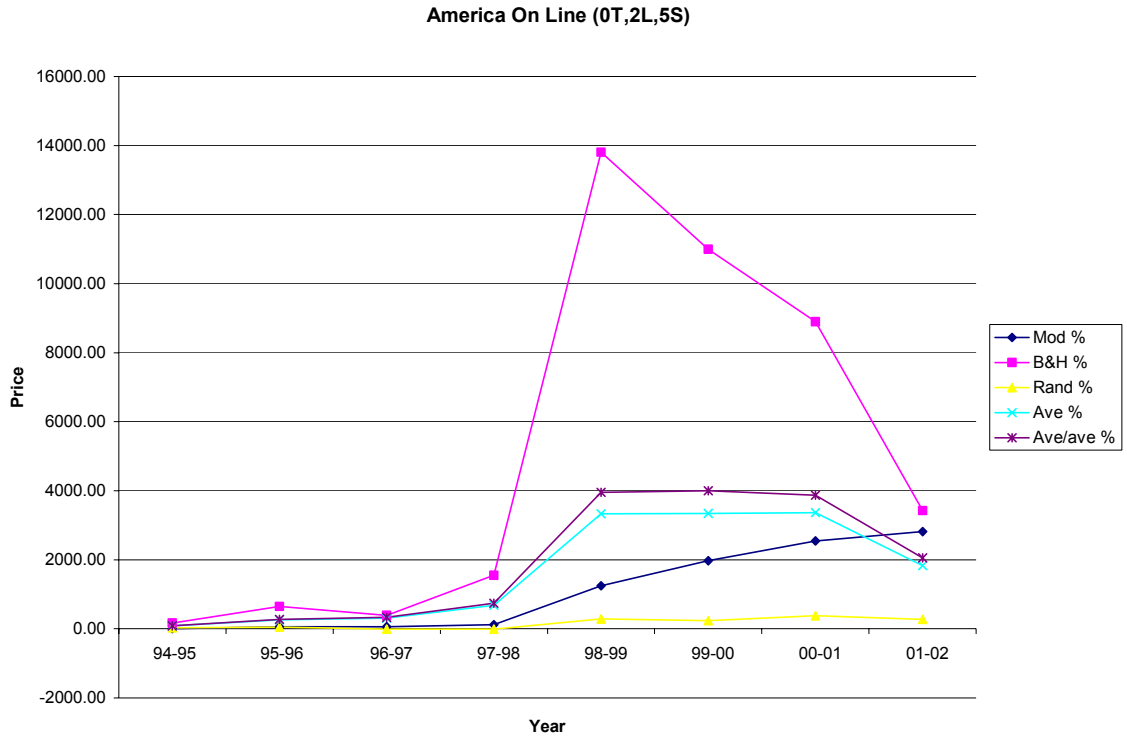


Figure 4.35 – AOL Time Warner Returns for 0 Thresh, 2 Year Training & 5 Snake Length & Other Strategies

4.5.13 Home Depot

The data examined spans from April 4, 1988 through May 1, 2002. For Home Depot, the model is set to examine the following.

Table 4.45 – Variables and Settings for Home Depot Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through twelve
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	781,1033,1285,1537,1789,2041,2293,2545,2797,3049,3301,3553
Year End Dates	May 3, 1991, May 1, 1992, April 30, 1993, April 29, 1994, April 28, 1995, April 26, 1996, April 25, 1997, April 27, 1998, April 27, 1999, April 25, 2000, April 25, 2001, May 1, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

Home Depot has twelve, eleven, and ten years' data for the two, three, and four year training periods.

The high level summaries for Home Depot yearly returns are as follows.

Tables 4.46 – Percent Returns for Home Depot with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	15.66	22.21	15.55	2	15.66	22.21	15.55
3	13.80	12.88	13.82	3	13.80	12.88	13.82
4	10.22	10.26	9.21	4	10.22	10.26	9.21
5	12.28	12.63	6.47	5	12.28	12.63	6.47
6	8.89	12.78	8.70	6	8.89	12.78	8.70
7	4.32	10.65	10.31	7	4.32	10.65	10.31
8	9.80	9.80	5.59	8	9.80	9.80	5.59
9	6.16	7.81	8.71	9	6.16	7.81	8.71
10	14.29	12.64	9.07	10	14.29	12.64	9.07
11	22.43	18.32	16.20	11	22.43	18.32	16.20
12	12.85	12.92	11.01	12	22.18	18.29	15.36

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	15.66	22.21	15.55
3	13.80	12.88	13.82
4	10.22	10.26	9.21
5	12.28	12.63	6.47
6	8.89	12.78	8.70
7	4.32	10.65	10.31
8	9.80	9.80	5.59
9	6.16	7.81	8.71
10	14.29	12.64	9.07
11	22.43	18.32	16.20
12	22.21	18.82	16.13

The best return for Home Depot appears to be the zero thresholds, four years of training data and a nine-length snake (0T, 2L, 11S). Expected yearly return would be 22.43%.

The chart comparing the model's return to the return of the strategies is given below.

Table 4.47 – Percent Returns for Home Depot (0,2,11) For Strategies

Price Change										
Values for Thresh = 0, Years=2, Snake=11						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
90-91	22.82	82.28	23.21	49.31	53.22	22.82	82.28	23.21	49.31	53.22
91-92	27.09	56.71	18.50	12.29	15.75	56.08	185.65	46.00	67.65	77.35
92-93	13.57	36.63	10.05	2.21	3.89	77.25	290.29	60.68	71.37	84.24
93-94	23.95	-0.87	-2.15	0.18	-0.21	119.70	286.92	57.22	71.68	83.86
94-95	2.01	-2.40	-3.81	-8.28	-8.40	124.13	277.64	51.23	57.46	68.42
95-96	34.78	12.51	2.19	6.00	6.26	202.08	324.89	54.54	66.91	78.96
96-97	11.49	25.32	7.57	8.38	8.89	236.80	432.49	66.24	80.90	94.87
97-98	54.21	82.81	35.16	35.04	38.97	419.37	873.42	124.69	144.28	170.81
98-99	54.28	77.94	40.80	34.69	39.59	701.26	1632.07	216.37	229.02	278.02
99-00	42.58	41.29	27.23	22.18	24.28	1042.43	2347.25	302.52	302.00	369.79
00-01	24.14	-20.88	-10.26	0.48	-4.33	1318.17	1836.29	261.22	303.94	349.45
01-02	-20.05	1.13	3.26	0.08	0.34	1033.86	1858.23	273.00	304.28	351.00

For the Home Depot security, the model built on price change snakes underperforms the buy and hold strategy. The graph of the cumulative Home Depot data is as follows.

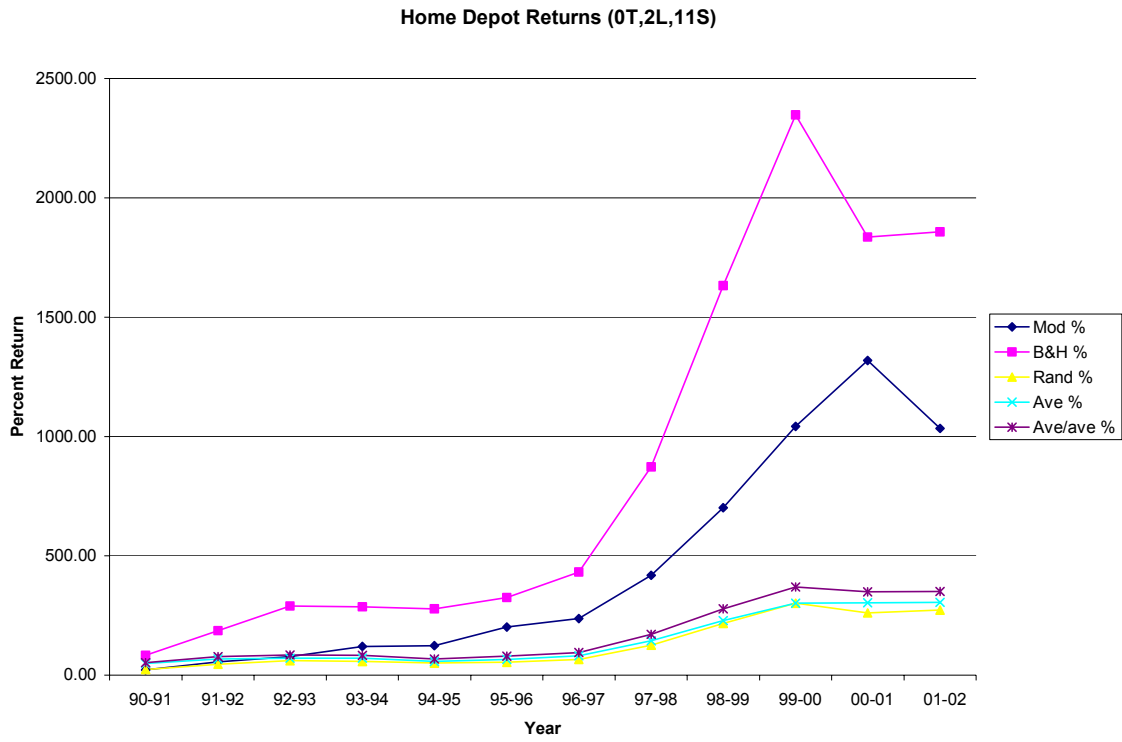


Figure 4.36 – Home Depot Returns for 0 Thresh, 2 Year Training & 11 Snake Length & Other Strategies

4.5.14 IBM

The data examined spans from April 4, 1988 through May 1, 2002. For IBM, the model is set to examine the following.

Table 4.48 – Variables and Settings for IBM Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through twelve
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	781,1033,1285,1537,1789,2041,2293,2545,2797,3049,3301,3553
Year End Dates	May 3, 1991, May 1, 1992, April 30, 1993, April 29, 1994, April 28, 1995, April 26, 1996, April 25, 1997, April 27, 1998, April 27, 1999, April 25, 2000, April 25, 2001, May 1, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

IBM Corporation has twelve, eleven, and ten years' data for the two, three, and four year training periods.

The high level summaries for IBM Corporation yearly returns are as follows.

Tables 4.49 – Percent Returns for IBM Corporation with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	4.23	5.64	10.87	2	4.23	5.64	10.87
3	1.99	3.76	2.97	3	1.99	3.76	2.97
4	-0.77	0.58	-0.62	4	-0.77	0.58	-0.62
5	2.29	7.68	6.16	5	2.29	7.68	6.16
6	15.02	17.94	20.95	6	15.02	17.94	20.95
7	12.78	11.17	12.05	7	12.78	11.17	12.05
8	18.01	18.04	17.89	8	18.01	18.04	17.89
9	7.13	6.75	7.95	9	7.13	6.75	7.95
10	4.27	6.46	5.70	10	4.27	6.46	5.70
11	4.14	5.68	6.66	11	4.14	5.68	6.66
12	5.10	10.16	11.21	12	4.09	5.68	6.15

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	4.23	5.64	10.87
3	1.99	3.76	2.97
4	-0.77	0.58	-0.62
5	2.29	7.68	6.16
6	15.02	17.94	20.95
7	12.78	11.17	12.05
8	18.01	18.04	17.89
9	7.13	6.75	7.95
10	4.27	6.46	5.70
11	4.14	5.68	6.66
12	4.14	5.68	6.66

The best return for IBM Corporation appears to be the zero thresholds, four years of training data and a six-length snake (0T, 4L, 6S). Expected yearly return would be 20.95%.

The chart comparing the model's return to the return of the strategies is given below.

Table 4.50 – Percent Returns for IBM Corporation (0,4,6) For Strategies

Price Change										
Values for Thresh = 0, Years=4, Snake=6						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
92-93	-18.19	-46.33	-52.61	-29.63	-30.83	-18.19	-46.33	-52.61	-29.63	-30.83
93-94	31.73	18.22	11.78	14.94	14.82	7.76	-36.55	-47.02	-19.11	-20.58
94-95	28.71	64.58	40.59	37.44	39.92	38.70	4.43	-25.52	11.17	11.12
95-96	0.11	13.90	27.98	6.80	8.63	38.85	18.94	-4.68	18.73	20.71
96-97	4.41	39.88	3.11	20.61	21.89	44.97	66.37	-1.72	43.20	47.13
97-98	52.19	53.01	-16.31	17.88	21.08	120.64	154.56	-17.75	68.80	78.14
98-99	47.99	83.84	34.93	49.58	54.28	226.51	367.97	10.97	152.49	174.83
99-00	55.19	6.14	-10.99	-1.31	0.46	406.72	396.69	-1.22	149.17	176.08
00-01	46.94	2.09	2.10	9.61	6.93	644.60	407.09	0.85	173.11	195.21
01-02	-10.01	-26.61	-28.12	-21.57	-21.90	570.06	272.17	-27.51	114.20	130.55

For the IBM Corporation security, the model built on price change snakes outperforms all other strategies. The graph of the cumulative IBM Corporation data is on the following page.

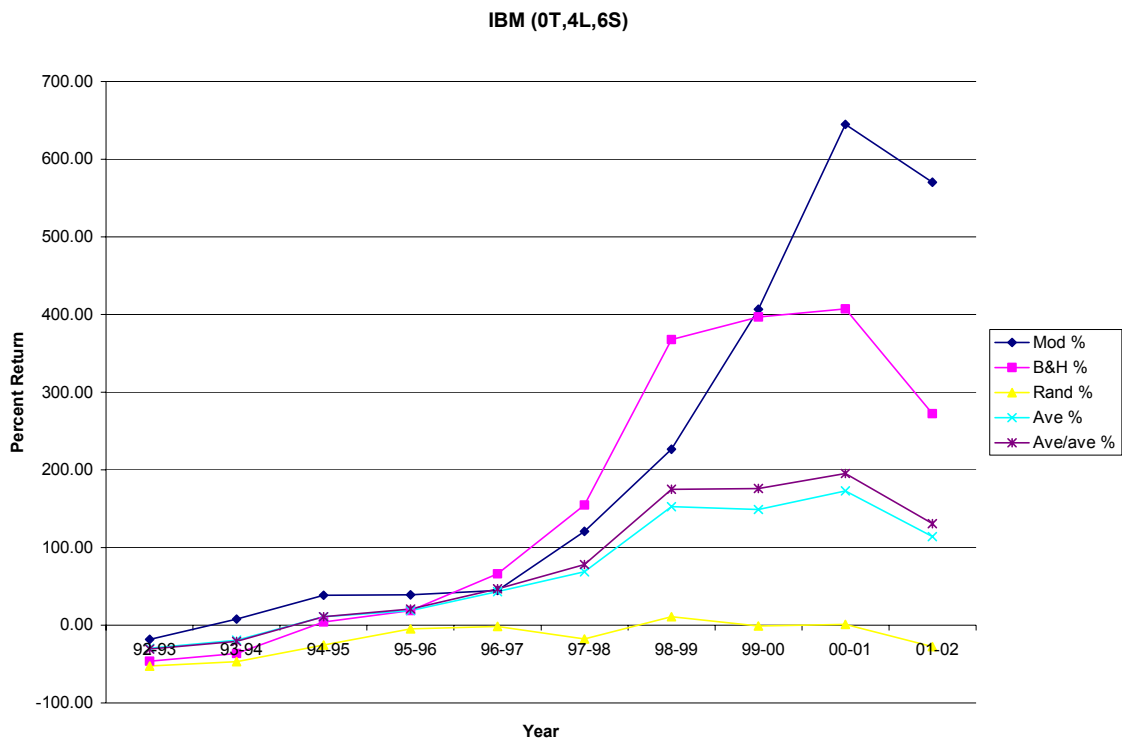


Figure 4.37 – IBM Corporation Returns for 0 Thresh, 4 Year Training & 6 Snake Length & Other Strategies

4.5.15 Cisco

The data examined spans from March 26, 1990 through May 1, 2002. For Cisco, the model is set to examine the following.

Table 4.51 – Variables and Settings for the Cisco Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through twelve
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	1289,1541,1793,2045,2297,2549,2801,3053
Year End Dates	April 28, 1995, April 26, 1996, April 25, 1997, April 27, 1998, April 27, 1999, April 25, 2000, April 25, 2001, May 1, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

Cisco Corporation has ten, nine, and eight years' data for the two, three, and four year training periods.

The high level summaries for Cisco yearly returns are as follows.

Tables 4.52 – Percent Returns for Cisco Corporation with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	16.41	16.04	14.73	2	16.41	16.04	14.73
3	16.86	9.90	14.93	3	16.86	9.90	14.93
4	27.82	28.25	28.65	4	27.82	28.25	28.65
5	14.84	20.97	19.39	5	14.84	20.97	19.39
6	3.80	10.27	8.20	6	3.80	10.27	8.20
7	-1.30	-0.76	-4.40	7	-1.30	-0.76	-4.40
8	10.00	7.67	5.74	8	10.00	7.67	5.74
9	13.92	15.22	11.69	9	13.92	15.22	11.69
10	9.82	7.66	11.69	10	9.82	7.66	11.69
11	1.75	-3.73	-1.02	11	1.75	-3.73	-1.02
12	-2.87	-5.34	-3.66	12	2.35	-3.28	-0.57

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	16.41	16.04	14.73
3	16.86	9.90	14.93
4	27.82	28.25	28.65
5	14.84	20.97	19.39
6	3.80	10.27	8.20
7	-1.30	-0.76	-4.40
8	10.00	7.67	5.74
9	13.92	15.22	11.69
10	9.82	7.66	11.69
11	1.75	-3.73	-1.02
12	2.28	-3.49	-0.76

The best return for Cisco Corporation appears to be the zero thresholds, four years of training data and a four-length snake (0T, 4L, 4S). Expected yearly return would be 28.65%.

The chart comparing the model's return to the return of the strategies is given below.

Table 4.53 – Percent Returns for Cisco Corporation (0,4,4) For Strategies

Price Change										
Values for Thresh = 0, Years=4, Snake=4						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
94-95	-0.02	32.14	-0.74	30.24	31.55	-0.02	32.14	-0.74	30.24	31.55
95-96	63.29	162.16	50.63	56.84	60.04	63.25	246.43	49.52	104.28	110.54
96-97	-9.91	-11.51	-8.96	-21.34	-21.16	47.08	206.55	36.12	60.69	66.00
97-98	51.82	127.96	51.51	35.92	38.13	123.30	598.81	106.23	118.42	129.29
98-99	167.68	144.97	37.30	63.95	72.68	497.72	1611.90	183.15	258.08	295.94
99-00	81.35	129.49	85.37	70.45	76.63	983.98	3828.56	424.86	510.35	599.32
00-01	-27.89	-76.17	-78.62	-63.90	-66.63	681.70	836.29	12.22	120.33	133.39
01-02	-3.98	-12.91	-39.01	-20.06	-22.45	650.58	715.46	-31.56	76.13	81.00

For the Cisco Corporation security the model built on price change snakes outperforms all strategies except the buy and hold. The graph of the cumulative Cisco Corporation data is as follows.

Cisco Returns (0T,4L,4S)

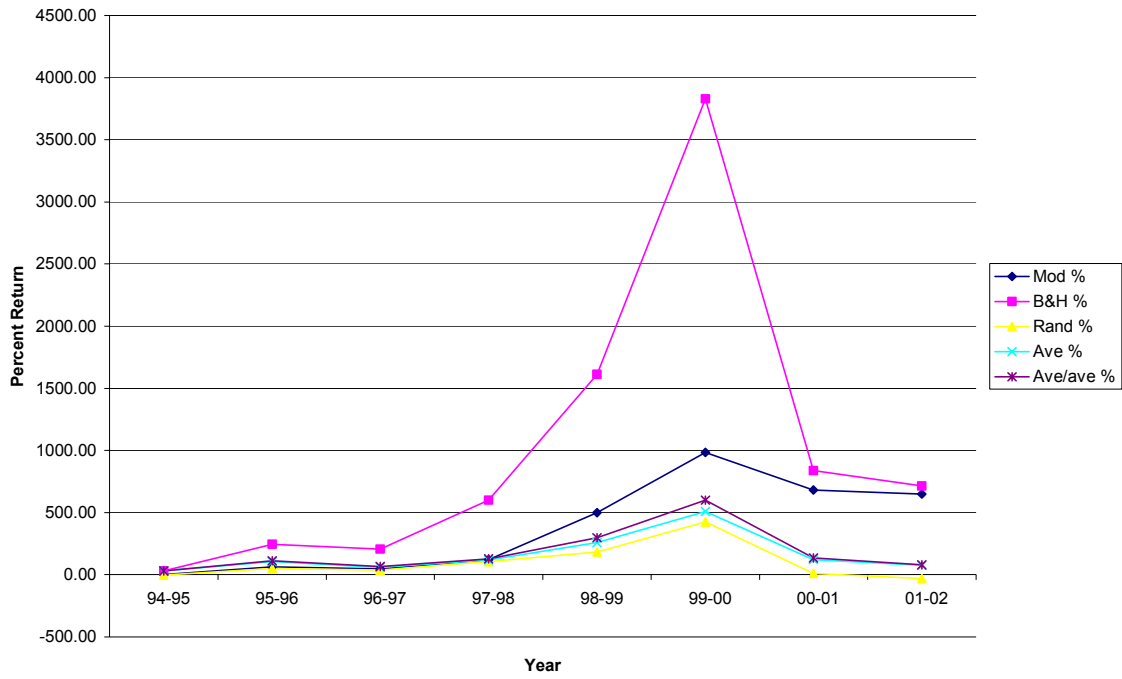


Figure 4.38 – Cisco Corporation Returns for 0 Thresh, 4 Year Training & 4 Snake Length & Other Strategies

4.5.16 Johnson and Johnson

The data examined spans from April 4, 1988 through May 1, 2002. For Johnson and Johnson, the model is set to examine the following.

Table 4.54 – Variables and Settings for Johnson and Johnson Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through twelve
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	781,1033,1285,1537,1789,2041,2293,2545,2797,3049,3301,3553
Year End Dates	May 3, 1991, May 1, 1992, April 30, 1993, April 29, 1994, April 28, 1995, April 26, 1996, April 25, 1997, April 27, 1998, April 27, 1999, April 25, 2000, April 25, 2001, May 1, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

Johnson & Johnson has twelve, eleven, and ten years' data for the two, three, and four year training periods.

The high level summaries for Johnson & Johnson yearly returns are as follows.

Tables 4.55 – Percent Returns for Johnson & Johnson with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	12.97	16.78	15.17	2	12.97	16.78	15.17
3	17.30	19.64	21.23	3	17.30	19.64	21.23
4	18.59	23.25	27.84	4	18.59	23.25	27.84
5	18.49	15.98	24.44	5	18.49	15.98	24.44
6	18.76	20.14	23.27	6	18.76	20.14	23.27
7	11.60	13.27	15.08	7	11.60	13.27	15.08
8	16.11	11.80	14.69	8	16.11	11.80	14.69
9	15.93	15.24	14.99	9	15.93	15.24	14.99
10	12.86	7.24	10.74	10	12.86	7.24	10.74
11	11.70	6.97	10.38	11	11.70	6.97	10.38
12	10.28	5.88	6.48	12	11.52	7.30	11.91

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	12.97	16.78	15.17
3	17.30	19.64	21.23
4	18.59	23.25	27.84
5	18.49	15.98	24.44
6	18.76	20.14	23.27
7	11.60	13.27	15.08
8	16.11	11.80	14.69
9	15.93	15.24	14.99
10	12.86	7.24	10.74
11	11.70	6.97	10.38
12	11.70	7.05	10.80

The best return for Johnson & Johnson appears to be the zero thresholds, four years of training data, and a four-length snake (0T, 4L, 4S). Expected yearly return would be 27.84%.

The chart comparing the model's return to the return of the strategies is given below.

Table 4.56 – Percent Returns for Johnson & Johnson (0,4,4) For Strategies

Price Change						Cumulative				
Values for Thresh = 0, Years=4, Snake=4										
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
92-93	43.18	-8.05	-15.15	-9.24	-9.81	43.18	-8.05	-15.15	-9.24	-9.81
93-94	-16.73	-3.17	-10.98	-2.41	-2.69	19.23	-10.97	-24.46	-11.42	-12.23
94-95	37.15	63.16	13.10	28.18	30.68	63.51	45.27	-14.57	13.54	14.70
95-96	18.14	42.38	35.33	16.32	19.16	93.18	106.84	15.62	32.07	36.68
96-97	42.31	31.13	39.11	13.69	14.92	174.91	171.23	60.84	50.15	57.07
97-98	16.20	23.96	12.14	12.16	14.38	219.45	236.22	80.36	68.41	79.66
98-99	62.88	45.39	35.25	30.05	31.18	420.32	388.83	143.94	119.03	135.68
99-00	35.72	-18.79	-11.36	-11.89	-11.24	606.16	296.98	116.23	92.98	109.19
00-01	26.39	14.14	-4.53	0.75	0.85	792.49	353.12	106.43	94.42	110.96
01-02	30.65	40.99	34.61	15.86	18.01	1066.01	538.83	177.88	125.25	148.96

For the Johnson & Johnson security the model built on price change snakes outperforms all strategies. The graph of the cumulative Johnson & Johnson data is as follows.

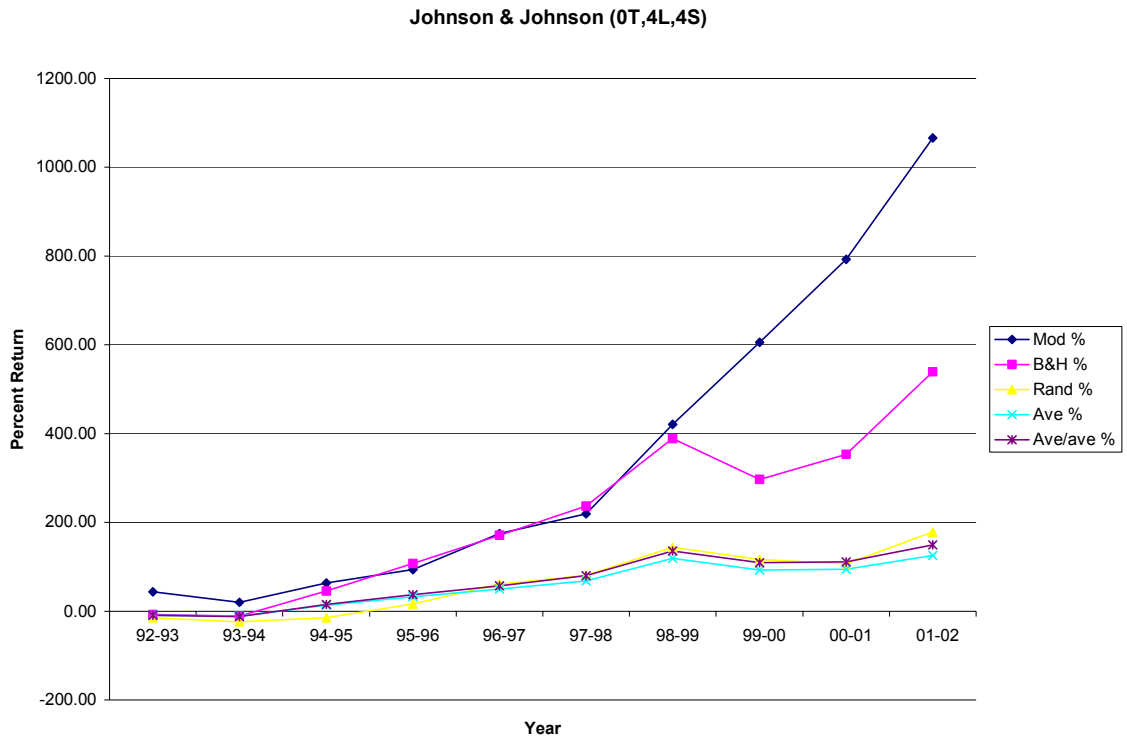


Figure 4.39 – Johnson & Johnson Returns for 0 Thresh, 4 Year Training & 4 Snake Length & Other Strategies

4.5.17 Coca Cola

The data examined spans from April 4, 1988 through May 1, 2002. For Coca Cola, the model is set to examine the following.

Table 4.57 – Variables and Settings for Coca Cola Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through twelve
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	781,1033,1285,1537,1789,2041,2293,2545,2797,3049,3301,3553
Year End Dates	May 3, 1991, May 1, 1992, April 30, 1993, April 29, 1994, April 28, 1995, April 26, 1996, April 25, 1997, April 27, 1998, April 27, 1999, April 25, 2000, April 25, 2001, May 1, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

Coca Cola has twelve, eleven, and ten years' data for the two, three, and four year training periods.

The high level summaries for Coca Cola yearly returns are as follows.

Tables 4.58 – Percent Returns for Coca Cola with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	15.42	12.75	10.64	2	15.42	12.75	10.64
3	19.89	17.25	19.89	3	19.89	17.25	19.89
4	9.17	12.19	9.33	4	9.17	12.19	9.33
5	8.40	9.65	4.92	5	8.40	9.65	4.92
6	9.77	6.88	8.94	6	9.77	6.88	8.94
7	7.82	6.15	7.65	7	7.82	6.15	7.65
8	11.72	14.19	12.91	8	11.72	14.19	12.91
9	11.65	13.61	12.02	9	11.65	13.61	12.02
10	9.27	8.54	6.69	10	9.27	8.54	6.69
11	7.89	8.04	5.96	11	7.89	8.04	5.96
12	11.02	12.79	10.48	12	8.44	8.13	5.96

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	15.42	12.75	10.64
3	19.89	17.25	19.89
4	9.17	12.19	9.33
5	8.40	9.65	4.92
6	9.77	6.88	8.94
7	7.82	6.15	7.65
8	11.72	14.19	12.91
9	11.65	13.61	12.02
10	9.27	8.54	6.69
11	7.89	8.04	5.96
12	7.89	8.04	5.96

The best return for Coca Cola appears to be the zero thresholds, four years of training data, and a three-length snake (0T, 4L, 3S). Expected yearly return would be 19.89%.

The chart comparing the model's return to the return of the strategies is given below.

Table 4.59 – Percent Returns for Coca Cola (0,4,3) For Strategies

Price Change										
Values for Thresh = 0, Years=4, Snake=3						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
92-93	-12.80	-3.63	5.04	-5.94	-5.24	-12.80	-3.63	5.04	-5.94	-5.24
93-94	23.30	7.83	-1.71	-1.06	-0.20	7.52	3.91	3.25	-6.94	-5.43
94-95	24.49	41.55	34.30	21.86	24.65	33.85	47.08	38.66	13.40	17.89
95-96	30.06	41.63	4.36	17.41	19.14	74.07	108.32	44.71	33.15	40.45
96-97	46.92	46.97	27.64	16.75	19.04	155.75	206.17	84.71	55.45	67.19
97-98	20.60	23.49	-9.51	12.31	13.32	208.44	278.08	67.14	74.59	89.46
98-99	-10.62	-3.20	25.39	-1.72	-1.71	175.70	265.97	109.58	71.58	86.23
99-00	20.89	-26.44	-20.04	-13.88	-13.55	233.31	169.22	67.58	47.77	60.99
00-01	66.31	-3.31	-8.15	-10.76	-11.92	454.31	160.30	53.92	31.87	41.80
01-02	10.72	20.97	21.60	22.50	23.87	513.75	214.87	87.16	61.55	75.64

For the Coca Cola security the model built on price change snakes outperforms all strategies. The graph of the cumulative Coca Cola data is on the following page.

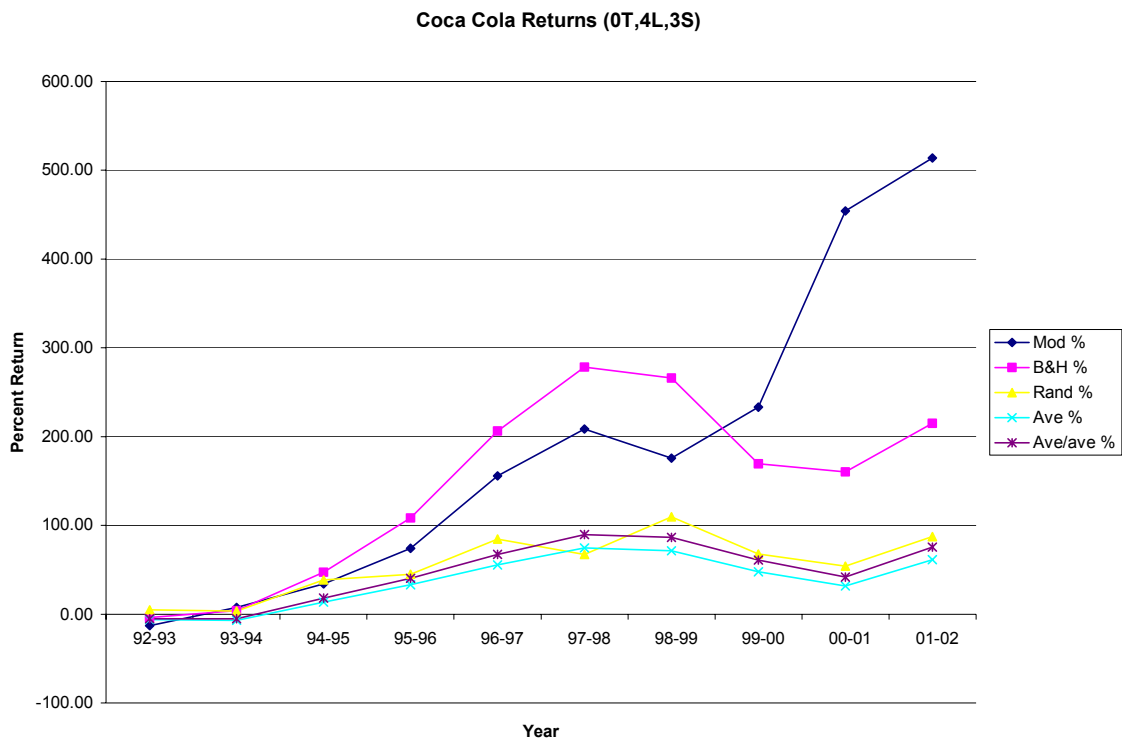


Figure 4.40 – Coca Cola Returns for 0 Thresh, 4 Year Training & 3 Snake Length & Other Strategies

4.5.18 JP Morgan Chase

The data examined spans from April 4, 1988 through May 1, 2002. For JP Morgan Chase, the model is set to examine the following.

Table 4.60 – Variables and Settings for JP Morgan Chase Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through twelve
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	779,1031,1283,1535,1787,2039,2291,2543,2795,3047,3329,3551
Year End Dates	May 3, 1991, May 1, 1992, April 30, 1993, April 29, 1994, April 28, 1995, April 26, 1996, April 25, 1997, April 27, 1998, April 27, 1999, April 25, 2000, April 25, 2001, May 1, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

JP Morgan Chase has twelve, eleven, and ten years' data for the two, three, and four year training periods.

The high level summaries for JP Morgan Chase yearly returns are as follows.

Tables 4.61 – Percent Returns for JP Morgan Chase with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=	Snake Length=						
2	8.81	14.52	14.88	2	8.81	14.52	14.88
3	12.23	15.91	15.27	3	12.23	15.91	15.27
4	11.18	14.27	10.21	4	11.18	14.27	10.21
5	13.82	13.83	15.26	5	13.82	13.83	15.26
6	12.48	21.07	15.57	6	12.48	21.07	15.57
7	5.37	15.26	6.05	7	5.37	15.26	6.05
8	10.74	17.87	13.74	8	10.74	17.87	13.74
9	14.80	15.41	15.57	9	14.80	15.41	15.57
10	9.24	13.26	9.37	10	9.24	13.26	9.37
11	3.06	9.95	5.60	11	3.06	9.95	5.60
12	-8.61	1.27	1.68	12	1.02	11.02	4.87

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=	Snake Length=		
2	8.81	14.52	14.88
3	12.23	15.91	15.27
4	11.18	14.27	10.21
5	13.82	13.83	15.26
6	12.48	21.07	15.57
7	5.37	15.26	6.05
8	10.74	17.87	13.74
9	14.80	15.41	15.57
10	9.24	13.26	9.37
11	3.06	9.95	5.60
12	3.15	8.59	6.53

The best return for JP Morgan Chase appears to be the zero thresholds, three years of training data and a six-length snake (0T, 3L, 6S). Expected yearly return would be 21.07%.

The chart comparing the model's return to the return of the strategies is given below.

Table 4.62 – Percent Returns for JP Morgan Chase (0,3,6) For Strategies

Price Change										
Values for Thresh = 0, Years=3, Snake=6						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
91-92	67.74	82.11	27.31	43.48	46.12	67.74	82.11	27.31	43.48	46.12
92-93	20.39	11.45	-3.03	5.44	6.82	101.95	102.95	23.45	51.28	56.08
93-94	12.31	-3.94	-8.30	-9.09	-9.40	126.80	94.95	13.21	37.52	41.41
94-95	4.59	23.54	6.27	14.14	13.58	137.21	140.84	20.30	56.96	60.62
95-96	34.78	63.81	22.58	21.21	24.16	219.71	294.52	47.47	90.25	99.43
96-97	31.93	32.44	13.10	7.35	9.11	321.80	422.52	66.79	104.24	117.60
97-98	57.62	62.37	30.95	27.07	27.84	564.83	748.42	118.41	159.53	178.17
98-99	-5.02	27.72	15.31	30.27	32.84	531.45	983.57	151.85	238.08	269.51
99-00	49.23	-7.25	0.25	-1.90	-1.23	842.29	905.05	152.48	231.65	264.95
00-01	13.22	-5.49	-5.49	4.87	0.18	966.82	849.89	138.61	247.82	265.59
01-02	-23.23	-22.16	-10.60	-4.91	-6.21	719.04	639.36	113.32	230.75	242.88

For the JP Morgan Chase security, the model built on price change snakes outperforms all other strategies. The graph of the cumulative JP Morgan Chase data is as follows.

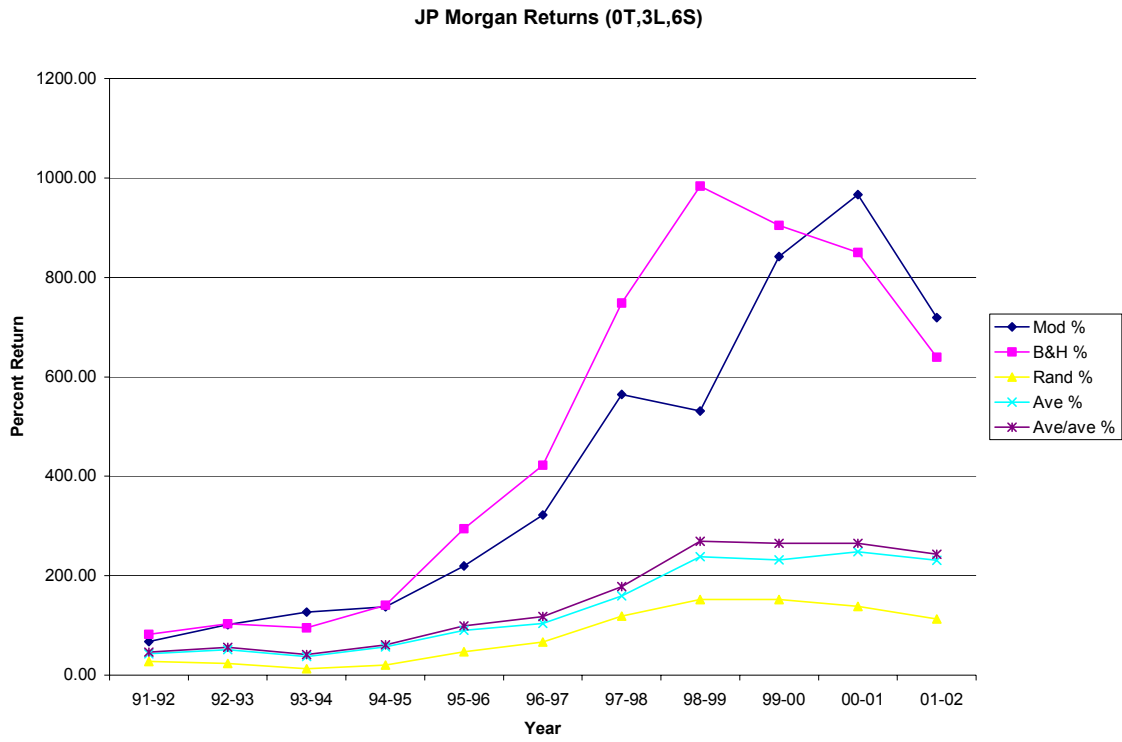


Figure 4.41 – JP Morgan Chase Returns for 0 Thresh, 3 Year Training & 6 Snake Length & Other Strategies

4.5.19 SBC

The data examined spans from April 4, 1988 through May 1, 2002. For SBC, the model is set to examine the following.

Table 4.63 – Variables and Settings for SBC Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through twelve
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	781,1033,1285,1537,1789,2041,2293,2545,2797,3049,3301,3553
Year End Dates	May 3, 1991, May 1, 1992, April 30, 1993, April 29, 1994, April 28, 1995, April 26, 1996, April 25, 1997, April 27, 1998, April 27, 1999, April 25, 2000, April 25, 2001, May 1, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

SBC has twelve, eleven, and ten years' data for the two, three, and four year training periods.

The high level summaries for SBC yearly returns are as follows.

Tables 4.64 – Percent Returns for SBC with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	7.78	11.02	11.46	2	7.78	11.02	11.46
3	8.64	8.45	9.86	3	8.64	8.45	9.86
4	5.00	5.17	1.80	4	5.00	5.17	1.80
5	0.27	3.30	7.90	5	0.27	3.30	7.90
6	7.20	8.78	7.76	6	7.20	8.78	7.76
7	6.46	8.50	7.83	7	6.46	8.50	7.83
8	4.45	6.77	8.40	8	4.45	6.77	8.40
9	7.12	11.66	11.05	9	7.12	11.66	11.05
10	7.74	4.96	4.93	10	7.74	4.96	4.93
11	0.72	2.68	1.79	11	0.72	2.68	1.79
12	1.09	3.92	5.94	12	0.59	2.35	1.16

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	7.78	11.02	11.46
3	8.64	8.45	9.86
4	5.00	5.17	1.80
5	0.27	3.30	7.90
6	7.20	8.78	7.76
7	6.46	8.50	7.83
8	4.45	6.77	8.40
9	7.12	11.66	11.05
10	7.74	4.96	4.93
11	0.72	2.68	1.79
12	0.55	2.68	1.79

The best return for SBC appears to be the zero thresholds, three years of training data and a nine-length snake (0T, 3L, 9S). Expected yearly return would be 11.66%.

The chart comparing the model's return to the return of the strategies is given below.

Table 4.65 – Percent Returns for SBC (0,3,9) For Strategies

Price Change										
Values for Thresh = 0, Years=3, Snake=9						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
91-92	-1.84	23.28	20.30	12.03	13.45	-1.84	23.28	20.30	12.03	13.45
92-93	2.77	29.24	9.21	16.11	17.64	0.88	59.33	31.38	30.07	33.46
93-94	34.36	11.52	5.22	2.76	4.35	35.55	77.68	38.24	33.67	39.27
94-95	9.65	10.45	-7.41	6.96	8.09	48.63	96.24	28.00	42.97	50.53
95-96	9.59	16.73	0.56	-0.92	-0.11	62.89	129.08	28.71	41.66	50.36
96-97	8.47	7.59	6.95	3.95	4.67	76.69	146.46	37.65	47.26	57.37
97-98	51.53	58.51	23.10	26.17	27.94	167.73	290.66	69.45	85.79	101.35
98-99	29.81	40.21	12.18	25.28	25.21	247.53	447.75	90.10	132.76	152.10
99-00	-30.46	-16.71	13.34	-4.63	-7.92	141.67	356.22	115.46	122.00	132.13
00-01	22.24	-7.29	8.56	-11.03	-11.85	195.43	322.96	133.91	97.50	104.63
01-02	13.86	-17.88	23.85	-17.39	-18.21	236.39	247.32	189.69	63.15	67.37

For the SBC security, the model built on price change snakes underperforms the buy and hold strategy. The graph of the cumulative SBC data is as follows.

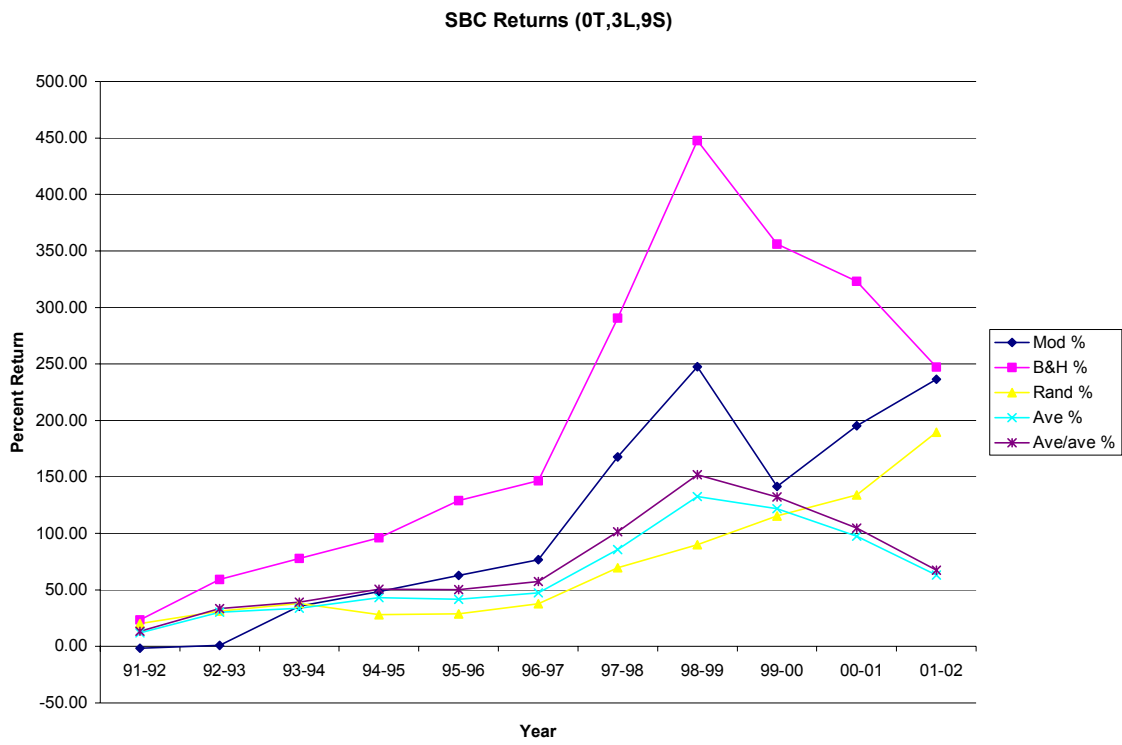


Figure 4.42 – SBC Returns for 0 Thresh, 3 Year Training & 9 Snake Length & Other Strategies

4.5.20 Exxon Mobil Corporation

The data examined spans from April 4, 1988 through May 1, 2002. For Exxon Mobil, the model is set to examine the following.

Table 4.66 – Variables and Settings for Exxon Mobil Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through twelve
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	781,1033,1285,1537,1789,2041,2293,2545,2797,3049,3301,3553
Year End Dates	May 3, 1991, May 1, 1992, April 30, 1993, April 29, 1994, April 28, 1995, April 26, 1996, April 25, 1997, April 27, 1998, April 27, 1999, April 25, 2000, April 25, 2001, May 1, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

Exxon Mobil has twelve, eleven, and ten years' data for the two, three, and four year training periods.

The high level summaries for Exxon Mobil yearly returns are as follows.

Tables 4.67 – Percent Returns for Exxon Mobil with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	17.07	19.13	22.22	2	17.07	19.13	22.22
3	17.40	17.64	19.99	3	17.40	17.64	19.99
4	13.61	12.89	18.07	4	13.61	12.89	18.07
5	12.39	12.03	15.94	5	12.39	12.03	15.94
6	12.73	12.31	14.35	6	12.73	12.31	14.35
7	13.97	11.42	12.27	7	13.97	11.42	12.27
8	8.52	5.07	6.96	8	8.52	5.07	6.96
9	6.34	2.41	3.20	9	6.34	2.41	3.20
10	6.86	7.10	8.95	10	6.86	7.10	8.95
11	8.67	6.84	9.14	11	8.67	6.84	9.14
12	8.48	5.99	9.27	12	8.84	7.01	9.42

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	17.07	19.13	22.22
3	17.40	17.64	19.99
4	13.61	12.89	18.07
5	12.39	12.03	15.94
6	12.73	12.31	14.35
7	13.97	11.42	12.27
8	8.52	5.07	6.96
9	6.34	2.41	3.20
10	6.86	7.10	8.95
11	8.67	6.84	9.14
12	8.67	6.84	9.14

The best return for Exxon Mobil appears to be the zero thresholds, four years of training data, and a two-length snake (0T, 4L, 2S). Expected yearly return would be 22.22%.

The chart comparing the model's return to the return of the strategies is given below.

Table 4.68 – Percent Returns for Exxon Mobil (0,4,2) For Strategies

Price Change										
Values for Thresh = 0, Years=4, Snake=2						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
92-93	1.39	11.41	6.13	5.25	6.38	1.39	11.41	6.13	5.25	6.38
93-94	9.66	-4.73	4.98	-3.89	-3.82	11.17	6.14	11.41	1.15	2.32
94-95	14.05	10.56	1.64	13.04	13.75	26.80	17.35	13.25	14.34	16.38
95-96	34.70	21.35	0.45	11.93	12.65	70.79	42.40	13.76	27.99	31.11
96-97	29.35	25.08	-2.25	15.58	16.99	120.92	78.12	11.20	47.92	53.39
97-98	39.62	40.83	23.85	20.39	21.18	208.46	150.84	37.72	78.08	85.87
98-99	21.00	5.30	2.20	9.41	9.94	273.22	164.15	40.76	94.83	104.33
99-00	42.04	3.53	28.49	3.44	2.93	430.14	173.46	80.86	101.53	110.31
00-01	36.22	9.98	3.70	6.71	6.61	622.13	200.74	87.55	115.06	124.21
01-02	2.97	-8.64	6.77	-1.63	-0.80	643.56	174.75	100.26	111.57	122.42

For the Exxon Mobil security, the model built on price change snakes outperforms all other strategies. The graph of the cumulative Exxon Mobil data is as follows.

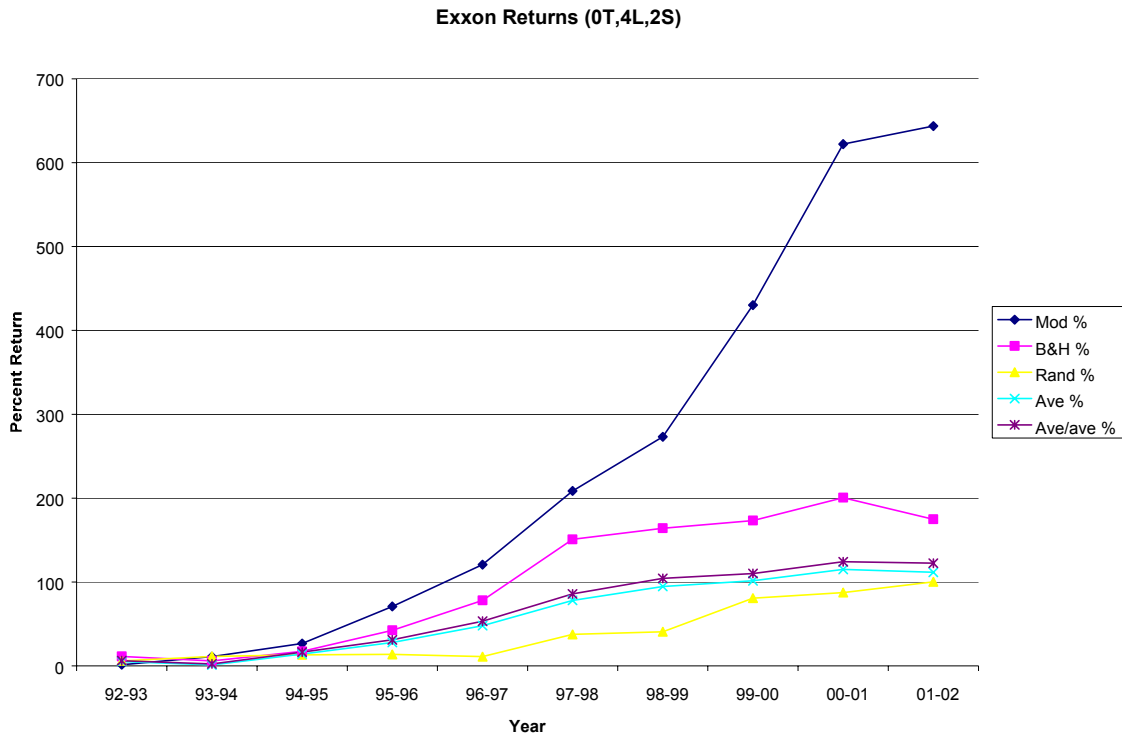


Figure 4.43 – Exxon Mobil Returns for 0 Thresh, 4 Year Training & 2 Snake Length & Other Strategies

4.5.21 Dow Jones Index

The data examined spans from April 4, 1988 through May 1, 2002. For Dow Jones Index, the model is set to examine the following.

Table 4.69 – Variables and Settings for Dow Jones Index Experiment

Variables	
Thresholds	Zero, three, and six
Training Years	Two, three, and four
Snake Lengths	Two through twelve
Other Settings	
Testing period	252 days
Slide Days	Five
Year Ends	781,1033,1285,1537,1789,2041,2293,2545,2797,3049,3301,3553
Year End Dates	May 3, 1991, May 1, 1992, April 30, 1993, April 29, 1994, April 28, 1995, April 26, 1996, April 25, 1997, April 27, 1998, April 27, 1999, April 25, 2000, April 25, 2001, May 1, 2002
Closing Price Analysis	Yes, 5 cents or greater is UP

Dow Jones Index has twelve, eleven, and ten years' data for the two, three, and four year training periods.

The high level summaries for Dow Jones Index yearly returns are as follows.

Tables 4.70 – Percent Returns for Dow Jones Index with Variable Thresholds, Snake Lengths and Training Data Set Sizes

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	11.69	9.76	9.37	2	11.69	9.76	9.37
3	15.39	15.42	15.99	3	15.39	15.42	15.99
4	12.48	11.42	12.06	4	12.48	11.42	12.06
5	8.74	8.52	8.81	5	8.74	8.52	8.81
6	9.69	9.81	8.23	6	9.69	9.81	8.23
7	12.50	10.26	12.61	7	12.50	10.26	12.61
8	7.86	8.27	8.44	8	7.86	8.27	8.44
9	7.37	9.68	10.65	9	7.37	9.68	10.65
10	8.13	11.42	11.51	10	8.13	11.42	11.51
11	8.87	12.32	10.29	11	8.87	12.32	10.29
12	8.32	8.78	8.44	12	8.87	12.32	10.26

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	11.69	9.76	9.37
3	15.39	15.42	15.99
4	12.48	11.42	12.06
5	8.74	8.52	8.81
6	9.69	9.81	8.23
7	12.50	10.26	12.61
8	7.86	8.27	8.44
9	7.37	9.68	10.65
10	8.13	11.42	11.51
11	8.87	12.32	10.29
12	8.87	12.32	10.29

The best return for Dow Jones Index appears to be the zero thresholds, four years of training data and a three-length snake (0T, 4L, 3S). Expected yearly return would be 15.99%.

The chart comparing the model's return to the return of the strategies is given below.

Table 4.71 – Percent Returns for Dow Jones Index (0,4,3) For Strategies

Price Change										
Values for Thresh = 0, Years=4, Snake=3						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
92-93	3.97	2.74	-0.22	3.02	3.68	3.97	2.74	-0.22	3.02	3.68
93-94	6.73	7.41	-1.98	1.09	1.34	10.97	10.36	-2.20	4.14	5.07
94-95	19.88	17.37	14.74	12.76	13.55	33.03	29.53	12.22	17.43	19.30
95-96	23.94	28.85	19.99	14.94	15.84	64.87	66.90	34.65	34.98	38.19
96-97	27.53	21.03	8.68	10.89	11.92	110.26	102.00	46.34	49.68	54.67
97-98	26.43	32.33	31.79	14.38	15.38	165.82	167.30	92.86	71.20	78.45
98-99	39.10	21.46	16.74	20.95	22.21	269.75	224.68	125.14	107.07	118.08
99-00	26.39	2.71	6.50	3.33	3.59	367.33	233.46	139.77	113.97	125.91
00-01	2.54	-4.49	-0.82	0.92	-0.28	379.19	218.49	137.81	115.94	125.27
01-02	-8.00	-5.32	5.03	0.11	0.01	340.88	201.54	149.78	116.17	125.30

For the Dow Jones Index security, the model built on price change snakes outperforms all other strategies. The graph of the cumulative Dow Jones Index data is as follows.

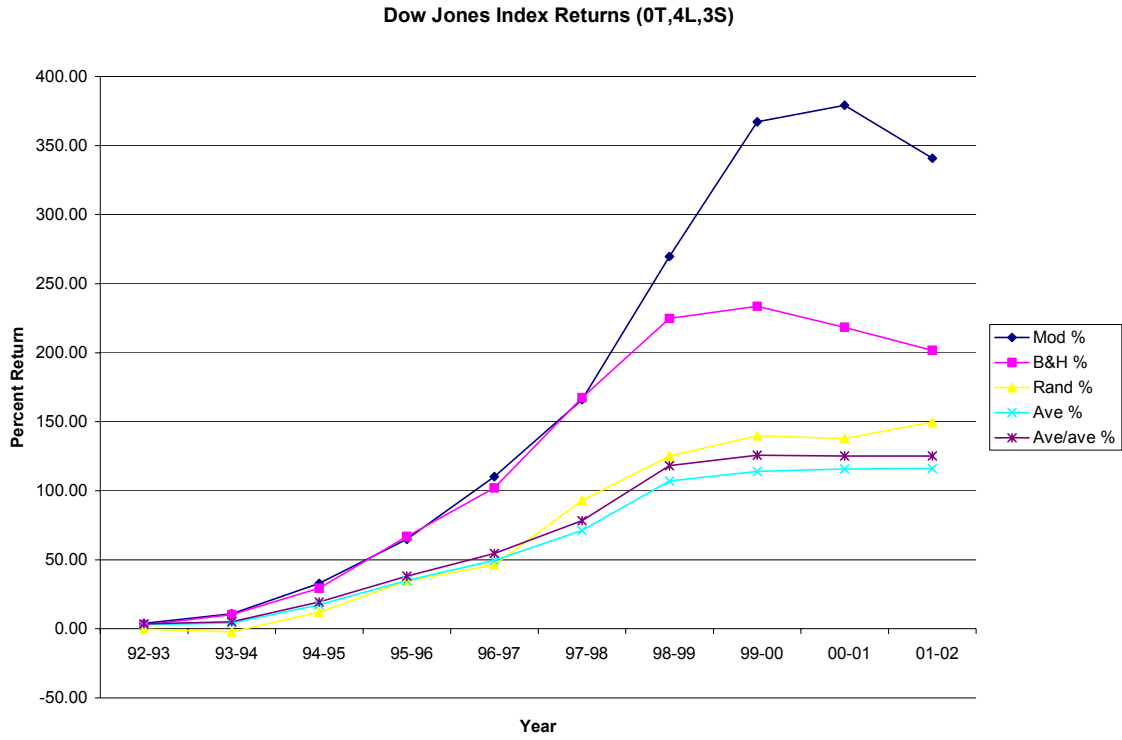


Figure 4.44 – Dow Jones Index Returns for 0 Thresh, 4 Year Training & 3 Snake Length & Other Strategies

4.6 Summary

The following table summarizes the returns of this first set of 21 securities. Future work will examine the returns realized by the model based on volume changes.

Table 4.72 – Model Yearly Percent Returns for Price Snakes

Best for Price Only Snake				
	Yearly Return	Threshold	Years Train	Price Snake Length
S&P	18.81	0	4	9
I2	42.72	0	2	12
Tesoro	7.13	0	2	11
Symbol	19.91	0	4	2
Duke Energy	11.89	0	4	10
Bristol Myers	17.50	0	2	3
Intel	22.71	0	4	9
Lucent	-8.19	0	2	3
OMI Corp	3.74	0	2	12
ATT	14.41	0	4	2
General Electric	17.72	0	4	4
AOL TimeWarner	52.43	0	2	5
Home Depot	22.43	0	2	11
IBM Corp	20.95	0	4	6
Cisco	28.65	0	4	4
Johnson & Johnson	27.84	0	4	4
Coca Cola	19.89	0	4	3
JP Morgan	21.07	0	3	6
SBC Corp	11.66	0	3	9
Exxon Mobil	22.22	0	4	2
Dow Jones	15.99	0	4	3

Using only the change in price and selecting the best snake pattern provides an average yearly return of 19.59%.

Chapter 5 A Markov Decision Process Model

Based on Volume Change

The model presented in chapter 4 focused on closing price change. In this chapter a similar model is developed and evaluated based upon changes in the daily volume of trading for the security. Volume is often the indication that large investors are entering or leaving a security. Their actions may have an impact on the future price of the security.

The volume change functions the same as the price change model with the exception that the “up” and “down” indicators are based on volume. A strict greater than policy is used for classification of “up.” That is, if today’s volume is greater than yesterday’s volume then it is “up,” otherwise it is considered “down.”

5.1 State Definition

State definitions are the same as respect to price change; however, the volume drives the up and down indicator. Any positive increase in volume from one day to the next day will be designated as an “up.” The reverse is true for “down.”

5.2 Experimental Plan

The same experimental plan as defined in chapter 4 is run using the change in volume-based model. To assist in understanding the volume changes, plots of the total daily shares traded for the securities for the examined period are provided on the next few pages.

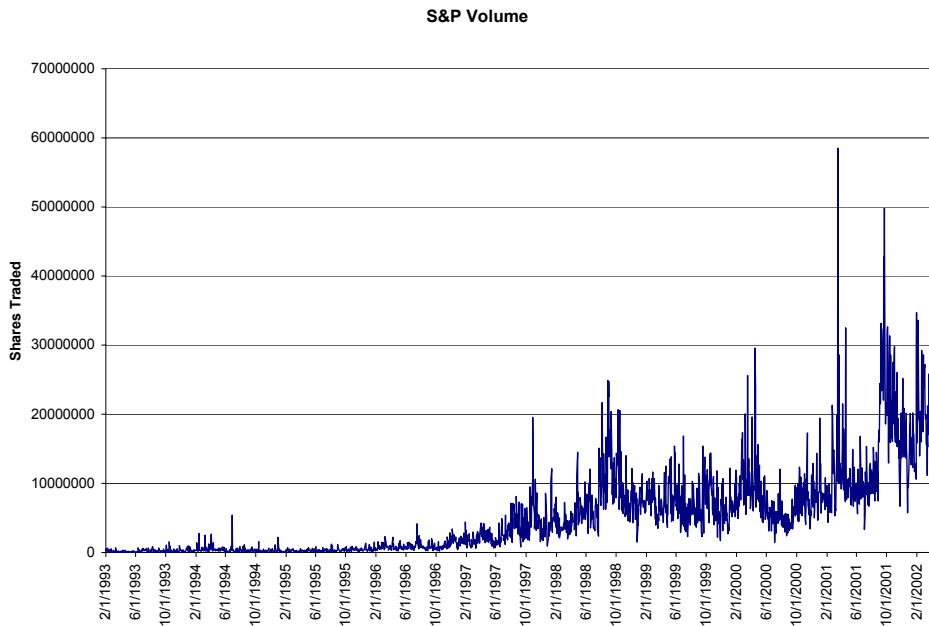


Figure 5.1 – Volume Traded S&P Index Fund

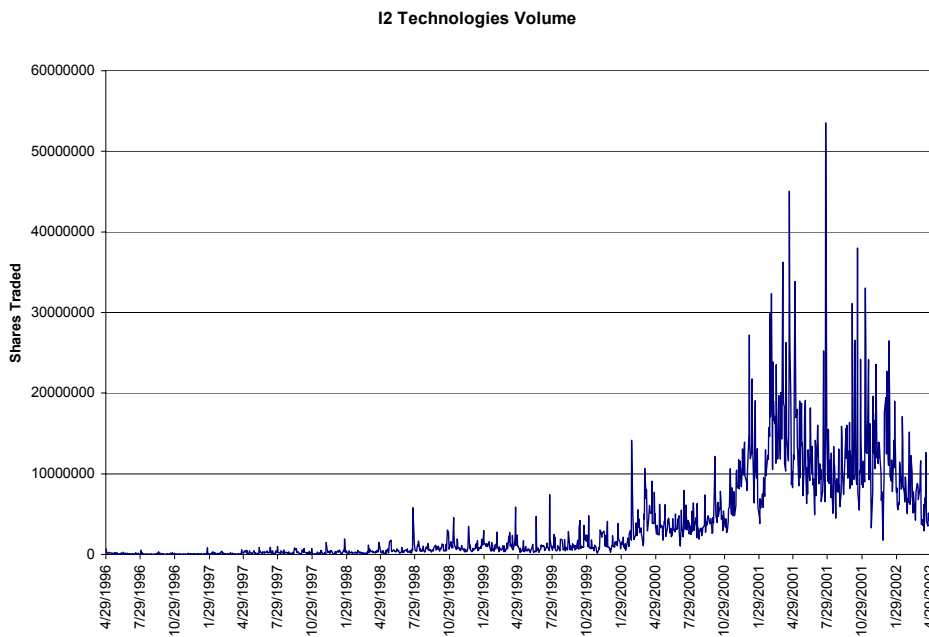


Figure 5.2 – Volume Traded I2 Technologies

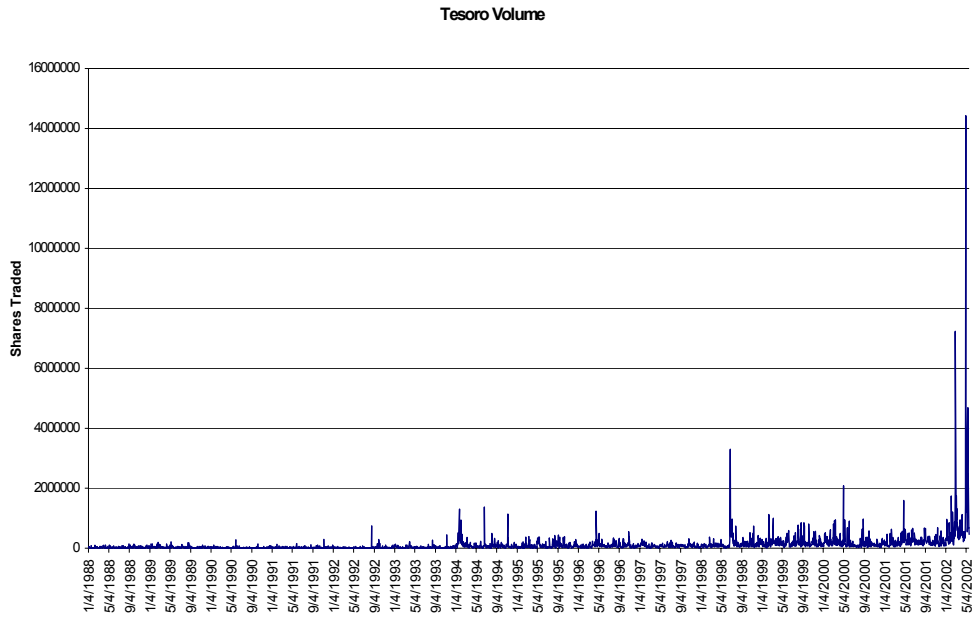


Figure 5.3 – Volume Traded Tesoro Petroleum

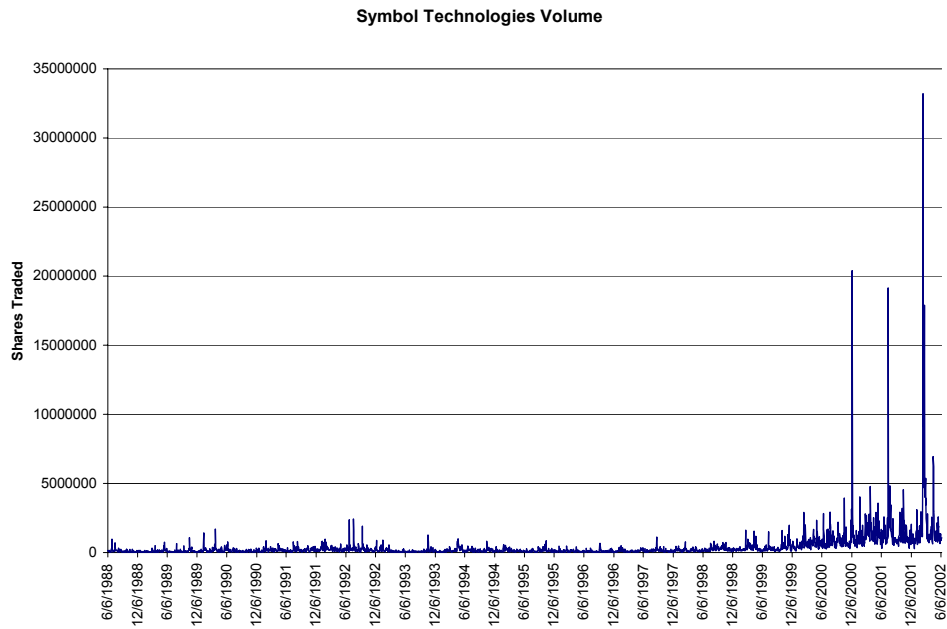


Figure 5.4 – Volume Traded Symbol Technologies

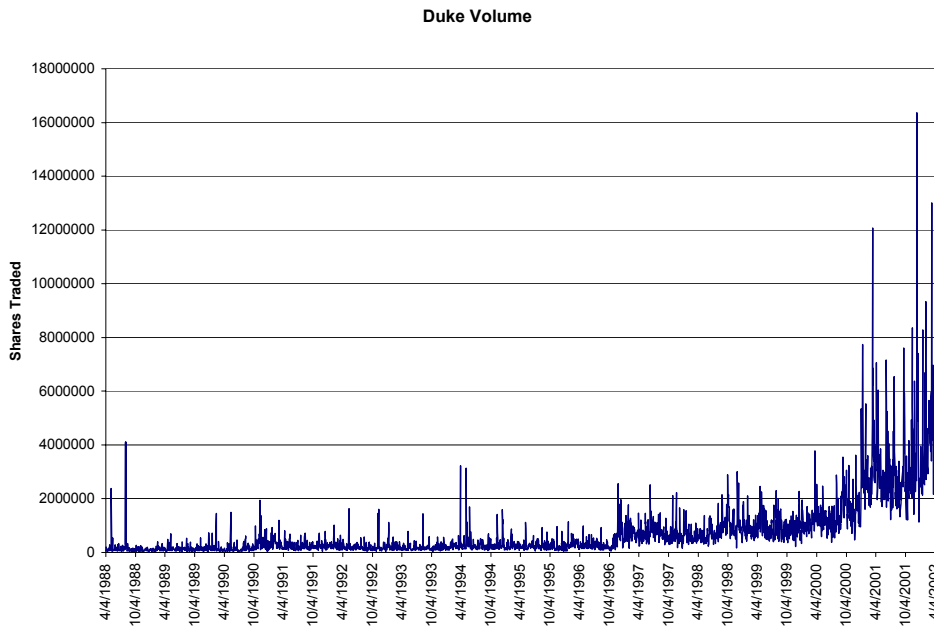


Figure 5.5 – Volume Traded Duke Energy

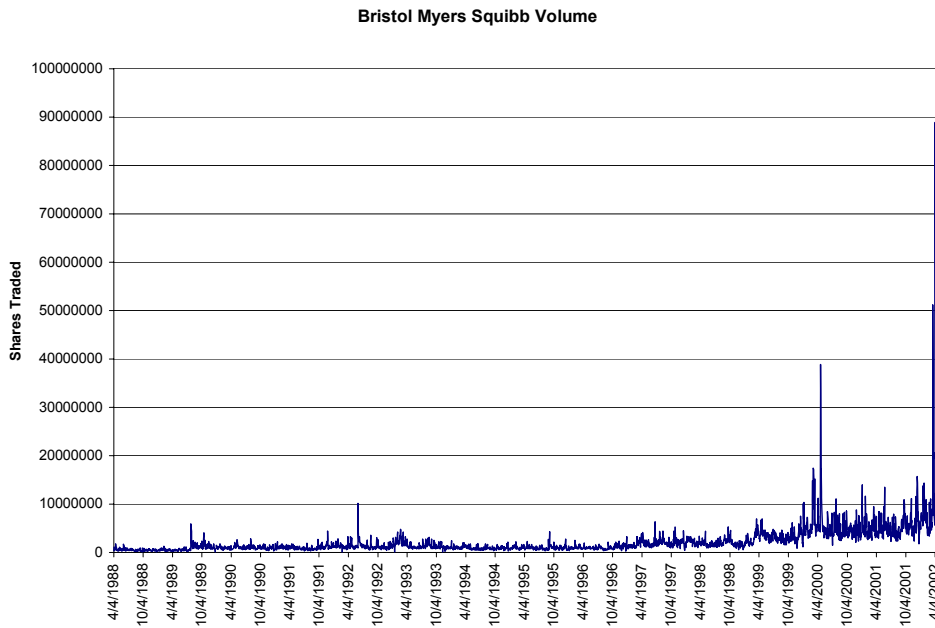


Figure 5.6 – Volume Traded Bristol Myers

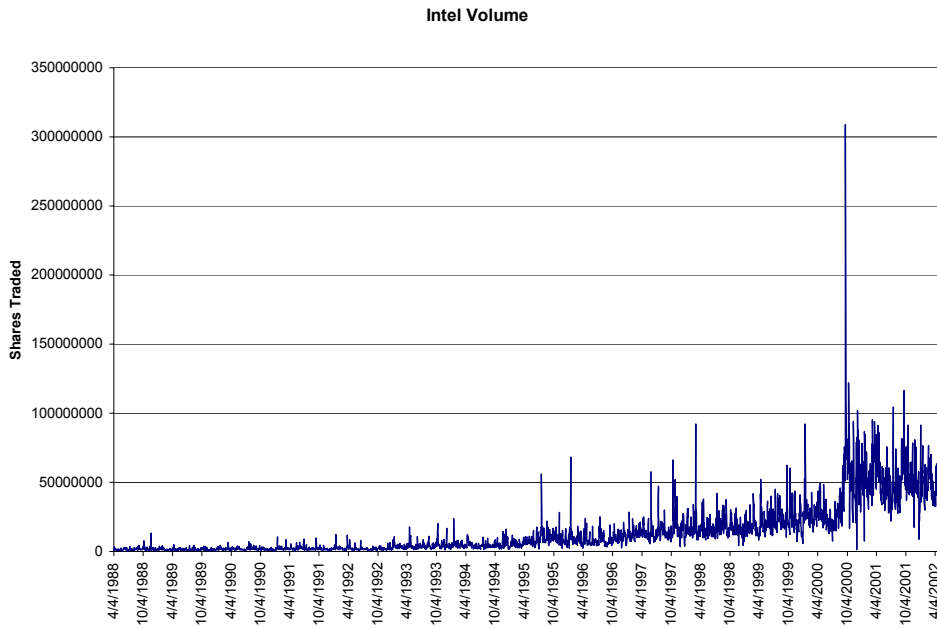


Figure 5.7 – Volume Traded Intel

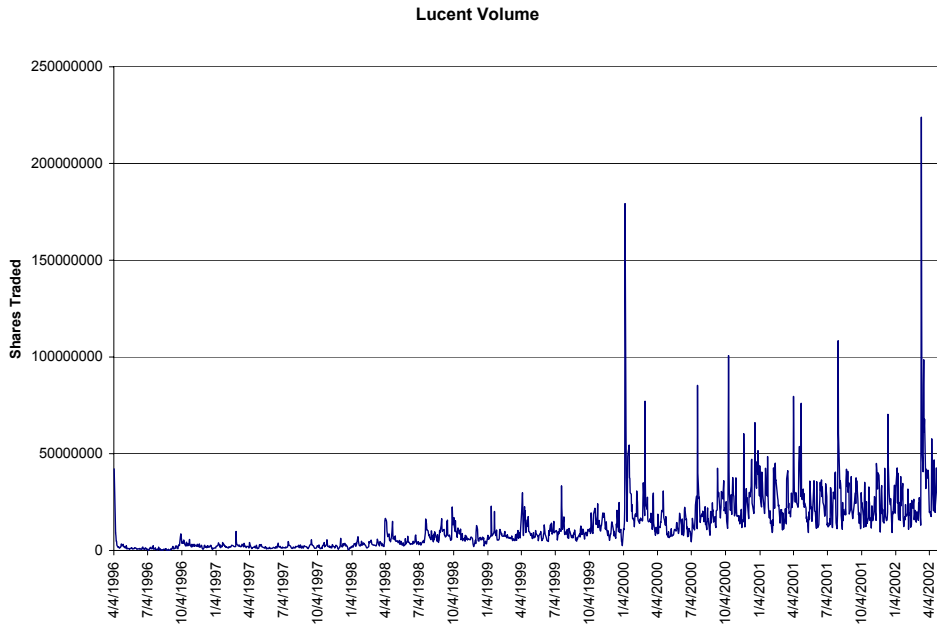


Figure 5.8 – Volume Traded Lucent

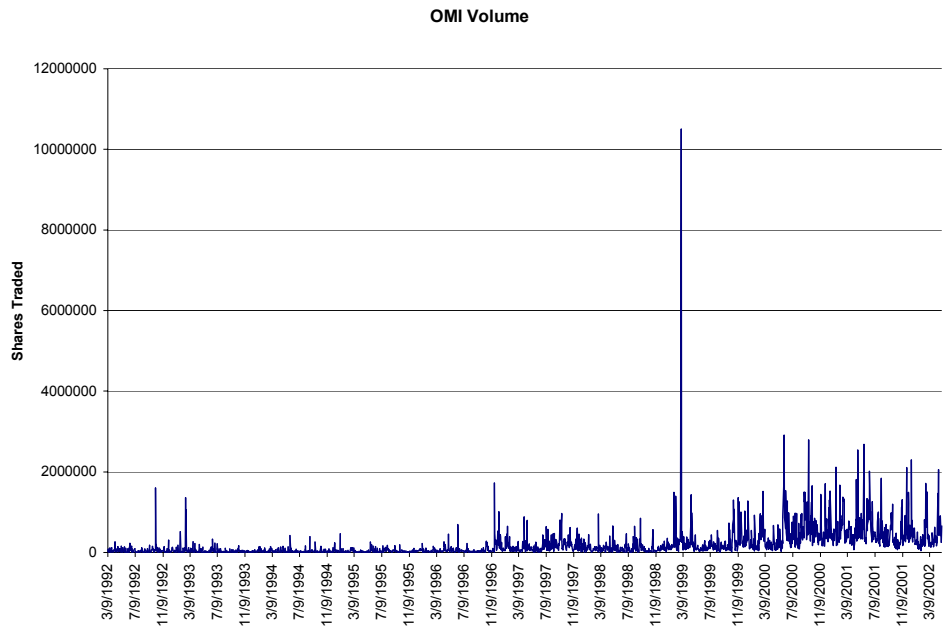


Figure 5.9 – Volume Traded OMI Corporation

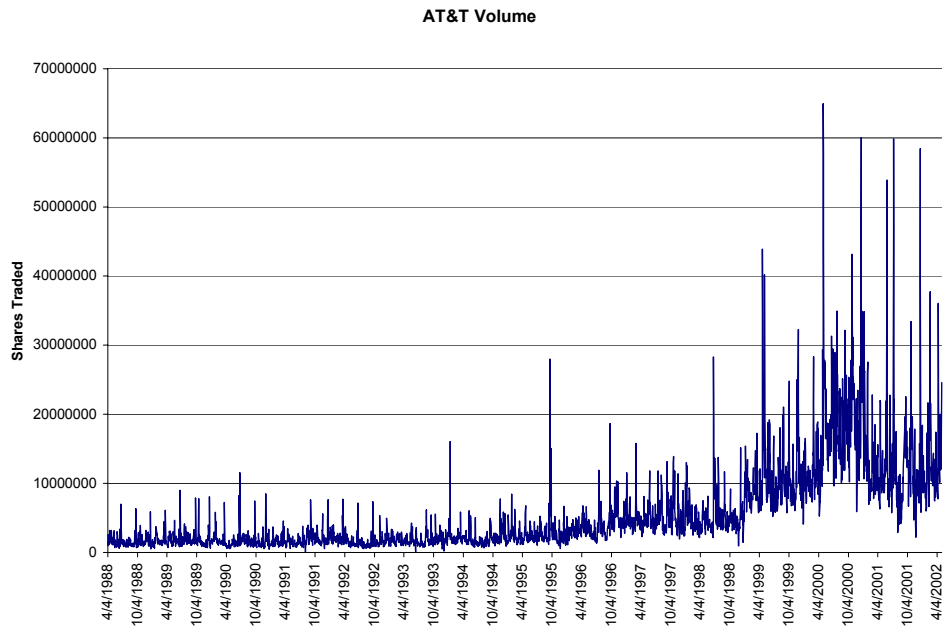


Figure 5.10 – Volume Traded AT&T

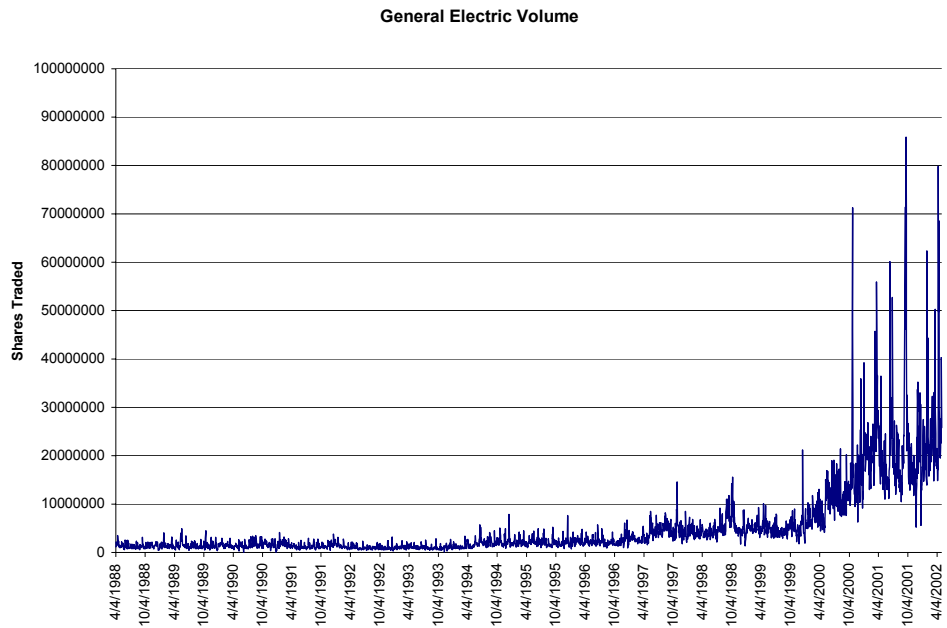


Figure 5.11 – Volume Traded General Electric

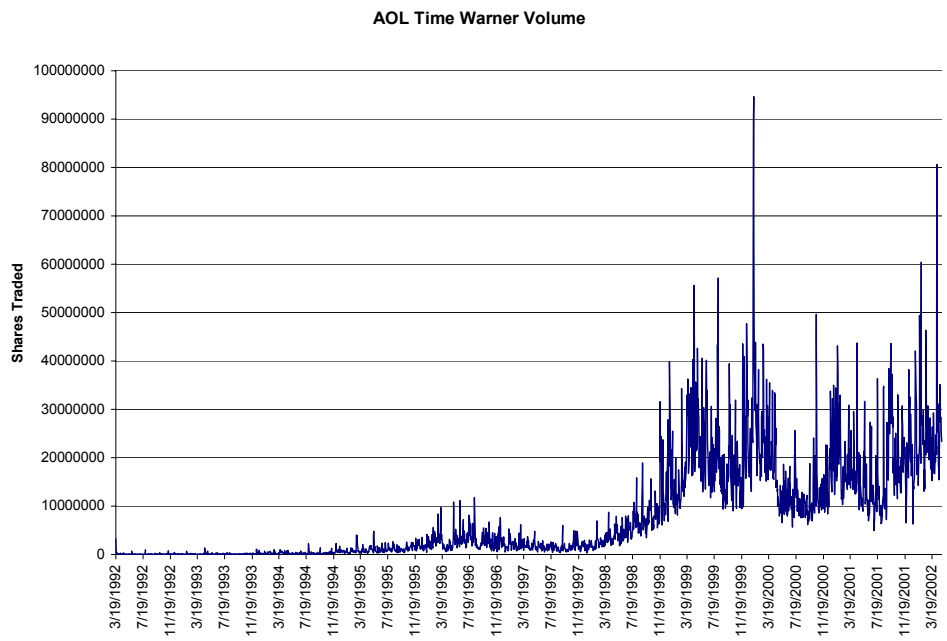


Figure 5.12 – Volume Traded AOL Time Warner

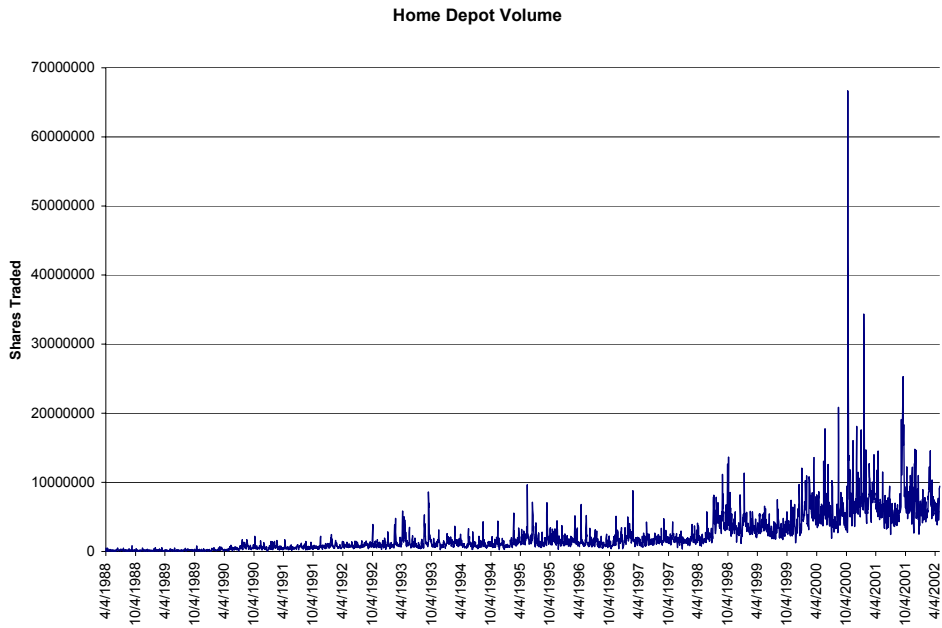


Figure 5.13 – Volume Traded Home Depot

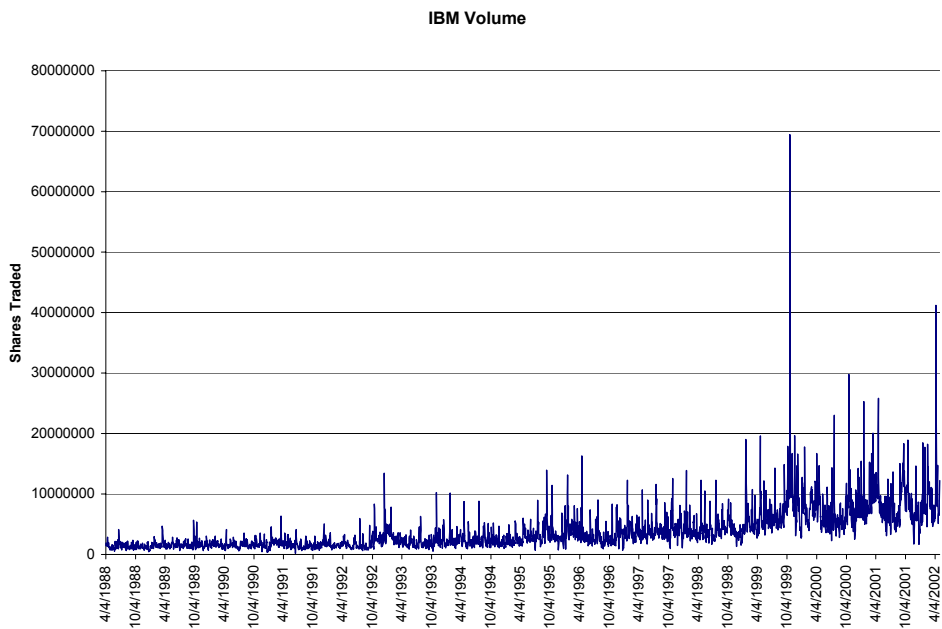


Figure 5.14 – Volume Traded IBM Corporation

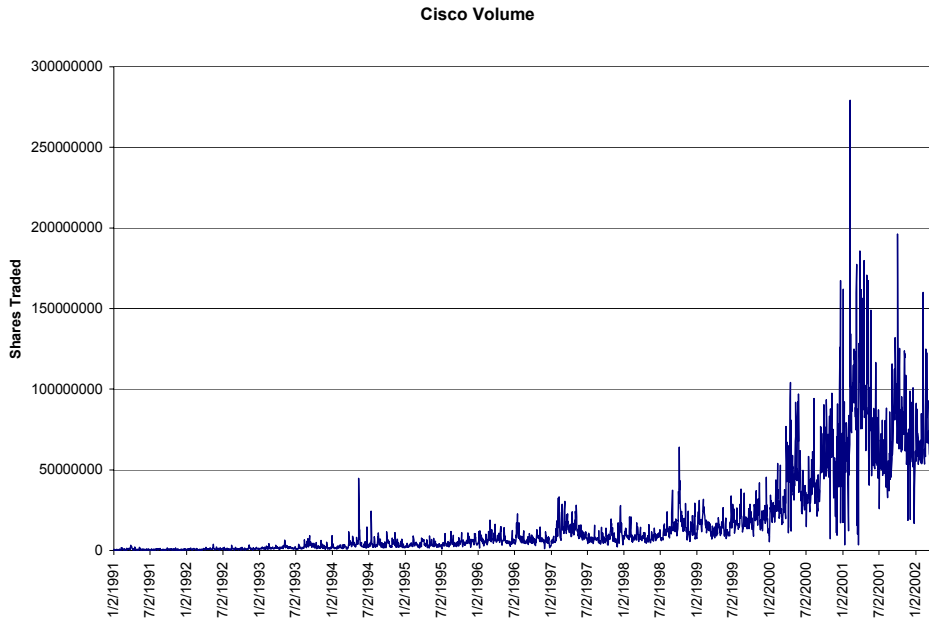


Figure 5.15 – Volume Traded Cisco Corporation

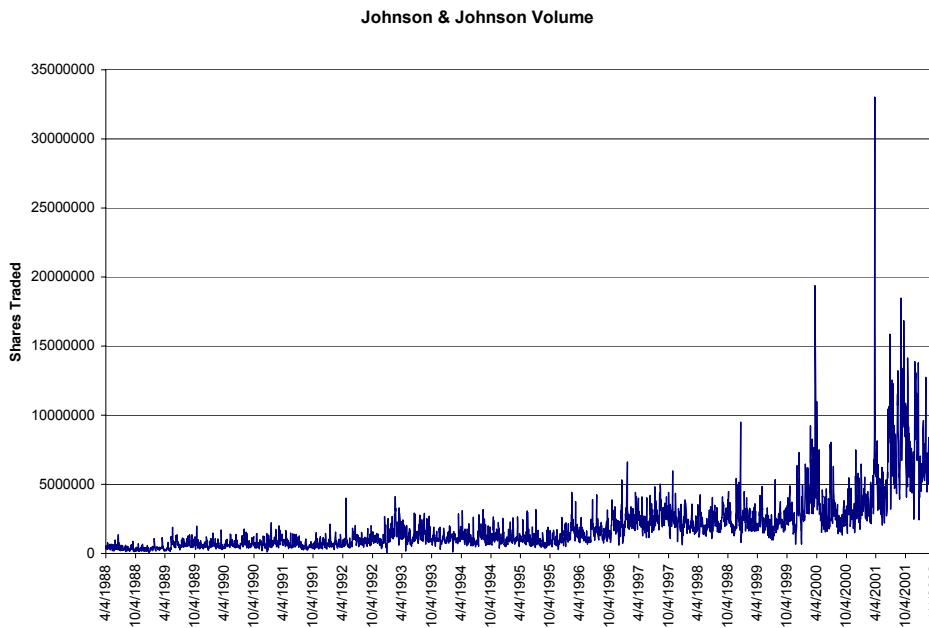


Figure 5.16 – Volume Traded Johnson & Johnson

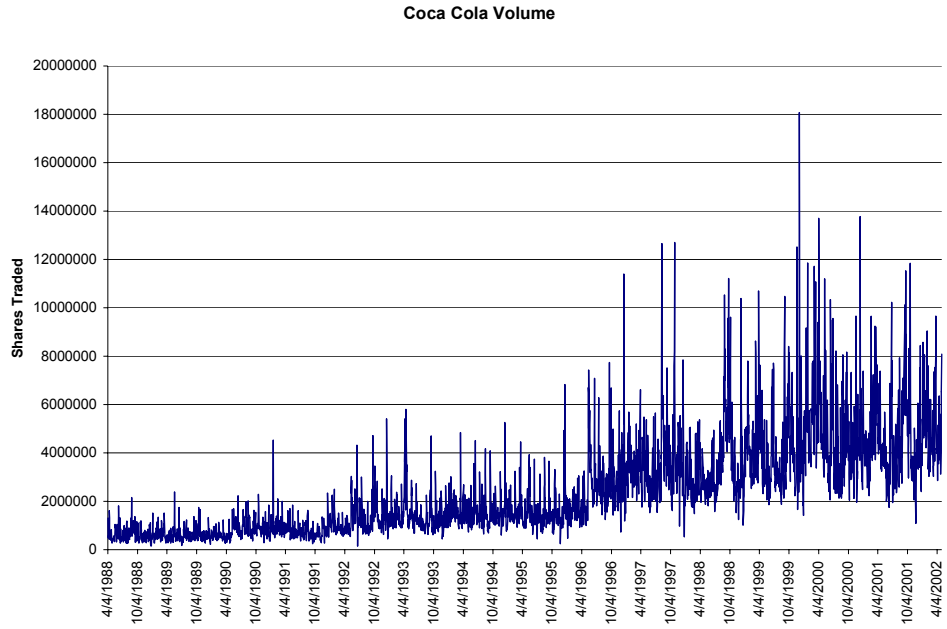


Figure 5.17 – Volume Traded Coca Cola

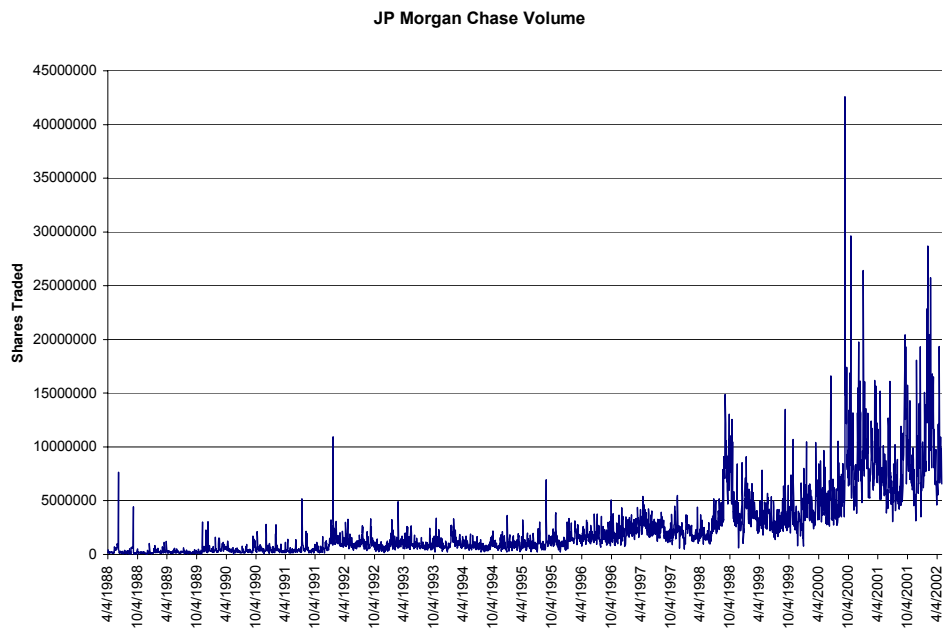


Figure 5.18 – Volume Traded JP Morgan Chase

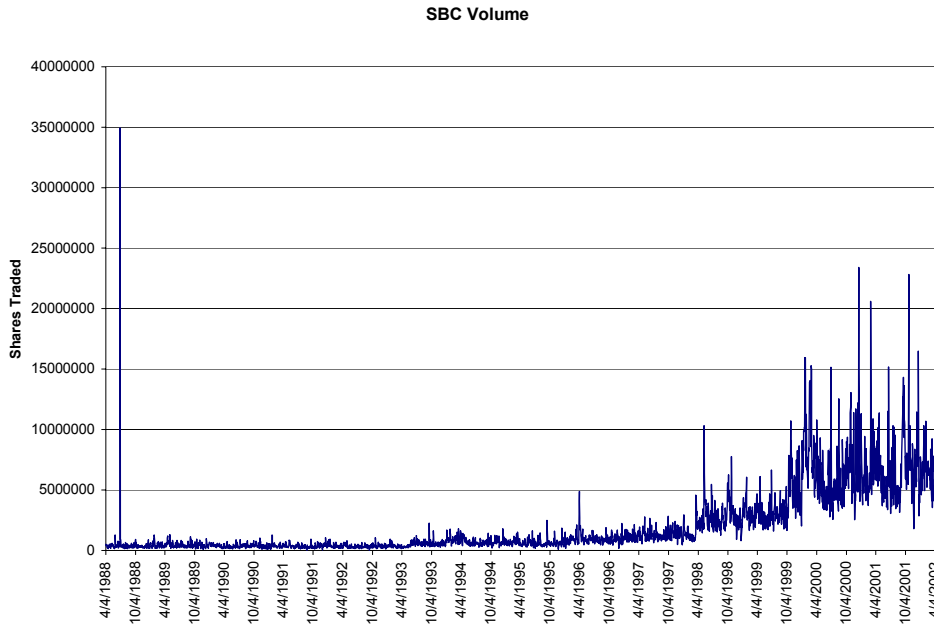


Figure 5.19 – Volume Traded SBC

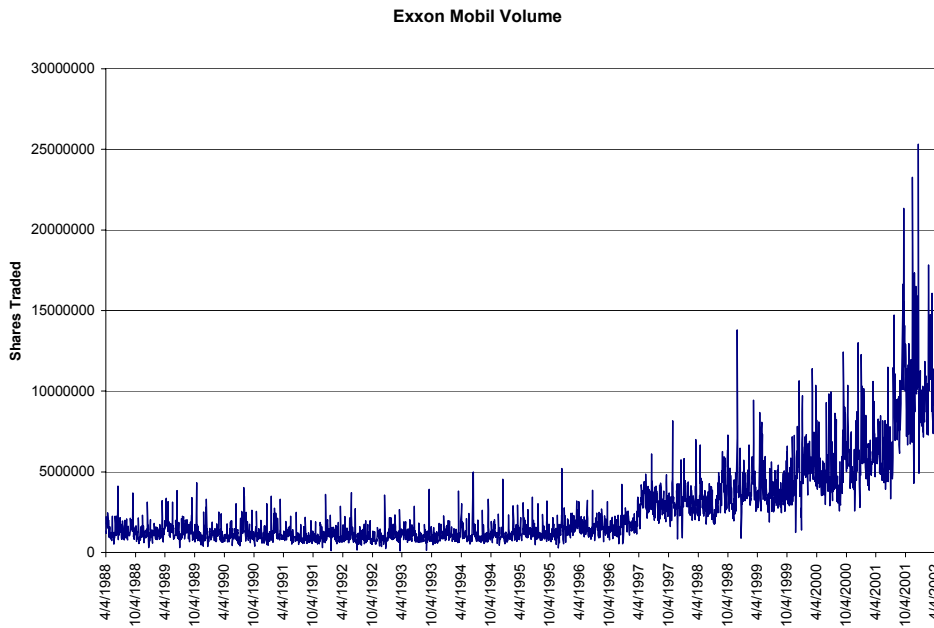


Figure 5.20 – Volume Traded Exxon Mobil

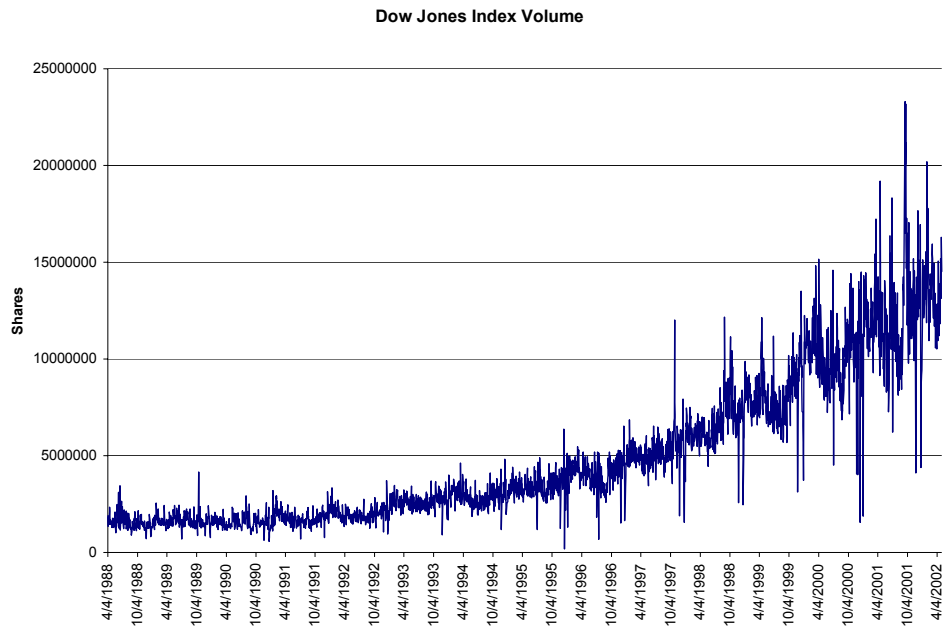


Figure 5.21 – Volume Traded Dow Jones Index

5.3 Experimental Results

In this section the Markov model is examined in relation to changes in volume traded. The same twenty securities and one index are examined. Only the construction of the snake patterns is different.

5.3.1 S&P 500

The S&P 500 (SPY) is examined for the same periods. The high level summaries pertaining to volume change yearly yield for the S&P 500 index stock reside in the following tables.

Tables 5.1 – Percent Returns for S&P with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	16.92	19.38	17.89	2	16.92	19.38	17.89
3	18.55	20.95	14.69	3	18.55	20.95	14.69
4	15.23	13.17	13.65	4	15.37	13.17	13.65
5	9.34	-0.96	2.46	5	9.94	-0.53	1.51
6	12.40	13.84	9.04	6	13.15	14.12	8.08
7	13.36	13.14	15.30	7	14.67	13.12	13.88
8	13.95	10.06	12.38	8	15.76	14.24	10.63
9	16.37	11.97	12.62	9	14.79	15.64	14.91
10	7.69	3.17	0.62	10	14.39	14.80	12.85
11	9.83	3.77	2.15	11	14.32	14.86	13.06
12	10.60	7.16	6.17	12	14.32	14.86	13.01
13	12.94	9.94	2.27	13	14.32	14.86	13.01
14	9.65	8.47	3.25	14	14.32	14.86	13.01
15	4.69	6.07	3.61	15	14.32	14.86	13.01

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	16.92	19.38	17.89
3	18.55	20.95	14.69
4	15.67	13.17	13.65
5	10.19	0.19	1.55
6	13.68	14.16	8.46
7	14.11	12.70	13.95
8	14.96	13.73	9.90
9	13.87	14.25	11.39
10	15.11	15.59	13.05
11	15.11	15.59	13.05
12	15.11	15.59	13.05
13 - 15	15.11	15.59	13.05

From the returns listed, previously the best appears to be zero threshold, three years training, and a snake length of three. The value of 20.95% is highlighted in the first table of the three. The following table compares this best model performance to the other scenarios.

Table 5.2 – Percent Returns for S&P (0,3,3) Using Volume & Other Strategies

Volume Change						Cumulative				
Summary for 0 Thresh, 3 Year Training, 3 Length Snake										
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
96-97	20.99	23.57	11.43	13.75	14.20	20.99	23.57	11.43	13.75	14.20
97-98	38.12	39.09	18.05	18.70	19.28	67.11	71.87	31.53	35.01	36.21
98-99	19.37	24.41	14.27	18.08	18.98	99.49	113.83	50.31	59.42	62.06
99-00	17.91	9.80	8.92	7.66	7.71	135.21	134.79	63.71	71.62	74.56
00-01	13.09	-12.96	-3.29	-7.34	-8.87	166.00	104.36	58.32	59.02	59.07
01-02	17.71	-13.66	-2.67	-6.61	-6.59	213.12	76.45	54.09	48.51	48.58

The following graphs the cumulative side of the table.

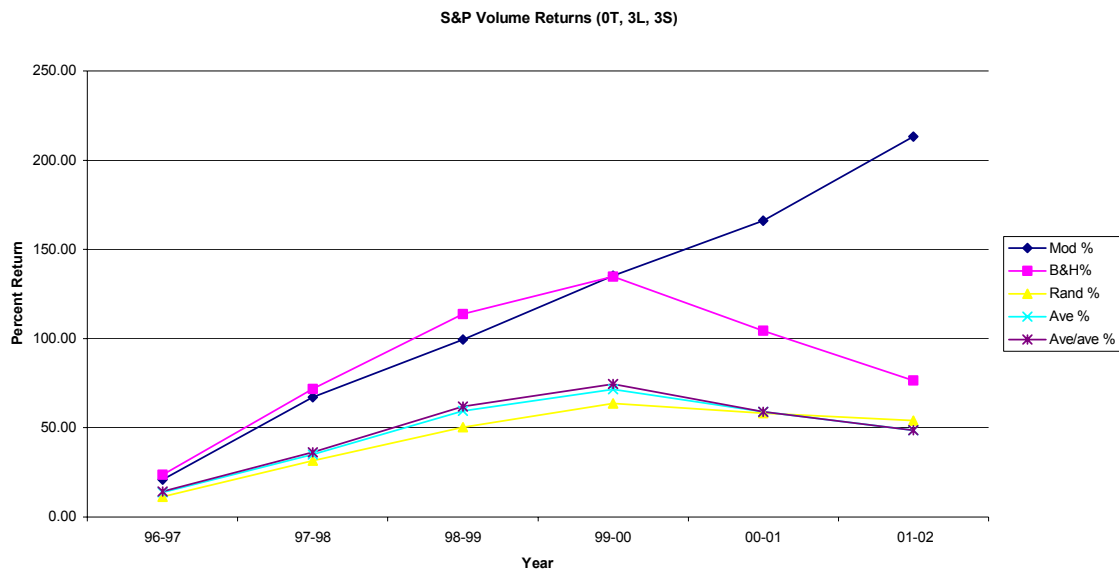


Figure 5.22 – S&P Returns for 0 Thresh, 3 Year Training & 3 Snake Length Using Volume & Other Strategies

The volume model performs well with the S&P index stock. Even in the poorly performing years for the other strategies, the model continues to improve on the yield. At over 210% cumulative return, the volume model with the S&P performs much better than the price change model of chapter 4.

5.3.2 I2 Technologies

Next the model examines the I2 Technologies data using snake patterns formed from the change in volume. The high level summaries of yearly returns for I2 Technologies using volume to form the snake patterns are as follows.

Tables 5.3 – Percent Returns for ITWO with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave	2Yr Ave	3Yr Ave	4	Thresh=3	Yr Ave	2Yr Ave	3Yr Ave	4
Snake Length=					Snake Length=				
2	-36.16	-13.12	-65.52		2	-36.16	-13.12	-65.52	
3	-6.71	-12.36	-66.39		3	-6.71	-12.36	-66.39	
4	-35.91	-7.69	-55.87		4	-35.91	-7.69	-55.87	
5	-24.88	-10.12	-61.71		5	-21.14	-4.17	-57.86	
6	-29.56	-31.97	-59.76		6	-27.05	-32.03	-59.86	
7	-7.51	-23.00	-52.37		7	-13.68	-17.56	-45.69	
8	-22.57	-14.87	-67.86		8	-29.89	-15.53	-60.69	
9	-41.61	-62.96	-73.42		9	-41.64	-43.37	-71.64	
10	8.92	-50.03	-76.82		10	-40.41	-37.80	-68.32	
11	11.88	-23.76	-62.22		11	-40.41	-37.80	-69.48	
12	9.78	-4.24	-57.99		12	-40.41	-37.80	-69.48	
13	6.70	-4.96	-50.76		13	-40.41	-37.80	-69.48	
14	4.93	13.75	-48.89		14	-40.41	-37.80	-69.48	
15	-2.35	0.34	-40.61		15	-40.41	-37.80	-69.48	

Tables 5.3 (continued)

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	-36.16	-13.12	-65.52
3	-6.71	-12.36	-66.39
4	-35.91	-7.69	-55.87
5	-23.94	-5.41	-57.86
6	-22.11	-20.71	-58.10
7	-9.32	-12.41	-44.66
8	-7.89	-14.94	-39.67
9 - 15	-7.89	-14.94	-44.54

The best return for the I2 Technologies is highlighted and is a zero threshold, three years of training and a fourteen-length snake (0T, 3L, 14S). The average return is approximately 13.75% per year with the model using these parameters for threshold, years to train and snake length.

The chart comparing the model's return to the return of the strategies is given as follows.

Table 5.4 – Percent Returns for ITWO (0,3,14) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=3, Snake=14						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
99-00	280.67	607.06	236.60	265.77	293.06	280.67	607.06	236.60	265.77	293.06
00-01	-28.98	-58.74	-29.97	-46.74	-47.80	170.36	191.72	135.72	94.81	105.18
01-02	-45.56	-85.99	-54.81	-47.10	-53.88	47.17	-59.12	6.53	3.06	-5.37

The graph of the cumulative data for I2 Technologies using the volume for snake pattern is as follows.

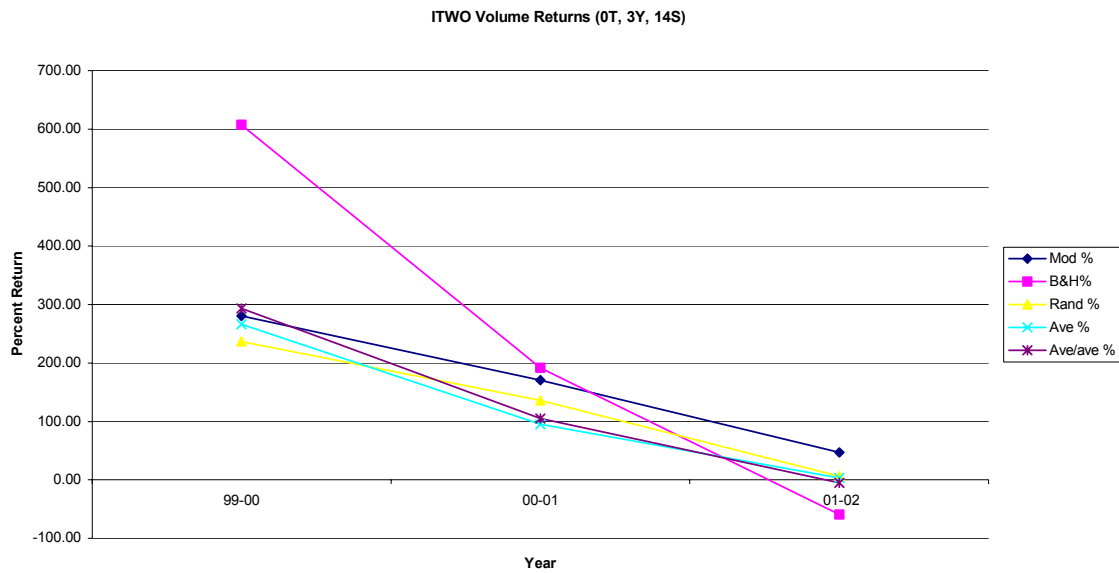


Figure 5.23 – ITWO Returns for 0 Thresh, 3 Year Training & 14 Snake Length For Volume Change & Other Strategies

Once again for the I2 data, the model outperforms the other strategies; however, none appear to be very satisfactory. All investment scenarios with respect to the volume model and the other strategies are trending in a negative direction for the I2 Technologies security.

5.3.3 Tesoro Petroleum

The model examines Tesoro Petroleum with respect to snakes built upon volume changes. The high level summaries for yearly returns for Tesoro built on volume snake patterns are as follows.

Tables 5.5 – Percent Returns for TSO with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	-3.33	-4.68	-8.23	2	-3.33	-4.68	-8.23
3	-10.55	-4.81	1.44	3	-10.55	-4.81	1.44
4	-5.78	-2.29	1.12	4	-5.75	-2.26	1.12
5	-8.03	0.15	8.28	5	-9.09	-1.20	8.56
6	-9.74	-8.63	-0.34	6	-7.75	-8.65	0.51
7	-10.38	-9.39	-7.15	7	-5.48	-7.00	-8.79
8	-12.16	-11.21	-5.97	8	-6.36	-3.86	-6.40
9	-9.93	-13.88	-11.27	9	-6.91	-4.77	-10.77
10	-8.29	-12.61	2.09	10	-6.48	-3.45	-10.24
11	-5.88	-8.54	-4.76	11	-7.64	-4.69	-12.17
12	1.60	0.01	4.45	12	-7.64	-4.67	-12.17
13	-0.27	-3.18	3.03	13	-7.64	-4.67	-12.17
14	-4.70	-2.23	10.32	14	-7.64	-4.67	-12.17
15	-9.75	-5.51	-4.06	15	-7.64	-4.67	-12.17

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	-3.33	-4.68	-8.23
3	-10.55	-4.81	1.44
4	-3.90	-2.26	1.12
5	-9.96	-2.79	8.81
6	-4.24	-10.84	2.45
7	-3.81	-8.19	-5.24
8	-4.60	-12.58	-4.08
9	-6.61	-12.83	-4.04
10 - 15	-7.66	-13.07	-5.89

The best return for Tesoro using the change in daily volume appears to be the zero threshold, four years of training, and a fourteen length snake (0T, 4L, 14S). This value of about 10.32% per year is highlighted in the previous table.

The chart comparing the model's return to the return of the other strategies is given below.

Table 5.6 – Percent Returns for TSO (0,4,14) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=4, Snake=14						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
92-93	-14.49	38.89	20.00	53.00	51.13	-14.49	38.89	20.00	53.00	51.13
93-94	118.82	92.00	51.93	71.59	72.10	87.10	166.67	82.31	162.54	160.11
94-95	16.50	-7.33	-2.94	12.73	11.28	117.96	147.11	76.96	195.95	189.44
95-96	22.77	1.17	-3.04	21.82	23.60	167.59	150.00	71.58	260.53	257.74
96-97	20.52	15.56	1.32	5.15	3.71	222.50	188.89	73.85	279.07	270.99
97-98	10.43	46.62	24.10	17.50	21.07	256.13	323.56	115.74	345.42	349.17
98-99	-6.58	-36.73	-18.44	-5.72	-8.60	232.71	168.00	75.96	319.95	310.56
99-00	-17.51	-18.08	-3.60	-20.99	-22.19	174.45	119.56	69.63	231.81	219.46
00-01	38.01	57.90	20.58	42.43	44.55	278.78	246.67	104.54	372.59	361.78
01-02	-29.51	-49.62	-21.63	-38.13	-40.06	167.02	74.67	60.30	192.42	176.80

The graph of the cumulative Tesoro data may be found on the following page.

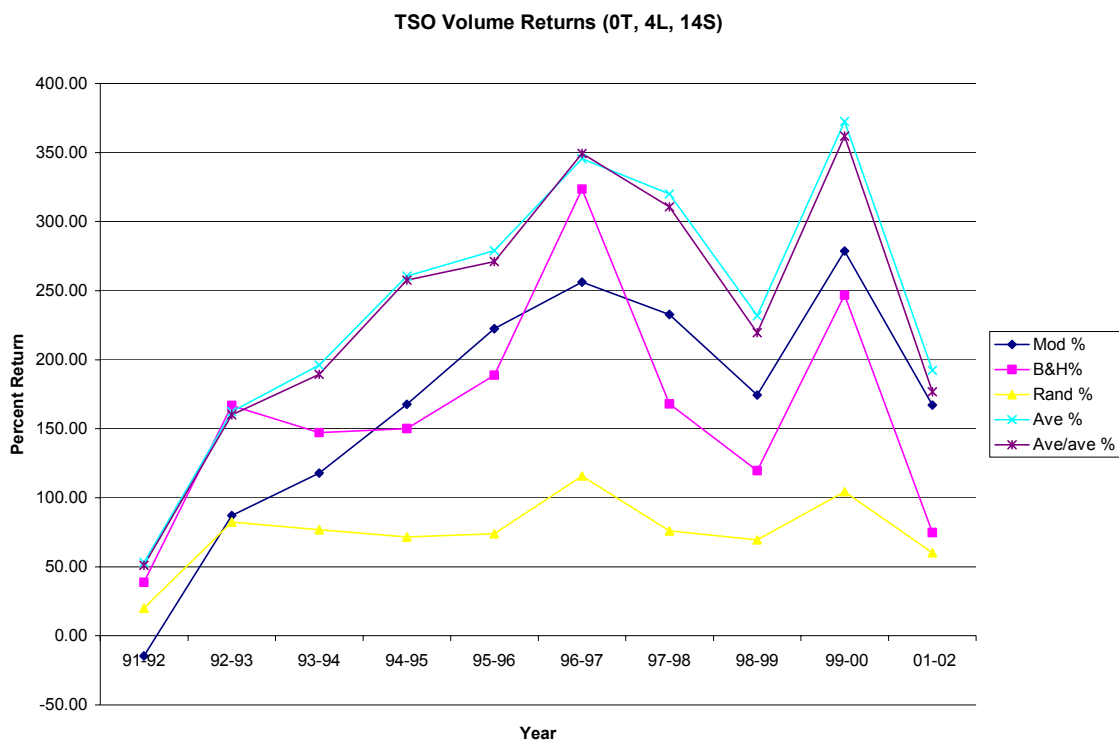


Figure 5.24 – Tesoro Returns for 0 Thresh, 4 Year Training & 14 Snake Length Volume Change & Other Strategies

The yearly return of 10.32% is better than the price snake patterns formed in chapter 4.

5.3.4 Symbol Technologies

Symbol Technologies is the next stock examined for volume change snakes. The high level summaries of yearly returns based on volume snakes for Symbol are as follows.

Tables 5.7 – Percent Returns for SBL with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	8.15	4.62	6.53	2	8.15	4.62	6.53
3	2.35	4.97	1.22	3	2.35	4.97	1.22
4	-4.01	-3.12	9.34	4	-4.01	-3.12	9.34
5	3.12	-6.39	10.89	5	3.24	-5.98	10.89
6	1.73	-6.79	-6.49	6	-0.68	-6.40	-5.80
7	-11.93	-6.97	-5.46	7	-9.30	-5.32	-4.27
8	-7.97	-10.24	-8.94	8	-9.53	-7.66	-10.92
9	-4.47	4.54	-2.04	9	-9.16	-1.63	-10.52
10	-4.47	3.99	-5.87	10	-9.21	-2.02	-8.61
11	-0.41	22.05	11.66	11	-9.89	-2.61	-9.97
12	-0.61	18.53	11.96	12	-9.89	-2.09	-9.62
13	2.56	17.94	7.55	13	-9.89	-2.09	-9.62
14	-2.82	4.80	1.07	14	-9.89	-2.09	-9.62
15	6.65	12.39	11.61	15	-9.89	-2.09	-9.62

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	8.15	4.62	6.53
3	2.35	4.97	1.22
4	-3.31	-3.12	9.34
5	0.21	-5.88	12.84
6	-6.33	-4.43	-3.86
7	-8.67	-1.37	-3.18
8	-8.36	-5.14	-3.07
9	-8.33	-3.51	-1.53
10	-8.33	-3.80	-1.53
11 - 15	-8.33	-3.80	-1.37

The best return for Symbol appears to be the zero thresholds, three years of training data, and an eleven-length snake (0T, 3L, 11S). Expected yearly return would be 22.05%.

The chart comparing the model's return to the return of the strategies is given below.

Table 5.8 – Percent Returns for SBL (0,3,11) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=3, Snake=11						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
93-94	59.37	81.92	15.09	45.30	46.51	59.37	81.92	15.09	45.30	46.51
94-95	25.75	52.48	13.26	24.69	26.34	100.41	177.40	30.35	81.17	85.10
95-96	23.06	18.74	7.25	15.71	18.07	146.62	229.38	39.80	109.63	118.55
96-97	-22.56	8.06	2.58	0.65	1.31	90.98	255.93	43.41	111.00	121.40
97-98	56.68	63.97	23.20	27.53	30.72	199.23	483.61	76.68	169.10	189.43
98-99	12.64	45.31	24.90	8.18	10.28	237.06	748.02	120.68	191.12	219.18
99-00	118.29	123.72	45.18	60.05	63.21	635.78	1797.17	220.38	365.93	420.92
00-01	-15.79	-24.12	-6.15	-7.99	-7.74	519.59	1339.54	200.69	328.71	380.60
01-02	-2.98	-64.99	-39.27	-35.58	-35.62	501.16	403.95	82.61	176.16	209.41

For the Symbol security, the model built on volume change outperforms all of the standard scenarios.

The graph of the cumulative Symbol data is as follows.

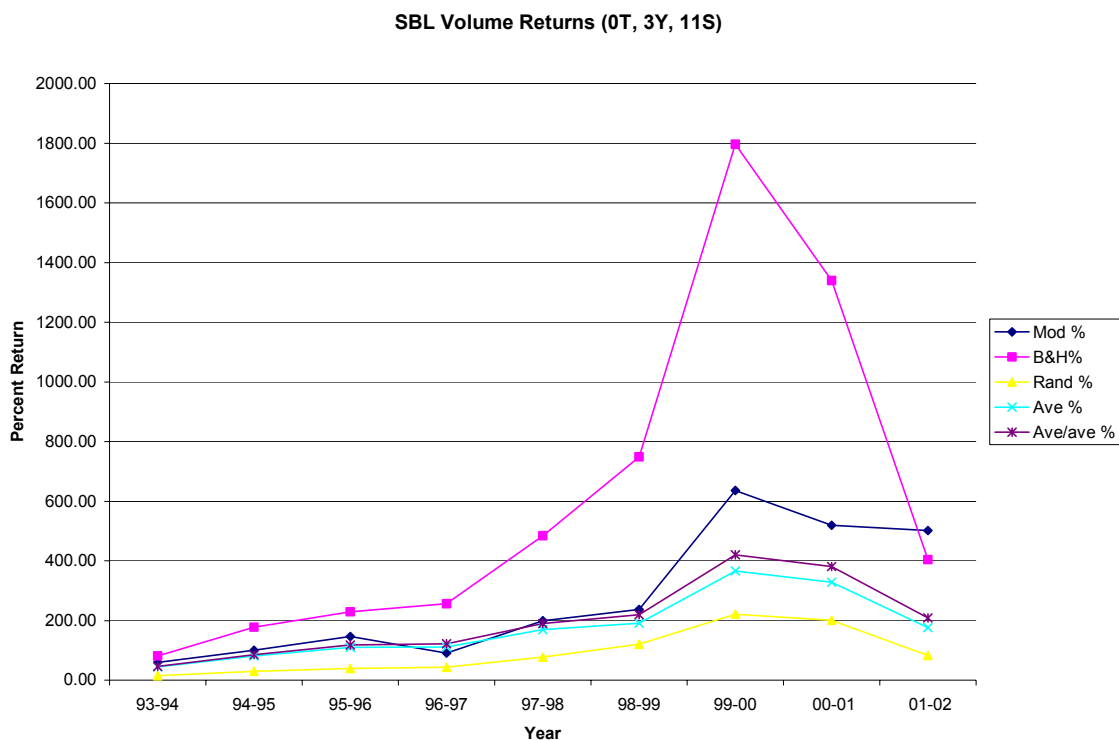


Figure 5.25 – Symbol Returns for 0 Thresh, 3 Year Training & 11 Snake Length For Volume Change & Other Strategies

For the Symbol security, the volume built patterns perform better than the price change patterns.

5.3.5 Duke

Duke Energy is examined for volume change snakes. The high level summaries of yearly returns based on volume snakes for Duke are as follows.

Tables 5.9 – Percent Returns for DUKE with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	-1.23	2.13	0.63	2	-1.23	2.13	0.63
3	4.66	6.20	5.78	3	4.66	6.20	5.78
4	1.77	2.86	1.40	4	1.77	2.86	1.40
5	6.33	4.98	6.93	5	6.33	4.98	6.93
6	4.02	1.24	5.61	6	4.02	1.24	5.61
7	6.30	7.09	8.95	7	6.30	7.09	8.95
8	8.45	7.31	8.09	8	8.45	7.31	8.09
9	6.46	8.14	8.57	9	6.46	8.14	8.57
10	6.84	5.32	8.89	10	6.84	5.32	8.89
11	5.86	3.54	6.56	11	5.86	3.54	6.56
12	1.76	1.15	3.16	12	1.76	1.15	3.16

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	-1.23	2.13	0.63
3	4.66	6.20	5.78
4	1.77	2.86	1.40
5	6.33	4.98	6.93
6	4.02	1.24	5.61
7	6.30	7.09	8.95
8	8.45	7.31	8.09
9	6.46	8.14	8.57
10	6.84	5.32	8.89
11	5.86	3.54	6.56
12	1.76	1.15	3.16

The best return for Duke appears to be the zero thresholds, four years of training data and a seven-length snake (0T, 4L, 7S). Expected yearly return would be 8.95%.

Duke Energy performs better using the price change for the snake pattern.

The chart comparing the model's return to the return of the strategies is given below.

Table 5.10 – Percent Returns for Duke (0,4,7) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=4, Snake=7						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
92-93	8.16	22.25	0.39	10.58	11.79	8.16	22.25	0.39	10.58	11.79
93-94	2.91	-2.32	-0.91	-9.64	-9.17	11.31	19.41	-0.52	-0.09	1.54
94-95	-3.73	13.50	-3.99	5.01	6.15	7.16	35.53	-4.49	4.92	7.78
95-96	16.66	23.65	-2.86	6.74	8.63	25.01	67.58	-7.22	11.99	17.09
96-97	-13.53	-5.63	-10.99	-9.37	-9.19	8.10	58.15	-17.42	1.50	6.33
97-98	8.23	39.84	19.78	14.42	15.44	17.00	121.16	-1.08	16.13	22.75
98-99	-15.89	-0.33	-30.72	-8.53	-9.14	-1.59	120.42	-31.47	6.22	11.53
99-00	32.11	12.67	-8.84	10.56	10.57	30.01	148.35	-37.52	17.44	23.32
00-01	93.95	61.17	26.84	29.04	31.29	152.15	300.28	-20.76	51.54	61.91

For the Duke Energy security, the model built on volume change outperforms all of the standard scenarios with the exception of the buy and hold strategy. The graph of the cumulative Duke data is as follows.

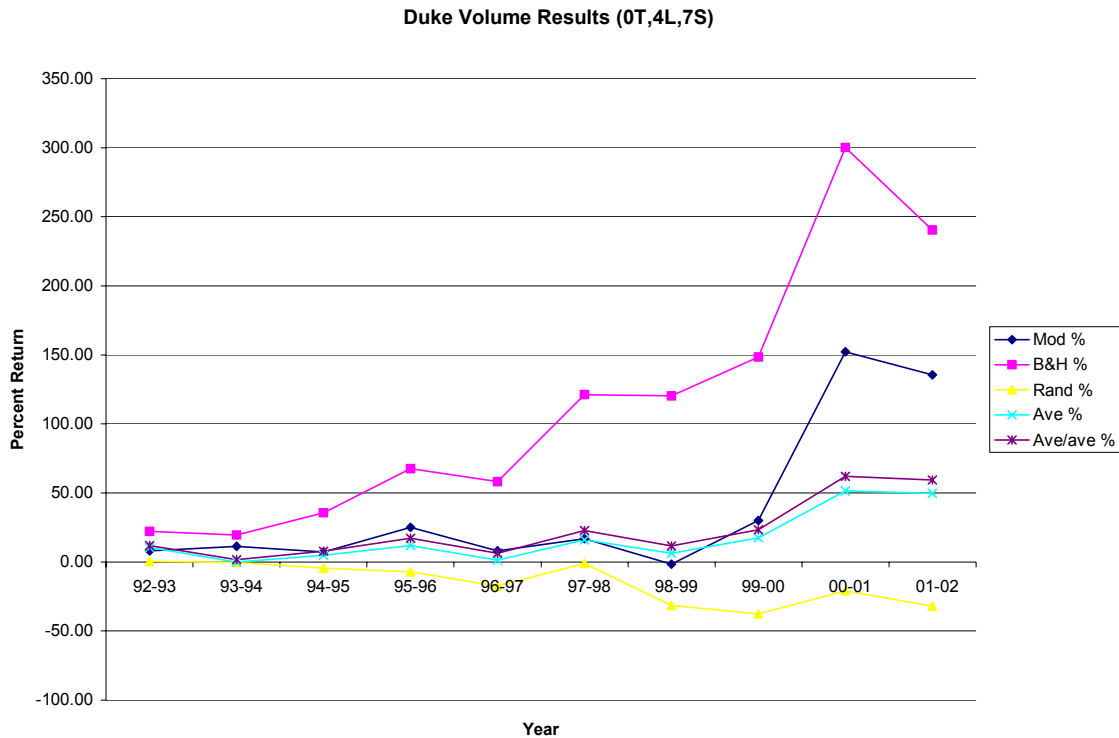


Figure 5.26 – Duke Returns for 0 Thresh, 4 Year Training & 7 Snake Length For Volume Change & Other Strategies

5.3.6 Bristol Myers

Bristol Myers is examined for volume change snakes. The high level summaries of yearly returns based on volume snakes for Bristol Myers are as follows.

Tables 5.11 – Percent Returns for Bristol Myers with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	4.93	7.75	5.18	2	4.93	7.75	5.18
3	1.41	4.33	2.13	3	1.41	4.33	2.13
4	3.94	0.43	0.88	4	3.94	0.43	0.88
5	-3.25	-2.32	-2.95	5	-3.25	-2.32	-2.95
6	-5.42	-7.84	-4.44	6	-5.42	-7.84	-4.44
7	-2.16	-4.27	-4.41	7	-2.16	-4.27	-4.41
8	-3.77	-6.70	-3.17	8	-3.77	-6.70	-3.17
9	4.42	0.60	2.94	9	4.42	0.60	2.94
10	3.55	6.47	5.95	10	3.55	6.47	5.95
11	5.40	5.89	3.61	11	5.40	5.89	3.61
12	2.23	6.95	5.74	12	2.23	6.95	5.74

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	4.93	7.75	5.18
3	1.41	4.33	2.13
4	3.94	0.43	0.88
5	-3.25	-2.32	-2.95
6	-5.42	-7.84	-4.44
7	-2.16	-4.27	-4.41
8	-3.77	-6.70	-3.17
9	4.42	0.60	2.94
10	3.55	6.47	5.95
11	5.40	5.89	3.61
12	2.23	6.95	5.74

The best return for Bristol Myers appears to be the zero thresholds, three years of training data, and a two-length snake (0T, 3L, 2S). Expected yearly return would be 7.75%.

Bristol Myers performs better using the price change for the snake pattern.

The chart comparing the model's return to the return of the strategies is given below.

Table 5.12 – Percent Returns for Bristol Myers (0,3,2) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=3, Snake=2						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
91-92	0.50	-2.28	0.50	-7.88	-7.09	0.50	-2.28	0.50	-7.88	-7.09
92-93	0.50	-15.91	0.50	-6.28	-6.81	1.00	-17.83	1.00	-13.66	-13.42
93-94	0.50	-5.64	0.50	-3.52	-4.24	1.51	-22.47	1.51	-16.70	-17.09
94-95	0.50	27.14	0.50	16.19	16.99	2.02	-1.43	2.02	-3.21	-3.00
95-96	0.50	30.83	0.50	11.51	12.84	2.53	28.96	2.53	7.93	9.46
96-97	30.08	54.15	-1.65	23.05	25.64	33.37	98.79	0.83	32.81	37.53
97-98	61.42	64.44	26.29	18.38	20.79	115.28	226.89	27.34	57.22	66.12
98-99	41.39	41.44	-0.64	22.22	22.47	204.39	362.35	26.52	92.14	103.44
99-00	-6.37	-25.61	9.06	-22.98	-23.05	185.00	243.94	37.98	47.99	56.56
00-01	6.69	14.02	22.03	-1.35	-1.82	204.05	292.16	68.38	45.99	53.71
01-02	-25.24	-46.60	-28.95	-41.46	-43.00	127.31	109.42	19.64	-14.53	-12.38

For the Bristol Myers security, the model built on volume change outperforms all of the standard scenarios. The graph of the cumulative Bristol Myers data is as follows.

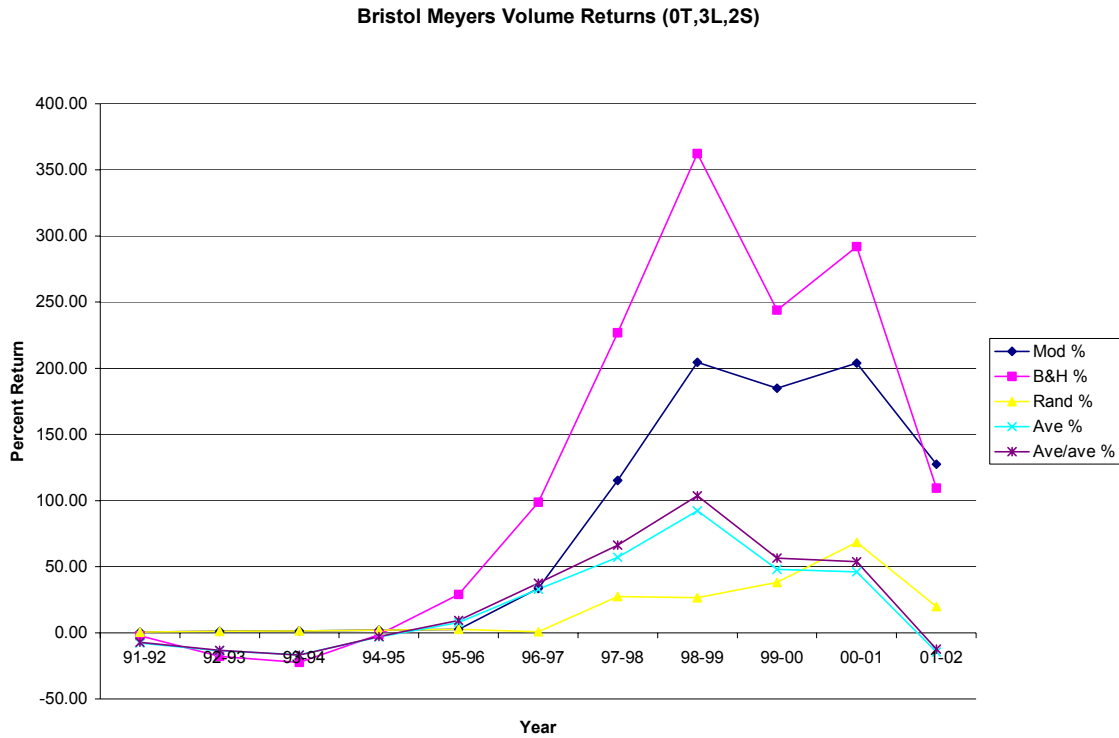


Figure 5.27 – Bristol Myers Returns for 0 Thresh, 3 Year Training & 2 Snake Length For Volume Change & Other Strategies

5.3.7 Intel

Intel is examined for volume change snakes. The high level summaries of yearly returns based on volume snakes for Intel are as follows.

Tables 5.13 – Percent Returns for Intel with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	7.41	6.03	2.28	2	7.41	6.03	2.28
3	7.39	10.24	11.79	3	7.39	10.24	11.79
4	0.55	-0.73	7.62	4	0.55	-0.73	7.62
5	-0.77	1.35	6.96	5	-0.77	1.35	6.96
6	-1.39	4.25	3.10	6	-1.39	4.25	3.10
7	16.16	12.20	6.69	7	16.16	12.20	6.69
8	5.64	11.17	7.68	8	5.64	11.17	7.68
9	7.64	10.77	12.05	9	7.64	10.77	12.05
10	11.33	11.49	9.85	10	11.33	11.49	9.85
11	4.85	5.17	6.37	11	4.85	5.17	6.37
12	-0.26	9.75	10.99	12	-0.26	9.75	10.99

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	7.41	6.03	2.28
3	7.39	10.24	11.79
4	0.55	-0.73	7.62
5	-0.77	1.35	6.96
6	-1.39	4.25	3.10
7	16.16	12.20	6.69
8	5.64	11.17	7.68
9	7.64	10.77	12.05
10	11.33	11.49	9.85
11	4.85	5.17	6.37
12	-0.26	9.75	10.99

The best return for Intel appears to be the zero thresholds, two years of training data and a seven-length snake (0T, 2L, 7S). Expected yearly return would be 16.16%.

Intel performs better using the price change for the snake pattern.

The chart comparing the model's return to the return of the strategies is given below.

Table 5.14 – Percent Returns for Intel (0,2,7) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=2, Snake=7						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
90-91	-0.31	15.15	1.01	8.81	9.93	-0.31	15.15	1.01	8.81	9.93
91-92	21.20	7.90	-40.27	-0.87	-1.65	20.83	24.24	-39.67	7.86	8.12
92-93	33.48	81.10	1.22	26.42	30.00	61.27	125.00	-38.94	36.36	40.56
93-94	16.36	28.28	-11.59	-3.07	-2.19	87.66	188.64	-46.01	32.17	37.49
94-95	27.62	67.98	24.77	51.88	54.41	139.50	384.85	-32.64	100.73	112.30
95-96	6.97	35.31	-13.72	15.46	15.49	156.19	556.07	-41.88	131.76	145.18
96-97	42.29	107.74	34.12	46.17	51.90	264.52	1262.89	-22.06	238.78	272.42
97-98	-16.20	11.17	-0.38	-2.53	-1.01	205.49	1415.17	-22.35	230.22	268.65
98-99	1.40	55.60	50.83	30.50	34.89	209.75	2257.60	17.12	330.92	397.27
99-00	39.00	100.84	117.22	64.15	66.45	330.55	4634.88	154.40	607.37	727.70
00-01	-7.89	-53.55	-27.10	-34.72	-36.41	296.56	2099.26	85.45	361.79	426.36
01-02	52.25	-1.38	7.32	0.42	-1.51	503.77	2068.95	99.02	363.74	418.39

For the Intel security, the model built on volume change outperforms all of the standard scenarios with the exception of the buy and hold strategy. The graph of the cumulative Intel data is as follows.

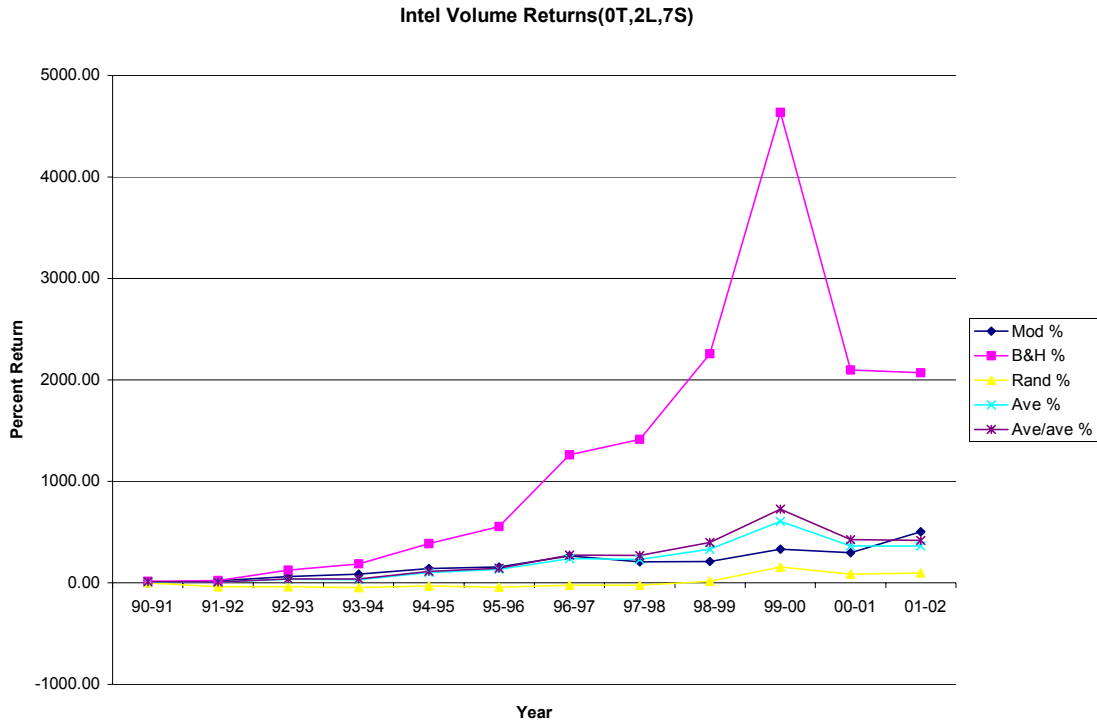


Figure 5.28 – Intel Returns for 0 Thresh, 2 Year Training & 7 Snake Length For Volume Change & Other Strategies

5.3.8 Lucent

Lucent is examined for volume change snakes. The high level summaries of yearly returns based on volume snakes for Lucent are as follows.

Tables 5.15 – Percent Returns for Lucent with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	-14.07	-31.02	-63.59	2	-14.07	-31.02	-63.59
3	-4.82	-44.99	-60.59	3	-4.82	-44.99	-60.59
4	-22.49	-41.00	-68.58	4	-22.49	-41.00	-68.58
5	-8.71	-37.74	-63.90	5	-8.71	-37.74	-63.90
6	-28.22	-44.34	-60.27	6	-28.22	-44.34	-60.27
7	-24.22	-39.96	-52.40	7	-24.22	-39.96	-52.40
8	-29.48	-47.76	-56.80	8	-29.48	-47.76	-56.80
9	-14.34	-53.69	-66.63	9	-14.34	-53.69	-66.63
10	-18.67	-47.33	-62.56	10	-18.67	-47.33	-62.56
11	-23.43	-24.81	-32.81	11	-23.43	-24.81	-32.81
12	-3.31	-10.41	-36.79	12	-3.31	-10.41	-36.79

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	-14.07	-31.02	-63.59
3	-4.82	-44.99	-60.59
4	-22.49	-41.00	-68.58
5	-8.71	-37.74	-63.90
6	-28.22	-44.34	-60.27
7	-24.22	-39.96	-52.40
8	-29.48	-47.76	-56.80
9	-14.34	-53.69	-66.63
10	-18.67	-47.33	-62.56
11	-23.43	-24.81	-32.81
12	-3.31	-10.41	-36.79

The best return for Lucent appears to be the zero thresholds, two years of training data, and a twelve length snake (0T, 2L, 12S). Expected yearly return would be -3.31%.

The chart comparing the model's return to the return of the strategies is given below.

Table 5.16 – Percent Returns for Lucent (0,2,12) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=2, Snake=12						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
98-99	73.80	70.15	35.94	39.82	44.55	73.80	70.15	35.94	39.82	44.55
99-00	13.72	4.59	2.65	0.63	-0.06	97.65	77.96	39.54	40.69	44.46
00-01	-46.94	-82.96	-60.31	-55.37	-59.34	4.87	-69.67	-44.62	-37.21	-41.27
01-02	-16.66	-55.48	-31.32	-31.74	-34.11	-12.60	-86.50	-61.96	-57.14	-61.30

For the Lucent security, the model built on volume change outperforms all of the standard scenarios. The graph of the cumulative Lucent data is as follows.

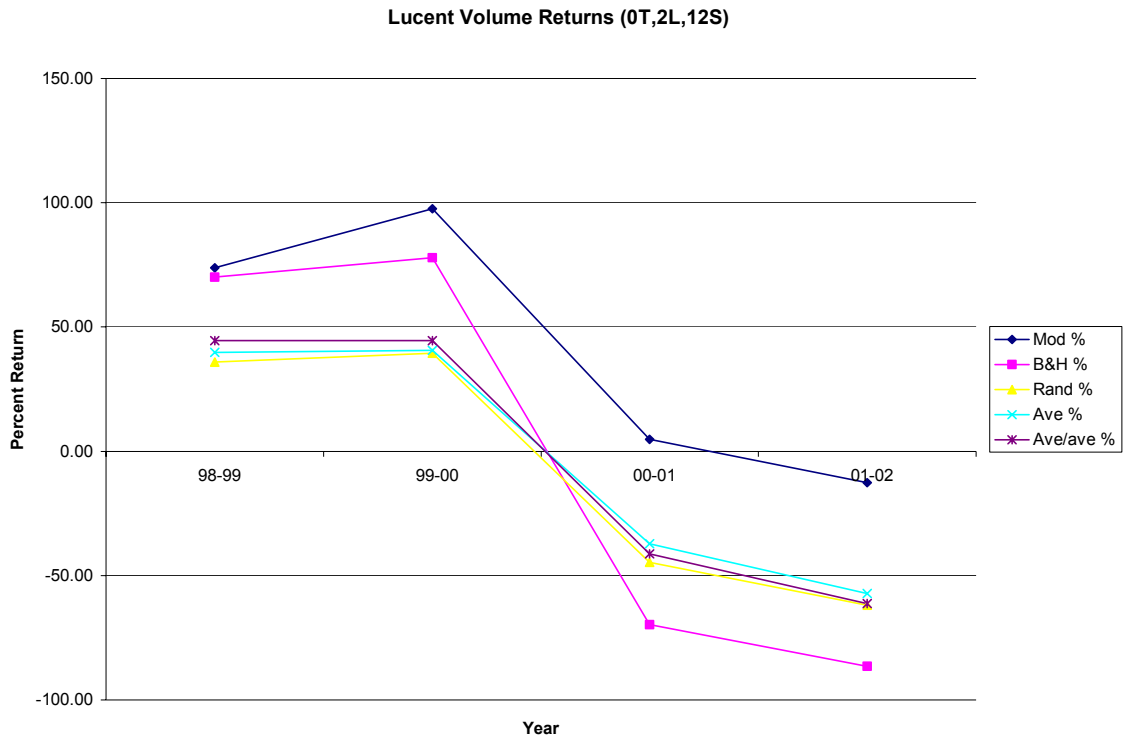


Figure 5.29 – Lucent Returns for 0 Thresh, 2 Year Training & 12 Snake Length For Volume Change & Other Strategies

5.3.9 OMI

OMI is examined for volume change snakes. The high level summaries of yearly returns based on volume snakes for OMI are as follows.

Tables 5.17 – Percent Returns for OMI with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	-17.56	-10.15	-4.36	2	-17.56	-10.15	-4.36
3	-20.12	-11.68	-5.61	3	-20.12	-11.68	-5.61
4	-13.37	-22.79	-22.45	4	-13.37	-22.79	-22.45
5	-13.73	-16.84	-9.06	5	-13.73	-16.84	-9.06
6	-15.96	-9.28	-5.49	6	-15.96	-9.28	-5.49
7	-12.36	-12.30	-16.93	7	-12.36	-12.30	-16.93
8	-12.28	-15.53	-11.34	8	-12.28	-15.53	-11.34
9	-1.71	-19.47	-13.14	9	-1.71	-19.47	-13.14
10	3.70	-6.81	-7.09	10	3.70	-6.81	-7.09
11	-1.58	-2.44	-13.62	11	-1.58	-2.44	-13.62
12	-3.71	8.39	7.78	12	-3.71	8.39	7.78

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	-17.56	-10.15	-4.36
3	-20.12	-11.68	-5.61
4	-13.37	-22.79	-22.45
5	-13.73	-16.84	-9.06
6	-15.96	-9.28	-5.49
7	-12.36	-12.30	-16.93
8	-12.28	-15.53	-11.34
9	-1.71	-19.47	-13.14
10	3.70	-6.81	-7.09
11	-1.58	-2.44	-13.62
12	-3.71	8.39	7.78

The best return for OMI appears to be the zero thresholds, three years of training data and a twelve-length snake (0T, 3L, 12S). Expected yearly return would be 8.39%.

OMI performs better using the cost change of chapter 4 for the snake pattern.

The chart comparing the model's return to the return of the strategies is given below.

Table 5.18 – Percent Returns for OMI (0,3,12) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=3, Snake=12						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
95-96	20.05	41.22	15.82	21.76	22.76	20.05	41.22	15.82	21.76	22.76
96-97	29.42	24.63	4.33	18.11	20.19	55.36	76.00	20.84	43.81	47.55
97-98	8.12	-12.95	1.25	-12.33	-13.75	67.98	53.22	22.35	26.07	27.27
98-99	-5.07	-72.99	-53.24	-31.10	-38.21	59.45	-58.61	-42.79	-13.13	-21.36
99-00	-8.05	28.57	18.55	31.54	33.27	46.61	-46.78	-32.18	14.27	4.81
00-01	1.81	156.54	60.39	44.77	40.97	49.26	36.52	8.78	65.42	47.74
01-02	17.73	-38.22	-38.22	6.34	5.82	75.72	-15.65	-32.80	75.91	56.34

For the OMI security, the model built on volume change outperforms or equals all of the standard scenarios. The graph of the cumulative OMI data is as follows.

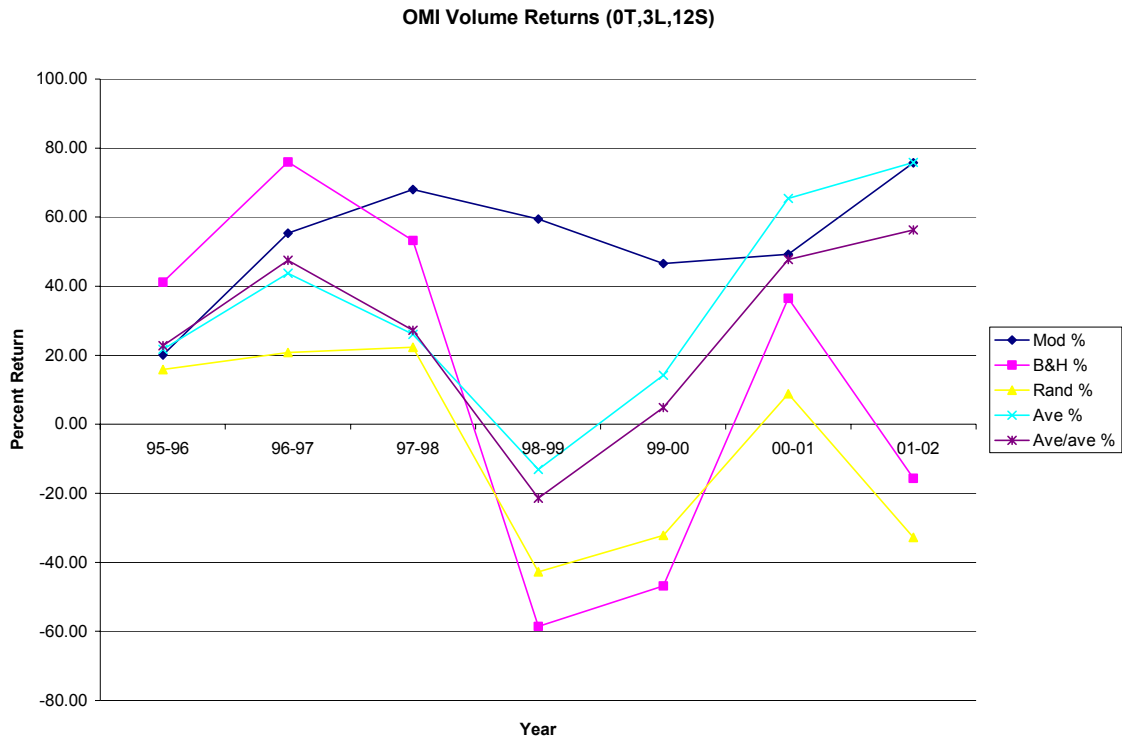


Figure 5.30 – OMI Returns for 0 Thresh, 3 Year Training & 12 Snake Length For Volume Change & Other Strategies

5.3.10 AT&T

AT&T is examined for volume change snakes. The high level summaries of yearly returns based on volume snakes for AT&T are as follows.

Tables 5.19 – Percent Returns for AT&T with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	-3.07	-9.10	-10.73	2	-3.07	-9.10	-10.73
3	-1.40	-5.48	-0.06	3	-1.40	-5.48	-0.06
4	-5.17	-4.72	-3.52	4	-5.17	-4.72	-3.52
5	-0.68	3.57	-2.28	5	-0.68	3.57	-2.28
6	1.30	4.53	3.52	6	1.30	4.53	3.52
7	-3.93	-2.64	-5.09	7	-3.93	-2.64	-5.09
8	-0.10	-6.30	-4.15	8	-0.10	-6.30	-4.15
9	2.88	1.83	-2.34	9	2.88	1.83	-2.34
10	-4.01	2.72	2.00	10	-4.01	2.72	2.00
11	-8.13	-8.03	-7.09	11	-8.13	-8.03	-7.09
12	-2.54	-2.17	-7.93	12	-2.54	-2.17	-7.93

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	-3.07	-9.10	-10.73
3	-1.40	-5.48	-0.06
4	-5.17	-4.72	-3.52
5	-0.68	3.57	-2.28
6	1.30	4.53	3.52
7	-3.93	-2.64	-5.09
8	-0.10	-6.30	-4.15
9	2.88	1.83	-2.34
10	-4.01	2.72	2.00
11	-8.13	-8.03	-7.09
12	-2.54	-2.17	-7.93

The best return for AT&T appears to be the zero thresholds, three years of training data, and a six-length snake (0T, 3L, 6S). Expected yearly return would be 4.53%.

AT&T performs better using the price change for the snake pattern.

The chart comparing the model's return to the return of the strategies is given below.

Table 5.20 – Percent Returns for AT&T (0,3,6) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=3, Snake=6						Cumulative				
Data End	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
91-92	7.44	16.19	6.68	12.68	13.15	7.44	16.19	6.68	12.68	13.15
92-93	17.11	29.57	15.08	19.45	20.73	25.82	50.55	22.76	34.59	36.61
93-94	-2.48	-8.30	6.12	-10.86	-11.13	22.70	38.05	30.28	19.98	21.40
94-95	3.64	-0.97	-17.58	-3.72	-3.57	27.17	36.71	7.38	15.51	17.07
95-96	19.94	20.95	20.77	4.69	5.40	52.52	65.36	29.68	20.94	23.39
96-97	-17.48	-49.07	-36.37	-31.67	-32.60	25.86	-15.78	-17.48	-17.36	-16.84
97-98	59.40	93.59	65.80	31.78	36.01	100.62	63.04	36.81	8.90	13.11
98-99	3.00	31.43	25.47	19.91	21.90	106.64	114.28	71.66	30.58	37.88
99-00	16.95	-2.12	-13.28	2.23	1.12	141.66	109.74	48.88	33.49	39.43
00-01	-36.35	-58.01	-50.38	-17.62	-20.98	53.83	-11.93	-26.12	9.96	10.17
01-02	5.84	-35.88	-23.09	-23.83	-25.07	62.81	-43.53	-43.18	-16.24	-17.45

For the AT&T security, the model built on volume change outperforms all of the standard scenarios. The graph of the cumulative AT&T data is as follows.

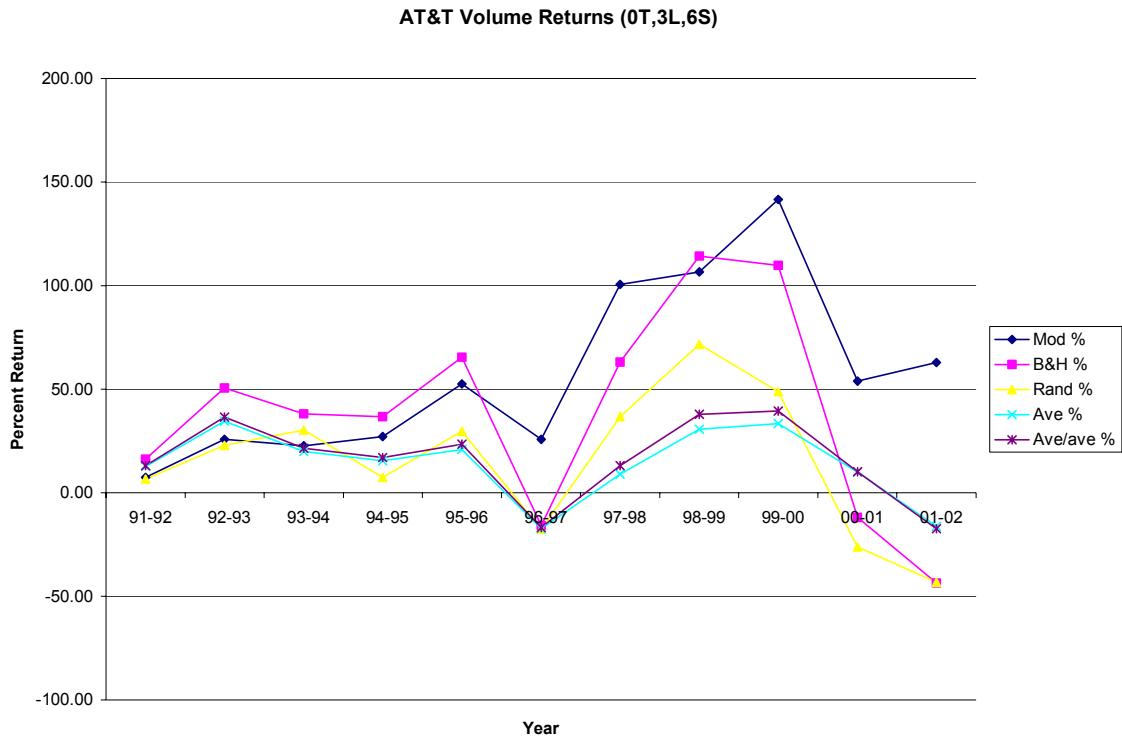


Figure 5.31 – AT&T Returns for 0 Thresh, 3 Year Training & 6 Snake Length For Volume Change & Other Strategies

5.3.11 General Electric

General Electric is examined for volume change snakes. The high level summaries of yearly returns based on volume snakes for General Electric are as follows.

Tables 5.21 – Percent Returns for General Electric with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	15.20	8.12	6.68	2	15.20	8.12	6.68
3	10.82	12.85	10.13	3	10.82	12.85	10.13
4	10.21	14.41	18.53	4	10.21	14.41	18.53
5	6.07	13.11	21.41	5	6.07	13.11	21.41
6	0.66	7.03	9.43	6	0.66	7.03	9.43
7	1.10	5.74	7.92	7	1.10	5.74	7.92
8	-3.83	-2.02	0.55	8	-3.83	-2.02	0.55
9	3.05	3.71	3.26	9	3.05	3.71	3.26
10	4.47	3.09	6.60	10	4.47	3.09	6.60
11	0.95	5.80	3.15	11	0.95	5.80	3.15
12	3.07	0.45	1.45	12	3.07	0.45	1.45

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	15.20	8.12	6.68
3	10.82	12.85	10.13
4	10.21	14.41	18.53
5	6.07	13.11	21.41
6	0.66	7.03	9.43
7	1.10	5.74	7.92
8	-3.83	-2.02	0.55
9	3.05	3.71	3.26
10	4.47	3.09	6.60
11	0.95	5.80	3.15
12	3.07	0.45	1.45

The best return for General Electric appears to be the zero thresholds, four years of training data, and a five-length snake (0T, 4L, 5S). Expected yearly return would be 21.41%.

General Electric performs better using the volume change for the snake pattern.

The chart comparing the model's return to the return of the strategies is given below.

Table 5.22 – Percent Returns for General Electric (0,4,5) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=4, Snake=5						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
92-93	19.45	23.23	7.32	12.25	13.46	19.45	23.23	7.32	12.25	13.46
93-94	-1.88	7.99	-1.00	-3.87	-3.52	17.20	33.07	6.25	7.91	9.47
94-95	0.88	21.30	5.41	12.24	13.66	18.23	61.42	12.00	21.12	24.42
95-96	26.24	42.68	31.65	21.63	22.90	49.26	130.31	47.45	47.31	52.91
96-97	52.47	39.57	42.43	16.19	17.66	127.57	221.46	110.01	71.17	79.91
97-98	39.59	57.32	37.43	21.25	23.00	217.67	405.71	188.62	107.54	121.29
98-99	41.34	38.38	15.25	23.01	26.11	348.98	599.81	232.62	155.28	179.08
99-00	32.76	49.26	9.51	34.02	36.59	496.05	944.49	264.24	242.13	281.18
00-01	16.73	-12.57	19.24	-3.68	-5.89	595.79	813.19	334.30	229.55	258.74
01-02	0.01	-32.57	-26.37	-22.56	-22.63	595.88	515.75	219.76	155.22	177.55

For the General Electric security, the model built on volume change out performs all of the standard scenarios. The graph of the cumulative General Electric data is as follows.

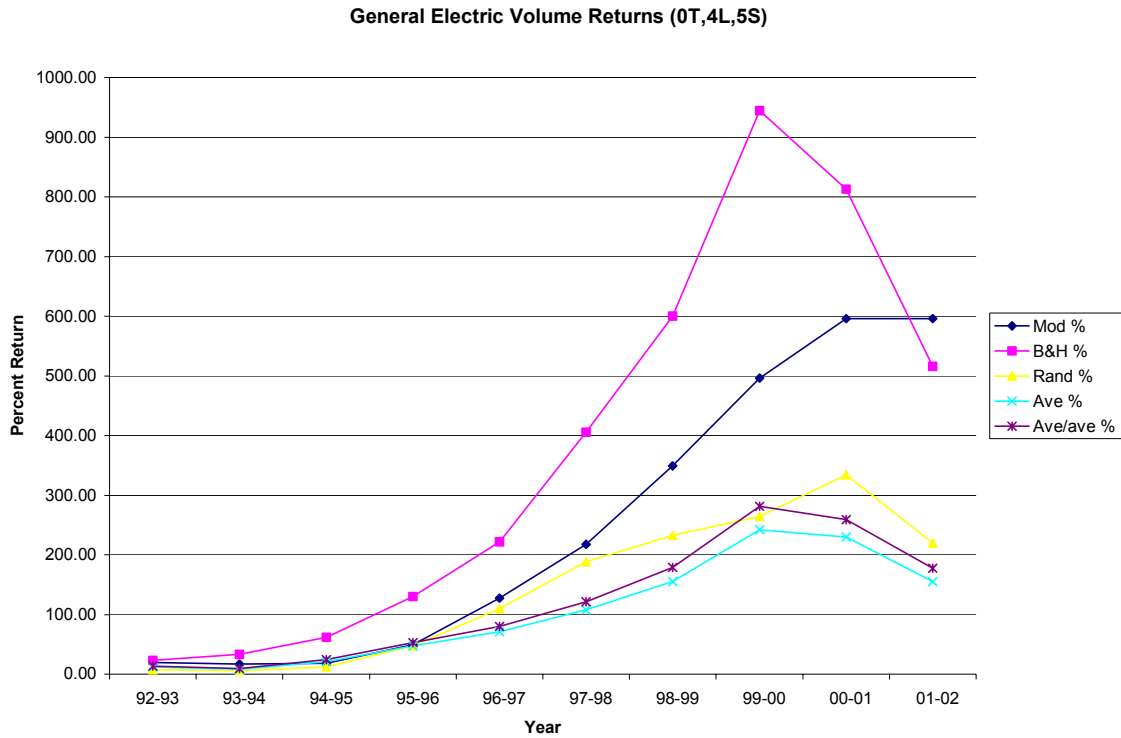


Figure 5.32 – General Electric Returns for 0 Thresh, 4 Year Training & 5 Snake Length For Volume Change & Other Strategies

5.3.12 AOL Time Warner

AOL Time Warner is examined for volume change snakes. The high level summaries of yearly returns based on volume snakes for AOL Time Warner are as follows.

Tables 5.23 – Percent Returns for AOL Time Warner with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	15.96	20.51	9.89	2	15.96	20.51	9.89
3	3.31	14.21	14.19	3	3.31	14.21	14.19
4	29.00	24.81	40.81	4	29.00	24.81	40.81
5	17.06	11.98	24.54	5	17.06	11.98	24.54
6	4.48	12.25	14.09	6	4.48	12.25	14.09
7	14.87	5.24	7.37	7	14.87	5.24	7.37
8	8.20	2.41	4.53	8	8.20	2.41	4.53
9	15.42	1.53	-1.67	9	15.42	1.53	-1.67
10	34.61	5.78	-6.81	10	34.61	5.78	-6.81
11	21.31	14.09	13.28	11	21.31	14.09	13.28
12	45.59	14.63	12.49	12	45.59	14.63	12.49

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	15.96	20.51	9.89
3	3.31	14.21	14.19
4	29.00	24.81	40.81
5	17.06	11.98	24.54
6	4.48	12.25	14.09
7	14.87	5.24	7.37
8	8.20	2.41	4.53
9	15.42	1.53	-1.67
10	34.61	5.78	-6.81
11	21.31	14.09	13.28
12	45.59	14.63	12.49

The best return for AOL Time Warner appears to be the zero thresholds, two years of training data, and a twelve-length snake (0T, 2L, 12S). Expected yearly return would be 45.59%.

AOL Time Warner performs better using the price change for the snake pattern.

The chart comparing the model's return to the return of the strategies is given below.

Table 5.24 – Percent Returns for AOL Time Warner (0,2,12) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=2, Snake=12						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
94-95	170.47	163.64	52.46	81.32	86.13	170.47	163.64	52.46	81.32	86.13
95-96	116.45	184.83	64.08	96.51	102.91	485.41	650.91	150.16	256.32	277.68
96-97	-26.63	-35.35	4.84	13.78	13.76	329.52	385.46	162.28	305.42	329.64
97-98	22.25	241.20	86.23	92.05	96.99	425.08	1556.37	388.43	678.61	746.34
98-99	247.64	739.74	237.27	340.91	378.51	1725.35	13809.14	1547.30	3332.94	3949.86
99-00	-23.44	-20.26	17.09	0.35	1.22	1297.44	10991.01	1828.74	3344.81	3999.23
00-01	39.03	-18.85	-24.55	0.67	-3.24	1842.88	8900.13	1355.28	3367.82	3866.62
01-02	3.90	-60.83	-35.39	-44.37	-45.70	1918.72	3425.53	840.31	1829.22	2054.07

For the AOL Time Warner security, the model built on volume change outperformed all of the standard scenarios with the exception of the buy and hold strategy and one of the averaging techniques. The graph of the cumulative AOL Time Warner data is as follows.

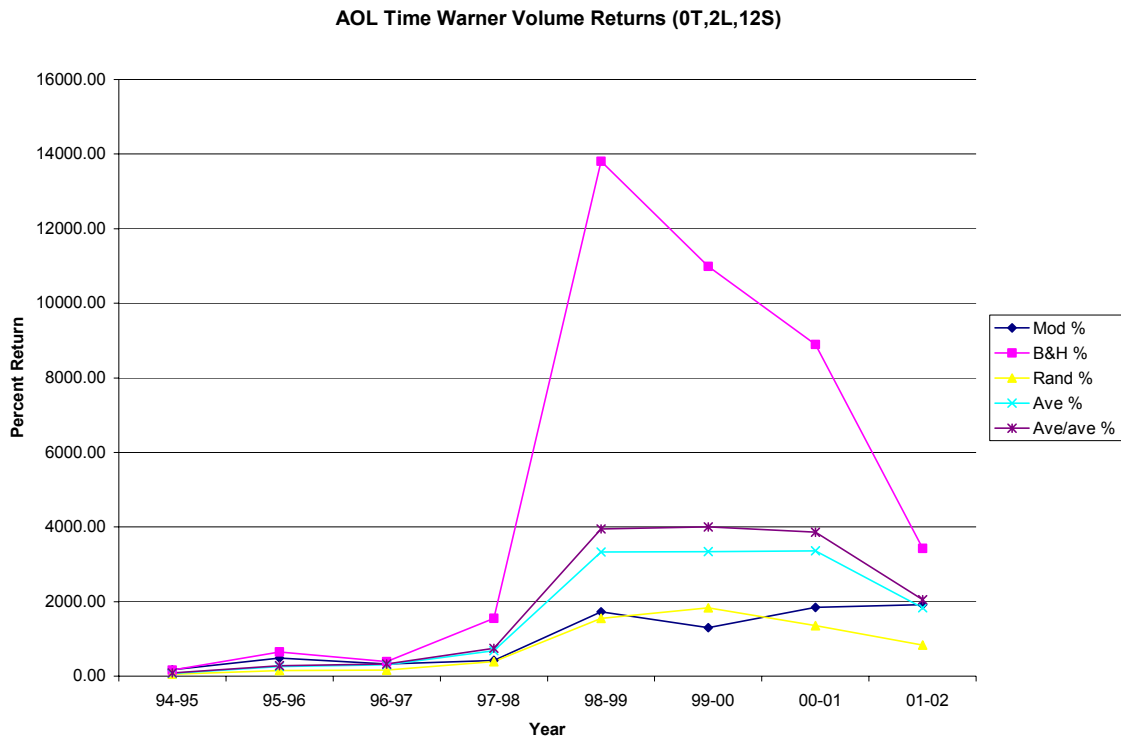


Figure 5.33 – AOL Time Warner Returns for 0 Thresh, 2 Year Training & 12 Snake Length For Volume Change & Other Strategies

5.3.13 Home Depot

Home Depot is examined for volume change snakes. The high level summaries of yearly returns based on volume snakes for Home Depot are as follows.

Tables 5.25 – Percent Returns for Home Depot with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	10.41	10.67	11.59	2	10.41	10.67	11.59
3	8.16	11.18	12.51	3	8.16	11.18	12.51
4	15.45	15.57	20.47	4	15.45	15.57	20.47
5	7.21	10.91	4.66	5	7.21	10.91	4.66
6	11.84	10.38	15.52	6	11.84	10.38	15.52
7	8.82	13.09	8.32	7	8.82	13.09	8.32
8	-1.78	1.44	7.68	8	-1.78	1.44	7.68
9	-4.67	-5.13	-0.68	9	-4.67	-5.13	-0.68
10	1.82	7.32	8.60	10	1.82	7.32	8.60
11	8.45	2.80	4.23	11	8.45	2.80	4.23
12	13.84	4.60	6.62	12	13.84	4.60	6.62

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	10.41	10.67	11.59
3	8.16	11.18	12.51
4	15.45	15.57	20.47
5	7.21	10.91	4.66
6	11.84	10.38	15.52
7	8.82	13.09	8.32
8	-1.78	1.44	7.68
9	-4.67	-5.13	-0.68
10	1.82	7.32	8.60
11	8.45	2.80	4.23
12	13.84	4.60	6.62

The best return for Home Depot appears to be the zero thresholds, four years of training data and, a four-length snake (0T, 4L, 4S). Expected yearly return would be 20.47%.

Home Depot performs better using the price change for the snake pattern.

The chart comparing the model's return to the return of the strategies is given below.

Table 5.26 – Percent Returns for Home Depot (0,4,4) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=4, Snake=4						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
92-93	19.80	36.63	9.86	2.21	3.89	19.80	36.63	9.86	2.21	3.89
93-94	16.57	-0.87	-9.29	0.18	-0.21	39.65	35.45	-0.35	2.40	3.67
94-95	-3.75	-2.40	-8.56	-8.28	-8.40	34.42	32.20	-8.87	-6.08	-5.03
95-96	30.39	12.51	-17.51	6.00	6.26	75.26	48.74	-24.83	-0.44	0.91
96-97	-5.17	25.32	1.42	8.38	8.89	66.20	86.41	-23.76	7.90	9.88
97-98	41.43	82.81	38.74	35.04	38.97	135.06	240.77	5.78	45.71	52.70
98-99	19.42	77.94	53.94	34.69	39.59	180.71	506.35	62.83	96.25	113.15
99-00	56.77	41.29	21.95	22.18	24.28	340.07	756.72	98.57	139.78	164.90
00-01	49.22	-20.88	-40.83	0.48	-4.33	556.67	577.85	17.50	140.94	153.43
01-02	-1.92	1.13	25.40	0.08	0.34	544.08	585.53	47.34	141.14	154.30

For the Home Depot security, the model built on volume change outperforms all of the standard scenarios with the exception of the buy and hold strategy. The graph of the cumulative Home Depot data is as follows.

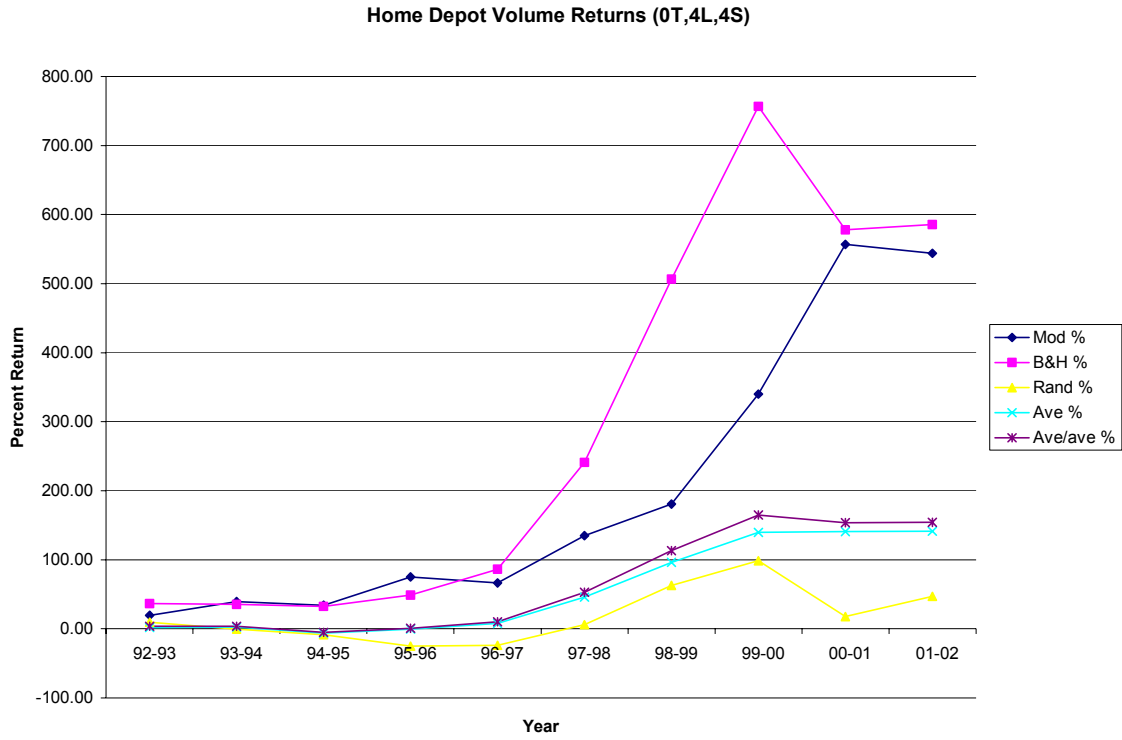


Figure 5.34 – Home Depot Returns for 0 Thresh, 4 Year Training & 4 Snake Length For Volume Change & Other Strategies

5.3.14 IBM

IBM is examined for volume change snakes. The high level summaries of yearly returns based on volume snakes for IBM are as follows.

Tables 5.27 – Percent Returns for IBM with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	6.52	11.49	5.93	2	6.52	11.49	5.93
3	-0.38	-3.24	-0.89	3	-0.38	-3.24	-0.89
4	5.69	8.38	11.49	4	5.69	8.38	11.49
5	2.83	3.89	10.26	5	2.83	3.89	10.26
6	4.42	-0.09	7.51	6	4.42	-0.09	7.51
7	6.10	4.66	4.24	7	6.10	4.66	4.24
8	10.15	14.77	17.99	8	10.15	14.77	17.99
9	16.54	20.45	18.74	9	16.54	20.45	18.74
10	12.91	8.31	2.33	10	12.91	8.31	2.33
11	6.08	7.78	3.67	11	6.08	7.78	3.67
12	0.07	3.83	6.73	12	0.07	3.83	6.73

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	6.52	11.49	5.93
3	-0.38	-3.24	-0.89
4	5.69	8.38	11.49
5	2.83	3.89	10.26
6	4.42	-0.09	7.51
7	6.10	4.66	4.24
8	10.15	14.77	17.99
9	16.54	20.45	18.74
10	12.91	8.31	2.33
11	6.08	7.78	3.67
12	0.07	3.83	6.73

The best return for IBM appears to be the zero thresholds, three years of training data and a nine-length snake (0T, 3L, 9S). Expected yearly return would be 20.45%.

IBM results were almost equal for the price and the volume model examination.

The chart comparing the model's return to the return of the strategies is given below.

Table 5.28 – Percent Returns for IBM (0,3,9) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=3, Snake=9						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
91-92	-13.48	-12.54	2.22	-5.04	-6.50	-13.48	-12.54	2.22	-5.04	-6.50
92-93	-24.32	-46.33	-31.06	-29.63	-30.83	-34.52	-53.06	-29.52	-33.18	-35.33
93-94	-12.68	18.22	16.58	14.94	14.82	-42.83	-44.50	-17.84	-23.19	-25.74
94-95	35.61	64.58	25.36	37.44	39.92	-22.47	-8.67	3.00	5.56	3.90
95-96	15.13	13.90	33.26	6.80	8.63	-10.73	4.02	37.25	12.74	12.87
96-97	31.06	39.88	24.55	20.61	21.89	16.99	45.51	70.95	35.98	37.57
97-98	91.62	53.01	51.10	17.88	21.08	124.18	122.64	158.31	60.29	66.57
98-99	102.18	83.84	35.37	49.58	54.28	353.24	309.29	249.67	139.76	156.98
99-00	43.72	6.14	57.24	-1.31	0.46	551.41	334.41	449.84	136.61	158.15
00-01	28.34	2.09	9.88	9.61	6.93	735.99	343.50	504.14	159.34	176.04
01-02	-7.40	-26.61	-20.01	-21.57	-21.90	674.14	225.51	383.28	103.40	115.58

For the IBM security, the model built on volume change outperforms all of the standard scenarios. The graph of the cumulative IBM data is as follows.

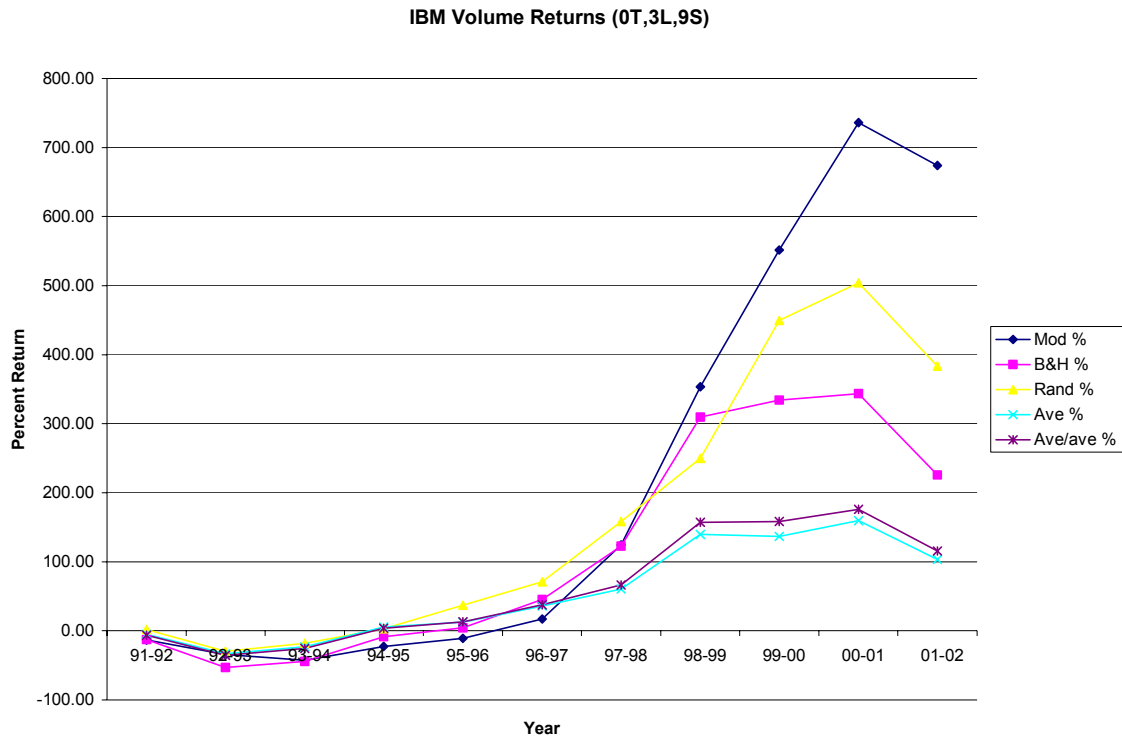


Figure 5.35 – IBM Returns for 0 Thresh, 3 Year Training & 9 Snake Length For Volume Change & Other Strategies

5.3.15 Cisco

Cisco is examined for volume change snakes. The high level summaries of yearly returns based on volume snakes for Cisco are as follows.

Tables 5.29 – Percent Returns for Cisco with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	28.82	7.96	10.08	2	28.82	7.96	10.08
3	21.93	17.98	16.23	3	21.93	17.98	16.23
4	30.68	30.85	23.80	4	30.68	30.85	23.80
5	34.25	40.03	27.38	5	34.25	40.03	27.38
6	32.21	20.09	30.94	6	32.21	20.09	30.94
7	26.64	25.00	26.19	7	26.64	25.00	26.19
8	15.24	10.51	11.22	8	15.24	10.51	11.22
9	5.89	2.17	10.23	9	5.89	2.17	10.23
10	16.88	10.65	12.55	10	16.88	10.65	12.55
11	8.36	1.41	11.14	11	8.36	1.41	11.14
12	28.78	13.29	17.38	12	28.78	13.29	17.38

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	28.82	7.96	10.08
3	21.93	17.98	16.23
4	30.68	30.85	23.80
5	34.25	40.03	27.38
6	32.21	20.09	30.94
7	26.64	25.00	26.19
8	15.24	10.51	11.22
9	5.89	2.17	10.23
10	16.88	10.65	12.55
11	8.36	1.41	11.14
12	28.78	13.29	17.38

The best return for Cisco appears to be the zero thresholds, three years of training data, and a five-length snake (0T, 3L, 5S). Expected yearly return would be 40.03%.

Cisco performs better using the volume change for the snake pattern.

The chart comparing the model's return to the return of the strategies is given below.

Table 5.30 – Percent Returns for Cisco (0,3,5) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=3, Snake=5						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
94-95	10.84	32.14	-24.09	30.24	31.55	10.84	32.14	-24.09	30.24	31.55
95-96	62.04	162.16	80.56	56.84	60.04	79.60	246.43	37.06	104.28	110.54
96-97	-11.43	-11.51	-22.28	-21.34	-21.16	59.08	206.55	6.53	60.69	66.00
97-98	33.98	127.96	6.63	35.92	38.13	113.14	598.81	13.58	118.42	129.29
98-99	96.59	144.97	63.89	63.95	72.68	319.00	1611.90	86.16	258.08	295.94
99-00	69.59	129.49	80.83	70.45	76.63	610.57	3828.56	236.62	510.35	599.32
00-01	-14.19	-76.17	-67.93	-63.90	-66.63	509.76	836.29	7.95	120.33	133.39
01-02	142.43	-12.91	-27.33	-20.06	-22.45	1378.27	715.46	-21.55	76.13	81.00

For the Cisco security, the model built on volume change outperforms all of the standard scenarios. The graph of the cumulative Cisco data is as follows.

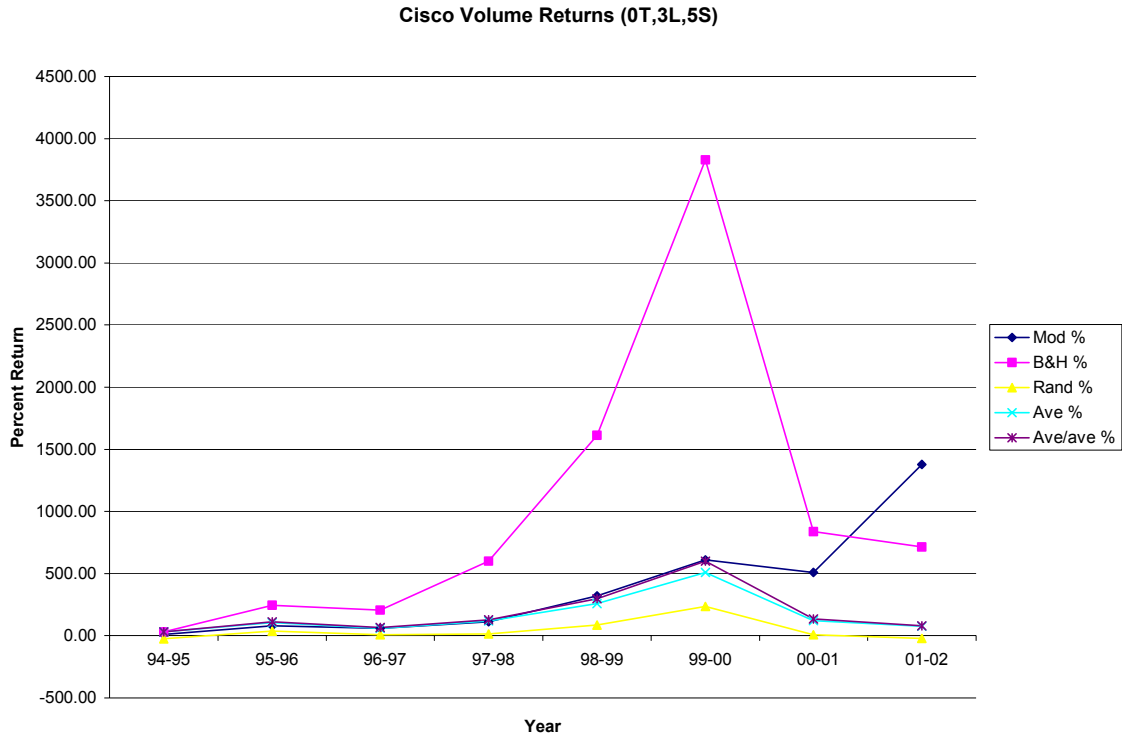


Figure 5.36 – Cisco Returns for 0 Thresh, 3 Year Training & 5 Snake Length For Volume Change & Other Strategies

5.3.16 Johnson & Johnson

Johnson & Johnson is examined for volume change snakes. The high level summaries of yearly returns based on volume snakes for Johnson & Johnson are as follows.

Tables 5.31 – Percent Returns for Johnson & Johnson with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	7.25	7.95	9.76	2	7.25	7.95	9.76
3	12.58	13.48	10.19	3	12.58	13.48	10.19
4	9.20	12.20	9.00	4	9.20	12.20	9.00
5	4.44	12.00	15.93	5	4.44	12.00	15.93
6	6.27	12.22	15.23	6	6.27	12.22	15.23
7	5.01	10.30	11.25	7	5.01	10.30	11.25
8	8.44	2.64	4.29	8	8.44	2.64	4.29
9	3.92	6.43	5.18	9	3.92	6.43	5.18
10	0.93	1.16	2.94	10	0.93	1.16	2.94
11	5.55	5.46	7.26	11	5.55	5.46	7.26
12	7.13	10.27	6.84	12	7.13	10.27	6.84

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	7.25	7.95	9.76
3	12.58	13.48	10.19
4	9.20	12.20	9.00
5	4.44	12.00	15.93
6	6.27	12.22	15.23
7	5.01	10.30	11.25
8	8.44	2.64	4.29
9	3.92	6.43	5.18
10	0.93	1.16	2.94
11	5.55	5.46	7.26
12	7.13	10.27	6.84

The best return for Johnson & Johnson appears to be the zero thresholds, four years of training data, and a five-length snake (0T, 4L, 5S). Expected yearly return would be 15.93%.

Johnson & Johnson performs better using the price change for the snake pattern.

The chart comparing the model's return to the return of the strategies is given below.

Table 5.32 – Percent Returns for Johnson & Johnson (0,4,5) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=4, Snake=5						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
93-94	-0.94	-8.05	-9.06	-9.24	-9.81	-0.94	-8.05	-9.06	-9.24	-9.81
94-95	-4.11	-3.17	-7.48	-2.41	-2.69	-5.01	-10.97	-15.86	-11.42	-12.23
95-96	44.50	63.16	44.86	28.18	30.68	37.26	45.27	21.89	13.54	14.70
96-97	32.16	42.38	22.05	16.32	19.16	81.41	106.84	48.76	32.07	36.68
97-98	20.76	31.13	-5.95	13.69	14.92	119.07	171.23	39.91	50.15	57.07
98-99	13.28	23.96	21.66	12.16	14.38	148.17	236.22	70.21	68.41	79.66
99-00	55.50	45.39	32.31	30.05	31.18	285.89	388.83	125.19	119.03	135.68
00-01	-21.47	-18.79	-17.04	-11.89	-11.24	203.05	296.98	86.81	92.98	109.19
01-02	17.33	14.14	7.79	0.75	0.85	255.58	353.12	101.37	94.42	110.96

For the Johnson & Johnson security, the model built on volume change outperforms all of the standard scenarios with the exception of buy and hold. The graph of the cumulative Johnson & Johnson data is as follows.

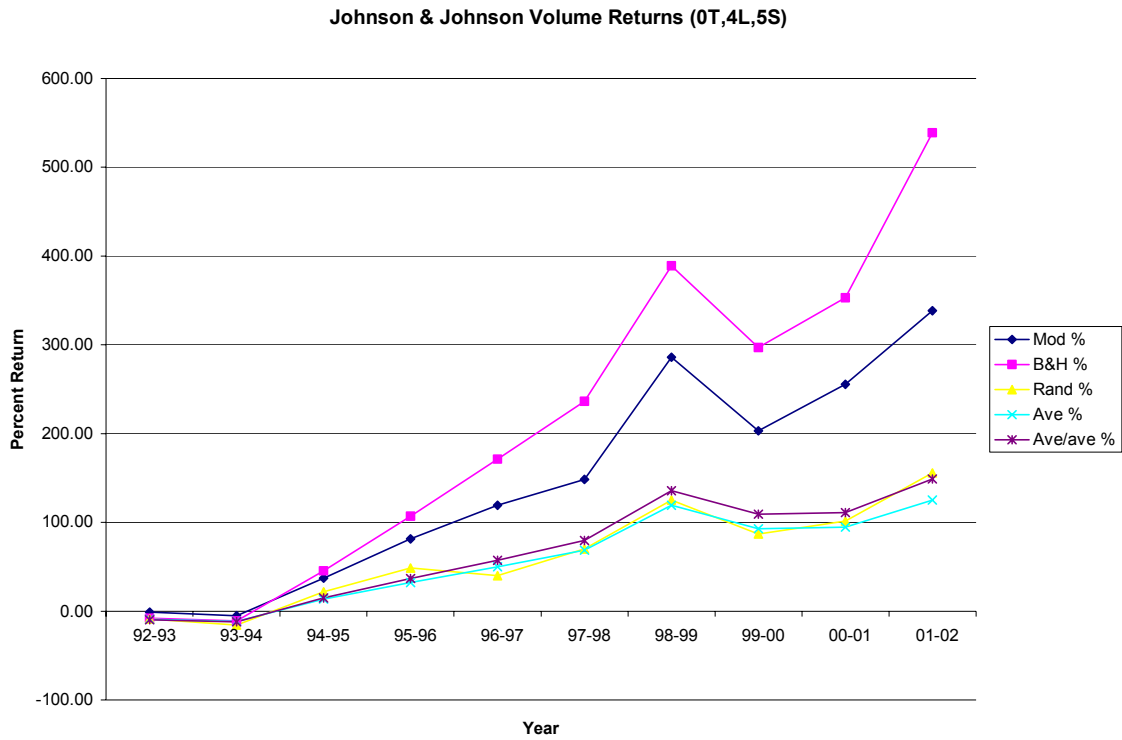


Figure 5.37 – Johnson & Johnson Returns for 0 Thresh, 4 Year Training & 5 Snake Length For Volume Change & Other Strategies

5.3.17 Coca Cola

Coca Cola is examined for volume change snakes. The high level summaries of yearly returns based on volume snakes for Coca Cola are as follows.

Tables 5.33 – Percent Returns for Coca Cola with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	10.18	7.96	11.87	2	10.18	7.96	11.87
3	11.73	9.47	11.56	3	11.73	9.47	11.56
4	10.38	12.87	10.39	4	10.38	12.87	10.39
5	3.42	7.16	7.90	5	3.42	7.16	7.90
6	4.93	8.63	7.74	6	4.93	8.63	7.74
7	6.17	10.83	5.46	7	6.17	10.83	5.46
8	4.52	8.92	7.46	8	4.52	8.92	7.46
9	8.25	5.97	1.12	9	8.25	5.97	1.12
10	7.17	11.30	9.82	10	7.17	11.30	9.82
11	10.92	14.73	11.45	11	10.92	14.73	11.45
12	14.27	18.62	14.19	12	14.27	18.62	14.19

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	10.18	7.96	11.87
3	11.73	9.47	11.56
4	10.38	12.87	10.39
5	3.42	7.16	7.90
6	4.93	8.63	7.74
7	6.17	10.83	5.46
8	4.52	8.92	7.46
9	8.25	5.97	1.12
10	7.17	11.30	9.82
11	10.92	14.73	11.45
12	14.27	18.62	14.19

The best return for Coca Cola appears to be the zero thresholds, three years of training data and a twelve-length snake (0T, 3L, 12S). Expected yearly return would be 18.62%.

Coca Cola performed about the same with volume change and price change for the snake pattern.

The chart comparing the model's return to the return of the strategies is given below.

Table 5.34 – Percent Returns for Coca Cola (0,3,12) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=3, Snake=12						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
91-92	16.08	52.61	6.94	24.01	27.52	16.08	52.61	6.94	24.01	27.52
92-93	7.76	-3.63	-11.95	-5.94	-5.24	25.09	47.06	-5.84	16.64	20.84
93-94	11.70	7.83	-4.26	-1.06	-0.20	39.73	58.57	-9.85	15.40	20.60
94-95	32.23	41.55	-3.19	21.86	24.65	84.76	124.45	-12.73	40.63	50.33
95-96	18.20	41.63	15.00	17.41	19.14	118.40	217.90	0.36	65.12	79.11
96-97	39.63	46.97	9.15	16.75	19.04	204.94	367.23	9.55	92.78	113.20
97-98	37.61	23.49	0.91	12.31	13.32	319.63	476.97	10.55	116.51	141.60
98-99	4.04	-3.20	-8.56	-1.72	-1.71	336.58	458.49	1.09	112.78	137.48
99-00	13.50	-26.44	4.22	-13.88	-13.55	395.53	310.84	5.36	83.25	105.30
00-01	1.63	-3.31	-7.33	-10.76	-11.92	403.60	297.22	-2.37	63.53	80.82

For the Coca Cola security, the model built on volume change outperforms all of the standard scenarios. The graph of the cumulative Coca Cola data is as follows.

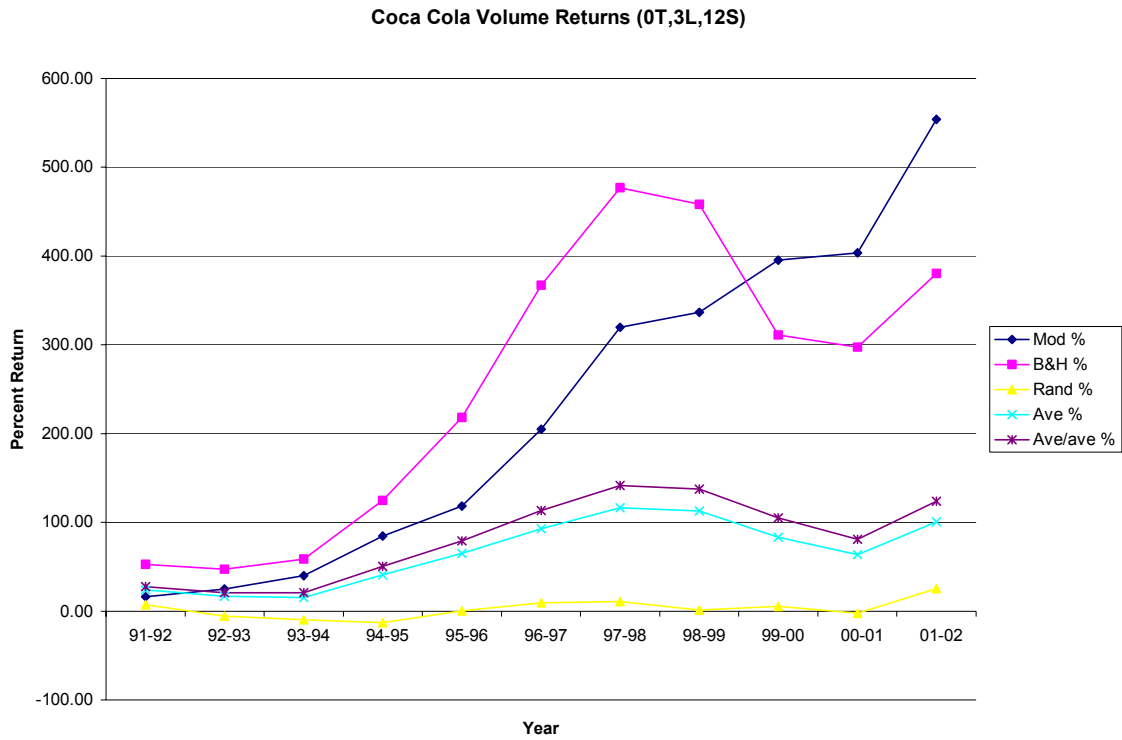


Figure 5.38 – Coca Cola Returns for 0 Thresh, 3 Year Training & 12 Snake Length For Volume Change & Other Strategies

5.3.18 JP Morgan Chase

JP Morgan Chase is examined for volume change snakes. The high level summaries of yearly returns based on volume snakes for JP Morgan Chase are as follows.

Tables 5.35 – Percent Returns for JP Morgan Chase with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	4.49	1.29	14.23	2	4.49	1.29	14.23
3	2.35	2.78	5.03	3	2.35	2.78	5.03
4	8.25	7.43	8.81	4	8.25	7.43	8.81
5	2.08	3.57	5.53	5	2.08	3.57	5.53
6	7.43	4.54	6.83	6	7.43	4.54	6.83
7	1.76	2.52	-0.72	7	1.76	2.52	-0.72
8	7.23	10.80	9.78	8	7.23	10.80	9.78
9	2.96	1.88	5.99	9	2.96	1.88	5.99
10	10.44	2.14	3.06	10	10.44	2.14	3.06
11	17.99	12.07	6.79	11	17.99	12.07	6.79
12	18.98	14.79	9.63	12	18.98	14.79	9.63

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	4.49	1.29	14.23
3	2.35	2.78	5.03
4	8.25	7.43	8.81
5	2.08	3.57	5.53
6	7.43	4.54	6.83
7	1.76	2.52	-0.72
8	7.23	10.80	9.78
9	2.96	1.88	5.99
10	10.44	2.14	3.06
11	17.99	12.07	6.79
12	18.98	14.79	9.63

The best return for JP Morgan Chase appears to be the zero thresholds, two years of training data and a twelve-length snake (0T, 2L, 12S). Expected yearly return would be 18.98%.

JP Morgan Chase performs better using the price change for the snake pattern.

The chart comparing the model's return to the return of the strategies is given below.

Table 5.36 – Percent Returns for JP Morgan Chase (0,2,12) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=2, Snake=12						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
90-91	73.21	-5.38	-29.65	27.78	22.01	73.21	-5.38	-29.65	27.78	22.01
91-92	98.69	82.11	78.65	43.48	46.12	244.14	72.31	25.67	83.33	78.28
92-93	11.15	11.45	-7.60	5.44	6.82	282.51	92.03	16.13	93.30	90.43
93-94	1.93	-3.94	-15.69	-9.09	-9.40	289.88	84.46	-2.09	75.72	72.53
94-95	3.50	23.54	-7.52	14.14	13.58	303.54	127.89	-9.46	100.56	95.97
95-96	32.39	63.81	12.17	21.21	24.16	434.24	273.31	1.56	143.09	143.32
96-97	12.32	32.44	22.12	7.35	9.11	500.03	394.42	24.03	160.97	165.48
97-98	10.28	62.37	41.14	27.07	27.84	561.70	702.79	75.06	231.62	239.38
98-99	43.31	27.72	40.55	30.27	32.84	848.26	925.30	146.04	331.99	350.83
99-00	-3.02	-7.25	21.46	-1.90	-1.23	819.67	850.99	198.84	323.77	345.26
00-01	-2.68	-5.49	10.39	4.87	0.18	794.99	798.80	229.87	344.43	346.05
01-02	-10.08	-22.16	31.89	-4.91	-6.21	704.74	599.60	335.06	322.62	318.34

For the JP Morgan Chase security, the model built on volume change outperforms all of the standard scenarios. The graph of the cumulative JP Morgan Chase data is as follows.

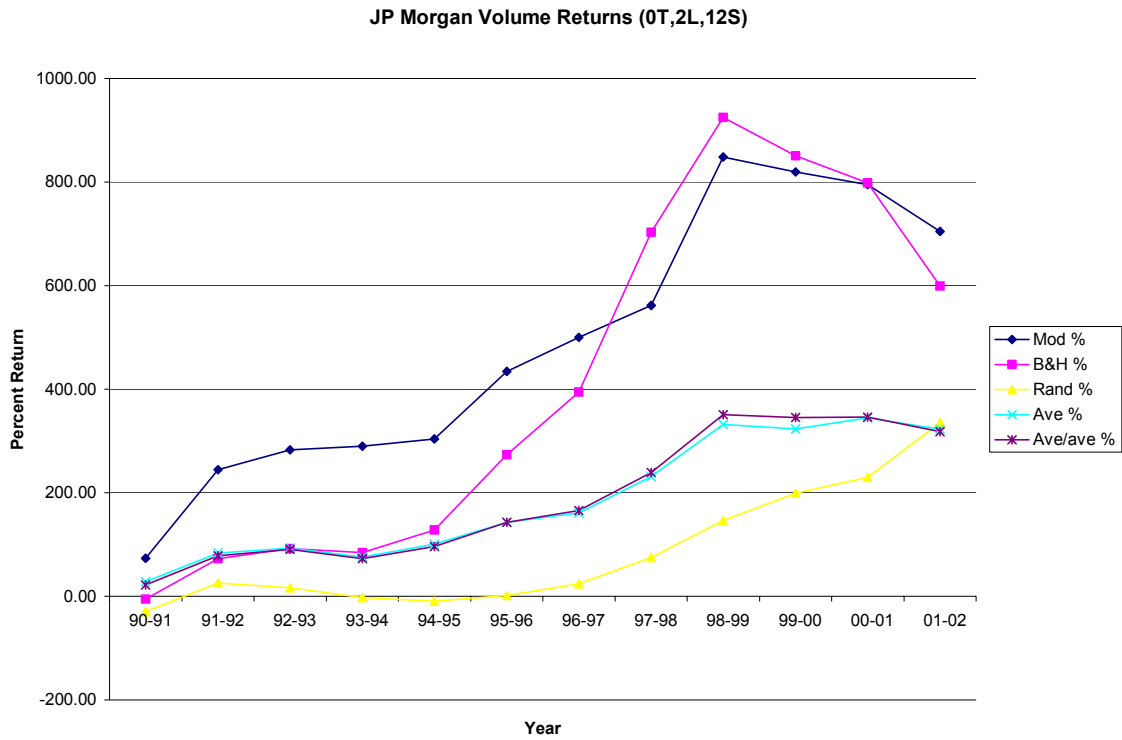


Figure 5.39 – JP Morgan Chase Returns for 0 Thresh, 2 Year Training & 12 Snake Length For Volume Change & Other Strategies

5.3.19 SBC

SBC is examined for volume change snakes. The high level summaries of yearly returns based on volume snakes for SBC are as follows.

Tables 5.37 – Percent Returns for SBC with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	1.15	3.62	5.17	2	1.15	3.62	5.17
3	2.96	7.91	0.46	3	2.96	7.91	0.46
4	7.53	5.35	6.57	4	7.53	5.35	6.57
5	1.37	0.65	-1.07	5	1.37	0.65	-1.07
6	5.37	0.29	0.44	6	5.37	0.29	0.44
7	-4.75	-5.02	-3.90	7	-4.75	-5.02	-3.90
8	-4.82	-3.55	-3.92	8	-4.82	-3.55	-3.92
9	-1.57	-2.73	-1.62	9	-1.57	-2.73	-1.62
10	2.30	-0.51	-3.19	10	2.30	-0.51	-3.19
11	5.11	3.48	1.67	11	5.11	3.48	1.67
12	6.89	3.52	0.79	12	6.89	3.52	0.79

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	1.15	3.62	5.17
3	2.96	7.91	0.46
4	7.53	5.35	6.57
5	1.37	0.65	-1.07
6	5.37	0.29	0.44
7	-4.75	-5.02	-3.90
8	-4.82	-3.55	-3.92
9	-1.57	-2.73	-1.62
10	2.30	-0.51	-3.19
11	5.11	3.48	1.67
12	6.89	3.52	0.79

The best return for SBC appears to be the zero thresholds, three years of training data, and a three-length snake (0T, 3L, 3S). Expected yearly return would be 7.91%.

SBC performs better using the price change for the snake pattern.

The chart comparing the model's return to the return of the strategies is given below.

Table 5.38 – Percent Returns for SBC (0,3,3) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=3, Snake=3						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
91-92	36.87	23.28	1.68	12.03	13.45	36.87	23.28	1.68	12.03	13.45
92-93	45.97	29.24	6.81	16.11	17.64	99.79	59.33	8.60	30.07	33.46
93-94	-5.77	11.52	8.69	2.76	4.35	88.27	77.68	18.04	33.67	39.27
94-95	6.96	10.45	4.70	6.96	8.09	101.38	96.24	23.59	42.97	50.53
95-96	-0.48	16.73	8.48	-0.92	-0.11	100.42	129.08	34.07	41.66	50.36
96-97	34.52	7.59	-2.36	3.95	4.67	169.61	146.46	30.91	47.26	57.37
97-98	25.83	58.51	27.48	26.17	27.94	239.24	290.66	66.88	85.79	101.35
98-99	28.96	40.21	-4.38	25.28	25.21	337.48	447.75	59.58	132.76	152.10
99-00	-36.29	-16.71	-7.80	-4.63	-7.92	178.74	356.22	47.13	122.00	132.13
00-01	7.75	-7.29	11.33	-11.03	-11.85	200.34	322.96	63.80	97.50	104.63
01-02	-23.07	-17.88	4.74	-17.39	-18.21	131.04	247.32	71.57	63.15	67.37

For the SBC security, the model built on volume change outperforms all of the standard scenarios with the exception of the buy and hold strategy. The graph of the cumulative SBC data is as follows.

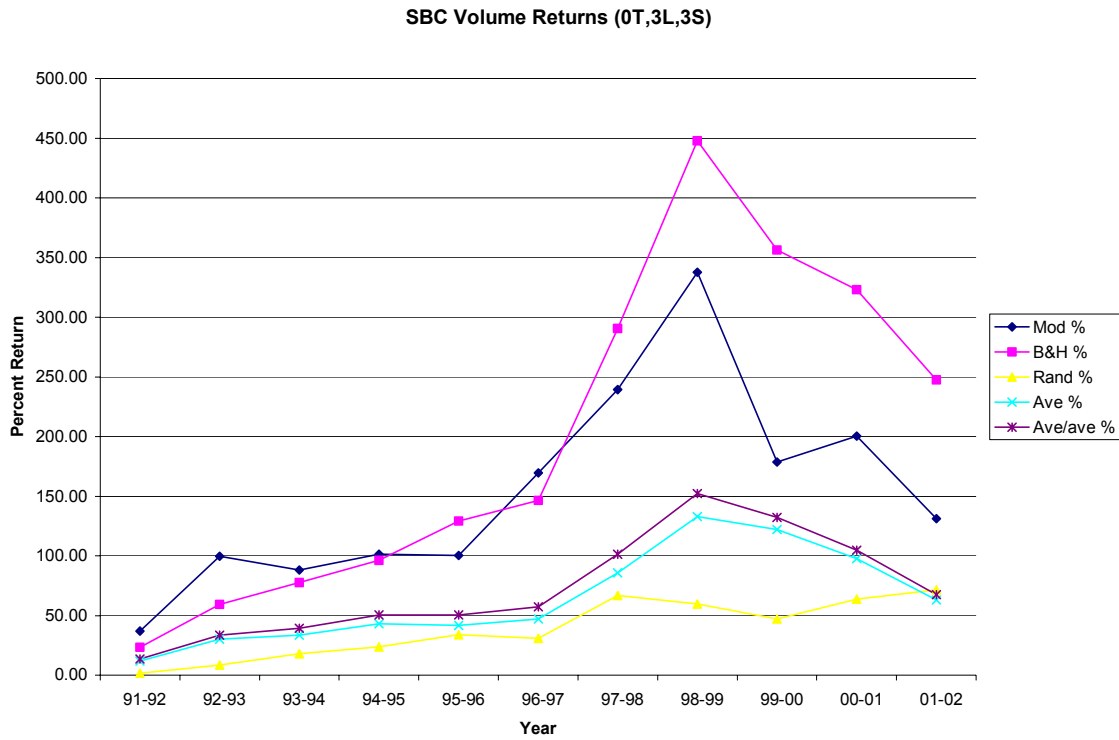


Figure 5.40 – SBC Returns for 0 Thresh, 3 Year Training & 3 Snake Length For Volume Change & Other Strategies

5.3.20 Exxon Mobil

Exxon Mobil is examined for volume change snakes. The high level summaries of yearly returns based on volume snakes for Exxon Mobil are as follows.

Tables 5.39 – Percent Returns for Exxon Mobil with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	9.02	4.93	1.85	2	9.02	4.93	1.85
3	1.85	2.03	3.99	3	1.85	2.03	3.99
4	-1.05	-3.22	-0.03	4	-1.05	-3.22	-0.03
5	5.24	0.29	3.45	5	5.24	0.29	3.45
6	5.35	1.89	0.52	6	5.35	1.89	0.52
7	7.19	3.70	2.05	7	7.19	3.70	2.05
8	4.90	4.48	0.18	8	4.90	4.48	0.18
9	4.84	0.88	-0.48	9	4.84	0.88	-0.48
10	3.43	-0.73	1.53	10	3.43	-0.73	1.53
11	1.02	-1.47	3.01	11	1.02	-1.47	3.01
12	3.05	1.74	5.14	12	3.05	1.74	5.14

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	9.02	4.93	1.85
3	1.85	2.03	3.99
4	-1.05	-3.22	-0.03
5	5.24	0.29	3.45
6	5.35	1.89	0.52
7	7.19	3.70	2.05
8	4.90	4.48	0.18
9	4.84	0.88	-0.48
10	3.43	-0.73	1.53
11	1.02	-1.47	3.01
12	3.05	1.74	5.14

The best return for Exxon Mobil appears to be the zero thresholds, two years of training data and a two-length snake (0T, 2L, 2S). Expected yearly return would be 9.02%.

Exxon Mobil performs much better using the price change for the snake pattern.

The chart comparing the model's return to the return of the strategies is given below.

Table 5.40 – Percent Returns for Exxon Mobil (0,2,2) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=2, Snake=2						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
90-91	11.29	27.45	16.58	16.20	17.06	11.29	27.45	16.58	16.20	17.06
91-92	0.91	0.00	-2.72	0.83	0.60	12.29	27.45	13.40	17.17	17.76
92-93	2.99	11.41	-5.24	5.25	6.38	15.65	42.00	7.46	23.31	25.27
93-94	-2.02	-4.73	3.40	-3.89	-3.82	13.32	35.28	11.11	18.51	20.49
94-95	0.50	10.56	0.50	13.04	13.75	13.88	49.57	11.66	33.97	37.06
95-96	22.82	21.35	1.25	11.93	12.65	39.87	81.50	13.06	49.96	54.40
96-97	34.60	25.08	9.77	15.58	16.99	88.26	127.02	24.11	73.31	80.63
97-98	22.92	40.83	32.56	20.39	21.18	131.42	219.71	64.51	108.64	118.88
98-99	0.38	5.30	-4.97	9.41	9.94	132.30	236.66	56.34	128.27	140.63
99-00	-0.50	3.53	-12.30	3.44	2.93	131.14	248.54	37.11	136.13	147.66
00-01	12.20	9.98	0.26	6.71	6.61	159.33	283.31	37.46	151.98	164.03
01-02	8.73	-8.64	-10.13	-1.63	-0.80	181.97	250.17	23.54	147.88	161.93

For the Exxon Mobil security, the model built on volume change outperforms all of the standard scenarios with the exception of buy and hold. The graph of the cumulative Exxon Mobil data is as follows.

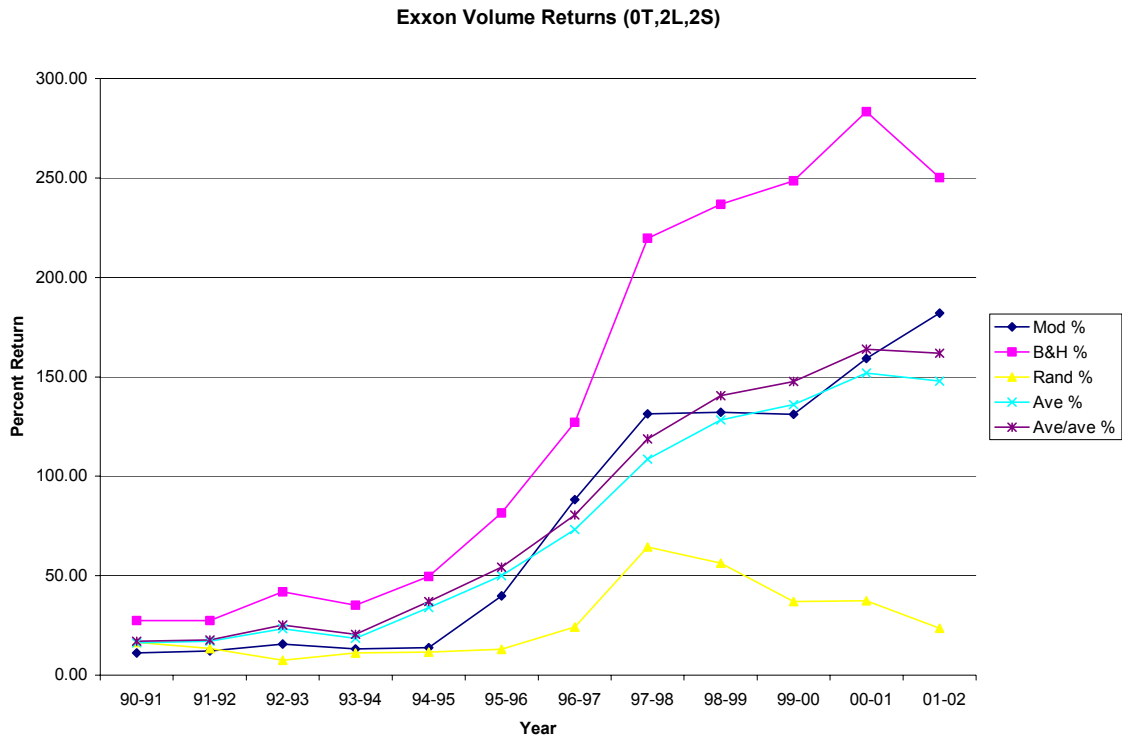


Figure 5.41 – Exxon Mobil Returns for 0 Thresh, 2 Year Training & 2 Snake Length For Volume Change & Other Strategies

5.3.21 Dow Jones Index

Dow Jones Index is examined for volume change snakes. The high level summaries of yearly returns based on volume snakes for Dow Jones Index are as follows.

Tables 5.41 – Percent Returns for Dow Jones Index with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Volume Change

Thresh=0	Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=				Snake Length=			
2	14.79	15.80	14.70	2	14.79	15.80	14.70
3	13.15	13.62	12.13	3	13.15	13.62	12.13
4	11.78	10.86	10.74	4	11.78	10.86	10.74
5	9.96	8.84	7.94	5	9.96	8.84	7.94
6	8.18	11.75	11.65	6	8.18	11.75	11.65
7	14.46	13.79	14.28	7	14.46	13.79	14.28
8	10.39	10.72	8.68	8	10.39	10.72	8.68
9	11.80	10.29	9.82	9	11.80	10.29	9.82
10	11.51	9.31	11.69	10	11.51	9.31	11.69
11	9.86	9.35	10.56	11	9.86	9.35	10.56
12	9.02	9.37	9.57	12	9.02	9.37	9.57

Thresh=6	Yr Ave 2	Yr Ave 3	Yr Ave 4
Snake Length=			
2	14.79	15.80	14.70
3	13.15	13.62	12.13
4	11.78	10.86	10.74
5	9.96	8.84	7.94
6	8.18	11.75	11.65
7	14.46	13.79	14.28
8	10.39	10.72	8.68
9	11.80	10.29	9.82
10	11.51	9.31	11.69
11	9.86	9.35	10.56
12	9.02	9.37	9.57

The best return for Dow Jones Index appears to be the zero thresholds, three years of training data and a two-length snake (0T, 3L, 2S). Expected yearly return would be 15.80%.

Dow Jones Index performs about the same with the price and the volume snake patterns.

The chart comparing the model's return to the return of the strategies is given below.

Table 5.42 – Percent Returns for Dow Jones Index (0,3,2) Using Volume & Other Strategies

Volume Change										
Values for Thresh = 0, Years=3, Snake=2						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
91-92	16.43	13.52	14.57	8.95	9.96	16.43	13.52	14.57	8.95	9.96
92-93	7.06	2.74	9.94	3.02	3.68	24.65	16.63	25.95	12.24	14.01
93-94	11.83	7.41	11.52	1.09	1.34	39.40	25.27	40.46	13.46	15.53
94-95	20.01	17.37	13.81	12.76	13.55	67.30	47.04	59.86	27.95	31.18
95-96	28.31	28.85	16.30	14.94	15.84	114.65	89.46	85.91	47.06	51.96
96-97	19.95	21.03	10.32	10.89	11.92	157.48	129.30	105.11	63.08	70.08
97-98	43.35	32.33	24.83	14.38	15.38	269.10	203.43	156.03	86.53	96.23
98-99	28.81	21.46	-9.32	20.95	22.21	375.42	268.56	132.18	125.60	139.81
99-00	0.09	2.71	-4.14	3.33	3.59	375.86	278.53	122.57	133.12	148.42
00-01	1.91	-4.49	4.91	0.92	-0.28	384.96	261.53	133.50	135.27	147.72
01-02	3.54	-5.32	-8.58	0.11	0.01	402.15	242.29	113.46	135.52	147.74

For the Dow Jones Index security, the model built on volume change outperforms all of the standard scenarios. The graph of the cumulative Dow Jones Index data is as follows.

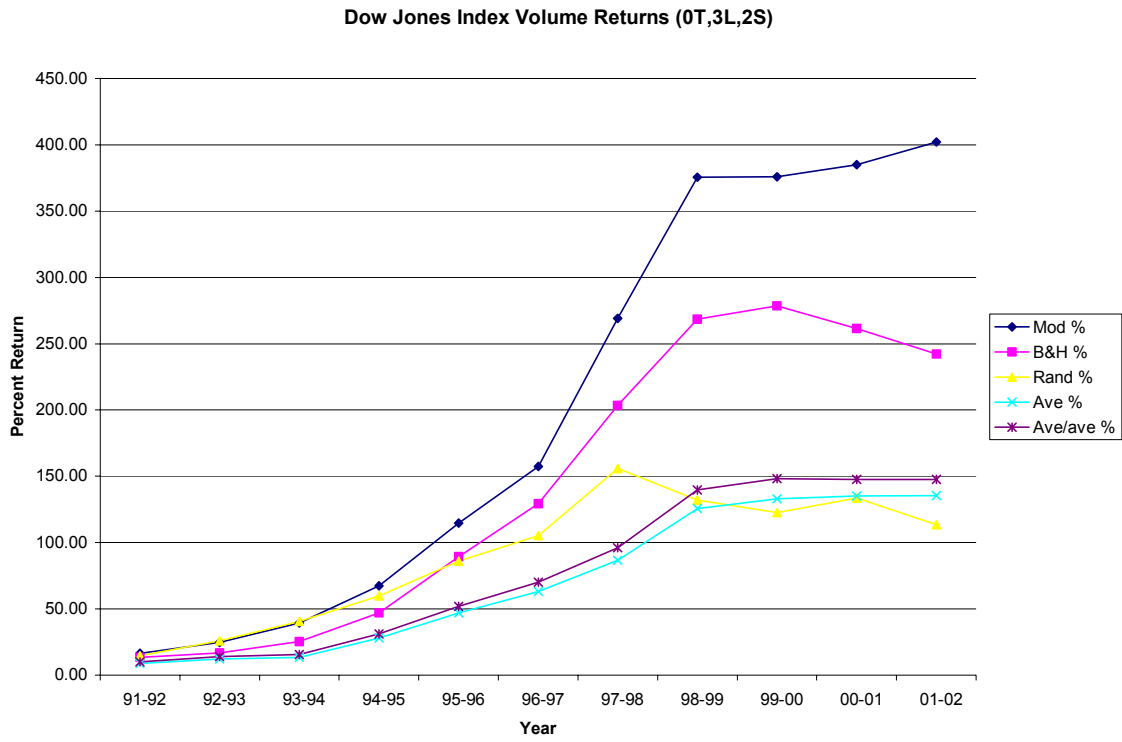


Figure 5.42 – Dow Jones Index Returns for 0 Thresh, 3 Year Training & 2 Snake Length For Volume Change & Other Strategies

5.4 Summary

The following table summarizes the returns for the first set of stocks using the volume change Markov model.

Table 5.43 – Percent Returns Using Volume Only Model

Best for Volume Only Snake				
	Yearly Return	Threshold	Years Train	Volume Snake Length
S&P	20.95	0	3	3
I2	13.75	0	3	14
Tesoro	10.32	0	4	14
Symbol	22.05	0	3	11
Duke Energy	8.95	0	4	7
Bristol Myers	7.75	0	3	2
Intel	16.16	0	2	7
Lucent	-3.31	0	2	12
OMI Corp	8.39	0	3	12
ATT	4.53	0	3	6
General Electric	21.41	0	4	5
AOL TimeWarner	45.59	0	2	12
Home Depot	20.47	0	4	4
IBM Corp	20.45	0	3	9
Cisco	40.03	0	3	5
Johnson & Johnson	15.93	0	4	5
Coca Cola	18.62	0	3	12
JP Morgan	18.98	0	2	12
SBC Corp	7.91	0	3	3
Exxon Mobil	9.02	0	2	2
Dow Jones	15.80	0	3	2

The average yearly return for this set of stocks is 16.37%. This average is slightly less than the average based on models built around price change. Next, the research examines the combination of both price and volume changes.

Chapter 6 A Markov Decision Process Model Based on Compound States of Price and Volume Change

The models presented in chapters 4 and 5 focused on closing price change or volume change. In this chapter, model modifications allow evaluations based upon changes in both the price and the volume for the security. This combination is examined for the potential of generating higher model returns than a pure price or pure volume change strategy.

To assure consistency, classification for “up” in the price portion will be the same as used earlier. Any movement greater than 5 cents will be deemed “up.” Other movements will be classified as “down.”

For the volume movement, a simple greater than policy is used for classification of “up.” That is, if today’s volume is greater than yesterday’s volume then the volume is “up,” otherwise the volume is considered “down.” Once again, this definition of volume is consistent with our previous models.

Thus far, our model has sometimes functioned better with price change and, for other stocks and time periods, functioned better with volume change. Of the 21 securities examined, 12 were better with the price model. Seven yielded better overall returns with the volume model and two securities were equal with either model. By combining price and volume change, a new dimension will be added and explored.

6.1 State Definition

State definitions are much more complex. For a snake length on the price side, the length on the volume side is allowed to vary. Once all the volume combinations of the snake are examined, the price side snake length is increased by one and re-examined with respect to various volume snake lengths. In this manner, all combinations of price and length are examined.

Using this technique to examine model results allows the capture of not only the combination of price and volume changes, but also the capture of the pure price and pure volume change states. This is accomplished in one processing run of the model.

An example of the states will help to explain the combination model. Examining the table on the next page provides the states associated with a three-length price and a three-length volume change snake. Notice the table also contains zero price and a one, two and three volume change for the volume only snake. The table also contains one price and zero volume, a two price and zero volume and a three price and zero volume. This combination captures the price only change.

Table 6.1 – Possible States for 3 Price and 3 Volume Combinations

Price Snake	Volume Snake	Price Part	Volume Part	Price Snake	Volume Snake	Price Part	Volume Part	Price Snake	Volume Snake	Price Part	Volume Part	Price Snake	Volume Snake	Price Part	Volume Part
0	1	-	U	2	3	D,D	D,D,D	3	0	D,D,D	-	3	3	D,D,D	D,D,D
0	1	-	D	2	3	D,D	D,D,U	3	0	D,D,U	-	3	3	D,D,D	D,D,U
0	2	-	D,D	2	3	D,D	D,U,D	3	0	D,U,D	-	3	3	D,D,D	D,U,D
0	2	-	D,U	2	3	D,D	D,U,U	3	0	D,U,U	-	3	3	D,D,D	D,U,U
0	2	-	U,D	2	3	D,D	U,D,D	3	0	U,D,D	-	3	3	D,D,D	U,D,D
0	2	-	U,U	2	3	D,D	U,U,U	3	0	U,U,U	-	3	3	D,D,D	U,U,U
0	3	-	D,D,D	2	3	D,D	U,U,D	3	0	U,U,D	-	3	3	D,D,D	U,U,D
0	3	-	D,D,U	2	3	D,D	U,U,U	3	0	U,U,U	-	3	3	D,D,D	U,U,U
0	3	-	D,U,D	2	3	D,D	D,D,D	3	1	D,D,D	D	3	3	D,D,U	D,D,D
0	3	-	D,U,U	2	3	D,D	D,D,U	3	1	D,D,D	U	3	3	D,D,U	D,D,U
0	3	-	U,D,D	2	3	D,D	D,U,D	3	1	D,D,U	D	3	3	D,D,U	D,U,D
0	3	-	U,D,U	2	3	D,D	D,U,U	3	1	D,D,U	U	3	3	D,D,U	D,U,U
0	3	-	U,U,D	2	3	D,D	U,D,D	3	1	D,U,D	D	3	3	D,D,U	U,D,D
0	3	-	U,U,U	2	3	D,D	U,U,U	3	1	D,U,U	U	3	3	D,D,U	U,U,U
1	0	D	-	2	3	D,D	U,U,D	3	1	D,U,U	D	3	3	D,D,U	U,U,D
1	0	U	-	2	3	D,D	U,U,U	3	1	D,U,U	U	3	3	D,D,U	U,U,U
1	1	D	D	2	3	D,U	D,D,D	3	1	U,D,D	D	3	3	D,U,D	D,D,D
1	1	D	U	2	3	D,U	D,D,U	3	1	U,D,D	U	3	3	D,U,D	D,D,U
1	1	U	D	2	3	D,U	D,U,D	3	1	U,D,U	D	3	3	D,U,D	D,U,D
1	1	U	U	2	3	D,U	D,U,U	3	1	U,D,U	U	3	3	D,U,D	D,U,U
1	2	D	D,D	2	3	D,U	U,D,D	3	1	U,U,D	D	3	3	D,U,D	U,D,D
1	2	D	D,U	2	3	D,U	U,D,U	3	1	U,U,D	U	3	3	D,U,D	U,D,U
1	2	D	U,D	2	3	D,U	U,U,D	3	1	U,U,U	D	3	3	D,U,D	U,U,D
1	2	D	U,U	2	3	D,U	U,U,U	3	1	U,U,U	U	3	3	D,U,D	U,U,U
1	2	U	D,D	2	3	D,U	D,D,D	3	2	D,D,D	D,D	3	3	D,U,U	D,D,D
1	2	U	D,U	2	3	D,U	D,D,U	3	2	D,D,D	D,U	3	3	D,U,U	D,D,U
1	2	U	U,D	2	3	D,U	D,U,D	3	2	D,D,D	U,D	3	3	D,U,U	D,U,D
1	2	U	U,U	2	3	D,U	D,U,U	3	2	D,D,D	U,U	3	3	D,U,U	D,U,U
1	3	D	D,D,D	2	3	D,U	U,D,D	3	2	D,D,U	D,D	3	3	D,U,U	U,D,D
1	3	D	D,D,U	2	3	D,U	U,D,U	3	2	D,D,U	D,U	3	3	D,U,U	U,D,U
1	3	D	D,U,D	2	3	D,U	U,U,D	3	2	D,D,U	U,D	3	3	D,U,U	U,U,D
1	3	D	D,U,U	2	3	D,U	U,U,U	3	2	D,D,U	U,U	3	3	D,U,U	U,U,U
1	3	D	U,D,D	2	3	U,D	D,D,D	3	2	D,U,D	D,D	3	3	U,D,D	D,D,D
1	3	D	U,D,U	2	3	U,D	D,D,U	3	2	D,U,D	D,U	3	3	U,D,D	D,D,U
1	3	D	U,U,D	2	3	U,D	D,U,D	3	2	D,U,D	U,D	3	3	U,D,D	D,U,D
1	3	D	U,U,U	2	3	U,D	D,U,U	3	2	D,U,D	U,U	3	3	U,D,D	D,U,U
1	3	U	D,D,D	2	3	U,D	U,D,D	3	2	D,U,U	D,D	3	3	U,D,D	U,D,D
1	3	U	D,D,U	2	3	U,D	U,D,U	3	2	D,U,U	D,U	3	3	U,D,D	U,D,U
1	3	U	D,U,D	2	3	U,D	U,U,D	3	2	D,U,U	U,D	3	3	U,D,D	U,U,D
1	3	U	D,U,U	2	3	U,D	U,U,U	3	2	D,U,U	U,U	3	3	U,D,D	U,U,U
2	0	D,D	-	2	3	U,D	U,D,D	3	2	U,D,U	D,D	3	3	U,D,U	U,D,D
2	0	D,U	-	2	3	U,D	U,D,U	3	2	U,D,U	D,U	3	3	U,D,U	U,D,U
2	0	U,D	-	2	3	U,D	U,U,D	3	2	U,D,U	U,D	3	3	U,D,U	U,U,D
2	0	U,U	-	2	3	U,D	U,U,U	3	2	U,D,U	U,U	3	3	U,D,U	U,U,U
2	1	D,D	D	2	3	U,U	D,D,D	3	2	U,U,D	D,D	3	3	U,U,D	D,D,D
2	1	D,D	U	2	3	U,U	D,D,U	3	2	U,U,D	D,U	3	3	U,U,D	D,D,U
2	1	D,U	D	2	3	U,U	D,U,D	3	2	U,U,D	U,D	3	3	U,U,D	D,U,D
2	1	D,U	U	2	3	U,U	D,U,U	3	2	U,U,D	U,U	3	3	U,U,D	D,U,U
2	1	U,D	D	2	3	U,U	U,D,D	3	2	U,U,U	D,D	3	3	U,U,D	U,D,D
2	1	U,D	U	2	3	U,U	U,D,U	3	2	U,U,U	D,U	3	3	U,U,D	U,D,U
2	1	U,U	D	2	3	U,U	U,U,D	3	2	U,U,U	U,D	3	3	U,U,D	U,U,D
2	1	U,U	U	2	3	U,U	U,U,U	3	2	U,U,U	U,U	3	3	U,U,D	U,U,U
2	2	D,D	D,D	2	3	U,U	D,D,D					3	3	U,U,U	D,D,D
2	2	D,D	D,U	2	3	U,U	D,D,U					3	3	U,U,U	D,D,U
2	2	D,D	U,D	2	3	U,U	D,U,D					3	3	U,U,U	D,U,D
2	2	D,D	U,U	2	3	U,U	D,U,U					3	3	U,U,U	D,U,U
2	2	D,U	D,D	2	3	U,U	U,D,D					3	3	U,U,U	U,D,D
2	2	D,U	D,U	2	3	U,U	U,D,U					3	3	U,U,U	U,D,U
2	2	D,U	U,D	2	3	U,U	U,U,D					3	3	U,U,U	U,U,D
2	2	D,U	U,U	2	3	U,U	U,U,U					3	3	U,U,U	U,U,U
2	2	U,D	D,D												
2	2	U,D	D,U												
2	2	U,D	U,D												
2	2	U,D	U,U												
2	2	U,U	D,D												
2	2	U,U	D,U												
2	2	U,U	U,D												
2	2	U,U	U,U												

The model must account for the dimension of the price and volume change to distinguish between the spaces. For example, “UUDUD” could be “UU” price and “DUD” for volume. This same space could appear as “UUD” for price and “UD” for volume for a 3 price and 2 volume scenario. The space could also assume other combinations of price and volume and still have the same appearance of “UUDUD.”

Another tricky part of working with the combination model is the threshold routine. As previously stated, threshold forces the model to reduce the state size until a state is located that contains the number of occurrences specified in the threshold limit. This is fairly simple in the price only or volume only models in that one reduces the price snake length or volume snake length. In the combination, one has a choice of either reducing the price or the volume. The model was set to reduce the snake length for the portion of the combination that requires the least amount of state space modification. For example, if the model processes a 6 price and a 6 volume combination, and the threshold is not met for a snake length of 4 price and 2 volume (4P2V) the following would be true. The threshold will not be met for 4P3V, 4P4V, 4P5V, and 4P6V. Also the threshold will not be met for 5P2V and 6P2V. Since the price change causes the least amount of disruption to the model, the price is dropped back to a 3 length and the processing is allowed to continue.

6.2 Experimental Plan

The same experimental plan as defined in Chapters 4 and 5 is run using the change in price and volume combination based model. The same stocks are examined. Snake lengths are six for both the price change and the volume change. In the event that the resulting best solution is a pure price change or a pure volume change, reference to the previous findings is made.

6.3 Experimental Results

In this section the Markov model is examined in relation to changes in price/volume traded. The same securities will be examined. The results are given on the next few pages.

6.3.1 S&P 500

The S&P 500 (SPY) is examined for the same periods. Tracking the SPY index fund mirrors the change in the S&P. A portion of the high level summaries pertaining to price/volume change yearly yield for the S&P 500 index stock reside in the table on the following page. This portion contains the best return for the S&P 500 fund using the combination snake patterns.

Table 6.2 – Percent Returns for S&P with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Price/Volume Change

		Years of Data Multiply												
Yr	Snake	Thresh=0			Thresh=3			Thresh=6			Thresh=9			
		SIPrice	SIVolume	Yr Ave	SIPrice	SIVolume	Yr Ave	SIPrice	SIVolume	Yr Ave	SIPrice	SIVolume	Yr Ave	
0	2	16.92	19.38	17.89	0	2	16.92	19.38	17.89	0	2	16.92	19.38	17.89
0	3	18.55	20.95	14.69	0	3	18.55	20.95	14.69	0	3	18.55	20.95	14.69
0	4	15.23	13.17	13.65	0	4	15.37	13.17	13.65	0	4	15.87	13.17	13.65
0	5	9.34	-0.96	2.46	0	5	10.70	-0.53	2.46	0	5	10.70	0.35	2.49
0	6	12.40	13.84	9.04	0	6	13.97	15.19	9.28	0	6	13.96	15.62	10.07
0	7	13.36	13.14	15.30	0	7	14.90	15.13	15.26	0	7	12.70	14.44	16.11
0	8	13.95	10.06	12.38	0	8	16.62	13.66	12.05	0	8	15.62	14.49	12.06
1	0	15.65	10.29	5.27	1	0	15.65	10.29	5.27	1	0	15.65	10.29	5.27
1	1	15.04	10.47	5.35	1	1	15.04	10.47	5.35	1	1	15.04	10.47	5.35
1	2	20.43	18.52	17.11	1	2	20.43	18.52	17.11	1	2	20.43	18.52	17.11
1	3	19.82	17.27	16.36	1	3	19.82	17.27	16.36	1	3	19.82	17.27	16.36
1	4	16.33	9.02	9.78	1	4	16.93	9.02	9.78	1	4	17.10	9.68	9.89
1	5	11.99	7.50	7.49	1	5	12.02	7.24	7.77	1	5	11.57	8.69	7.19
1	6	10.66	8.35	9.63	1	6	14.04	6.49	10.72	1	6	12.27	9.22	10.08
1	7	10.42	9.45	10.42	1	7	12.65	7.64	13.03	1	7	12.38	11.97	14.56
1	8	10.56	5.90	5.00	1	8	13.35	8.94	13.23	1	8	16.65	13.02	18.32
2	0	14.81	13.54	12.95	2	0	14.81	13.54	12.95	2	0	14.81	13.54	12.95
2	1	11.75	10.87	9.36	2	1	11.75	10.87	9.36	2	1	11.75	10.87	9.36
2	2	15.85	14.90	14.87	2	2	15.85	14.90	14.87	2	2	15.85	14.90	14.87
2	3	14.46	12.85	17.05	2	3	14.72	12.85	17.05	2	3	15.14	13.40	17.05
2	4	14.08	6.49	7.05	2	4	15.42	7.49	7.53	2	4	13.46	8.96	8.80
2	5	8.23	-0.02	3.09	2	5	8.29	1.97	1.88	2	5	11.06	5.55	2.55
2	6	8.25	7.70	11.93	2	6	8.20	7.10	8.99	2	6	8.92	9.66	11.68
2	7	8.11	3.14	4.54	2	7	12.32	5.50	8.66	2	7	10.48	10.83	8.54
2	8	8.42	10.04	8.16	2	8	11.89	7.66	7.65	2	8	11.54	7.08	8.13
3	0	10.79	15.95	15.96	3	0	10.79	15.95	15.96	3	0	10.79	15.95	15.96
3	1	12.34	14.45	5.76	3	1	12.34	14.45	5.76	3	1	12.34	14.45	5.76
3	2	11.22	12.93	15.02	3	2	11.22	12.93	15.02	3	2	9.70	12.93	15.02
3	3	18.71	19.03	20.26	3	3	17.73	19.03	19.35	3	3	18.46	19.51	19.61
3	4	19.19	12.22	16.35	3	4	17.19	13.85	15.46	3	4	20.93	12.33	16.03
3	5	18.73	13.84	13.11	3	5	17.46	22.46	12.52	3	5	17.78	20.80	19.29
3	6	8.16	10.50	9.25	3	6	17.97	24.01	14.02	3	6	18.63	21.10	21.91
3	7	11.59	12.69	14.97	3	7	18.43	18.72	10.21	3	7	18.49	18.93	18.54
3	8	8.44	7.49	6.26	3	8	18.61	14.73	10.65	3	8	18.18	18.54	22.14
4	0	11.65	10.34	10.30	4	0	11.65	10.34	10.30	4	0	11.65	10.34	10.30
4	1	14.82	10.88	7.63	4	1	14.82	10.88	7.63	4	1	13.77	10.88	7.63
4	2	11.49	9.26	11.24	4	2	11.67	9.26	11.24	4	2	11.50	9.54	11.77
4	3	15.19	11.48	12.72	4	3	12.45	13.11	12.32	4	3	18.37	13.76	13.87
4	4	11.94	6.84	3.89	4	4	16.00	8.47	4.88	4	4	16.58	13.77	8.51
4	5	9.56	7.13	8.51	4	5	14.37	8.75	10.38	4	5	14.18	15.53	8.11
4	6	9.76	9.15	6.00	4	6	14.40	10.80	11.66	4	6	16.45	15.68	9.02
4	7	8.37	9.74	12.48	4	7	15.51	10.13	10.46	4	7	17.50	16.45	10.82
4	8	8.36	9.11	9.14	4	8	16.24	9.35	11.16	4	8	18.21	15.99	10.25
5	0	11.35	14.25	9.14	5	0	11.35	14.25	9.14	5	0	11.09	14.25	9.14
5	1	12.65	10.49	7.97	5	1	13.65	10.59	7.97	5	1	14.63	11.51	8.57
5	2	4.56	9.61	6.27	5	2	7.97	10.69	5.45	5	2	9.00	14.36	9.91
5	3	10.76	5.55	8.66	5	3	10.85	8.42	6.10	5	3	16.86	9.45	8.79
5	4	9.32	5.72	5.54	5	4	14.96	7.40	6.93	5	4	17.36	14.69	8.20
5	5	9.94	8.46	10.68	5	5	15.10	9.46	11.66	5	5	16.32	15.20	8.82
5	6	10.22	7.88	10.01	5	6	15.26	11.67	11.45	5	6	16.41	15.19	8.60
5	7	8.60	9.35	12.63	5	7	15.38	11.37	10.22	5	7	17.14	16.32	8.64
5	8	7.17	10.37	9.11	5	8	15.36	11.41	12.33	5	8	16.84	15.17	8.13
6	0	5.39	12.19	13.47	6	0	5.94	12.18	13.47	6	0	5.93	12.39	13.68
6	1	8.85	9.17	7.47	6	1	9.38	7.74	7.15	6	1	13.09	6.86	8.32
6	2	8.11	11.99	10.84	6	2	6.39	5.47	6.44	6	2	7.68	6.21	9.10
6	3	12.67	14.33	17.54	6	3	9.23	9.95	10.54	6	3	17.03	14.20	12.25
6	4	13.00	7.11	7.64	6	4	15.35	11.71	13.03	6	4	18.88	16.36	11.03
6	5	9.98	9.44	12.78	6	5	15.17	11.81	11.62	6	5	17.48	15.79	9.61
6	6	11.28	6.50	8.34	6	6	15.50	12.89	11.83	6	6	17.05	15.17	9.01
6	7	14.26	12.16	12.64	6	7	15.92	12.56	11.36	6	7	17.74	15.37	9.63
6	8	8.29	9.02	12.18	6	8	15.93	11.93	11.83	6	8	17.68	15.41	9.08
7	0	15.52	14.79	11.34	7	0	12.17	12.07	10.82	7	0	11.21	13.58	10.58
7	1	14.80	12.95	13.61	7	1	8.62	7.21	11.17	7	1	9.98	5.52	6.58
7	2	11.25	11.37	14.86	7	2	5.37	1.31	3.37	7	2	7.94	5.40	8.22
7	3	12.77	10.04	9.59	7	3	9.88	9.51	7.28	7	3	14.80	13.53	12.73
7	4	14.19	15.29	10.84	7	4	15.03	11.88	15.01	7	4	17.78	15.76	10.77
7	5	13.23	12.28	13.20	7	5	13.71	10.88	12.14	7	5	16.62	14.49	9.67
7	6	10.96	9.30	11.32	7	6	15.05	12.14	12.64	7	6	16.18	14.84	9.49
7	7	7.09	7.94	10.34	7	7	14.97	11.99	12.11	7	7	16.66	14.87	9.86
7	8	1.92	6.10	7.62	7	8	15.28	12.03	12.11	7	8	16.81	15.14	9.26
8	0	8.63	10.58	16.82	8	0	10.91	10.39	15.54	8	0	10.33	17.43	13.31

From the returns on the previous page, the best appears to be three threshold, three years training, a snake length price of three combined with a snake length volume of six (3T, 3L, 3/6S). The value is highlighted in the table. The average per year return is 24.01%. The following table compares this best model performance to the other scenarios.

Table 6.3 – Percent Returns for S&P (3,3,3/6) Using Price/Volume & Other Strategies

Price/Volume Change										
Summary for 3 Thresh, 3 Year Training, 3/6Length Snake						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
96-97	25.92	23.57	11.62	13.75	14.20	25.92	23.57	11.62	13.75	14.20
97-98	42.40	39.09	22.16	18.70	19.28	79.32	71.87	36.36	35.01	36.21
98-99	56.69	24.41	22.65	18.08	18.98	180.98	113.83	67.24	59.42	62.06
99-00	4.29	9.80	8.14	7.66	7.71	193.03	134.79	80.85	71.62	74.56
00-01	3.99	-12.96	6.32	-7.34	-8.87	204.71	104.36	92.28	59.02	59.07
01-02	19.33	-13.66	-12.82	-6.61	-6.59	263.61	76.45	67.63	48.51	48.58

The following graphs the cumulative side of the table.

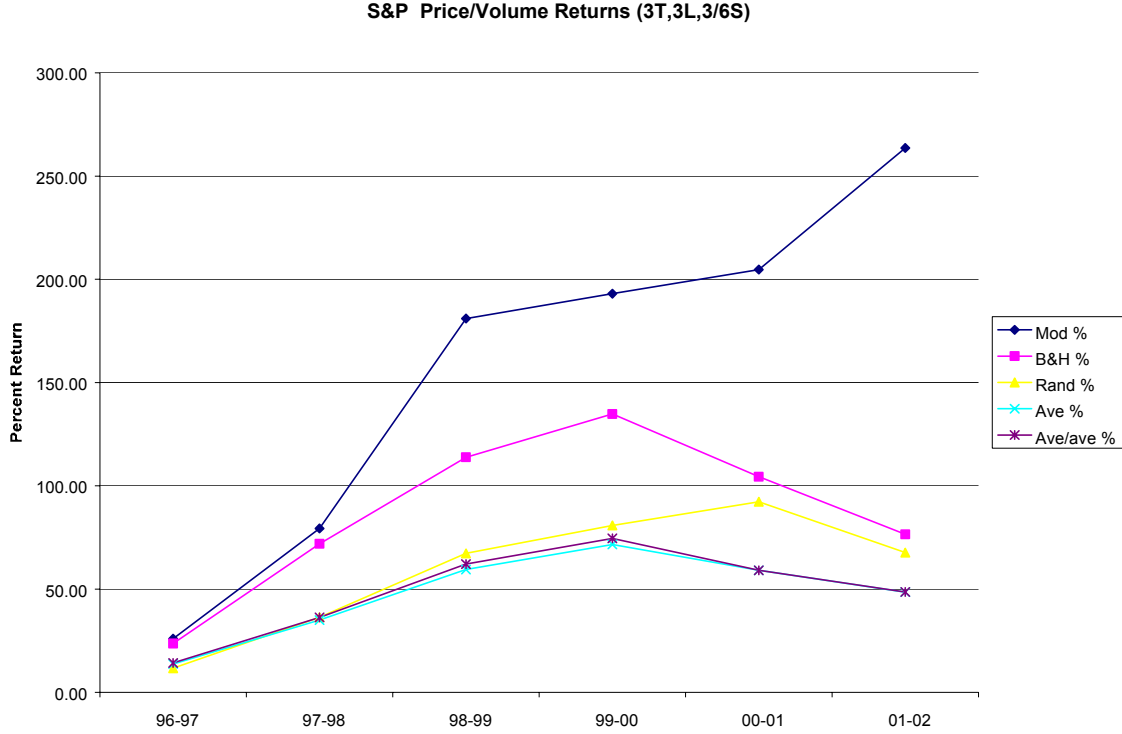


Figure 6.1 – S&P Returns for 3 Thresh, 3 Year Training & 3/6 Snake Length Using Price/Volume Change & Other Strategies

The price/volume model performs extremely well with the S&P index stock. Even in the poorly performing years for the other strategies, the model continues to improve on the yield. At over 263% cumulative return, the price/volume model with the S&P performs much better than either the price only or the volume only change model.

6.3.2 I2 Technologies

The I2 Technologies data are examined for the same periods using the combination model. A portion of the table of results is as follows.

Tables 6.4 – Percent Returns for ITWO with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Price/Volume Change

Thresh=0		Years of Data Multiply				Thresh=3		Yr Ave 2				Thresh=6		Yr Ave 3			
SIPrice	SIVolume	Yr Ave 2	Yr Ave 3	Yr Ave 4	SIPrice	SIVolume	Yr Ave 2	Yr Ave 3	Yr Ave 4	SIPrice	SIVolume	Yr Ave 2	Yr Ave 3	Yr Ave 4			
0	2	-36.16	-13.12	-65.52	0	2	-36.16	-13.12	-65.52	0	2	-36.16	-13.12	-65.52			
0	3	-6.71	-12.36	-66.39	0	3	-6.71	-12.36	-66.39	0	3	-6.71	-12.36	-66.39			
0	4	-35.91	-7.69	-55.87	0	4	-35.91	-7.69	-55.87	0	4	-37.26	-7.69	-55.87			
0	5	-24.88	-10.12	-61.71	0	5	-21.14	-4.17	-57.86	0	5	-19.06	-5.06	-57.86			
0	6	-29.56	-31.97	-59.76	0	6	-27.73	-30.13	-58.10	0	6	-30.93	-23.42	-58.49			
0	7	-7.51	-23.00	-52.37	0	7	-1.22	-14.66	-38.54	0	7	2.57	28.24	-41.86			
0	8	-22.57	-14.87	-67.86	0	8	-24.03	-5.94	-53.92	0	8	-14.57	0.08	-34.80			
1	0	-8.11	-12.15	-62.00	1	0	-8.11	-12.15	-62.00	1	0	-8.11	-12.15	-62.00			
1	1	-20.28	-35.34	-57.30	1	1	-20.28	-35.34	-57.30	1	1	-20.28	-35.34	-57.30			
1	2	-15.41	-16.36	-66.60	1	2	-15.41	-16.36	-66.60	1	2	-15.41	-16.36	-66.60			
1	3	-17.76	4.34	-61.96	1	3	-17.76	4.34	-61.96	1	3	-17.76	4.34	-61.96			
1	4	-43.54	-41.70	-74.32	1	4	-42.62	-44.54	-74.32	1	4	-39.61	-39.14	-74.32			
1	5	-10.36	-42.71	-74.31	1	5	-2.12	-46.72	-75.60	1	5	-8.89	-48.46	-74.97			
1	6	-4.69	-11.48	-46.24	1	6	-19.81	-17.42	-45.84	1	6	-13.22	-33.14	-47.33			
1	7	-16.62	-20.00	-59.05	1	7	10.03	-22.35	-61.37	1	7	-20.54	-18.39	-66.90			
1	8	-20.48	-29.16	-42.29	1	8	10.22	-38.69	-50.79	1	8	-25.03	-40.64	-63.41			
2	0	1.41	-39.63	-61.14	2	0	1.41	-39.63	-61.14	2	0	1.41	-39.63	-61.14			
2	1	-41.10	-58.63	-80.08	2	1	-41.10	-58.63	-80.08	2	1	-41.10	-58.63	-80.08			
2	2	-23.35	-39.27	-71.45	2	2	-23.35	-39.27	-71.45	2	2	-23.35	-39.27	-71.45			
2	3	-5.43	-0.74	-57.78	2	3	-5.95	-0.74	-57.78	2	3	-8.61	1.49	-57.78			
2	4	-23.09	-47.17	-52.78	2	4	-19.43	-50.18	-59.26	2	4	-32.71	-43.28	-60.18			
2	5	-16.74	1.08	-33.66	2	5	-11.53	-22.04	-45.46	2	5	-8.31	-20.21	-49.66			
2	6	3.16	-17.10	-40.68	2	6	-0.06	-14.61	-32.23	2	6	-21.45	-10.60	-47.40			
2	7	1.92	-24.29	-65.92	2	7	6.34	-23.91	-27.46	2	7	2.55	4.35	-32.93			
2	8	6.86	-2.49	-54.95	2	8	-3.48	-35.40	-20.30	2	8	4.45	-11.18	-28.66			
3	0	14.41	-19.01	-53.88	3	0	14.41	-19.01	-53.88	3	0	14.41	-19.01	-53.88			
3	1	-40.76	-58.58	-74.95	3	1	-40.76	-58.58	-74.95	3	1	-40.76	-58.58	-74.95			
3	2	-18.80	-27.42	-46.67	3	2	-19.00	-27.42	-46.67	3	2	-30.46	-29.29	-46.67			
3	3	-31.97	-32.80	-64.37	3	3	-35.95	-43.04	-64.37	3	3	-42.36	-29.34	-62.89			
3	4	-58.80	-61.00	-67.13	3	4	-64.36	-62.04	-72.04	3	4	-51.58	-58.47	-76.49			
3	5	-11.28	-23.04	-58.30	3	5	-50.74	-51.27	-61.71	3	5	-30.87	-54.26	-71.40			
3	6	17.83	-4.48	-49.52	3	6	-38.33	-38.50	-50.61	3	6	-35.24	-35.77	-76.61			
3	7	14.16	76.58	-20.74	3	7	-42.41	-27.26	-24.34	3	7	-35.97	-32.76	-75.19			
3	8	3.86	16.65	-46.08	3	8	-39.19	-40.93	-16.94	3	8	-23.21	-27.76	-74.83			
4	0	-20.86	-34.50	-70.80	4	0	-20.86	-34.50	-70.80	4	0	-20.86	-34.50	-70.80			
4	1	-38.18	-64.67	-80.51	4	1	-38.18	-64.67	-80.51	4	1	-35.14	-64.67	-80.51			
4	2	-51.16	-56.71	-81.52	4	2	-53.40	-57.15	-81.52	4	2	-48.26	-49.37	-79.96			
4	3	-47.24	-51.51	-80.29	4	3	-51.93	-49.80	-79.31	4	3	-35.57	-49.46	-69.66			
4	4	-54.42	-42.11	-79.45	4	4	-70.45	-59.96	-75.33	4	4	-59.36	-50.98	-71.35			
4	5	-37.90	-45.29	-82.49	4	5	-58.82	-47.99	-81.96	4	5	-41.64	-26.12	-73.34			
4	6	-40.89	-19.15	-78.10	4	6	-52.58	-40.53	-80.21	4	6	-37.80	-12.93	-69.03			
4	7	-30.91	-11.10	-71.71	4	7	-51.14	-48.41	-77.46	4	7	-31.01	-10.91	-70.87			
4	8	-1.16	-32.44	-61.96	4	8	-48.83	-44.57	-74.51	4	8	-29.81	-5.79	-68.95			
5	0	-34.99	-25.61	-52.31	5	0	-34.99	-25.61	-52.31	5	0	-33.27	-25.61	-52.31			
5	1	-41.64	-34.15	-63.65	5	1	-38.60	-33.91	-63.65	5	1	-36.67	-35.32	-65.13			
5	2	-40.70	-30.93	-63.69	5	2	-61.29	-50.77	-66.72	5	2	-57.74	-45.37	-62.33			
5	3	-65.14	-56.64	-78.65	5	3	-51.06	-52.54	-77.03	5	3	-48.85	-56.93	-74.88			
5	4	-63.37	-50.95	-81.16	5	4	-57.57	-58.64	-77.21	5	4	-45.20	-22.99	-66.16			
5	5	-53.21	-27.53	-81.25	5	5	-49.67	-37.67	-75.54	5	5	-35.13	-10.15	-70.64			
5	6	-58.71	-58.24	-86.88	5	6	-49.13	-39.81	-76.25	5	6	-37.03	-7.86	-70.69			
5	7	-39.64	-57.46	-78.35	5	7	-48.92	-44.90	-73.10	5	7	-29.84	-6.65	-69.37			
5	8	-20.09	-43.55	-59.39	5	8	-47.38	-48.70	-71.52	5	8	-26.89	-2.17	-69.46			
6	0	-32.31	-34.64	-69.23	6	0	-30.53	-34.07	-69.23	6	0	-22.11	-33.78	-68.28			
6	1	-49.94	-51.33	-68.35	6	1	-37.04	-45.52	-69.68	6	1	-52.39	-39.07	-61.40			
6	2	-51.06	-53.91	-77.76	6	2	-58.29	-64.36	-78.74	6	2	-51.03	-48.98	-66.57			
6	3	-43.77	-51.73	-72.64	6	3	-49.91	-30.82	-74.21	6	3	-49.98	-54.52	-72.22			
6	4	-30.69	-35.36	-67.51	6	4	-59.13	-52.15	-81.67	6	4	-45.57	-24.44	-67.91			
6	5	-43.79	-45.28	-74.14	6	5	-49.39	-35.95	-76.97	6	5	-38.84	-5.56	-68.05			
6	6	-58.82	-31.90	-73.82	6	6	-50.32	-41.86	-77.03	6	6	-36.45	1.13	-68.80			
6	7	-45.96	-43.41	-72.40	6	7	-50.00	-50.55	-76.66	6	7	-28.92	-3.90	-69.09			
6	8	-25.20	-41.00	-31.47	6	8	-46.76	-51.46	-76.23	6	8	-24.87	-0.39	-69.56			
7	0	-39.87	-28.28	-55.50	7	0	-41.53	-31.58	-58.98	7	0	-32.67	-39.51	-67.08			
7	1	-59.91	-60.71	-63.82	7	1	-37.31	-58.64	-80.17	7	1	-43.36	-43.11	-64.91			
7	2	-49.57	-54.58	-60.49	7	2	-53.98	-68.97	-75.72	7	2	-44.24	-51.42	-61.56			
7	3	-42.46	-29.38	-34.13	7	3	-37.47	-35.89	-76.42	7	3	-39.27	-44.50	-73.79			
7	4	-42.72	-21.14	-45.72	7	4	-53.79	-45.61	-81.53	7	4	-42.82	-22.00	-69.92			
7	5	-39.34	-18.11	-58.11	7	5	-48.38	-39.92	-75.05	7	5	-36.50	5.49	-68.98			

The best return for the I2 Technologies is highlighted and is a zero threshold, three years of training, three-length price change, and a seven length volume snake (0T, 3L, 3/7S). The average return is approximately 76.58% per year with the model using these parameters for threshold, years to train and snake length.

The chart comparing the model's return to the return of the strategies is given as follows.

Table 6.5 – Percent Returns for ITWO (0,3,3/7) Using Price/Volume & Other Strategies

Price/Volume Change										
Values for Thresh = 0, Years=3, Snake=3/7						Cumulative				
Data End	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
99-00	352.16	607.06	101.40	265.77	293.06	352.16	607.06	101.40	265.77	293.06
00-01	47.88	-58.74	-3.78	-46.74	-47.80	568.64	191.72	93.78	94.81	105.18
01-02	-17.65	-85.99	-81.65	-47.10	-53.88	450.63	-59.12	-64.43	3.06	-5.37

The graph of the cumulative data for I2 Technologies using the price/volume changes for snake pattern is as follows.

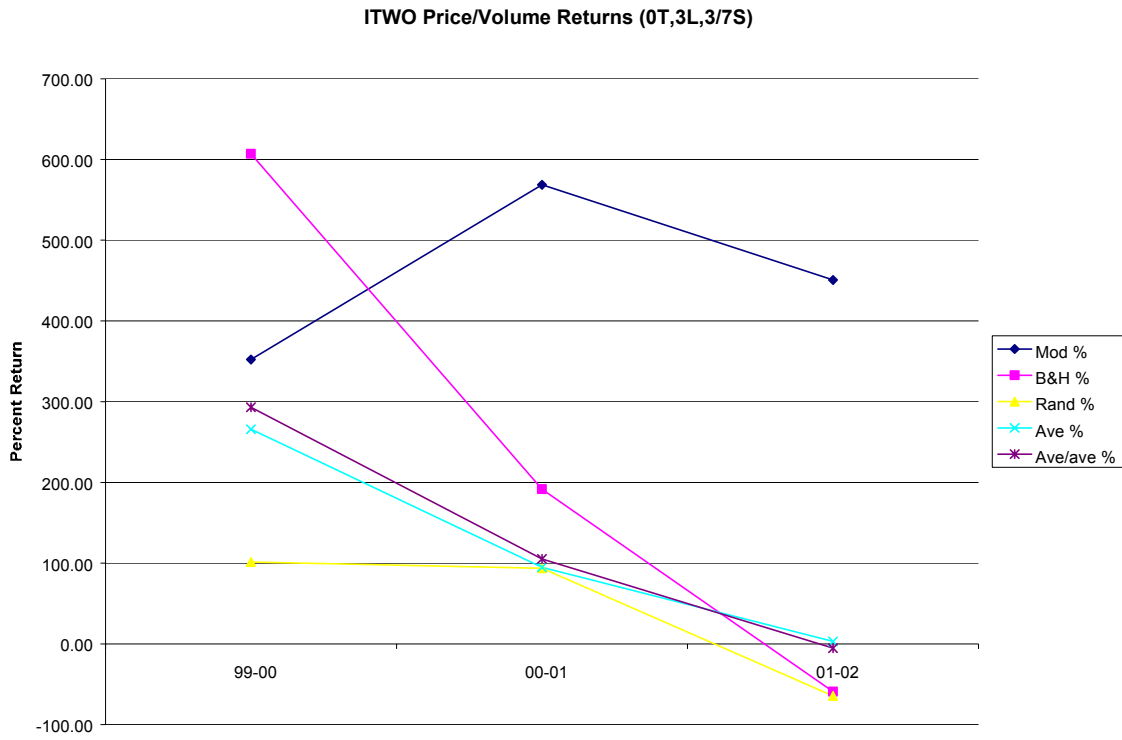


Figure 6.2 – ITWO Returns for 0 Thresh, 3 Year Training & 3/7 Snake Length For Price/Volume Change & Other Strategies

6.3.3 Tesoro Petroleum

Next the model examines Tesoro Petroleum with respect to snakes built upon price/volume changes. The high level summaries for yearly returns for Tesoro built on price/volume snake patterns are as follows.

Tables 6.6 – Percent Returns for TSO with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Price/Volume Change

Thresh=0		Years of Data Multiply			Thresh=3		Thresh=6							
SIPrice	SIVolume	Yr Ave 2	Yr Ave 3	Yr Ave 4	SIPrice	SIVolume	Yr Ave 2	Yr Ave 3	Yr Ave 4	SIPrice	SIVolume	Yr Ave 2	Yr Ave 3	Yr Ave 4
0	2	-3.33	-4.68	-8.23	0	2	-3.33	-4.68	-8.23	0	2	-3.33	-4.68	-8.23
0	3	-10.55	-4.81	1.44	0	3	-10.55	-4.81	1.44	0	3	-10.55	-4.81	1.44
0	4	-5.78	-2.29	1.12	0	4	-5.75	-2.26	1.12	0	4	-3.88	-2.26	1.12
0	5	-8.03	0.15	8.28	0	5	-10.26	-1.24	8.56	0	5	-10.61	-1.35	8.71
0	6	-9.74	-8.63	-0.34	0	6	-11.94	-7.18	2.08	0	6	-12.53	-6.84	3.32
1	0	-4.55	-6.41	-6.37	1	0	-4.55	-6.41	-6.37	1	0	-4.55	-6.41	-6.37
1	1	-5.43	-8.53	-11.07	1	1	-5.43	-8.53	-11.07	1	1	-5.43	-8.53	-11.07
1	2	-5.43	1.53	-3.18	1	2	-5.43	1.53	-3.18	1	2	-5.43	1.53	-3.18
1	3	-15.23	-11.88	-0.32	1	3	-15.23	-11.88	-0.32	1	3	-15.64	-11.88	-0.32
1	4	-14.45	-12.23	-15.09	1	4	-14.80	-12.22	-15.09	1	4	-15.09	-12.31	-15.52
1	5	-9.43	-5.64	-6.16	1	5	-9.88	-5.64	-6.49	1	5	-14.72	-6.77	-6.17
1	6	-19.37	-18.87	-9.49	1	6	-15.59	-16.22	-8.03	1	6	-20.62	-14.11	-7.65
2	0	-5.50	-6.90	-4.60	2	0	-5.50	-6.90	-4.60	2	0	-5.50	-6.90	-4.60
2	1	-3.85	-5.74	-5.76	2	1	-3.85	-5.74	-5.76	2	1	-3.85	-5.74	-5.76
2	2	-14.46	-7.33	-1.41	2	2	-14.46	-7.33	-1.41	2	2	-14.68	-7.37	-1.41
2	3	-14.15	-17.40	-4.71	2	3	-13.01	-17.49	-4.71	2	3	-13.61	-15.09	-4.40
2	4	-14.42	-15.65	-12.02	2	4	-14.41	-14.14	-12.14	2	4	-15.01	-13.37	-8.84
2	5	-13.25	-2.03	-6.45	2	5	-11.89	-3.57	-6.30	2	5	-15.33	-5.99	-8.86
2	6	-17.56	-12.37	-1.58	2	6	-11.29	-8.61	-1.83	2	6	-17.72	-10.45	-2.54
3	0	-1.43	3.62	-3.26	3	0	-1.43	3.62	-3.26	3	0	-1.43	3.62	-3.26
3	1	-5.67	-5.35	-4.21	3	1	-5.00	-5.35	-4.21	3	1	-3.66	-5.69	-4.21
3	2	-12.27	-7.24	-6.94	3	2	-12.41	-7.09	-7.33	3	2	-10.31	-6.17	-8.09
3	3	-11.01	-16.64	-4.81	3	3	-12.27	-18.70	-5.98	3	3	-10.09	-18.53	-7.37
3	4	-12.83	-13.76	-11.94	3	4	-15.25	-13.99	-7.96	3	4	-10.67	-14.21	-10.48
3	5	-7.80	-9.55	-10.81	3	5	-11.11	-12.60	-10.93	3	5	-15.27	-14.33	-14.77
3	6	-5.26	0.99	3.92	3	6	-10.88	-13.01	2.93	3	6	-14.85	-11.63	-9.72
4	0	-3.30	-4.53	3.97	4	0	-3.30	-4.53	3.97	4	0	-3.10	-4.53	3.97
4	1	-8.25	-13.13	-3.80	4	1	-7.64	-13.02	-3.80	4	1	-6.45	-13.16	-3.80
4	2	-10.60	-6.55	2.27	4	2	-10.90	-6.35	0.20	4	2	-9.27	-3.51	-2.59
4	3	-6.87	-0.39	10.02	4	3	-9.19	1.00	10.86	4	3	-9.91	-3.14	4.29
4	4	-10.79	-5.78	-2.69	4	4	-8.47	-2.32	-2.42	4	4	-13.64	-5.87	-7.62
4	5	-9.10	-0.56	5.10	4	5	-11.69	-7.13	1.39	4	5	-13.78	-8.33	-1.04
4	6	-7.52	0.00	7.01	4	6	-5.84	-7.95	-1.10	4	6	-15.00	-10.54	0.72
5	0	-16.33	-10.22	-0.13	5	0	-17.57	-10.22	-0.13	5	0	-17.70	-8.10	1.62
5	1	-17.73	-12.15	-12.70	5	1	-16.78	-11.20	-12.75	5	1	-14.39	-8.80	-10.99
5	2	-20.15	-10.00	-3.74	5	2	-16.53	-7.39	0.16	5	2	-16.90	-10.87	-10.01
5	3	-8.85	-16.61	-7.61	5	3	-15.28	-8.79	-1.85	5	3	-10.14	-11.87	-3.16
5	4	-3.30	-2.61	-0.09	5	4	-13.71	-9.02	-2.03	5	4	-15.01	-9.23	-5.47
5	5	-0.34	-2.76	3.04	5	5	-13.71	-11.15	-3.82	5	5	-12.13	-7.59	-3.48
5	6	8.60	6.61	6.18	5	6	-13.72	-11.54	-6.58	5	6	-13.85	-8.82	-3.05
6	0	-9.77	-1.21	3.72	6	0	-9.48	-0.79	4.58	6	0	-8.29	-1.23	9.22
6	1	-7.47	3.29	1.92	6	1	-14.97	5.82	1.54	6	1	-12.75	3.04	3.59
6	2	-7.36	-6.07	-5.76	6	2	-9.28	-8.21	-1.00	6	2	-12.54	-12.59	-7.13
6	3	-15.99	-18.21	-9.76	6	3	-15.18	-3.26	3.22	6	3	-11.57	-6.66	0.27
6	4	-9.61	-6.20	-8.67	6	4	-13.93	-8.05	-4.69	6	4	-13.22	-6.15	-7.30
6	5	-5.44	-7.18	-1.12	6	5	-15.66	-10.03	-4.91	6	5	-14.05	-7.02	-2.40
6	6	2.17	-2.07	4.21	6	6	-12.72	-10.24	-4.36	6	6	-13.55	-7.74	-2.33

The best return for Tesoro using the change in daily price/volume appears to be the three threshold, four years of training, four length price, and a three length volume snake (3T, 4L, 4/3S). This value of about 10.86% per year is highlighted in the previous table.

The chart comparing the model's return to the return of the other strategies is given below.

Table 6.7 – Percent Returns for Tesoro (3,4,4/3) Using Price/Volume & Other Strategies

Price/Volume Change										
Values for Thresh =3, Years=4, Snake=4/3						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H %	Rand %	Ave %	Ave/ave %
92-93	33.17	38.89	0.72	53.00	51.13	33.17	38.89	0.72	53.00	51.13
93-94	113.00	92.00	45.58	71.59	72.10	183.66	166.67	46.63	162.54	160.11
94-95	-2.05	-7.33	0.31	12.73	11.28	177.83	147.11	47.07	195.95	189.44
95-96	-15.37	1.17	-11.72	21.82	23.60	135.12	150.00	29.83	260.53	257.74
96-97	6.03	15.56	-8.09	5.15	3.71	149.30	188.89	19.32	279.07	270.99
97-98	17.40	46.62	15.75	17.50	21.07	192.69	323.56	38.11	345.42	349.17
98-99	-3.14	-36.73	-34.01	-5.72	-8.60	183.50	168.00	-8.86	319.95	310.56
99-00	-31.41	-18.08	15.51	-20.99	-22.19	94.46	119.56	5.27	231.81	219.46
00-01	56.33	57.90	22.17	42.43	44.55	204.01	246.67	28.61	372.59	361.78
01-02	-7.73	-49.62	-65.23	-38.13	-40.06	180.50	74.67	-55.29	192.42	176.80

The graph of the cumulative Tesoro data may be found below.

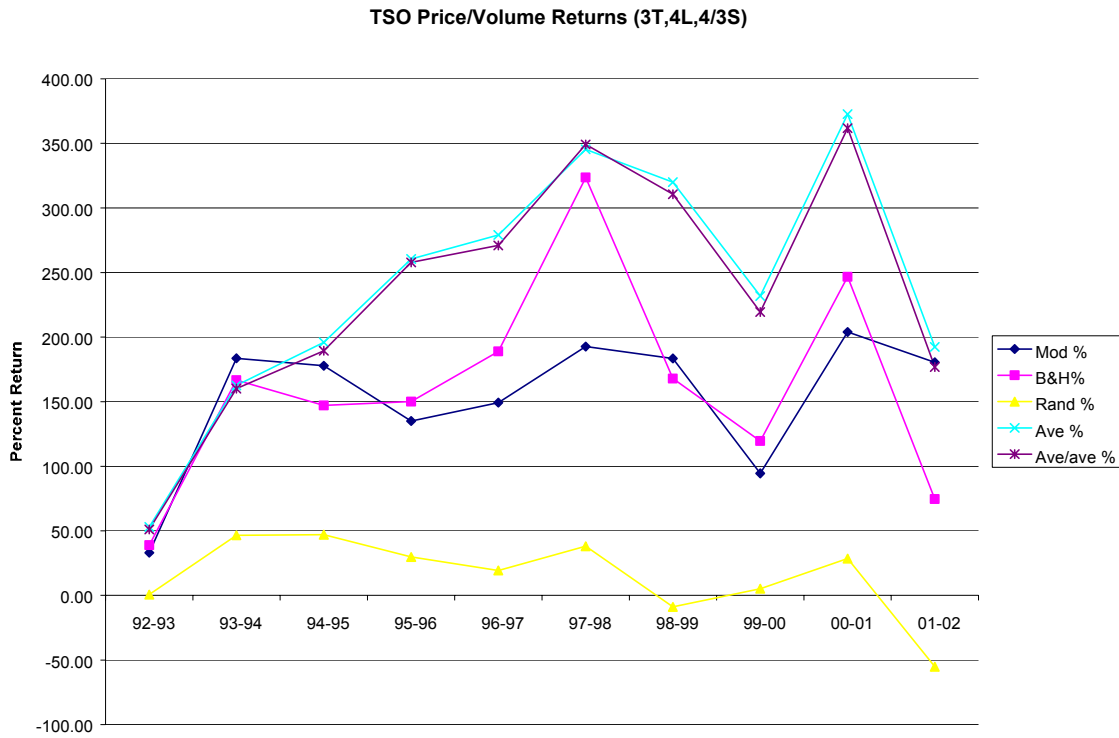


Figure 6.3 – Tesoro Returns for 3 Thresh, 4 Year Training & 4/3 Snake Length Price/Volume Change & Other Strategies

6.3.4 Symbol Technologies

Symbol Technologies is examined for price/volume change snakes. The high level summaries of yearly returns based on price/volume snakes for Symbol are as follows.

Tables 6.8 – Percent Returns for SBL with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Price/Volume Change

		Years of Data Multiply												
Thresh=0		Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3		Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=6		Yr Ave 2	Yr Ave 3	Yr Ave 4
SIPrice	SIVolume				SIPrice	SIVolume				SIPrice	SIVolume			
0	2	6.72	3.86	5.91	0	2	6.72	3.86	5.91	0	2	6.72	3.86	5.91
0	3	2.01	4.14	1.14	0	3	2.01	4.14	1.14	0	3	2.01	4.14	1.14
0	4	-5.84	-2.13	8.43	0	4	-5.86	-2.13	8.43	0	4	-4.75	-1.59	8.43
0	5	5.34	-5.34	7.18	0	5	5.13	-5.12	7.18	0	5	3.40	-4.78	11.72
0	6	-5.11	-8.25	-5.92	0	6	-5.27	-6.60	-5.25	0	6	-10.43	-4.24	-4.02
1	0	15.74	15.14	13.57	1	0	15.74	15.14	13.57	1	0	15.74	15.14	13.57
1	1	18.66	24.12	25.05	1	1	18.66	24.12	25.05	1	1	18.66	24.12	25.05
1	2	12.81	10.87	17.27	1	2	12.81	10.87	17.27	1	2	12.81	10.87	17.27
1	3	15.58	8.95	11.95	1	3	15.58	8.95	11.95	1	3	17.37	8.95	11.95
1	4	-2.81	1.57	9.50	1	4	-3.99	1.54	8.41	1	4	-2.85	1.79	10.90
1	5	2.34	-6.00	-0.33	1	5	1.53	-4.52	0.80	1	5	9.66	-1.66	4.24
1	6	-4.60	-4.44	0.80	1	6	1.89	1.66	6.99	1	6	2.87	-3.96	11.10
2	0	13.79	13.45	17.81	2	0	13.79	13.45	17.81	2	0	13.79	13.45	17.81
2	1	13.39	11.34	19.59	2	1	13.39	11.34	19.59	2	1	15.36	11.34	19.59
2	2	8.26	4.59	13.02	2	2	10.66	3.67	13.02	2	2	8.44	4.03	13.02
2	3	2.08	1.10	7.67	2	3	3.60	1.06	8.15	2	3	2.60	2.38	7.76
2	4	4.59	6.25	12.19	2	4	11.02	8.00	12.55	2	4	6.06	8.33	14.65
2	5	5.50	-1.86	7.38	2	5	13.59	-2.60	6.67	2	5	19.22	6.33	22.68
2	6	-8.75	-12.04	-6.77	2	6	1.05	-5.06	2.82	2	6	9.41	14.40	22.95
3	0	5.14	0.26	11.94	3	0	5.52	0.26	11.94	3	0	5.09	-0.51	11.94
3	1	2.57	8.82	4.16	3	1	3.13	9.96	4.16	3	1	6.12	10.10	4.33
3	2	5.36	4.69	12.05	3	2	5.24	2.39	11.67	3	2	7.80	7.90	14.52
3	3	-0.35	2.20	4.24	3	3	-1.28	5.30	6.10	3	3	-7.03	4.98	7.41
3	4	-0.30	-3.34	3.88	3	4	5.18	-1.56	6.65	3	4	-1.67	-4.31	4.14
3	5	1.19	-0.96	3.13	3	5	13.26	10.21	16.86	3	5	2.45	1.45	17.63
3	6	-3.99	-8.91	-4.41	3	6	14.73	4.03	14.59	3	6	-3.55	-1.22	17.13
4	0	6.07	10.32	15.11	4	0	6.44	11.39	15.11	4	0	5.73	11.09	15.11
4	1	17.08	3.90	8.28	4	1	14.94	3.88	8.48	4	1	21.23	5.22	8.31
4	2	12.73	7.85	14.94	4	2	12.20	7.44	13.43	4	2	23.34	9.31	18.44
4	3	8.88	6.76	10.05	4	3	10.50	8.22	10.41	4	3	3.57	10.09	5.11
4	4	-0.88	4.67	10.90	4	4	7.04	2.90	14.66	4	4	1.96	1.90	12.60
4	5	4.57	10.59	11.66	4	5	13.42	5.22	11.84	4	5	-2.02	0.32	16.41
4	6	10.54	19.39	20.33	4	6	10.55	11.43	15.66	4	6	-8.89	0.44	13.30
5	0	9.76	7.02	5.35	5	0	11.20	6.98	6.41	5	0	9.06	5.20	5.06
5	1	8.34	0.13	-1.26	5	1	3.05	-2.31	-3.24	5	1	17.28	4.05	-2.75
5	2	6.30	3.35	3.28	5	2	2.96	-0.79	-3.23	5	2	16.18	9.03	-1.61
5	3	-5.02	6.60	6.45	5	3	6.68	7.51	9.72	5	3	2.05	6.99	4.93
5	4	0.96	-10.43	-12.73	5	4	10.54	1.87	6.88	5	4	5.19	-0.31	10.49
5	5	2.79	6.36	-0.78	5	5	9.10	9.05	7.67	5	5	-4.92	3.51	13.09
5	6	-0.45	5.73	11.31	5	6	9.38	14.82	16.58	5	6	-8.35	2.03	14.51
6	0	-2.62	-6.53	-4.32	6	0	1.25	-1.28	-1.88	6	0	3.10	-4.10	-0.82
6	1	7.11	1.85	11.94	6	1	5.24	0.74	10.06	6	1	11.14	-2.85	4.30
6	2	-0.75	-6.76	-7.73	6	2	2.72	-4.55	-11.08	6	2	22.99	6.78	-5.58
6	3	2.57	0.43	-2.17	6	3	6.21	4.57	6.55	6	3	-3.38	-0.56	-1.25
6	4	8.34	0.74	-10.34	6	4	16.84	10.63	10.19	6	4	0.77	2.93	15.81
6	5	0.24	9.93	11.36	6	5	9.01	7.67	12.53	6	5	0.26	3.91	18.81
6	6	9.94	13.61	16.90	6	6	9.87	15.98	18.65	6	6	-5.56	2.64	14.36

The best return for Symbol appears to be the zero thresholds, four years of training data, one for price length, and one for volume length snake (0T, 4L, 1/S). Expected yearly return would be 25.05%.

The chart comparing the model's return to the return of the strategies is given below.

Table 6.9 – Percent Returns for Symbol (0,4,1/1) Using Price/Volume & Other Strategies

Price Change										
Values for Thresh = 0, Years=4, Snake=1/1						Cumulative				
Data End	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
92-93	-8.91	-38.97	28.07	-7.23	-8.24	-8.91	-38.97	28.07	-7.23	-8.24
93-94	64.41	81.92	36.47	45.30	46.51	49.77	11.03	74.77	34.79	34.44
94-95	37.91	52.48	6.38	24.69	26.34	106.55	69.31	85.93	68.07	69.85
95-96	-4.76	18.74	3.04	15.71	18.07	96.72	101.03	91.59	94.47	100.55
96-97	2.70	8.06	20.21	0.65	1.31	102.02	117.24	130.31	95.74	103.17
97-98	65.59	63.97	26.10	27.53	30.72	234.52	256.20	190.42	149.64	165.58
98-99	47.23	45.31	13.69	8.18	10.28	392.53	417.58	230.18	170.06	192.88
99-00	136.87	123.72	134.93	60.05	63.21	1066.66	1057.92	675.69	332.23	378.00
00-01	-45.06	-24.12	-39.52	-7.99	-7.74	540.91	778.61	369.12	297.71	341.01
01-02	-23.23	-64.99	-43.01	-35.58	-35.62	392.04	207.58	167.36	156.19	183.92

For the Symbol security the model built on price/volume change outperforms all of the standard scenarios. The graph of the cumulative Symbol data is as follows.

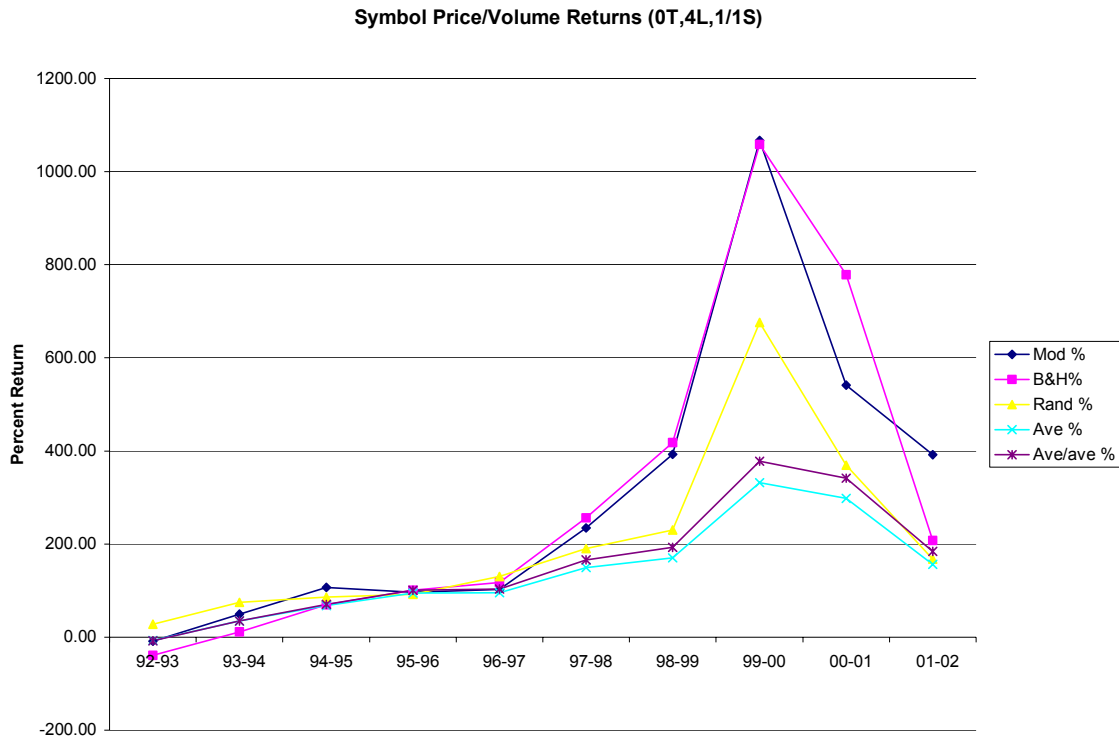


Figure 6.4 – Symbol Returns for 0 Thresh, 4 Year Training & 1/1 Snake Length For Price/Volume Change & Other Strategies

6.3.5 Duke Energy

Next, the model examines Duke Energy with respect to snakes built upon price/volume changes. The high level summaries for yearly returns for Duke Energy built on price/volume snake patterns are as follows.

Tables 6.10 – Percent Returns for Duke Energy with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Price/Volume Change

Years of Data Multiply																																			
Thresh=0		Yr Ave 2			Yr Ave 3			Yr Ave 4			Thresh=3		Yr Ave 2			Yr Ave 3			Yr Ave 4			Thresh=6		Yr Ave 2			Yr Ave 3			Yr Ave 4					
SI	Price	SI	Volume	SI	Price	SI	Volume	SI	Price	SI	Volume	SI	Price	SI	Volume	SI	Price	SI	Volume	SI	Price	SI	Volume	SI	Price	SI	Volume	SI	Price	SI	Volume	SI	Price	SI	Volume
0	2	-1.23	2.13	0.63	0	2	-1.23	2.13	0.63	0	2	-1.23	2.13	0.63	0	2	-1.23	2.13	0.63	0	2	-1.23	2.13	0.63	0	2	-1.23	2.13	0.63	0	2	-1.23	2.13	0.63	
0	3	4.66	6.20	5.78	0	3	4.66	6.20	5.78	0	3	4.66	6.20	5.78	0	3	4.66	6.20	5.78	0	3	4.66	6.20	5.78	0	3	4.66	6.20	5.78	0	3	4.66	6.20	5.78	
0	4	1.77	2.86	1.40	0	4	1.86	2.86	1.40	0	4	1.86	2.86	1.40	0	4	2.06	3.52	1.40	0	4	2.06	3.52	1.40	0	4	2.06	3.52	1.40	0	4	2.06	3.52	1.40	
0	5	6.33	4.98	6.93	0	5	6.13	4.89	6.83	0	5	6.13	4.89	6.83	0	5	6.24	5.01	6.31	0	5	6.24	5.01	6.31	0	5	6.24	5.01	6.31	0	5	6.24	5.01	6.31	
0	6	4.02	1.24	5.61	0	6	3.46	1.03	4.70	0	6	3.46	1.03	4.70	0	6	4.22	-0.32	4.82	0	6	4.22	-0.32	4.82	0	6	4.22	-0.32	4.82	0	6	4.22	-0.32	4.82	
1	0	1.71	0.15	2.14	1	0	1.71	0.15	2.14	1	0	1.71	0.15	2.14	1	0	1.71	0.15	2.14	1	0	1.71	0.15	2.14	1	0	1.71	0.15	2.14	1	0	1.71	0.15	2.14	
1	1	-1.05	6.78	0.74	1	1	-1.05	6.78	0.74	1	1	-1.05	6.78	0.74	1	1	-1.05	6.78	0.74	1	1	-1.05	6.78	0.74	1	1	-1.05	6.78	0.74	1	1	-1.05	6.78	0.74	
1	2	5.69	8.58	4.93	1	2	5.69	8.58	4.93	1	2	5.69	8.58	4.93	1	2	5.69	8.58	4.93	1	2	5.69	8.58	4.93	1	2	5.69	8.58	4.93	1	2	5.69	8.58	4.93	
1	3	8.38	10.62	11.54	1	3	8.74	10.62	11.54	1	3	8.74	10.62	11.54	1	3	8.22	11.07	11.54	1	3	8.22	11.07	11.54	1	3	8.22	11.07	11.54	1	3	8.22	11.07	11.54	
1	4	7.13	4.21	9.41	1	4	8.21	4.23	9.45	1	4	8.21	4.23	9.45	1	4	7.78	4.89	10.14	1	4	7.78	4.89	10.14	1	4	7.78	4.89	10.14	1	4	7.78	4.89	10.14	
1	5	5.54	4.70	6.80	1	5	4.16	4.72	6.91	1	5	4.16	4.72	6.91	1	5	6.74	6.15	6.94	1	5	6.74	6.15	6.94	1	5	6.74	6.15	6.94	1	5	6.74	6.15	6.94	
1	6	7.76	6.33	7.39	1	6	6.72	6.94	7.46	1	6	6.72	6.94	7.46	1	6	7.79	9.60	9.11	1	6	7.79	9.60	9.11	1	6	7.79	9.60	9.11	1	6	7.79	9.60	9.11	
2	0	2.50	7.52	4.19	2	0	2.50	7.52	4.19	2	0	2.50	7.52	4.19	2	0	2.50	7.52	4.19	2	0	2.50	7.52	4.19	2	0	2.50	7.52	4.19	2	0	2.50	7.52	4.19	
2	1	2.79	6.99	8.19	2	1	2.79	6.99	8.19	2	1	2.79	6.99	8.19	2	1	1.51	6.99	8.19	2	1	1.51	6.99	8.19	2	1	1.51	6.99	8.19	2	1	1.51	6.99	8.19	
2	2	5.09	3.10	6.75	2	2	5.43	3.10	6.75	2	2	5.43	3.10	6.75	2	2	5.62	3.20	6.75	2	2	5.62	3.20	6.75	2	2	5.62	3.20	6.75	2	2	5.62	3.20	6.75	
2	3	7.58	12.02	6.46	2	3	8.80	12.36	6.42	2	3	8.80	12.36	6.42	2	3	7.98	12.85	6.86	2	3	7.98	12.85	6.86	2	3	7.98	12.85	6.86	2	3	7.98	12.85	6.86	
2	4	3.64	9.30	7.80	2	4	2.30	8.44	7.10	2	4	2.30	8.44	7.10	2	4	4.85	8.70	6.84	2	4	4.85	8.70	6.84	2	4	4.85	8.70	6.84	2	4	4.85	8.70	6.84	
2	5	5.04	8.07	7.14	2	5	4.36	7.17	6.23	2	5	4.36	7.17	6.23	2	5	5.04	6.30	6.97	2	5	5.04	6.30	6.97	2	5	5.04	6.30	6.97	2	5	5.04	6.30	6.97	
2	6	3.69	4.99	7.10	2	6	3.94	4.92	6.40	2	6	3.94	4.92	6.40	2	6	1.91	4.39	7.50	2	6	1.91	4.39	7.50	2	6	1.91	4.39	7.50	2	6	1.91	4.39	7.50	
3	0	1.53	1.87	2.47	3	0	1.72	1.87	2.47	3	0	1.72	1.87	2.47	3	0	1.72	1.87	2.47	3	0	1.72	1.87	2.47	3	0	1.72	1.87	2.47	3	0	1.72	1.87	2.47	
3	1	7.22	6.80	5.74	3	1	6.54	6.80	5.74	3	1	6.54	6.80	5.74	3	1	6.18	6.75	5.74	3	1	6.18	6.75	5.74	3	1	6.18	6.75	5.74	3	1	6.18	6.75	5.74	
3	2	4.82	4.08	2.82	3	2	4.48	4.67	2.82	3	2	4.48	4.67	2.82	3	2	5.12	5.14	2.94	3	2	5.12	5.14	2.94	3	2	5.12	5.14	2.94	3	2	5.12	5.14	2.94	
3	3	8.54	7.58	6.55	3	3	9.03	9.31	6.93	3	3	9.03	9.31	6.93	3	3	5.53	6.90	5.90	3	3	5.53	6.90	5.90	3	3	5.53	6.90	5.90	3	3	5.53	6.90	5.90	
3	4	1.93	2.73	2.32	3	4	3.81	4.17	3.75	3	4	3.81	4.17	3.75	3	4	4.42	3.60	4.46	3	4	4.42	3.60	4.46	3	4	4.42	3.60	4.46	3	4	4.42	3.60	4.46	
3	5	2.34	3.37	6.02	3	5	0.09	5.59	4.92	3	5	0.09	5.59	4.92	3	5	0.88	3.63	4.21	3	5	0.88	3.63	4.21	3	5	0.88	3.63	4.21	3	5	0.88	3.63	4.21	
3	6	7.92	9.31	5.80	3	6	4.90	6.20	3.46	3	6	4.90	6.20	3.46	3	6	1.95	2.59	4.81	3	6	1.95	2.59	4.81	3	6	1.95	2.59	4.81	3	6	1.95	2.59	4.81	
4	0	7.25	9.61	7.69	4	0	6.84	9.11	7.69	4	0	6.84	9.11	7.69	4	0	7.82	9.07	7.59	4	0	7.82	9.07	7.59	4	0	7.82	9.07	7.59	4	0	7.82	9.07	7.59	
4	1	10.71	7.25	7.74	4	1	9.49	7.01	7.74	4	1	9.49	7.01	7.74	4	1	9.28	5.89	7.83	4	1	9.28	5.89	7.83	4	1	9.28	5.89	7.83	4	1	9.28	5.89	7.83	
4	2	6.63	9.07	6.34	4	2	7.59	8.50	7.17	4	2	7.59	8.50	7.17	4	2	7.17	10.82	7.57	4	2	7.17	10.82	7.57	4	2	7.17	10.82	7.57	4	2	7.17	10.82	7.57	
4	3	5.94	8.00	6.97	4	3	7.43	10.84	7.92	4	3	7.43	10.84	7.92	4	3	4.49	6.68	9.89	4	3	4.49	6.68	9.89	4	3	4.49	6.68	9.89	4	3	4.49	6.68	9.89	
4	4	6.67	8.29	7.41	4	4	8.71	7.54	9.10	4	4	8.71	7.54	9.10	4	4	6.49	9.12	9.51	4	4	6.49	9.12	9.51	4	4	6.49	9.12	9.51	4	4	6.49	9.12	9.51	
4	5	6.50	8.38	8.63	4	5	7.25	7.03	7.10	4	5	7.25	7.03	7.10	4	5	4.47	8.65	6.83	4	5	4.47	8.65	6.83	4	5	4.47	8.65	6.83	4	5	4.47	8.65	6.83	
4	6	4.02	4.01	3.39	4	6	8.52	7.56	7.89	4	6	8.52	7.56	7.89	4	6	4.50	7.06	6.96	4	6	4.50	7.06	6.96	4	6	4.50	7.06	6.96	4	6	4.50	7.06	6.96	
5	0	4.68	3.78	2.00	5	0	5.34	3.53	1.98	5	0	5.34	3.53	1.98	5	0	4.91	3.53	2.00	5	0	4.91	3.53	2.00	5	0	4.91	3.53	2.00	5	0	4.91	3.53	2.00	
5	1	8.06	7.80	9.50	5	1	6.00	7.73	8.97	5	1	6.00	7.73	8.97	5	1	4.75	7.75	9.75	5	1	4.75	7.75	9.75	5	1	4.75	7.75	9.75	5	1	4.75	7.75	9.75	
5	2	5.07	6.11	6.18	5	2	5.23	5.38	5.75	5	2	5.23	5.38	5.75	5	2	6.59	4.45	4.51	5	2	6.59	4.45	4.51	5	2	6.59	4.45	4.51	5	2	6.59	4.45	4.51	
5	3	8.71	11.25	7.65	5	3	5.29	11.12	8.40	5	3	5.29	11.12	8.40	5	3	3.07	7.89	10.44	5	3	3.07	7.89	10.44	5	3	3.07	7.89	10.44	5	3	3.07	7.89	10.44	
5	4	7.66	9.91	10.80	5	4	7.77	7.62	11.75	5	4	7.77	7.62	11.75	5	4	3.30	7.47	7.70	5	4	3.30	7.47	7.70	5	4	3.30	7.47	7.70	5	4	3.30	7.47	7.70	
5	5	8.94	6.13	7.66	5	5	4.60	7.28	9.61	5	5	4.60	7.28	9.61	5	5	3.29	7.93	6.95	5	5	3.29	7.93	6.95	5	5	3.29	7.93	6.95	5	5	3.29	7.93	6.95	
5	6	3.51	9.81	10.51	5	6	7.42	7.69	9.78	5	6	7.42	7.69	9.78	5	6	3.91	8.09	9.64	5	6	3.91	8.09	9.64	5	6	3.91	8.09	9.64	5	6	3.91	8.09	9.64	
6	0	5.04	2.12	2.04	6	0	8.73	3.55	2.42	6	0	8.73	3.55	2.42	6	0	5.91	1.73	1.86	6	0	5.91	1.73	1.86	6	0	5.91	1.73	1.86	6	0	5.91	1.73	1.86	
6	1	7.92	5.21	5.37	6	1	9.18	7.99	6.86	6	1	9.18	7.99	6.86	6	1	4.60	9.58	9.09	6	1	4.60	9.58	9.09	6	1	4.60	9.58	9.09	6	1	4.60	9.58	9.09	
6	2	3.38	3.97	2.70	6	2	5.24	5.99	4.10	6	2	5																							

The chart comparing the model's return to the return of the other competing strategies is given below.

Table 6.11 – Percent Returns for Duke Energy (3,4,6/4) Using Price/Volume & Other Strategies

Price/Volume Change										
Values for Thresh = 3, Years=4, Snake=6/4						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
92-93	6.44	22.25	15.42	10.58	11.79	6.44	22.25	15.42	10.58	11.79
93-94	-11.43	-2.32	-20.34	-9.64	-9.17	-5.72	19.41	-8.06	-0.09	1.54
94-95	-6.69	13.50	14.05	5.01	6.15	-12.03	35.53	4.85	4.92	7.78
95-96	25.94	23.65	2.88	6.74	8.63	10.79	67.58	7.87	11.99	17.09
96-97	5.09	-5.63	-7.50	-9.37	-9.19	16.43	58.15	-0.22	1.50	6.33
97-98	13.90	39.84	0.16	14.42	15.44	32.61	121.16	-0.06	16.13	22.75
98-99	16.99	-0.33	-2.05	-8.53	-9.14	55.14	120.42	-2.11	6.22	11.53
99-00	30.11	12.67	6.03	10.56	10.57	101.85	148.35	3.79	17.44	23.32
00-01	54.08	61.17	8.68	29.04	31.29	211.01	300.28	12.80	51.54	61.91
01-02	13.54	-14.92	11.81	-1.18	-1.48	253.12	240.57	26.12	49.76	59.52

The graph of the cumulative Duke Energy data may be found below.

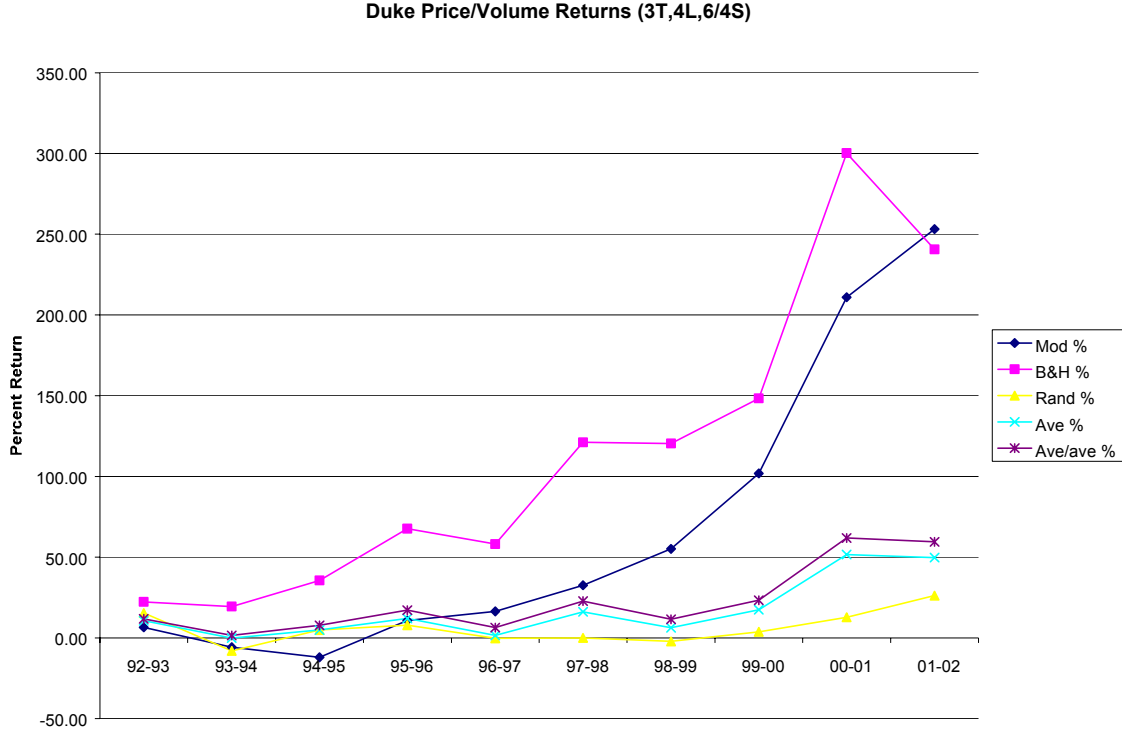


Figure 6.5 – Duke Energy Returns for 3 Thresh, 4 Year Training & 6/4 Snake Length Price/Volume Change & Other Strategies

6.3.6 Bristol Myers Squibb

The model examines Bristol Myers Squibb with respect to snakes built upon price/volume changes. For the Bristol Myers Squibb security, the combination of price and volume snakes does not outperform the model with a price only snake. The best solution is zero threshold, two years training, and a three-length price only snake. These results are shown in chapter 4 for Bristol Myers Squibb and will not be repeated. Later a summary of the best policies will be given.

6.3.7 Intel Corporation

Next, the model examines Intel with respect to snakes built upon price/volume changes. Unlike Bristol Meyers Squibb, Intel does perform better with a combination of price and volume snake pattern. The high level summaries for yearly returns for Intel built on price/volume snake patterns are as follows.

Tables 6.12 – Percent Returns for Intel with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Price/Volume Change

Years of Data Multiply		Yr Ave 2			Yr Ave 3			Yr Ave 4			Yr Ave 2		Yr Ave 3		Yr Ave 4	
SIPrice	SIVolume	SIPrice	SIVolume	SIPrice	SIVolume	SIPrice	SIVolume	SIPrice	SIVolume	SIPrice	SIVolume	SIPrice	SIVolume	SIPrice	SIVolume	
0	2	7.41	6.03	2.28	0	2	7.41	6.03	2.28	0	2	7.41	6.03	2.28		
0	3	7.39	10.24	11.79	0	3	7.39	10.24	11.79	0	3	7.39	10.24	11.79		
0	4	0.55	-0.73	7.62	0	4	0.55	-0.73	7.62	0	4	1.63	-0.73	7.62		
0	5	-0.77	1.35	6.96	0	5	-0.69	1.17	6.96	0	5	0.43	1.65	5.51		
0	6	-1.39	4.25	3.10	0	6	0.13	2.97	2.86	0	6	4.01	3.99	3.54		
1	0	12.38	13.57	12.84	1	0	12.38	13.57	12.84	1	0	12.38	13.57	12.84		
1	1	10.56	11.49	5.90	1	1	10.56	11.49	5.90	1	1	10.56	11.49	5.90		
1	2	25.80	26.32	32.82	1	2	26.73	27.34	32.82	1	2	27.03	28.31	33.93		
1	3	25.14	26.67	26.89	1	3	18.55	23.33	26.47	1	3	21.44	27.34	29.37		
1	4	9.39	5.74	9.90	1	4	8.10	2.36	9.09	1	4	8.38	2.19	10.45		
1	5	11.78	14.72	15.15	1	5	14.25	14.32	14.33	1	5	15.93	16.31	18.54		
1	6	5.63	4.87	5.84	1	6	10.67	6.98	7.76	1	6	16.54	15.39	12.12		
2	0	3.98	12.47	13.16	2	0	3.98	12.47	13.16	2	0	3.98	12.47	13.16		
2	1	4.52	8.50	4.32	2	1	2.29	5.97	1.65	2	1	2.35	6.04	1.72		
2	2	5.84	9.28	12.08	2	2	5.49	9.28	12.08	2	2	7.07	10.11	10.90		
2	3	5.61	15.99	12.41	2	3	6.39	16.63	13.40	2	3	10.39	18.44	13.75		
2	4	5.07	7.33	4.96	2	4	2.48	7.02	7.25	2	4	3.51	1.72	5.81		
2	5	11.46	12.33	11.76	2	5	8.26	11.11	11.91	2	5	8.29	7.10	11.00		
2	6	13.38	9.12	10.89	2	6	13.78	13.80	15.61	2	6	11.44	16.78	11.27		
3	0	14.46	10.21	15.10	3	0	20.25	13.38	15.10	3	0	20.25	13.38	15.10		
3	1	5.96	9.35	4.73	3	1	10.85	10.04	3.02	3	1	10.32	10.64	2.97		
3	2	4.82	13.38	17.76	3	2	5.81	14.83	17.27	3	2	8.78	15.62	17.61		
3	3	4.31	10.35	3.45	3	3	9.29	10.32	4.12	3	3	11.42	12.15	5.33		
3	4	-3.13	5.08	3.34	3	4	0.64	3.98	7.13	3	4	5.29	2.54	4.76		
3	5	-2.18	-2.43	5.89	3	5	4.72	3.27	12.11	3	5	6.18	3.28	8.62		
3	6	11.53	18.31	18.29	3	6	10.20	8.81	13.23	3	6	8.53	7.92	10.95		
4	0	12.19	14.86	17.39	4	0	15.16	16.84	18.59	4	0	15.16	16.84	18.59		
4	1	3.30	7.20	0.68	4	1	4.20	7.95	-0.79	4	1	0.78	6.30	-0.16		
4	2	-2.13	-1.49	5.78	4	2	1.14	1.64	6.10	4	2	3.08	3.53	7.72		
4	3	1.28	8.08	10.79	4	3	7.99	8.45	11.86	4	3	10.17	15.22	12.50		
4	4	1.70	7.65	1.59	4	4	5.74	9.00	5.00	4	4	3.28	2.14	3.59		
4	5	3.53	-0.88	2.50	4	5	10.69	1.87	7.67	4	5	6.67	0.28	6.97		
4	6	11.28	6.17	11.55	4	6	11.10	7.60	11.95	4	6	10.14	4.33	9.38		
5	0	9.14	7.98	6.47	5	0	13.09	12.26	8.09	5	0	12.69	16.04	12.43		
5	1	6.56	8.64	15.08	5	1	12.21	15.62	20.76	5	1	11.03	14.57	20.52		
5	2	6.83	9.83	18.29	5	2	10.94	15.51	24.41	5	2	15.17	15.96	23.87		
5	3	1.71	9.99	8.27	5	3	10.89	11.82	12.12	5	3	12.94	17.49	20.19		
5	4	12.04	17.24	10.97	5	4	11.63	13.93	9.08	5	4	5.73	4.12	6.35		
5	5	2.73	2.53	2.28	5	5	14.87	5.71	10.57	5	5	8.94	2.47	6.22		
5	6	12.82	13.35	14.69	5	6	16.00	10.43	17.40	5	6	11.66	2.68	12.07		
6	0	8.54	7.12	4.77	6	0	14.50	10.39	6.82	6	0	13.07	13.44	9.01		
6	1	6.62	8.06	0.80	6	1	10.77	13.57	9.42	6	1	12.54	17.54	9.86		
6	2	5.13	9.42	8.95	6	2	12.59	15.08	20.14	6	2	13.16	11.99	10.62		
6	3	-6.30	4.80	-1.45	6	3	13.05	16.50	11.86	6	3	14.20	16.03	17.20		
6	4	3.43	3.98	8.17	6	4	10.87	12.62	9.15	6	4	9.46	4.28	9.92		
6	5	7.13	3.45	9.89	6	5	17.41	9.44	12.68	6	5	9.58	1.95	9.32		
6	6	13.95	10.26	12.04	6	6	13.71	14.34	15.01	6	6	10.00	6.16	13.19		

The best return for Intel using the change in daily price/volume appears to be the six threshold, four years of training, one year price, and two year volume length snake (6T, 4L, 1/2S). This value of about 33.93% per year is highlighted in the previous table. The yearly return actually outperforms all other strategies. The chart comparing the model's return to the return of the other competing strategies is given as follows.

Table 6.13 – Percent Returns for Intel (6,4,1/2) Using Price/Volume & Other Strategies

Price/Volume Change										
Values for Thresh = 6, Years=4, Snake=1/2						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
92-93	73.56	81.10	58.52	26.42	30.00	73.56	81.10	58.52	26.42	30.00
93-94	15.98	28.28	28.32	-3.07	-2.19	101.29	132.32	103.41	22.54	27.16
94-95	66.22	67.98	1.41	51.88	54.41	234.58	290.25	106.29	86.11	96.35
95-96	24.90	35.31	0.15	15.46	15.49	317.87	428.05	106.59	114.88	126.76
96-97	149.28	107.74	31.76	46.17	51.90	941.66	996.95	172.19	214.09	244.44
97-98	11.83	11.17	38.76	-2.53	-1.01	1064.93	1119.52	277.70	206.16	240.96
98-99	70.48	55.60	9.14	30.50	34.89	1885.91	1797.57	312.23	299.52	359.91
99-00	60.56	100.84	46.94	64.15	66.45	3088.52	3710.98	505.74	555.83	665.51
00-01	-49.54	-53.55	-7.67	-34.72	-36.41	1508.86	1670.12	459.27	328.14	386.81
01-02	15.40	-1.38	-17.07	0.42	-1.51	1756.58	1645.73	363.81	329.96	379.44

The graph of the cumulative Intel data may be found as follows.

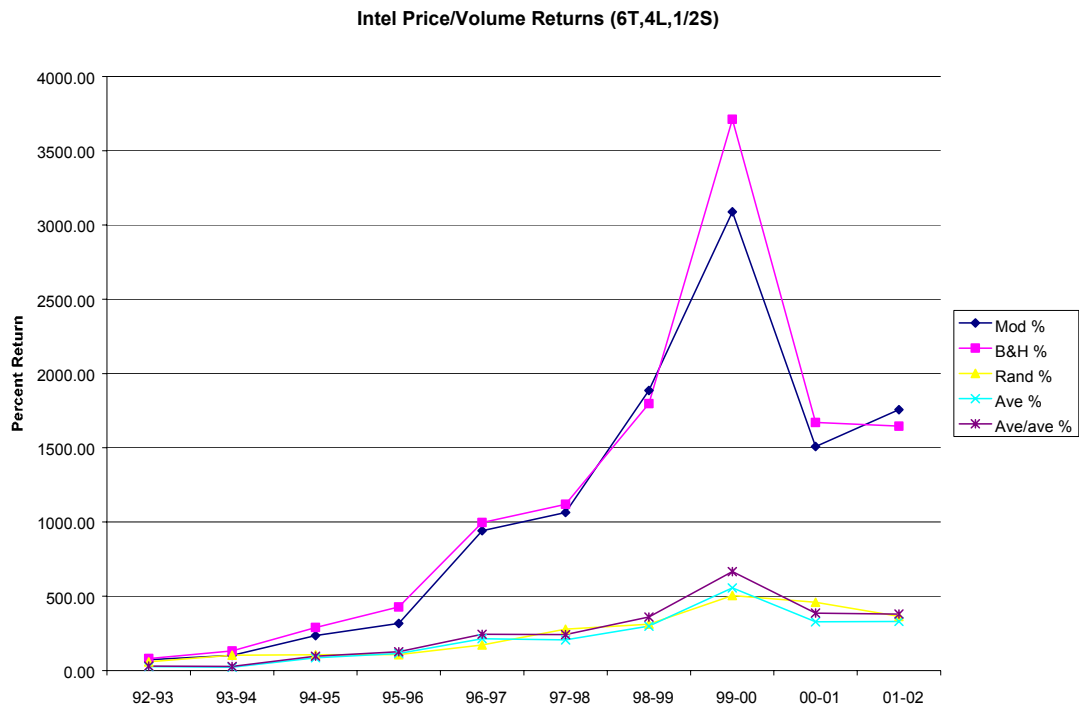


Figure 6.6 – Intel Returns for 6 Thresh, 4 Year Training & 1/2 Snake Length Price/Volume Change & Other Strategies

6.3.8 Lucent Technologies

The model examines Lucent with respect to snakes built upon price/volume changes. The high level summaries for yearly returns for Lucent built on volume snake patterns are as follows.

Tables 6.14 – Percent Returns for Lucent with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Price/Volume Change

		Years of Data Multiply																						
Thresh=0		Yr Ave 2			Yr Ave 3			Yr Ave 4			Thresh=3		Yr Ave 2			Yr Ave 3			Yr Ave 4					
SIPrice	SIVolume										SIPrice	SIVolume							SIPrice	SIVolume				
0	2	-14.07	-31.02	-63.59	0	2	-14.07	-31.02	-63.59	0	2	-14.07	-31.02	-63.59	0	2	-14.07	-31.02	-63.59	0	2	-14.07	-31.02	-63.59
0	3	-4.82	-44.99	-60.59	0	3	-4.82	-44.99	-60.59	0	3	-4.82	-44.99	-60.59	0	3	-4.82	-44.99	-60.59	0	3	-4.82	-44.99	-60.59
0	4	-22.49	-41.00	-68.58	0	4	-22.49	-41.00	-68.58	0	4	-22.49	-41.00	-68.58	0	4	-20.46	-41.00	-68.58	0	4	-20.46	-41.00	-68.58
0	5	-8.71	-37.74	-63.90	0	5	-8.28	-37.74	-63.90	0	5	-8.55	-37.74	-63.90	0	5	-8.55	-37.74	-63.90	0	5	-8.55	-37.74	-63.90
0	6	-28.22	-44.34	-60.27	0	6	-31.18	-44.34	-60.27	0	6	-28.19	-47.37	-59.63	0	6	-28.19	-47.37	-59.63	0	6	-28.19	-47.37	-59.63
1	0	-3.31	-27.86	-42.69	1	0	-3.31	-27.86	-42.69	1	0	-3.31	-27.86	-42.69	1	0	-3.31	-27.86	-42.69	1	0	-3.31	-27.86	-42.69
1	1	10.93	-3.81	-40.11	1	1	10.93	-3.81	-40.11	1	1	10.93	-3.81	-40.11	1	1	10.93	-3.81	-40.11	1	1	10.93	-3.81	-40.11
1	2	-14.60	-31.07	-50.49	1	2	-14.60	-31.07	-50.49	1	2	-14.60	-31.07	-50.49	1	2	-14.60	-31.07	-50.49	1	2	-14.60	-31.07	-50.49
1	3	-11.41	-7.60	-33.35	1	3	-11.41	-7.60	-33.35	1	3	-11.41	-7.60	-33.35	1	3	-11.41	-7.60	-33.35	1	3	-11.41	-7.60	-33.35
1	4	-29.52	-40.19	-66.61	1	4	-29.52	-40.19	-66.61	1	4	-28.57	-38.22	-66.61	1	4	-28.57	-38.22	-66.61	1	4	-28.57	-38.22	-66.61
1	5	-26.18	-36.92	-62.48	1	5	-25.51	-37.86	-62.48	1	5	-25.51	-37.86	-62.48	1	5	-14.27	-37.64	-63.42	1	5	-14.27	-37.64	-63.42
1	6	-27.52	-28.77	-53.56	1	6	-31.53	-36.13	-58.38	1	6	-27.89	-26.66	-57.98	1	6	-27.89	-26.66	-57.98	1	6	-27.89	-26.66	-57.98
2	0	-16.82	-48.86	-56.13	2	0	-16.82	-48.86	-56.13	2	0	-16.82	-48.86	-56.13	2	0	-16.82	-48.86	-56.13	2	0	-16.82	-48.86	-56.13
2	1	-8.77	-35.01	-60.10	2	1	-8.77	-35.01	-60.10	2	1	-8.77	-35.01	-60.10	2	1	-8.77	-35.01	-60.10	2	1	-8.77	-35.01	-60.10
2	2	8.84	-7.58	-33.29	2	2	8.84	-7.58	-33.29	2	2	8.84	-7.58	-33.29	2	2	8.84	-7.58	-33.29	2	2	8.84	-7.58	-33.29
2	3	-15.74	-24.01	-39.00	2	3	-13.85	-24.01	-39.00	2	3	-16.78	-23.81	-39.00	2	3	-16.78	-23.81	-39.00	2	3	-16.78	-23.81	-39.00
2	4	-28.53	-40.32	-58.12	2	4	-25.43	-39.73	-58.12	2	4	-19.53	-31.34	-55.14	2	4	-19.53	-31.34	-55.14	2	4	-19.53	-31.34	-55.14
2	5	-26.65	-33.86	-53.31	2	5	-10.63	-32.87	-55.03	2	5	-27.59	-16.53	-48.02	2	5	-27.59	-16.53	-48.02	2	5	-27.59	-16.53	-48.02
2	6	-16.04	-17.97	-27.21	2	6	-14.25	-32.67	-44.59	2	6	-22.72	-27.81	-51.36	2	6	-22.72	-27.81	-51.36	2	6	-22.72	-27.81	-51.36
3	0	-8.19	-33.35	-53.01	3	0	-8.19	-33.35	-53.01	3	0	-8.19	-33.35	-53.01	3	0	-8.19	-33.35	-53.01	3	0	-8.19	-33.35	-53.01
3	1	-19.95	-33.95	-42.93	3	1	-19.95	-33.95	-42.93	3	1	-19.95	-33.95	-42.93	3	1	-19.95	-33.95	-42.93	3	1	-19.95	-33.95	-42.93
3	2	2.89	-5.47	-19.14	3	2	2.98	-5.47	-19.14	3	2	7.85	-6.38	-19.14	3	2	7.85	-6.38	-19.14	3	2	7.85	-6.38	-19.14
3	3	-16.46	-17.53	-31.52	3	3	-19.83	-17.53	-31.52	3	3	-19.91	-23.15	-31.52	3	3	-19.91	-23.15	-31.52	3	3	-19.91	-23.15	-31.52
3	4	-17.22	-35.22	-55.04	3	4	-25.23	-23.82	-55.27	3	4	-20.95	-31.76	-52.12	3	4	-20.95	-31.76	-52.12	3	4	-20.95	-31.76	-52.12
3	5	-16.34	-31.53	-44.75	3	5	-1.05	-24.35	-40.22	3	5	-6.38	-18.32	-42.66	3	5	-6.38	-18.32	-42.66	3	5	-6.38	-18.32	-42.66
3	6	-21.96	-25.51	-34.33	3	6	-18.39	-27.80	-44.69	3	6	-14.08	-23.14	-45.89	3	6	-14.08	-23.14	-45.89	3	6	-14.08	-23.14	-45.89
4	0	-11.41	-38.22	-61.18	4	0	-11.41	-38.22	-61.18	4	0	-11.41	-38.22	-61.18	4	0	-11.41	-38.22	-61.18	4	0	-11.41	-38.22	-61.18
4	1	-25.14	-36.85	-50.60	4	1	-25.14	-36.85	-50.60	4	1	-25.18	-36.85	-50.60	4	1	-25.18	-36.85	-50.60	4	1	-25.18	-36.85	-50.60
4	2	5.07	-15.49	-32.62	4	2	5.40	-13.85	-32.62	4	2	-2.35	-7.91	-30.66	4	2	-2.35	-7.91	-30.66	4	2	-2.35	-7.91	-30.66
4	3	-20.73	3.03	-36.02	4	3	-22.35	-0.10	-30.61	4	3	-29.46	-13.00	-21.24	4	3	-29.46	-13.00	-21.24	4	3	-29.46	-13.00	-21.24
4	4	-14.69	-30.79	-49.07	4	4	-24.01	-30.51	-60.43	4	4	-21.78	-27.83	-46.19	4	4	-21.78	-27.83	-46.19	4	4	-21.78	-27.83	-46.19
4	5	-28.62	-27.69	-56.52	4	5	-18.81	-27.03	-55.04	4	5	-22.79	-24.52	-50.10	4	5	-22.79	-24.52	-50.10	4	5	-22.79	-24.52	-50.10
4	6	-6.87	-25.05	-33.66	4	6	-22.68	-28.59	-52.00	4	6	-28.10	-22.73	-45.60	4	6	-28.10	-22.73	-45.60	4	6	-28.10	-22.73	-45.60
5	0	-15.63	-29.99	-47.94	5	0	-15.63	-29.99	-47.94	5	0	-15.63	-29.99	-47.94	5	0	-15.63	-29.99	-47.94	5	0	-15.63	-29.99	-47.94
5	1	-22.88	-34.05	-46.06	5	1	-14.99	-35.52	-46.06	5	1	-13.70	-30.99	-45.19	5	1	-13.70	-30.99	-45.19	5	1	-13.70	-30.99	-45.19
5	2	-4.58	-21.83	-36.44	5	2	-0.13	-14.31	-37.83	5	2	-17.56	-15.16	-20.50	5	2	-17.56	-15.16	-20.50	5	2	-17.56	-15.16	-20.50
5	3	-32.60	-36.83	-49.46	5	3	-20.85	-11.01	-34.52	5	3	-17.43	-31.54	-24.46	5	3	-17.43	-31.54	-24.46	5	3	-17.43	-31.54	-24.46
5	4	-11.21	-15.63	-20.23	5	4	-21.60	-29.11	-55.96	5	4	-20.08	-35.51	-40.27	5	4	-20.08	-35.51	-40.27	5	4	-20.08	-35.51	-40.27
5	5	-19.78	-22.79	-37.96	5	5	-30.45	-33.04	-54.66	5	5	-22.58	-28.76	-45.96	5	5	-22.58	-28.76	-45.96	5	5	-22.58	-28.76	-45.96
5	6	-13.59	-29.26	-44.92	5	6	-27.02	-36.70	-55.27	5	6	-16.14	-25.48	-43.60	5	6	-16.14	-25.48	-43.60	5	6	-16.14	-25.48	-43.60
6	0	-33.06	-37.64	-47.83	6	0	-34.78	-37.64	-47.83	6	0	-23.51	-38.70	-47.83	6	0	-23.51	-38.70	-47.83	6	0	-23.51	-38.70	-47.83
6	1	-35.19	-45.51	-53.55	6	1	-8.60	-43.45	-51.42	6	1	-11.76	-30.05	-47.47	6	1	-11.76	-30.05	-47.47	6	1	-11.76	-30.05	-47.47
6	2	-34.05	-39.56	-53.77	6	2	3.11	-19.88	-50.88	6	2	-9.70	-12.56	-29.43	6	2	-9.70	-12.56	-29.43	6	2	-9.70	-12.56	-29.43
6	3	-40.03	-51.73	-58.82	6	3	-24.11	-20.00	-46.30	6	3	-24.26	-43.72	-32.22	6	3	-24.26	-43.72	-32.22	6	3	-24.26	-43.72	-32.22
6	4	-37.40	-44.12	-57.16	6	4	-19.14	-34.36	-59.27	6	4	-20.28	-37.23	-48.00	6	4	-20.28	-37.23	-48.00	6	4	-20.28	-37.23	-48.00
6	5	-42.43	-36.83	-54.15	6	5	-26.42	-33.59	-58.53	6	5	-23.17	-27.73	-49.12	6	5	-23.17	-27.73	-49.12	6	5	-23.17	-27.73	-49.12
6	6	-25.86	-42.61	-49.75	6	6	-25.16	-40.22	-59.33	6	6	-17.78	-26.58	-48.27	6	6	-17.78	-26.58	-48.27	6	6	-17.78	-26.58	-48.27

The best return for Lucent using the change in daily price/volume appears to be the zero threshold, two years of training, one for price length, and a one for volume length snake (0T, 2L, 1/1S). This value of about 10.93% per year is highlighted in the previous table. This return is better than the return generated with a previously pure price and pure volume models. In addition, this combination model provides a positive return.

The chart comparing the model's return to the return of the other competing strategies is given below.

Table 6.15 – Percent Returns for Lucent (0,2,1/1) Using Price/Volume & Other Strategies

Price/Volume Change										
Values for Thresh = 0, Years=2, Snake=1/1						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
98-99	73.80	70.15	35.94	39.82	44.55	73.80	70.15	35.94	39.82	44.55
99-00	13.72	4.59	2.65	0.63	-0.06	97.65	77.96	39.54	40.69	44.46
00-01	-46.94	-82.96	-60.31	-55.37	-59.34	4.87	-69.67	-44.62	-37.21	-41.27
01-02	-16.66	-55.48	-31.32	-31.74	-34.11	-12.60	-86.50	-61.96	-57.14	-61.30

The graph of the cumulative Lucent data may be found as follows.

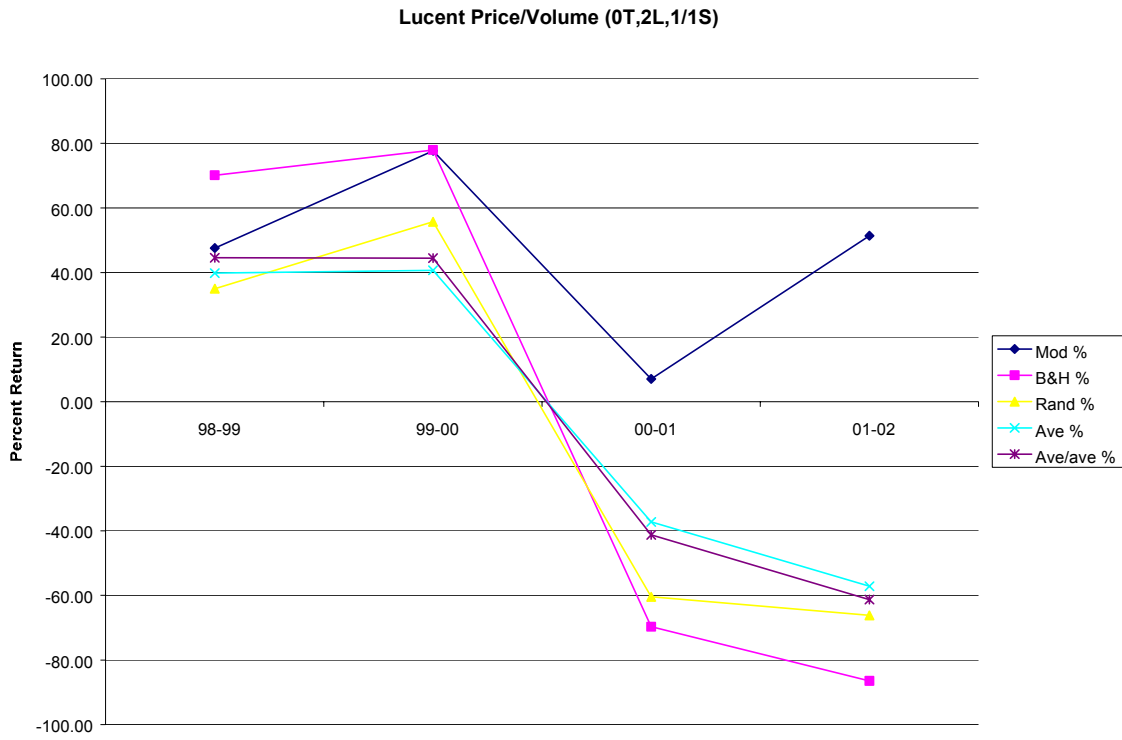


Figure 6.7 – Lucent Returns for 0 Thresh, 2 Year Training & 1/1 Snake Length Price/Volume Change & Other Strategies

6.3.9 OMI Corporation

Next the model examines OMI Corporation with respect to snakes built upon price/volume changes. The high level summaries for yearly returns for OMI Corporation built on price/volume snake patterns are as follows.

Tables 6.16 – Percent Returns for OMI Corporation with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Price/Volume Change

Thresh=0		Years of Data Multiply			Thresh=3		Thresh=6							
SIPrice	SIVolume	Yr Ave 2	Yr Ave 3	Yr Ave 4	SIPrice	SIVolume	Yr Ave 2	Yr Ave 3	Yr Ave 4	SIPrice	SIVolume	Yr Ave 2	Yr Ave 3	Yr Ave 4
0	2	-17.56	-10.15	-4.36	0	2	-17.56	-10.15	-4.36	0	2	-17.56	-10.15	-4.36
0	3	-20.12	-11.68	-5.61	0	3	-20.12	-11.68	-5.61	0	3	-20.12	-11.68	-5.61
0	4	-13.37	-22.79	-22.45	0	4	-13.18	-22.79	-22.45	0	4	-11.83	-20.49	-20.10
0	5	-13.73	-16.84	-9.06	0	5	-14.29	-16.41	-9.05	0	5	-8.93	-12.39	-7.62
0	6	-15.96	-9.28	-5.49	0	6	-15.21	-9.26	-5.00	0	6	-15.02	-2.75	0.98
1	0	-11.67	-3.03	0.50	1	0	-11.67	-3.03	0.50	1	0	-11.67	-3.03	0.50
1	1	-9.47	-5.76	-5.83	1	1	-9.47	-5.76	-5.83	1	1	-9.47	-5.76	-5.83
1	2	-11.06	-6.24	-10.43	1	2	-11.06	-6.24	-10.43	1	2	-11.06	-6.24	-10.43
1	3	-16.50	-14.05	-16.86	1	3	-16.50	-14.05	-16.86	1	3	-16.74	-13.86	-16.86
1	4	-10.46	-20.89	-10.26	1	4	-9.84	-22.01	-12.24	1	4	-6.28	-21.04	-11.08
1	5	-13.13	-20.56	-17.76	1	5	-17.09	-21.53	-24.18	1	5	-18.71	-23.83	-23.91
1	6	-7.60	-13.52	-27.07	1	6	-6.66	-11.85	-30.28	1	6	-23.82	-7.47	-28.31
2	0	-6.26	-18.49	-17.46	2	0	-6.26	-18.49	-17.46	2	0	-6.26	-18.49	-17.46
2	1	-18.03	-11.80	-13.05	2	1	-18.03	-11.80	-13.05	2	1	-18.03	-11.80	-13.05
2	2	-10.59	-16.68	-12.91	2	2	-10.59	-16.68	-12.91	2	2	-9.70	-16.68	-12.91
2	3	-13.07	-22.23	-16.91	2	3	-13.58	-22.23	-16.93	2	3	-12.31	-20.70	-16.93
2	4	7.70	1.62	-18.31	2	4	1.93	-1.59	-18.35	2	4	0.57	3.43	-23.08
2	5	0.67	-7.57	-0.09	2	5	8.22	-8.04	1.82	2	5	-5.25	-6.86	-12.31
2	6	-12.25	-13.57	-27.11	2	6	-4.91	-9.75	-15.56	2	6	-16.63	-15.37	-24.33
3	0	-16.05	-13.87	-28.88	3	0	-16.05	-13.87	-28.88	3	0	-16.05	-13.87	-28.88
3	1	-11.70	-10.13	-22.67	3	1	-11.70	-10.13	-22.67	3	1	-11.70	-10.13	-22.67
3	2	-4.11	1.28	-4.19	3	2	-4.50	1.49	-4.19	3	2	-5.09	0.86	-3.00
3	3	-4.61	-12.57	-28.36	3	3	-7.76	-12.64	-30.82	3	3	-8.16	-10.30	-30.37
3	4	-1.72	-3.03	-17.83	3	4	-4.02	1.86	-17.83	3	4	0.17	-1.00	-20.14
3	5	-6.86	0.67	-9.48	3	5	-8.56	-6.87	-13.40	3	5	-3.80	-4.14	-18.57
3	6	-20.32	-20.69	-26.61	3	6	-7.01	-12.47	-28.18	3	6	-12.34	-12.32	-15.07
4	0	-12.83	-11.80	-23.99	4	0	-12.83	-11.80	-23.99	4	0	-11.24	-11.80	-23.99
4	1	2.24	-5.72	-22.03	4	1	2.94	-6.77	-22.03	4	1	1.62	-7.29	-22.49
4	2	-6.73	-5.21	-16.72	4	2	-7.29	-7.76	-17.98	4	2	-5.46	-9.74	-19.71
4	3	-14.13	-18.05	-21.74	4	3	-11.07	-15.02	-23.43	4	3	-10.25	-13.00	-23.41
4	4	-2.97	-9.04	-26.49	4	4	-4.65	-6.56	-24.92	4	4	-6.32	-2.72	-25.96
4	5	-9.61	-2.05	-14.26	4	5	-11.56	-10.99	-19.60	4	5	-10.14	-5.02	-22.59
4	6	-11.04	-12.85	-21.81	4	6	-7.07	-10.89	-18.80	4	6	-17.14	-3.42	-15.86
5	0	-11.41	-4.32	-20.49	5	0	-11.49	-6.69	-20.49	5	0	-11.36	-6.78	-22.90
5	1	-6.44	-11.00	-27.73	5	1	-10.22	-12.77	-27.63	5	1	-8.12	-12.67	-27.11
5	2	-11.04	-10.22	-17.84	5	2	-8.47	-7.48	-16.45	5	2	-4.95	-11.41	-14.62
5	3	-25.66	-21.21	-31.80	5	3	-27.77	-23.83	-30.83	5	3	-16.11	-22.54	-35.28
5	4	-17.81	-24.30	-19.78	5	4	-5.62	-22.69	-33.12	5	4	-9.03	-11.28	-28.63
5	5	-9.87	-20.38	-24.46	5	5	-7.33	-18.98	-28.89	5	5	-13.59	-6.90	-23.81
5	6	10.05	-4.16	-22.70	5	6	-0.45	-21.75	-28.91	5	6	-17.73	-8.21	-21.87
6	0	-12.98	-10.03	-15.42	6	0	-13.20	-10.27	-16.63	6	0	-14.87	-12.84	-21.01
6	1	-1.01	-8.24	-19.98	6	1	-11.49	-14.92	-21.49	6	1	-7.44	-16.39	-26.15
6	2	-18.60	-12.90	-20.93	6	2	-14.75	-5.68	-16.15	6	2	-14.66	-9.82	-15.87
6	3	-30.12	-22.77	-33.40	6	3	-30.13	-27.73	-28.32	6	3	-15.83	-19.99	-37.59
6	4	-21.20	-26.60	-28.15	6	4	-6.58	-28.87	-34.67	6	4	-6.83	-8.58	-26.41
6	5	0.99	-1.33	12.44	6	5	-5.85	-20.47	-26.83	6	5	-10.06	-4.34	-23.85
6	6	19.47	15.49	8.44	6	6	-2.54	-18.39	-32.33	6	6	-14.94	-5.31	-22.35

The best return for OMI Corporation using the change in daily price/volume appears to be the zero threshold, two years of training, six length price, and a six length snake (0T, 2L, 6/6S). This value of about 19.47% per year is highlighted in the table above. This return is greater than the return generated with a previously pure price and volume models.

Furthermore, using the combination of price/volume the model greatly outperforms all other strategies. This is revealed in the cumulative graph provided on the next page.

The chart comparing the model's return to the return of the other competing strategies excluding the previous price only model is given below.

Table 6.17 – Percent Returns for OMI Corporation (0,2,6/6) Using Price/Volume & Other Strategies

Price/Volume Change										
Values for Thresh = 0, Years=2, Snake=6/6						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
94-95	-6.82	-11.54	-21.00	-7.67	-8.46	-6.82	-11.54	-21.00	-7.67	-8.46
95-96	49.81	41.22	44.27	21.76	22.76	39.60	24.92	13.98	12.42	12.38
96-97	-6.03	24.63	12.45	18.11	20.19	31.18	55.69	28.17	32.77	35.07
97-98	20.79	-12.95	-7.07	-12.33	-13.75	58.45	35.54	19.10	16.40	16.50
98-99	-46.04	-72.99	-54.10	-31.10	-38.21	-14.50	-63.38	-45.33	-19.80	-28.01
99-00	97.83	28.57	55.55	31.54	33.27	69.14	-52.92	-14.96	5.50	-4.06
00-01	112.80	156.54	8.94	44.77	40.97	259.93	20.77	-7.36	52.73	35.24
01-02	15.28	-38.22	-45.75	6.34	5.82	314.91	-25.38	-49.74	62.42	43.11

The graph of the cumulative OMI Corporation data may be found on the following page.

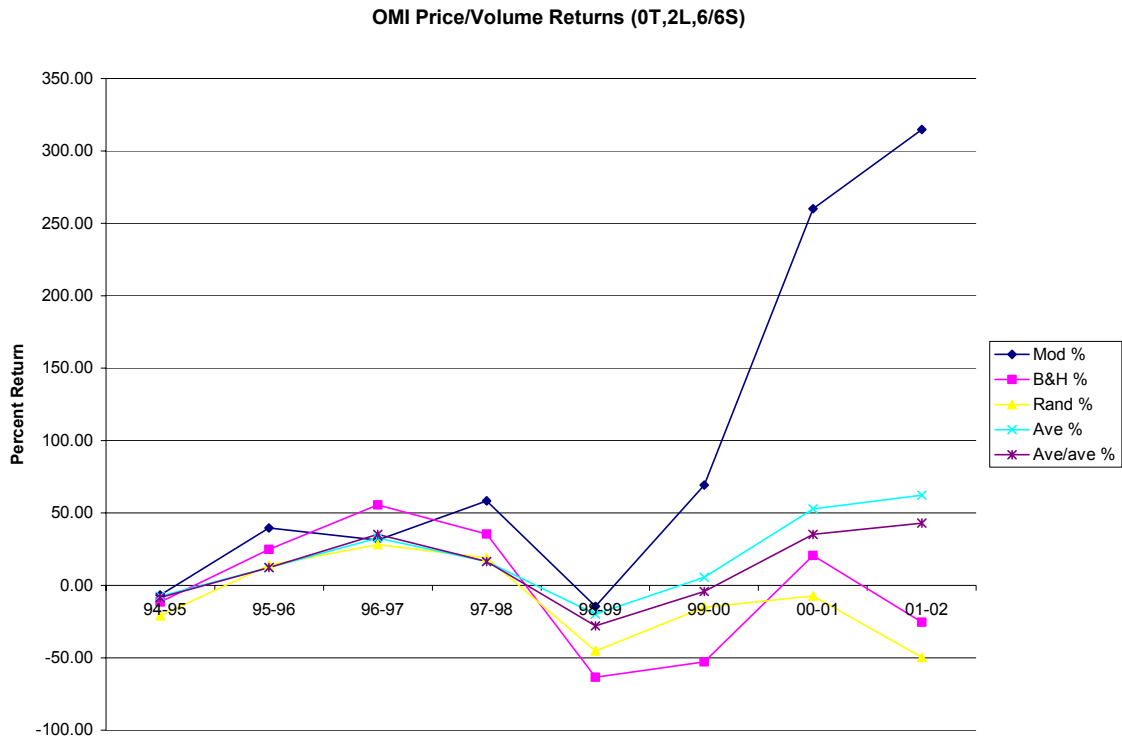


Figure 6.8 – OMI Corporation Returns for 0 Thresh, 2 Year Training & 6/6 Snake Length Price/Volume Change & Other Strategies

For OMI the model has strong years in 1999 through 2002.

6.3.10 AT&T

The model examines AT&T with respect to snakes built upon price/volume changes. For AT&T the combination model did not outperform the price only model. That is, the 2-length pure price snake provides the best cumulative returns. These results have been shown in chapter 4 for AT&T and will not be repeated.

6.3.11 General Electric

For General Electric a pure volume state definition provides the best returns. These results reside in Chapter 5. General Electric yields the best returns for a 5 length volume based model.

6.3.12 AOL Time Warner

Next the model examines AOL Time Warner with respect to snakes built upon price/volume changes. The high level summaries for yearly returns for AOL Time Warner built on price/volume snake patterns are as follows.

Tables 6.18 – Percent Returns for AOL Time Warner with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Price/Volume Change

Years of Data Multiply		Yr Ave 2			Yr Ave 3			Yr Ave 4			Yr Ave 2		Yr Ave 3		Yr Ave 4	
Thresh=0		Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=3		Yr Ave 2	Yr Ave 3	Yr Ave 4	Thresh=6		Yr Ave 2	Yr Ave 3	Yr Ave 4		
SI	SV	SI	SV	SI	SI	SV	SI	SV	SI	SV	SI	SV	SI	SV		
0	2	15.96	20.51	9.89	0	2	15.96	20.51	9.89	0	2	15.96	20.51	9.89		
0	3	3.31	14.21	14.19	0	3	3.31	14.21	14.19	0	3	3.31	14.21	14.19		
0	4	29.00	24.81	40.81	0	4	11.06	24.81	40.81	0	4	6.07	17.26	40.81		
0	5	17.06	11.98	24.54	0	5	7.31	11.98	24.54	0	5	0.59	9.60	25.38		
0	6	4.48	12.25	14.09	0	6	8.14	14.47	15.82	0	6	11.33	11.72	24.45		
1	0	39.58	42.25	28.87	1	0	39.58	42.25	28.87	1	0	39.58	42.25	28.87		
1	1	39.53	34.37	19.00	1	1	39.38	36.25	19.00	1	1	39.38	36.25	19.00		
1	2	42.74	65.98	52.86	1	2	39.69	68.98	52.86	1	2	39.62	67.73	51.54		
1	3	56.49	60.88	54.07	1	3	49.07	66.89	55.44	1	3	48.99	65.64	54.07		
1	4	39.79	48.26	28.53	1	4	32.04	50.27	26.44	1	4	32.12	50.47	29.77		
1	5	40.96	44.36	44.85	1	5	34.04	49.90	39.24	1	5	31.03	49.94	43.62		
1	6	12.84	18.38	13.91	1	6	27.39	29.99	13.30	1	6	27.25	34.41	16.79		
2	0	32.57	49.38	41.13	2	0	31.18	49.38	41.13	2	0	33.72	52.69	41.13		
2	1	43.81	55.66	46.77	2	1	40.76	53.74	46.77	2	1	46.07	60.39	46.77		
2	2	31.72	31.07	43.76	2	2	30.59	36.57	45.49	2	2	41.03	51.49	48.82		
2	3	22.55	22.23	27.00	2	3	26.83	32.46	27.30	2	3	35.52	46.18	30.19		
2	4	32.21	35.05	31.13	2	4	37.34	43.17	28.35	2	4	32.70	40.40	25.75		
2	5	28.95	16.28	8.04	2	5	36.40	25.92	11.54	2	5	25.83	33.28	13.06		
2	6	15.49	10.17	-6.77	2	6	26.87	16.20	3.55	2	6	22.16	14.05	-1.00		
3	0	24.74	26.17	19.07	3	0	25.27	28.32	19.07	3	0	24.75	27.71	19.07		
3	1	63.62	76.17	67.96	3	1	68.18	85.30	70.52	3	1	69.84	88.71	70.52		
3	2	36.93	40.83	30.68	3	2	37.80	48.69	28.10	3	2	49.57	55.93	28.51		
3	3	25.24	24.79	27.00	3	3	22.77	35.44	24.65	3	3	22.28	38.95	28.02		
3	4	29.10	36.74	27.53	3	4	35.05	34.99	14.86	3	4	29.91	32.87	19.78		
3	5	33.06	26.07	19.87	3	5	36.35	49.53	26.42	3	5	34.69	27.38	13.85		
3	6	22.01	20.23	1.22	3	6	19.74	36.92	19.65	3	6	25.98	15.05	3.60		
4	0	45.81	43.35	36.86	4	0	49.96	49.92	36.85	4	0	53.11	54.58	35.48		
4	1	31.53	45.99	39.33	4	1	38.28	57.41	38.33	4	1	39.49	63.30	38.93		
4	2	47.80	53.32	64.74	4	2	37.60	49.03	54.07	4	2	51.24	55.17	50.90		
4	3	25.26	49.25	55.11	4	3	24.92	46.53	35.39	4	3	33.38	47.78	37.92		
4	4	21.00	16.51	17.94	4	4	42.11	39.48	25.09	4	4	31.19	24.48	7.19		
4	5	32.47	21.58	17.62	4	5	40.61	44.31	20.79	4	5	25.56	28.19	6.38		
4	6	14.27	14.98	4.19	4	6	28.48	32.05	7.12	4	6	22.92	23.15	4.97		
5	0	52.43	51.81	46.29	5	0	51.24	51.92	45.40	5	0	56.19	60.36	49.40		
5	1	41.02	50.62	44.58	5	1	57.99	64.73	44.98	5	1	56.43	67.73	43.46		
5	2	47.85	52.13	47.12	5	2	58.94	79.19	64.85	5	2	64.15	67.94	48.83		
5	3	7.25	16.28	27.69	5	3	32.31	38.81	22.62	5	3	35.04	35.33	31.58		
5	4	14.14	12.14	19.47	5	4	32.32	32.95	7.75	5	4	26.06	16.03	-2.57		
5	5	14.54	4.02	-2.04	5	5	25.38	34.17	8.71	5	5	16.93	14.61	-2.13		
5	6	-3.21	-14.96	-18.97	5	6	29.65	34.04	9.72	5	6	19.49	14.78	3.43		
6	0	22.93	31.19	19.54	6	0	20.94	27.51	21.75	6	0	22.67	33.16	24.62		
6	1	52.91	54.78	48.41	6	1	51.89	60.94	50.11	6	1	54.21	54.15	31.79		
6	2	29.75	34.15	30.69	6	2	30.17	40.83	39.79	6	2	65.93	58.25	39.87		
6	3	12.15	22.11	16.70	6	3	21.00	22.98	7.72	6	3	27.78	35.86	32.85		
6	4	13.82	7.00	8.70	6	4	30.53	20.64	2.35	6	4	26.35	20.24	7.63		
6	5	7.94	-4.78	-15.06	6	5	28.17	28.89	7.52	6	5	23.49	20.64	4.08		
6	6	4.32	-7.94	-16.67	6	6	29.91	27.27	6.83	6	6	20.70	18.99	7.44		

The best return for AOL Time Warner using the change in daily price/volume appears to be the six threshold, three years of training, three length price, and a one length volume snake (6T, 3L, 3/1S). This value of about 88.71% per year is highlighted in the previous table.

This return is greater than the return generated with a previously pure price or pure volume models. Furthermore, the yearly return of the combination model outperforms all other strategies.

The chart comparing the model's return to the return of the other competing strategies is given in the following table.

Table 6.19 – Percent Returns for AOL Time Warner (6,3,3/1) Using Price/Volume & Other Strategies

Price/Volume Change										
Values for Thresh = 6, Years=3, Snake=3/1						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
95-96	226.91	184.83	-35.48	96.51	102.91	226.91	184.83	-35.48	96.51	102.91
96-97	-12.01	-35.35	-52.19	13.78	13.76	187.63	84.14	-69.15	123.59	130.82
97-98	232.17	241.20	109.97	92.05	96.99	855.41	528.28	-35.22	329.40	354.70
98-99	352.99	739.74	260.56	340.91	378.51	4227.93	5175.89	133.56	1793.27	2075.78
99-00	54.98	-20.26	-52.56	0.35	1.22	6607.43	4106.94	10.81	1799.82	2102.30
00-01	32.40	-18.85	9.97	0.67	-3.24	8780.30	3313.85	21.85	1812.51	2031.05
01-02	-4.02	-60.83	-60.40	-44.37	-45.70	8423.67	1237.27	-51.75	963.97	1057.27

The graph of the cumulative AOL Time Warner data may be found on the following page.

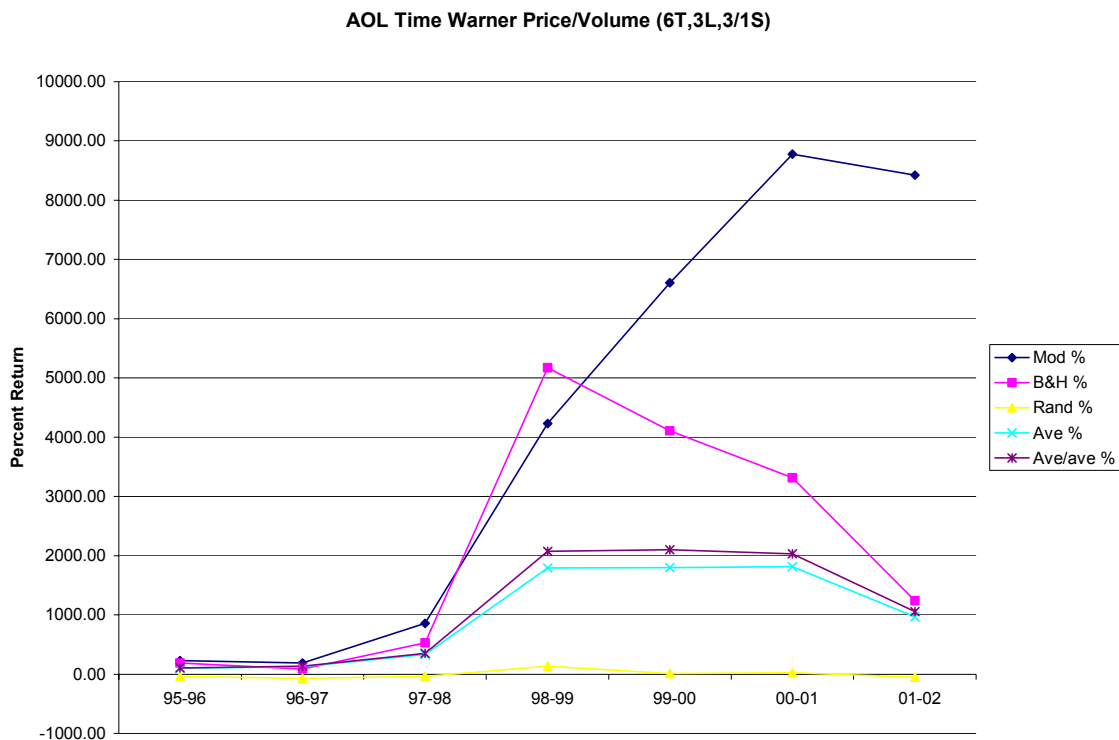


Figure 6.9 – AOL Time Warner Returns for 6 Thresh, 3 Year Training & 3/1 Snake Length Price/Volume Change & Other Strategies

6.3.13 Home Depot

The model examines Home Depot with respect to snakes built upon price/volume changes. The high level summaries for yearly returns for Home Depot built on price/volume snake patterns are on the following page.

Tables 6.20 – Percent Returns for Home Depot with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Price/Volume Change

Years of Data Multiply		Yr Ave 2			Yr Ave 3			Yr Ave 4			Yr Ave 2		Yr Ave 3		Yr Ave 4	
Thresh=0	SIPrice	SIVolume	SIPrice	SIVolume	SIPrice	SIVolume	SIPrice	SIVolume	SIPrice	SIVolume	SIPrice	SIVolume	SIPrice	SIVolume	SIPrice	SIVolume
0	0	2	10.41	10.67	11.59	0	2	10.41	10.67	11.59	0	2	10.41	10.67	11.59	11.59
0	0	3	8.16	11.18	12.51	0	3	8.16	11.18	12.51	0	3	8.16	11.18	12.51	12.51
0	0	4	15.45	15.57	20.47	0	4	15.79	15.57	20.47	0	4	15.30	15.57	20.47	20.47
0	0	5	7.21	10.91	4.66	0	5	6.76	11.05	4.28	0	5	8.34	11.67	4.45	4.45
0	0	6	11.84	10.38	15.52	0	6	10.62	11.67	15.32	0	6	9.44	11.02	17.47	17.47
1	1	0	18.69	14.69	7.99	1	0	18.69	14.69	7.99	1	0	18.69	14.69	7.99	7.99
1	1	1	16.26	18.90	13.23	1	1	16.26	18.90	13.23	1	1	15.60	18.90	13.23	13.23
1	1	2	14.50	23.34	22.95	1	2	16.74	23.34	22.95	1	2	17.15	23.34	22.95	22.95
1	1	3	13.79	17.21	13.01	1	3	14.80	17.21	13.01	1	3	13.35	15.96	13.01	13.01
1	1	4	13.48	14.02	8.99	1	4	14.24	14.18	9.18	1	4	16.50	14.26	9.13	9.13
1	1	5	13.65	16.10	16.08	1	5	15.45	15.82	14.10	1	5	14.14	13.05	15.71	15.71
1	1	6	23.27	18.05	21.40	1	6	22.00	21.06	21.31	1	6	18.19	18.44	21.00	21.00
2	2	0	15.66	22.21	15.55	2	0	15.66	22.21	15.55	2	0	13.85	22.21	15.55	15.55
2	2	1	8.52	12.05	7.56	2	1	8.24	12.05	7.56	2	1	8.01	12.05	7.56	7.56
2	2	2	15.29	15.59	18.14	2	2	14.72	15.45	18.14	2	2	15.48	15.70	18.14	18.14
2	2	3	9.76	8.33	11.34	2	3	10.95	8.38	11.34	2	3	9.84	9.43	11.91	11.91
2	2	4	2.93	6.05	8.03	2	4	1.11	4.32	7.50	2	4	2.42	4.51	4.41	4.41
2	2	5	12.30	14.55	19.55	2	5	5.20	11.12	16.45	2	5	6.98	4.33	12.13	12.13
2	2	6	13.85	13.23	22.00	2	6	14.47	14.76	19.62	2	6	3.32	6.59	21.94	21.94
3	3	0	13.80	12.88	13.82	3	0	13.51	12.88	13.82	3	0	13.34	13.30	13.82	13.82
3	3	1	7.86	9.15	8.28	3	1	8.26	9.33	8.28	3	1	9.57	9.61	8.28	8.28
3	3	2	5.75	11.28	15.14	3	2	5.46	10.33	14.59	3	2	4.12	10.84	14.14	14.14
3	3	3	10.24	6.89	7.00	3	3	9.17	5.13	5.83	3	3	9.77	5.02	5.32	5.32
3	3	4	0.70	2.27	4.84	3	4	-2.47	-0.26	3.19	3	4	2.58	-2.79	-0.97	-0.97
3	3	5	5.99	9.04	10.12	3	5	-0.65	-3.61	3.99	3	5	4.03	-4.42	-3.29	-3.29
3	3	6	13.19	9.75	16.52	3	6	-1.04	-2.36	13.79	3	6	0.94	-4.19	0.52	0.52
4	4	0	10.22	10.26	9.21	4	0	9.47	10.31	9.21	4	0	10.90	10.55	9.34	9.34
4	4	1	0.10	3.14	5.65	4	1	1.24	2.65	5.30	4	1	-0.11	3.06	5.25	5.25
4	4	2	10.21	5.01	5.07	4	2	6.29	4.51	4.14	4	2	10.45	6.39	6.23	6.23
4	4	3	9.98	10.71	7.64	4	3	6.47	4.98	4.09	4	3	6.61	4.68	6.12	6.12
4	4	4	7.21	3.87	5.67	4	4	-0.49	1.10	5.17	4	4	2.78	-3.85	-2.19	-2.19
4	4	5	5.65	7.43	7.90	4	5	1.32	-1.61	7.23	4	5	6.36	-3.30	-1.82	-1.82
4	4	6	13.25	13.76	14.65	4	6	0.04	1.82	9.42	4	6	4.01	-3.68	-3.39	-3.39
5	5	0	12.28	12.63	6.47	5	0	8.57	10.96	6.14	5	0	9.74	12.60	6.61	6.61
5	5	1	-2.95	1.58	-1.12	5	1	2.10	2.50	-0.77	5	1	1.50	6.20	1.21	1.21
5	5	2	9.19	7.06	5.44	5	2	10.67	8.79	6.56	5	2	13.52	10.49	11.68	11.68
5	5	3	7.78	4.83	3.86	5	3	4.56	-2.72	0.05	5	3	-0.28	1.53	2.34	2.34
5	5	4	1.56	6.49	3.56	5	4	-2.60	1.24	8.43	5	4	1.86	-2.60	1.01	1.01
5	5	5	4.73	3.38	5.38	5	5	-1.58	-1.81	6.14	5	5	2.15	-4.39	-1.62	-1.62
5	5	6	16.68	13.60	15.70	5	6	1.84	-0.37	3.52	5	6	5.55	-3.65	-0.28	-0.28
6	6	0	8.89	12.78	8.70	6	0	5.55	10.96	7.47	6	0	10.72	12.60	7.97	7.97
6	6	1	3.45	11.67	8.22	6	1	1.76	5.80	7.06	6	1	2.26	3.80	3.84	3.84
6	6	2	11.36	10.38	9.17	6	2	6.14	3.64	6.74	6	2	12.50	8.87	9.72	9.72
6	6	3	8.65	7.67	4.92	6	3	1.23	-2.51	-1.80	6	3	5.52	4.31	5.29	5.29
6	6	4	2.20	3.93	2.07	6	4	0.69	2.95	7.97	6	4	3.97	-4.18	0.98	0.98
6	6	5	2.73	1.14	-0.70	6	5	-0.73	-0.10	4.60	6	5	2.39	-4.50	-1.77	-1.77
6	6	6	3.93	4.93	10.12	6	6	3.49	-2.04	0.60	6	6	4.32	-4.07	-2.38	-2.38

The best return for Home Depot using the change in daily price/volume appears to be the zero threshold, three years of training, a one length price, and a two length volume snake (0T, 3L, 1/2S). This value of about 23.34% per year is highlighted in the table above.

This return responds well but cumulative return does not reach the height of the buy and hold. When the buy and hold strategy generates negative or low returns in the 2000 through 2002 period, the model generates positive returns. Both the buy and hold and the combination model outperform the other strategies by a large margin.

The chart comparing the model's return to the return of the other competing strategies may be found as follows.

Table 6.21 – Percent Returns for Home Depot (0,3,1/2) Using Price/Volume & Other Strategies

Price/Volume Change										
Values for Thresh = 0, Years=3, Snake=1/2						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
91-92	50.84	56.71	22.24	12.29	15.75	50.84	56.71	22.24	12.29	15.75
92-93	35.16	36.63	24.87	2.21	3.89	103.86	114.12	52.63	14.78	20.25
93-94	-5.67	-0.87	0.54	0.18	-0.21	92.30	112.27	53.46	14.98	20.00
94-95	-9.66	-2.40	-11.85	-8.28	-8.40	73.72	107.18	35.28	5.46	9.92
95-96	-1.60	12.51	4.05	6.00	6.26	70.94	133.10	40.76	11.79	16.80
96-97	5.15	25.32	5.00	8.38	8.89	79.75	192.13	47.79	21.16	27.19
97-98	35.59	82.81	99.19	35.04	38.97	143.72	434.03	194.38	63.61	76.75
98-99	65.74	77.94	13.03	34.69	39.59	303.94	850.23	232.75	120.37	146.72
99-00	20.78	41.29	52.74	22.18	24.28	387.89	1242.59	408.25	169.25	206.62
00-01	59.90	-20.88	-43.51	0.48	-4.33	680.12	962.27	187.11	170.55	193.34
01-02	28.85	1.13	28.80	0.08	0.34	905.21	974.31	269.80	170.77	194.35

The graph of the cumulative Home Depot data may be found on the following page.

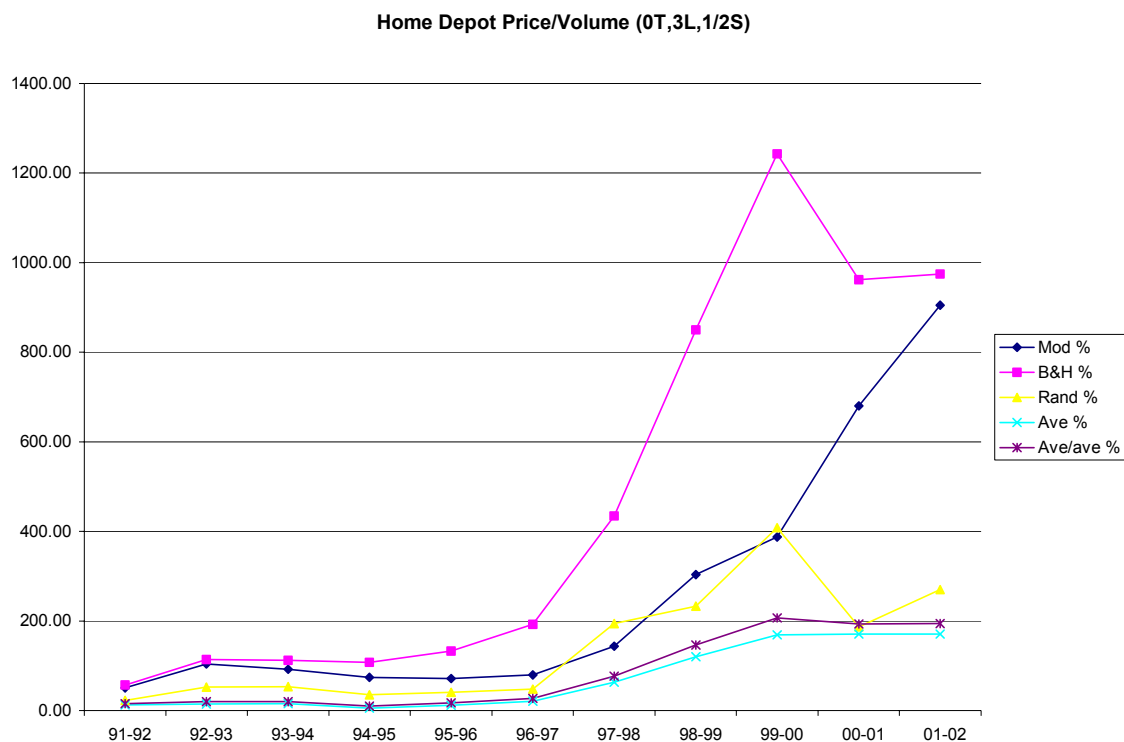


Figure 6.10 – Home Depot Returns for 0 Thresh, 3 Year Training & 1/2 Snake Length Price/Volume Change & Other Strategies

6.3.14 IBM Corporation

The model examines IBM with respect to snakes built upon price/volume changes. For IBM the highest cumulative return is for a six-length price only snake. The price only chart and figure is located in chapter 4.

6.3.15 Cisco

Next the model examines Cisco with respect to snakes built upon price/volume changes. For Cisco the highest cumulative return is a five-length volume snake. See chapter 5 for the chart and figure.

6.3.16 Johnson and Johnson

The model examines Johnson and Johnson with respect to snakes built upon price/volume changes. For Johnson and Johnson the best cumulative return is generated with a four-length price snake.

6.3.17 Coca Cola

Next the model examines Coca Cola with respect to snakes built upon price/volume changes. For Coca Cola the best return is generated with a three-length price only snake.

6.3.18 JP Morgan Chase

The model examines JP Morgan Chase with respect to snakes built upon price/volume changes. The high level summaries for yearly returns for JP Morgan Chase built on price/volume snake patterns are on the following page.

Tables 6.22 – Percent Returns for JP Morgan Chase with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Price/Volume Change

Thresh=0		Years of Data Multiply			Thresh=3		Yr Ave 2			Yr Ave 3			Yr Ave 4			Thresh=6	
SIPrice	SIVolume	Yr Ave 2	Yr Ave 3	Yr Ave 4	SIPrice	SIVolume	Yr Ave 2	Yr Ave 3	Yr Ave 4	SIPrice	SIVolume	Yr Ave 2	Yr Ave 3	Yr Ave 4	SIPrice	SIVolume	
0	2	4.49	1.29	14.23	0	2	4.49	1.29	14.23	0	2	4.49	1.29	14.23	0	2	
0	3	2.35	2.78	5.03	0	3	2.35	2.78	5.03	0	3	2.35	2.78	5.03	0	3	
0	4	8.25	7.43	8.81	0	4	8.25	7.43	8.81	0	4	8.17	7.43	8.81	0	4	
0	5	2.08	3.57	5.53	0	5	2.24	3.92	5.71	0	5	4.56	3.92	6.02	0	5	
0	6	7.43	4.54	6.83	0	6	5.05	4.27	5.43	0	6	3.25	4.45	6.91	0	6	
1	0	12.31	12.89	14.01	1	0	12.31	12.89	14.01	1	0	12.31	12.89	14.01	1	0	
1	1	3.47	5.48	8.07	1	1	3.47	5.48	8.07	1	1	3.47	5.48	8.07	1	1	
1	2	12.23	10.87	18.50	1	2	12.23	10.87	18.50	1	2	12.23	10.87	18.50	1	2	
1	3	16.49	11.75	9.81	1	3	16.49	11.75	9.81	1	3	16.86	11.75	9.81	1	3	
1	4	13.88	17.39	15.35	1	4	12.55	18.02	15.35	1	4	12.37	17.45	14.45	1	4	
1	5	8.40	15.52	11.69	1	5	8.19	16.08	12.49	1	5	8.39	16.65	11.28	1	5	
1	6	4.44	4.26	7.01	1	6	5.06	6.55	6.94	1	6	11.29	6.07	5.24	1	6	
2	0	8.81	14.52	14.88	2	0	8.81	14.52	14.88	2	0	8.81	14.52	14.88	2	0	
2	1	12.78	14.75	13.25	2	1	12.78	14.75	13.25	2	1	12.78	14.75	13.25	2	1	
2	2	5.66	4.70	2.81	2	2	5.66	4.70	2.81	2	2	5.02	4.70	2.81	2	2	
2	3	9.68	7.46	7.52	2	3	13.22	7.43	7.52	2	3	14.73	7.98	7.79	2	3	
2	4	4.44	4.44	7.23	2	4	7.93	4.73	8.24	2	4	10.90	5.79	7.20	2	4	
2	5	4.10	6.64	14.37	2	5	10.37	6.20	10.34	2	5	11.67	3.44	5.31	2	5	
2	6	4.72	0.84	9.25	2	6	10.09	7.13	10.66	2	6	13.38	7.33	2.63	2	6	
3	0	12.23	15.91	15.27	3	0	12.23	15.91	15.27	3	0	12.23	15.91	15.27	3	0	
3	1	11.15	14.43	14.30	3	1	11.15	14.43	14.30	3	1	11.07	14.43	14.30	3	1	
3	2	12.34	9.61	14.20	3	2	14.30	9.61	14.20	3	2	14.35	10.02	13.78	3	2	
3	3	4.54	10.10	12.76	3	3	4.97	10.93	13.90	3	3	2.76	8.11	11.52	3	3	
3	4	8.22	15.68	11.51	3	4	10.10	19.23	12.52	3	4	9.40	13.83	12.60	3	4	
3	5	1.14	4.22	5.13	3	5	4.95	14.10	9.14	3	5	3.66	13.74	14.41	3	5	
3	6	1.16	5.79	5.99	3	6	8.72	15.20	8.35	3	6	7.43	16.43	12.41	3	6	
4	0	11.18	14.27	10.21	4	0	11.18	14.27	10.21	4	0	10.89	14.27	10.21	4	0	
4	1	2.20	5.91	-0.13	4	1	1.99	5.91	-0.13	4	1	3.78	4.28	0.24	4	1	
4	2	8.49	14.15	12.18	4	2	12.94	13.04	11.43	4	2	13.01	10.20	10.67	4	2	
4	3	-0.30	4.55	-0.31	4	3	4.72	5.90	0.01	4	3	3.14	6.57	0.49	4	3	
4	4	1.49	11.41	8.06	4	4	6.23	10.51	9.79	4	4	10.03	12.39	11.35	4	4	
4	5	2.42	5.23	6.77	4	5	5.55	7.70	9.00	4	5	10.26	12.83	10.41	4	5	
4	6	5.21	6.54	0.20	4	6	5.12	7.25	6.38	4	6	6.63	12.03	9.84	4	6	
5	0	13.82	13.83	15.26	5	0	11.48	13.83	15.26	5	0	13.56	16.83	15.26	5	0	
5	1	12.30	16.34	9.58	5	1	12.25	16.75	10.01	5	1	8.29	15.80	9.31	5	1	
5	2	8.97	13.31	11.08	5	2	4.93	15.48	11.60	5	2	5.14	15.30	16.75	5	2	
5	3	3.02	7.29	5.03	5	3	8.64	14.53	11.77	5	3	4.09	7.22	11.38	5	3	
5	4	-4.05	6.62	3.16	5	4	2.54	11.97	10.71	5	4	9.01	12.80	15.70	5	4	
5	5	-4.12	7.25	2.23	5	5	2.91	7.22	10.99	5	5	11.88	12.53	11.23	5	5	
5	6	2.96	5.27	-0.43	5	6	4.06	9.39	10.57	5	6	8.92	13.05	12.76	5	6	
6	0	12.48	21.07	15.57	6	0	8.50	19.40	14.52	6	0	8.11	20.69	13.06	6	0	
6	1	21.99	18.93	11.25	6	1	17.13	16.43	11.76	6	1	8.49	18.31	6.05	6	1	
6	2	13.14	20.60	12.60	6	2	12.31	21.16	12.89	6	2	11.83	18.20	19.74	6	2	
6	3	8.65	5.83	1.35	6	3	11.28	12.88	5.73	6	3	5.86	8.19	10.31	6	3	
6	4	4.02	11.81	1.28	6	4	2.17	10.30	8.65	6	4	10.01	14.68	11.06	6	4	
6	5	6.04	13.67	9.12	6	5	7.21	9.97	10.95	6	5	11.85	15.27	11.70	6	5	
6	6	7.08	15.97	6.66	6	6	6.06	10.82	11.80	6	6	9.79	15.40	11.92	6	6	

The best return for JP Morgan Chase using the change in daily price/volume appears to be the zero threshold, two years of training, a six length price, and a one length volume snake (0T, 2L, 6/1S). This value of about 21.99% per year is highlighted in the table above.

The chart comparing the model's return to the return of the other competing strategies is given on the following page.

Table 6.23 – Percent Returns for JP Morgan Chase (0,2,6/1) Using Price/Volume & Other Strategies

Price/Volume Change										
Values for Thresh = 0, Years=2, Snake=6/1						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
90-91	13.79	-5.38	-16.86	27.78	22.01	13.79	-5.38	-16.86	27.78	22.01
91-92	51.20	82.11	5.20	43.48	46.12	72.05	72.31	-12.54	83.33	78.28
92-93	31.53	11.45	26.04	5.44	6.82	126.29	92.03	10.24	93.30	90.43
93-94	10.23	-3.94	-7.95	-9.09	-9.40	149.44	84.46	1.47	75.72	72.53
94-95	-2.38	23.54	12.98	14.14	13.58	143.49	127.89	14.64	100.56	95.97
95-96	36.42	63.81	24.01	21.21	24.16	232.18	273.31	42.16	143.09	143.32
96-97	11.44	32.44	1.51	7.35	9.11	270.16	394.42	44.31	160.97	165.48
97-98	24.49	62.37	20.85	27.07	27.84	360.80	702.79	74.40	231.62	239.38
98-99	-1.81	27.72	-6.20	30.27	32.84	352.45	925.30	63.58	331.99	350.83
99-00	52.57	-7.25	-40.12	-1.90	-1.23	590.32	850.99	-2.05	323.77	345.26
00-01	48.13	-5.49	31.57	4.87	0.18	922.56	798.80	28.88	344.43	346.05
01-02	6.19	-22.16	2.34	-4.91	-6.21	985.90	599.60	31.90	322.62	318.34

The combination model cumulative returns outperform all of the other strategies. Excellent returns in the 1999 through 2002 period with the model allow model results to surpass the buy and hold strategy.

The graph of the cumulative JP Morgan Chase data may be found on the following page.

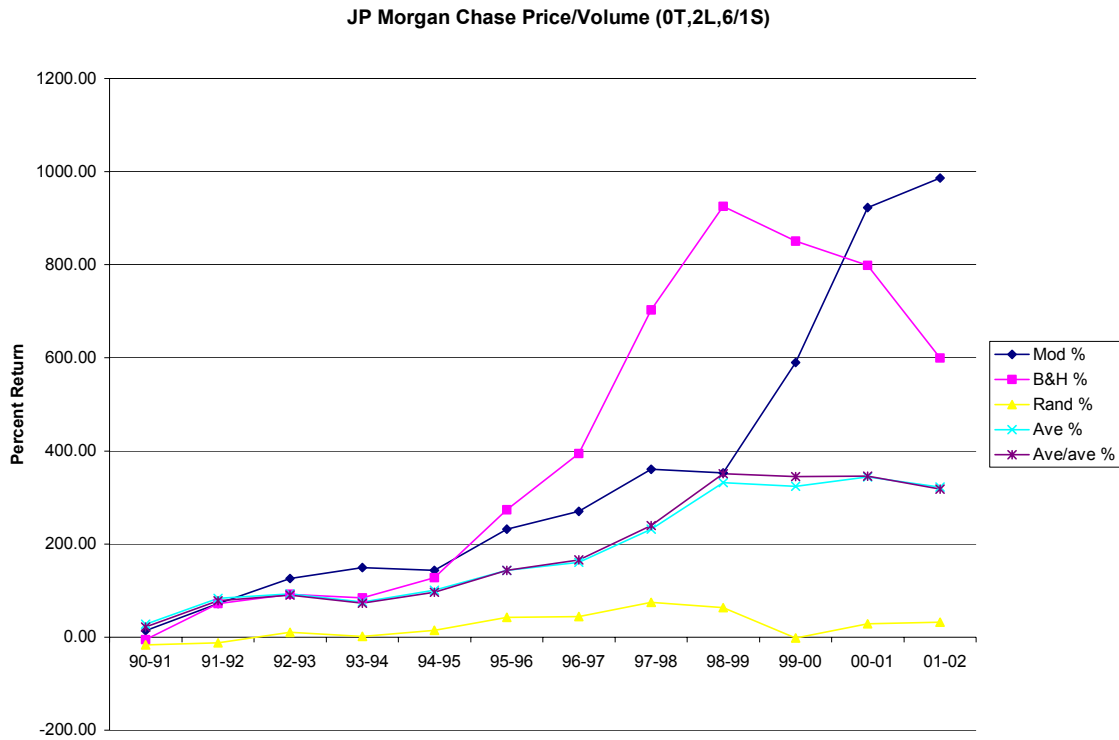


Figure 6.11 – JP Morgan Chase Returns for 0 Thresh, 2 Year Training & 6/1 Snake Length Price/Volume Change & Other Strategies

6.3.19 SBC

Next, the model examines SBC with respect to snakes built upon price/volume changes. The high level summaries for yearly returns for SBC built on price/volume snake patterns are as follows.

Tables 6.24 – Percent Returns for SBC with Variable Thresholds, Snake Lengths and Training Data Set Sizes For Price/Volume Change

Thresh=0	Years of Data Multiply			Thresh=3	Years of Data Multiply			Thresh=6	Years of Data Multiply					
	SIPrice	SIVolume	Yr Ave 2		Yr Ave 3	Yr Ave 4	SIPrice		SIVolume	Yr Ave 2	Yr Ave 3	Yr Ave 4		
0	2	1.15	3.62	5.17	0	2	1.15	3.62	5.17	0	2	1.15	3.62	5.17
0	3	2.96	7.91	0.46	0	3	2.96	7.91	0.46	0	3	2.96	7.91	0.46
0	4	7.53	5.35	6.57	0	4	7.67	5.35	6.57	0	4	7.31	5.28	6.57
0	5	1.37	0.65	-1.07	0	5	1.10	0.68	-1.07	0	5	0.38	0.66	-1.04
0	6	5.37	0.29	0.44	0	6	5.13	-0.02	0.44	0	6	0.62	-2.92	-0.41
1	0	2.73	3.85	3.92	1	0	2.73	3.85	3.92	1	0	2.73	3.85	3.92
1	1	0.36	9.21	7.28	1	1	0.36	9.21	7.28	1	1	0.36	9.21	7.28
1	2	0.25	4.18	8.57	1	2	0.25	4.18	8.57	1	2	0.25	4.18	8.57
1	3	10.27	12.99	14.21	1	3	10.27	12.99	14.21	1	3	10.34	12.99	14.21
1	4	13.33	11.49	10.12	1	4	13.62	11.79	10.12	1	4	13.91	12.90	11.05
1	5	9.91	5.01	5.93	1	5	9.34	4.86	5.29	1	5	9.58	6.19	8.22
1	6	-0.32	1.20	3.71	1	6	3.81	3.55	4.77	1	6	1.81	3.70	4.48
2	0	7.78	11.02	11.46	2	0	7.78	11.02	11.46	2	0	7.78	11.02	11.46
2	1	1.66	0.96	3.97	2	1	1.66	0.96	3.97	2	1	1.66	0.96	3.97
2	2	2.53	1.57	2.61	2	2	2.53	1.57	2.61	2	2	2.53	1.57	2.61
2	3	4.46	6.11	1.72	2	3	4.74	6.11	1.72	2	3	3.97	6.57	2.18
2	4	8.26	8.98	7.94	2	4	8.26	10.07	8.72	2	4	10.70	12.02	9.58
2	5	5.21	4.46	6.17	2	5	4.06	8.19	7.44	2	5	8.09	10.90	9.66
2	6	1.62	-3.50	3.57	2	6	3.32	2.00	4.77	2	6	5.56	7.05	5.75
3	0	8.64	8.45	9.86	3	0	8.64	8.45	9.86	3	0	8.64	8.45	9.86
3	1	2.45	3.78	3.31	3	1	2.45	3.78	3.31	3	1	2.45	3.78	3.31
3	2	-1.12	1.24	4.82	3	2	-1.30	1.18	4.82	3	2	-1.42	1.46	4.85
3	3	3.30	3.40	6.71	3	3	3.72	5.18	7.56	3	3	3.91	5.73	7.56
3	4	2.84	8.50	12.52	3	4	7.22	8.44	10.08	3	4	8.28	13.09	16.09
3	5	1.17	-0.05	2.54	3	5	6.10	1.21	4.46	3	5	4.91	6.90	7.88
3	6	2.64	-2.00	2.90	3	6	6.72	4.00	5.31	3	6	4.77	8.54	8.37
4	0	5.00	5.17	1.80	4	0	5.00	5.17	1.80	4	0	5.00	5.17	1.80
4	1	-0.44	3.75	0.65	4	1	-0.41	3.75	0.65	4	1	-0.96	3.82	0.65
4	2	4.27	4.02	5.73	4	2	2.30	3.86	6.08	4	2	6.15	-0.08	5.37
4	3	6.46	12.33	10.98	4	3	5.83	10.46	8.87	4	3	6.01	10.48	7.72
4	4	5.54	7.43	11.35	4	4	7.42	4.38	5.36	4	4	8.38	10.23	9.31
4	5	6.34	5.38	4.01	4	5	7.92	4.86	0.75	4	5	8.85	8.64	5.97
4	6	3.78	3.84	5.27	4	6	7.71	4.29	1.25	4	6	8.30	9.18	6.30
5	0	0.27	3.30	7.90	5	0	0.27	3.30	7.90	5	0	1.76	3.73	7.90
5	1	1.25	0.61	-0.27	5	1	1.12	0.79	0.20	5	1	0.91	0.43	-0.69
5	2	4.26	7.57	3.52	5	2	1.63	6.85	3.98	5	2	3.65	1.78	3.05
5	3	7.41	5.46	10.95	5	3	6.51	7.06	9.25	5	3	7.56	4.41	2.91
5	4	11.79	11.26	8.33	5	4	6.04	4.15	-1.33	5	4	8.95	8.12	8.64
5	5	11.27	12.22	9.19	5	5	6.65	4.51	0.08	5	5	9.18	7.96	7.15
5	6	10.62	9.58	8.36	5	6	6.37	4.41	0.26	5	6	9.52	8.53	7.62
6	0	7.20	8.78	7.76	6	0	6.91	8.20	7.69	6	0	9.37	8.87	6.79
6	1	0.81	4.33	0.85	6	1	2.30	4.51	0.54	6	1	-1.45	4.25	1.50
6	2	6.49	8.33	0.13	6	2	3.21	6.12	6.18	6	2	3.13	-0.99	4.54
6	3	3.88	4.39	2.24	6	3	5.70	5.12	1.62	6	3	8.17	7.85	1.81
6	4	7.95	7.88	5.63	6	4	6.38	3.27	0.73	6	4	9.69	6.73	7.73
6	5	10.53	11.03	3.88	6	5	5.08	2.66	-1.21	6	5	8.00	7.01	5.69
6	6	6.67	5.70	5.67	6	6	4.46	4.03	0.95	6	6	7.06	6.63	6.91

The best return for SBC using the change in daily price/volume appears to be the six threshold, four years of training, three length price, and a four length volume snake (6T, 4L, 3/4S). This value of about 16.09% per year is highlighted in the table above.

This combination model outperforms buy and hold in the latter years to yield better cumulative returns than the other strategies.

The chart comparing the model's return to the return of the other competing strategies excluding the previous price only model is given below.

Table 6.25 – Percent Returns for SBC (6,4,3/4) Using Volume & Other Strategies

Price/Volume Change										
Values for Thresh = 6, Years=4, Snake=3/4						Cumulative				
Year	Mod %	B&H%	Rand %	Ave %	Ave/ave %	Mod %	B&H%	Rand %	Ave %	Ave/ave %
92-93	13.55	29.24	-6.22	16.11	17.64	13.55	29.24	-6.22	16.11	17.64
93-94	15.65	11.52	10.21	2.76	4.35	31.32	44.13	3.35	19.32	22.76
94-95	10.10	10.45	5.49	6.96	8.09	44.58	59.18	9.02	27.62	32.68
95-96	21.73	16.73	18.88	-0.92	-0.11	75.99	85.81	29.61	26.45	32.53
96-97	13.83	7.59	-0.58	3.95	4.67	100.33	99.91	28.86	31.45	38.72
97-98	16.76	58.51	33.57	26.17	27.94	133.90	216.88	72.11	65.84	77.48
98-99	52.50	40.21	36.77	25.28	25.21	256.70	344.30	135.40	107.77	122.21
99-00	-11.54	-16.71	-39.15	-4.63	-7.92	215.52	270.06	43.24	98.16	104.61
00-01	44.70	-7.29	-18.94	-11.03	-11.85	356.57	243.08	16.12	76.29	80.37
01-02	-2.60	-17.88	27.10	-17.39	-18.21	344.70	181.72	47.59	45.63	47.52

The graph of the cumulative SBC data may be found on the following page.

SBC Price/Volume Returns (6T,4L,3/4S)

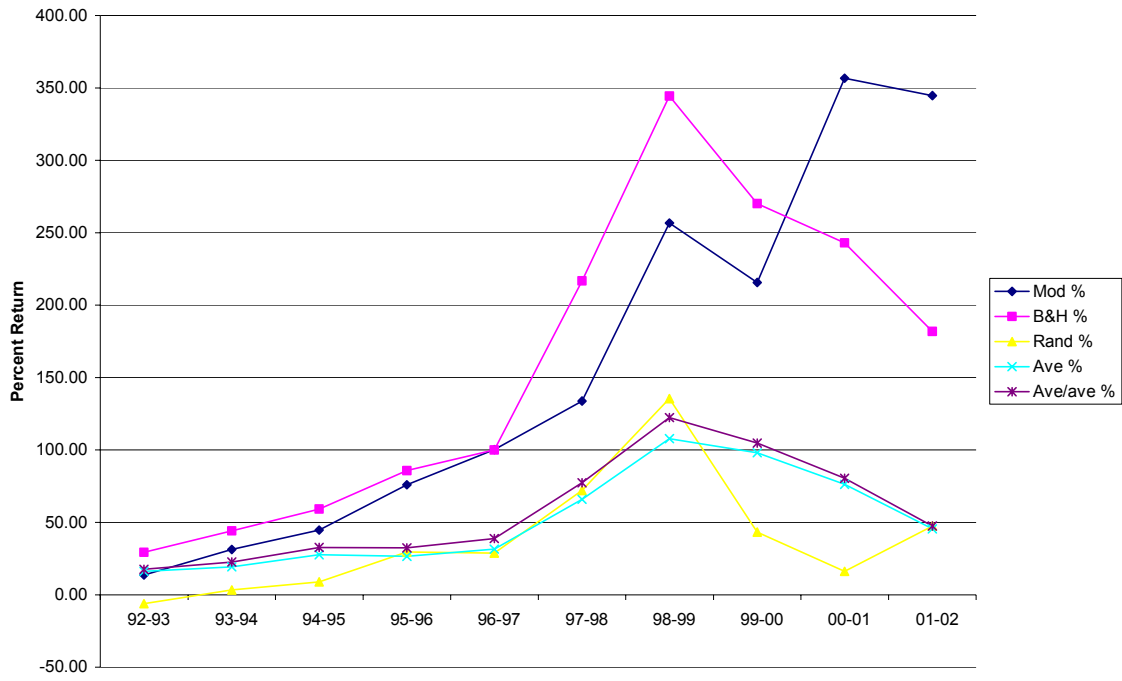


Figure 6.12 – SBC Returns for 6 Thresh, 4 Year Training & 3/4 Snake Length Price/Volume Change & Other Strategies

6.3.20 Exxon Mobil Corporation

The model examines Exxon Mobil with respect to snakes built upon price/volume changes. Similar to AT&T, IBM, Johnson and Johnson, and Coca Cola, Exxon Mobil generates the highest return with a pure price model. The 2-length snake for price only yielded the best return.

6.3.21 Dow Jones Index

Next, the model examines Dow Jones Index with respect to snakes built upon price/volume changes. The Dow Jones Index generates the highest cumulative return with a three-length price only snake. See chapter 4 for the chart and figure.

6.4 Summary of Combinations

As stated earlier, the combination processing also examines the pure price and pure volume models. For the 21 stocks/index chosen for this study, the model outperforms all of the other competing strategies for 19 of the examined securities. Only Tesoro Petroleum and Home Depot proved better with another strategy.

For the last ten years, Tesoro cumulative return was 10.86% per year versus 11.33% for the averaging technique. Furthermore, the model's return tracked the averaging technique for the entire period.

For the Home Depot security, the buy and hold cumulative return outperformed the model for the eleven years. Once again the model's return and the buy and hold return are close with buy and hold yielding 24.09% and the model yielding 23.34% per year.

The following chart shows the yearly combination yields.

Table 6.26 – Percent Returns for Securities

Best for Price/Volume Combination Snake						
	Yearly Return	Threshold	Years Train	Price Snake Length	Volume Snake Length	Competing Strategies Better
S&P	24.01	3	3	3	6	
I2	76.58	0	3	3	7	
Tesoro	10.86	3	4	4	3	Yes
Symbol	25.05	0	4	1	1	
Duke Energy	13.45	3	4	6	4	
Bristol Myers	17.50	0	2	3		
Intel	33.93	6	4	1	2	
Lucent	10.93	0	2	1	1	
OMI Corp	19.47	0	2	6	6	
ATT	14.41	0	4	2		
General Electric	21.41	0	4		5	
AOL TimeWarner	88.71	6	3	3	1	
Home Depot	23.34	0	3	1	2	Yes
IBM Corp	20.95	0	4	6		
Cisco	40.03	0	3		5	
Johnson & Johnson	27.84	0	4	4		
Coca Cola	19.89	0	4	3		
JP Morgan	21.99	0	2	6	1	
SBC Corp	16.09	6	4	3	4	
Exxon Mobil	22.22	0	4	2		
Dow Jones	15.99	0	4	3		

The average yearly return for this set of stocks using the compound model is 26.89%. This average is greater than the averages built around the pure price or pure volume model. Once again in all cases, the compound model is forced to select one buy and sell pattern and stay with that pattern over the entire length of the study. In the next chapter, the model will be allowed to dynamically switch to differing patterns based on the fluctuations in returns of the security.

Chapter 7 A Dynamic Markov Decision Process Model Based on Compound States

In this research all models examined thus far have dealt with a fixed policy. Using the fixed policy, the models have assumed that the same policy was to be used over the entire time frame examined. However, what if one were to modify the policy based on the previous results and attempt to convert to a policy that provided a better return in the future? This chapter (Chapter 7) examines the dynamic reassignment of the policy and the obtained results.

7.1 Choosing the Best

The first challenge encountered in the dynamic model is the selection techniques to determine how and when to change states. At least three dimensions are required to determine the suitable dynamic model. These dimensions include “how long the examination period must be,” “how long the selected model must run under the new policy” and finally, “what characteristic should be used to determine when to make the switch.”

Research begins by examining the characteristic to determine the switch. Three techniques examine the returns to locate the best fit for the securities. The three methods are:

- 1) Continued Returns – This technique computes the return over a fixed period. From the computed return, the best policy is selected and the policy is used for the following period. At the end of this period, the computed return is recomputed and another policy is followed for the same length of time. This continues until the stock pricing data reaches the end point.

- 2) Slope – This technique computes a slope line through the returns for a fixed period. At the end of the fixed period, the best slope is chosen for the policy for the security. This policy is used for the subsequent period. At the end of this period, the slope is once again recalculated and used for the succeeding period. This process continues until the data is consumed.
- 3) Expected Value – The expected value technique is similar to the slope technique with the exception that instead of choosing the most positive slope, this technique selects the highest expected value. The reiterative process of the selection follows the same routine of method one and two.

Using any of these methods allows the model for the security to modify the length of the underlying compound snake and threshold. These methods also become candidates for selection of a better technique to increase yields.

An important characteristic of the dynamic model is that the model uses shorter-term results to modify the future policy. Operation in this manner is more attuned to the method in which individuals make buy and sell decisions.

7.2 Examination / Time Used Period

In addition to the model method, the examination and length of time used must be established. The examination length is the period of time in days that the model is allowed to operate to generate returns for best policy selection. The model examination length is a multiple of the number of days that the selected period will be used. A variety of combinations are examined to determine the periods that respond best. Once the examination period and execution period are selected, the surrounding possibilities of periods are also examined. An example of the selection and operation is provided to assist in understanding this portion of the dynamic model.

7.3 Example of Dynamic Model

Suppose the examination period is 252 days and the “length of time used” is 12 days. The model generates the returns for all combination of two, three or four years of training, the thresholds of zero, three, and six and the price and volume “snake lengths” for 2 through 6 for a 12 day period. Since the examination period is 252 days, the model combines the returns for 21 of these periods to predict the policy needed for the next 12-day period. If the model is using the “slope method,” the slope of a line drawn through the 21 points is examined. The largest slope selected from the 414 slopes generated would specify the policy that would be used for the next 12 days. The return using this selected policy is stored. Next the examination period is pushed forward and the slope recalculated for the new 21 point 252 day period. The best slope is once again used to determine the policy. This process repeats until all of the stock data is examined.

7.4 Experimental Plan

The experimental plan for testing the dynamic model is to examine all 21 securities with periods (examination and time used) that respond well using the S&P, I2, Tesoro Petroleum, and Duke Energy data. The following table contains the periods examined.

Table 7.1 – Dynamic Examination and Run Periods

Examination Period	126	168	182	210	252	252	252	273
Used Period	63	84	91	42	126	84	21	91

Examination periods of less than 126 days or run periods of less than 21 days produce inferior returns to the above period combinations.

From these combinations the securities are processed using the dynamic approach.

7.5 Experimental Results

In this section the Markov model is examined in relation to the dynamic model. The results are compared to the results buy and hold and the fixed policy model.

The dynamic model proves to outperform the buy and hold strategy in 19 of the 21 securities. That is, about 90% of the examined securities perform better with the dynamic model than with the buy and hold strategy. However, comparing the dynamic model to the fixed model did not provide better results. The dynamic model outperformed the fixed model only about 30% of the time. One would obtain better gains from the fixed than the dynamic model.

The following table provides the average yearly return experienced with the buy and hold, the dynamic policy and the fixed policy over the shortest consistent length of test data. That is, the 2-year train and the 3-year train are processed on the examination data defined by the 4-year training data.

Table 7.2 – Yearly Average Return B&H, Dynamic and Fixed

Security	Buy & Hold	Dynamic Policy	Fixed Policy
S&P	0.66	15.03	8.85
I2	-68.68	20.52	87.34
Tesoro	2.58	12.20	20.64
Symbol	10.97	23.67	28.25
Dow Jones	13.05	14.11	13.44
Bristol Myers	7.92	18.59	19.91
Duke Energy	12.51	14.69	11.23
Intel	32.29	22.56	35.74
Lucent	-74.31	11.53	14.60
OMI Corp	-2.02	22.06	24.08
AOL TimeWarner	51.20	101.75	93.10
ATT	-6.96	20.27	15.46
General Electric	18.74	23.17	22.15
Home Depot	21.23	22.23	22.51
IBM Corp	8.65	8.53	20.75
Johnson & Johnson	19.20	25.17	28.54
Cisco	29.99	42.20	30.65
JP Morgan	14.54	18.61	27.23
Coca Cola	12.16	13.72	19.72
SBC Corp	9.04	13.61	9.54
Exxon Mobil	10.55	18.49	22.63

In the above table, only Intel and IBM Corp perform better with a buy and hold strategy than with the dynamic model.

In the previous table, notice that in eight cases (S&P, Dow Jones, Duke Energy, AOL Time-Warner, AT&T, General Electric, Cisco, and SBC Corp) the dynamic outperforms the fixed. For the other securities, the fixed policy yields a better return.

A graph of these average yearly returns is provided below.

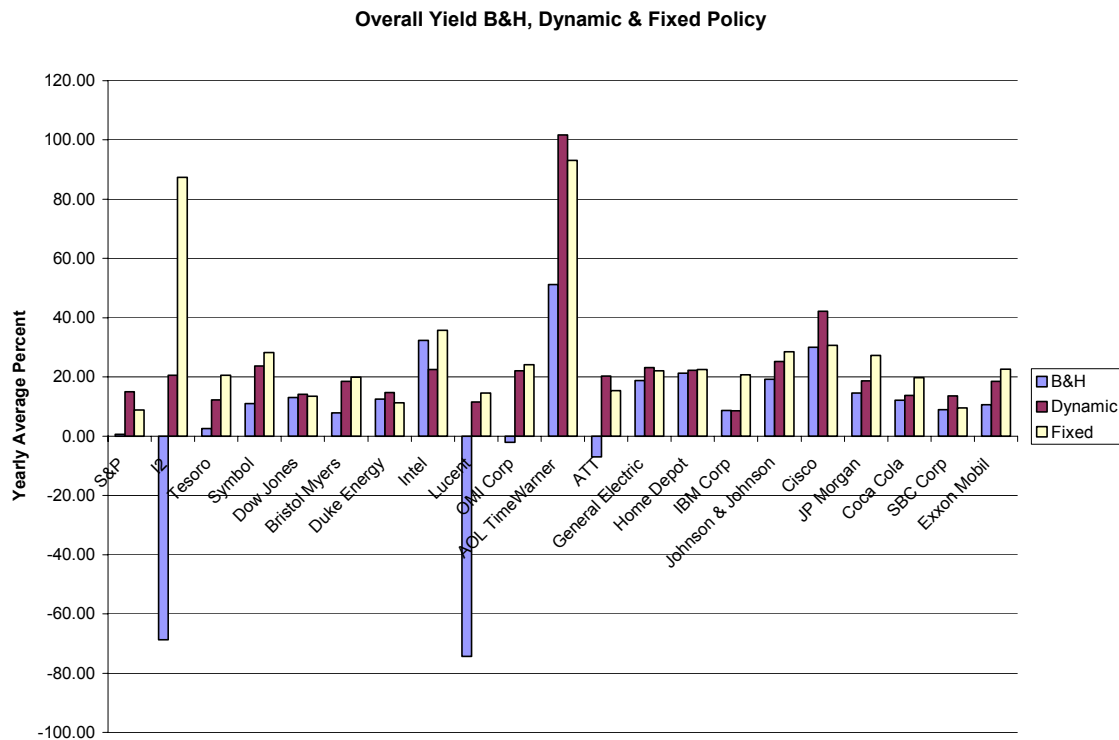


Figure 7.1 – Yearly B&H, Dynamic and Fixed Policy

After adjusting the examined period, the average overall yield of the fixed policies increases from 26.89% per year to 27.45% per year. The overall yearly average of the dynamic policy is 22.99%. Although the dynamic policy yields smaller returns than the fixed policy, the dynamic policy is used for future research because it better approximates the manner in which one would invest in the stock market. An investor would not be inclined to maintain a

consistent policy for a 10 to 15 year period based on policies established 20 to 30 years in the past.

In the next chapter, the dynamic model is modified to include the ability to select the best stock from the group. Using this technique the model will obtain the yield of a stock for a period of time and then switch to another security.

Chapter 8 Security Selection Using Dynamic Markov Decision Process Model

All of the previous work with the stock model involves working with only one security of the many examined. This section of research develops a method to sort through the variety of securities and obtain the best security for purchasing for a period of time.

8.1 Selection Characteristics

After all the dynamic results are derived for the individual securities, the securities are characterized with statistics relating to price and volume change. These characteristics are calculated for the security for the period used for the actual return and for the training period used to generate the decision tables mentioned earlier in this document. For each security the following price/volume characteristics are calculated:

Period Possible Dollars - In the examined period, the stock price moves up and down. This measure captures the dollars of “up” movement only. More ragged stock movement provides a larger possible dollar value.

Period Average Closing Price – The average closing price of the stock for the examined period is used as a characteristic.

Standard Deviation Price – For the same period that is used for return calculation the standard deviation is computed. The standard deviation of the price provides the third characteristic to examine.

Range Price – The range of the price over the examined period is computed. This measures the difference between the high and low price for the period.

Volume Data – The average volume, standard deviation of the volume, and the range of the volume are calculated for the volume data. These three measures are also used for characteristics of the stock.

Total Average Price – The average closing price of the stock for the total of the examined period and the training period form a characteristic. This characteristic is identical to the second characteristic with the exception of the length of time examined.

Total Data – The standard deviation, range, and volume data are all repeated on the larger group of data composed of period and training period.

Buy and Hold Training – The buy and hold results during the training period were also identified as a characteristic for future correlation.

Indicator value – Finally, the indicator value is correlated to the next period's return. The indicator would be the value of average returns, slope, or expected value as calculated in the dynamic portion of the model.

8.2 Correlation of Characteristics

For each stock, the characteristics are calculated for each period. The characteristics are attached to the returns generated by the dynamic model for the security. Next, each set of characteristics is correlated to the next period's return for four sequential periods. The correlation slides down dropping the first period's return and adding a new period's return.

This calculation is performed on all of the 15 characteristics. If the correlation is greater than “ $r = .66$,” then the characteristic passes the first hurdle to being identified as positive.

The second hurdle for the characteristic to pass is the improvement test. In addition to good correlation, improvement in the characteristic implies that a stronger than normal improvement in yield might be expected in the next period for the security. The percentage better than the average of the previous four characteristic values must be 10%. If the characteristic is at least 10% better, for this period, the security characteristic passes the second hurdle for consideration.

The third hurdle for a characteristic to pass is that the present period yield must be positive. This is required to prevent the model from selecting securities with a strong correlation in the incorrect direction.

Thus, for a characteristic to be considered positive for an examined period, it must pass all three hurdles. This is true for each of the 15 characteristics. Now, some stocks for the period will have a larger number of characteristics passing than other securities. The assumption is made that the security with the larger number of positive characteristics will have the higher probability of yielding a positive above average return. To capitalize on this assumption the securities are sorted for the examined period and the security with the largest number of positive characteristics is recommended for the next investment period. Sometimes securities are equal (tie) in the number of positive characteristics. In these cases, the randomness of the sort engine determines the security selected.

8.3 Out of the Market for a Period

At this point, characteristics correlate to the next period's returns. Strong correlations over .66 which couple with 10% increase in the characteristic and a positive return for the period are used to sort the stocks for the period. Stocks with the largest number of positive

characteristics are selected. Ties for largest are randomly selected. However, there are periods where no stock would appear attractive. These periods are identified when no stock in our group of stocks had two or more characteristics in the “green go zone.” For a characteristic to be in the “green go zone” all of the three hurdles have been overcome. In these situations where two or less characteristics are in the “green go zone,” the model recommends staying out of the market for the 3-month period.

8.4 Out of the Market Threshold

A threshold is set for selecting the number of positive characteristics to allow a security to be bought and sold for a period. This threshold is set at two positive characteristics. Thus, any period in which all of the stocks from our group of stocks has two or fewer of the characteristics that meet the three hurdles, then the model recommends staying out of the stock market.

8.5 Weaving

Weaving is the term assigned to picking the correct security. The model is weaving in and out of stocks for the period based upon the correlated values supporting the strength of characteristics.

Basically, weaving worked by using the base model to generate the entry and exit points on each individual stock using the dynamic model.

Because of the lack of long term data, the I2 and Lucent securities are dropped. The remaining 19 securities and years of data examined are as follows.

Table 8.1 – Weaved Stocks Group 1 and Years

Stock	Years Data
S&P	5
TESORO	10
SYMBOL	10
DOWJONES	10
BRISTOL MYERS	10
DUKE	10
INTEL	10
OMI	6
AOL	6
ATT	10
GE	10
HOME DEPOT	10
IBM	10
JJ	10
CISCO	8
JP MORGAN	10
COCACOLA	10
SBC	10
EXXON	10

First, the dynamic model is run for all stocks. The dynamic model is set to 63 and 252. That is, use the 3 year training period for zero, three and six threshold for combination snakes of 4/4 for 63 days. Examine 4 sets of 63-day returns, totaling 252 days before switching price/volume snake size. Thus, to start the model, the software examines the 63-day returns of the dynamic model for 4 periods (252 days). Based on the model's yields using the three methods outlined in chapter 7 for all of the 4/4 snakes, the model chooses the best snake length for both price and volume. After the next 63 days, the first 63-day period is dropped and the last 63-day period is added. Next, the compound snake length is reset for price and volume and the new dynamic combination snake results are used for this period. This

process is repeated until all of the data is examined. Remembering that 21 trading days form a month, the model has the potential to dynamically change to a new combination snake length about once every 3 months.

Determining the “best yields” of the examined period was discussed earlier. Recall three methods are examined – slope of the yield, expected value of the yield, and finally a simple average of the yields. An example may be in order. Suppose one was to have three periods and the snake combinations gave minus10, 0 and plus 10 percent yield. The first method would provide +10, the second would “predict” +20, and the third method would provide “0” for the results. Thus, depending on the method the “relative value” of this method may change. Methods are balanced. Slightly more of the stocks (7) work best with the average (method 3); however, all of the methods are presented to the “weaving software.” At this point, the model introduces some pre-selection based on the dynamic method, but all possibilities are still carried to the next step.

The next step weaves the stocks, selecting the best security. At this point the data has a flaw in that certain stocks may not be chosen in the earlier years given the lack of any data for those years. Looking at the previous stocks when selecting the first stock to use – S&P, Omi, AOL and Cisco could not be chosen. Data does not exist for the stocks in that period. As the weaving progresses, these stocks are allowed to compete with the others for selection. The stock with the highest number of characteristics passing the correlation, improvement, and positive direction for the period is selected. If no stock has more than 2 positive characteristics passing for the 3-month period, the investor should stay out of the market. Weaving yields the following table.

Table 8.2 – Selected Stocks Group 1

Months	Security	Months	Security	Months	Security
Apr-91	SBC	Feb-95	BristolMyers	Dec-98	Cisco
Jul-91	Duke	May-95	Cisco	Mar-99	Symbol
Oct-91	Intel	Aug-95	CocaCola	Jun-99	Intel
Jan-92	Tesoro Oil	Nov-95	CocaCola	Sep-99	OMI Corp
Apr-92		Feb-96	BristolMyers	Dec-99	AT&T
Jul-92		May-96	HomeDepot	Mar-00	JPMorgan
Oct-92		Aug-96	BristolMyers	Jun-00	
Jan-93		Nov-96	AolTimeWarner	Sep-00	
May-93		Feb-97	JPMorgan	Dec-00	
Aug-93		May-97	AolTimeWarner	Mar-01	Cisco
Nov-93	CocaCola	Aug-97	AolTimeWarner	Jun-01	SP
Feb-94	Intel	Dec-97	Cisco	Sep-01	
May-94	Intel	Mar-98	Cisco	Dec-01	
Aug-94	Intel	Jun-98	AolTimeWarner	Apr-02	
Nov-94	Cisco	Sep-98	AT&T		

During blank periods, no stocks are recommended and the investor should stay out of the market. Some of the 19 stocks are never recommended. Those include the Dow Jones tracking stock, GE, IBM, Johnson & Johnson, and Exxon Mobil. All of the other stocks are used for at least 3 months. Intel is used for a 9-month period.

When the weaver model runs over the 10-year span with the 63/252 dynamic model for the base yields, the following weaved return is obtained.

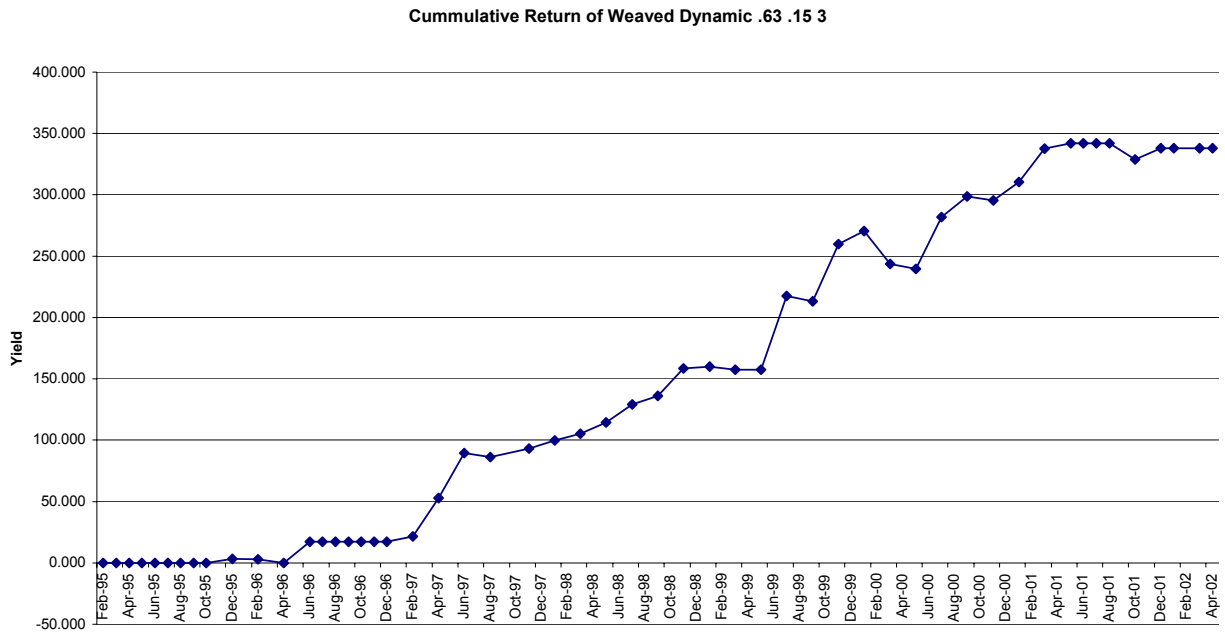


Figure 8.1 – Weaved Stocks Cumulative Return Group One

The above model generates excellent results; however, concern exists around the number of securities examined, freshness of the data, exclusion of stocks due to lack of data, and ordering of the securities in the selection process. What if a new set of securities are chosen? Would they yield outstanding returns?

Chapter 9 Security Selection Using Dynamic Markov Decision Process Model on Group Two Data

This section of research addresses some of the concerns raised in the previous chapter. In this chapter, 41 securities are selected. A majority of these securities are the most widely held securities on the New York and NASDAQ exchanges. Two small capitalization stocks provide the model with this dimension of the market. All of the securities bring 10 to 17 years of data for analysis. The 10-year securities are S&P index, OMI, and AOL Time Warner. To assure “freshness of the data,” all of the data extends into August 2003.

Prices for all 41 stocks include any dividend impact experienced by the security. A fixed amount of \$30,000 is used to purchase the stocks. The \$30,000 would have been invested entirely in one security or “laid out” of the market for a more promising period to enter the market. The previous technique of buying 1000 shares of a security varies the starting amount based on the price of the security at the entry point. Now, using a fixed \$30,000, this is corrected.

The 41 stocks arranged by trading symbols are shown in table 9.1 on the following page.

Table 9.1 – Group Two Stocks

Group Two Securities	
Alcoa	International Paper
Amer International Group	Johnson & Johnson
Amgen	JPMorgan
AOL Time Warner	Coca Cola
Bank of America	McDonalds
Bristol Myers	Altria
Boeing	Merck
Citigroup	Microsoft
Caterpillar	Omi Corp
Cisco	Procter & Gamble
DuPont	SBC Corp
Disney	Symbol
Duke Energy	S&P Index
Eastman Kodak	ATT
GE	Tesoro Oil
General Motors	United Technologies
Home Depot	Verizon
Honeywell	Wells Fargo
Hewlett Packard	Walmart
IBM	ExxonMobil
Intel	

9.1 More Stocks Better

The first question to be answered, dealing with the next set of stocks, pertains to the return relative to the number of stocks. Intuition implies that for stocks selected at random more stocks should produce a higher yield.

9.1.1 More Stocks Better Experiment

For the 41 stocks, batches of 10, 20, 30 and 41 stocks are selected. Forty individual executions of the model are processed. For these trials, statistics on the average return and the best and worst returns are captured.

For the dynamic portion of the model, 63-day returns are averaged in groups of 4 using the average, slope, and expected technique. Once the dynamic returns are generated the weaving process is engaged. For the weaving, the “green go zone” for the characteristics consists of 4 successive positive correlations above “ $r = .66$,” characteristics 10 percent better than the average of the previous 4, the last return being positive, and at least 3 characteristics meeting these 3 criteria.

The model first uses 10 stocks from the 41. Since the selected 10 stocks would have an impact on the results, the “weaver” is set to try 40 different random sets of 10 stocks each. These sets are averaged to provide the mean return using 10 stocks. The following chart shows the results of the model cumulative average return to the cumulative buy and hold return for the corresponding stocks. Furthermore, since the buy and hold return of the 10 stocks varies based on the stocks selected, the buy and hold results are averaged for the 10 securities.

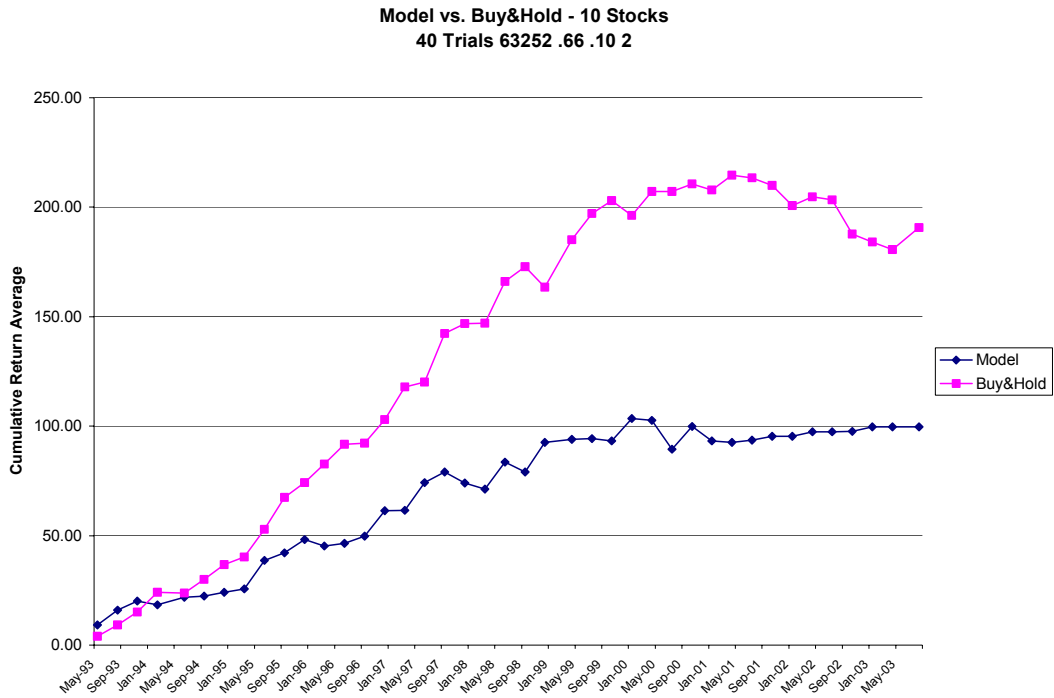


Figure 9.1 – Model 10 Stocks of 41 – 40 Trials

At this point the model, with 10 stocks the model seems to underperform the buy and hold strategy.

Next, the experiment repeats using groups of 20 stocks from the 41. The other precautions used for 10 stocks are followed for the 20 stocks. The following chart provides the results.

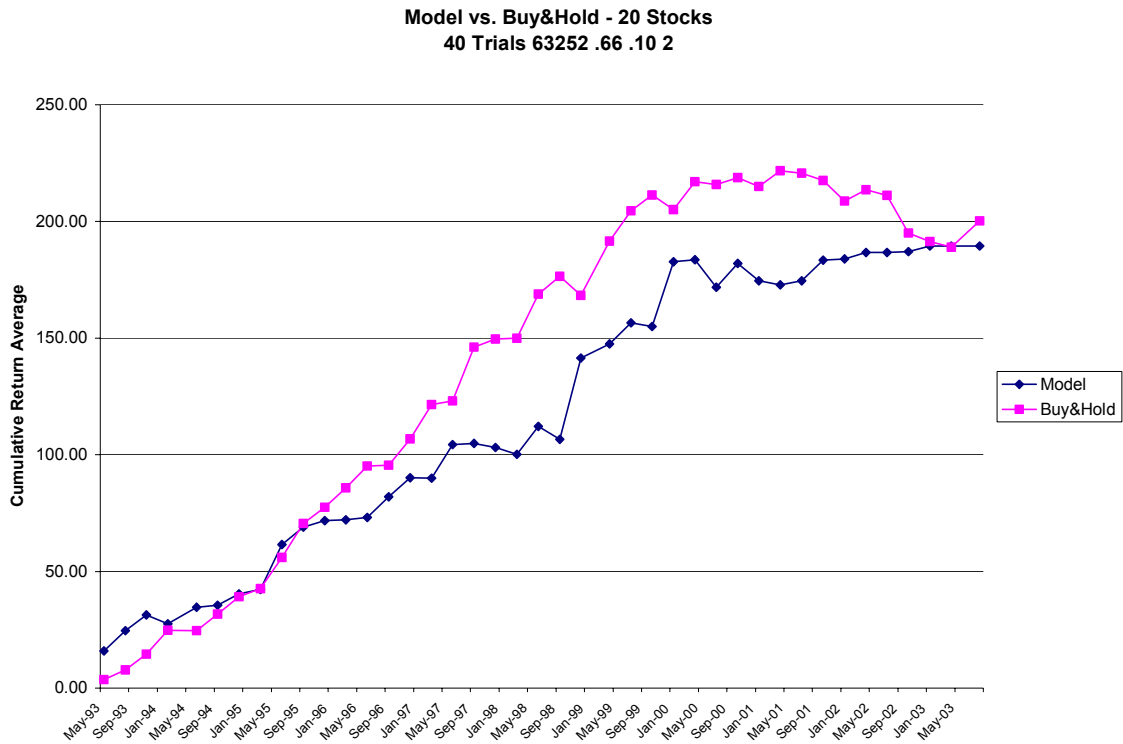


Figure 9.2 – Model 20 Stocks of 41 – 40 Trials

Once again the buy and hold strategy appears to be slightly better.

The following page provides two charts with the results for 30 and 41 stocks chosen at random. Since all stocks are used, for the 41 stocks only the sequence is different. For thirty securities, the model begins to out perform the buy and hold strategy.

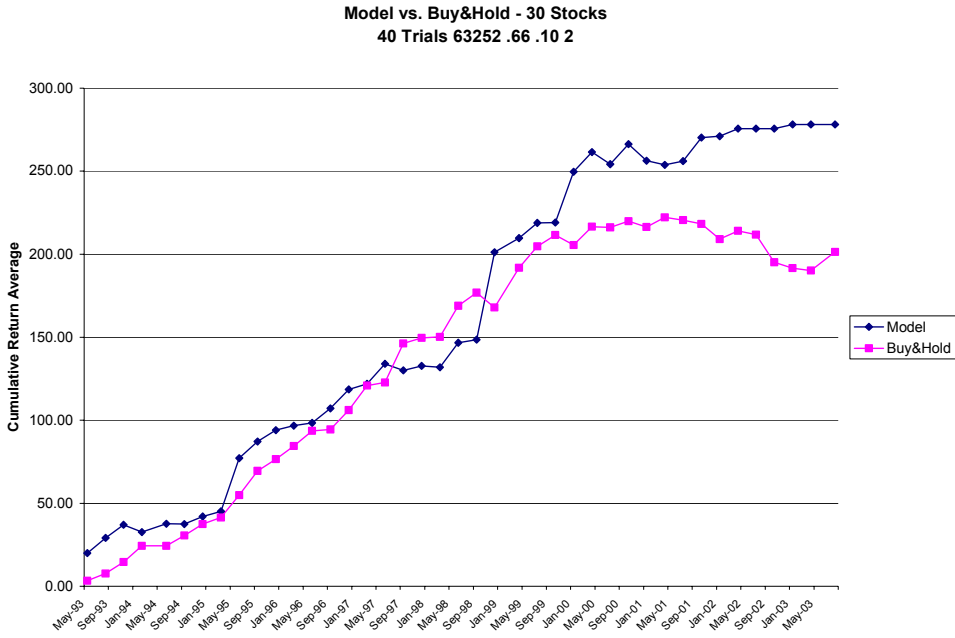


Figure 9.3 – Model 30 Stocks of 41 – 40 Trials

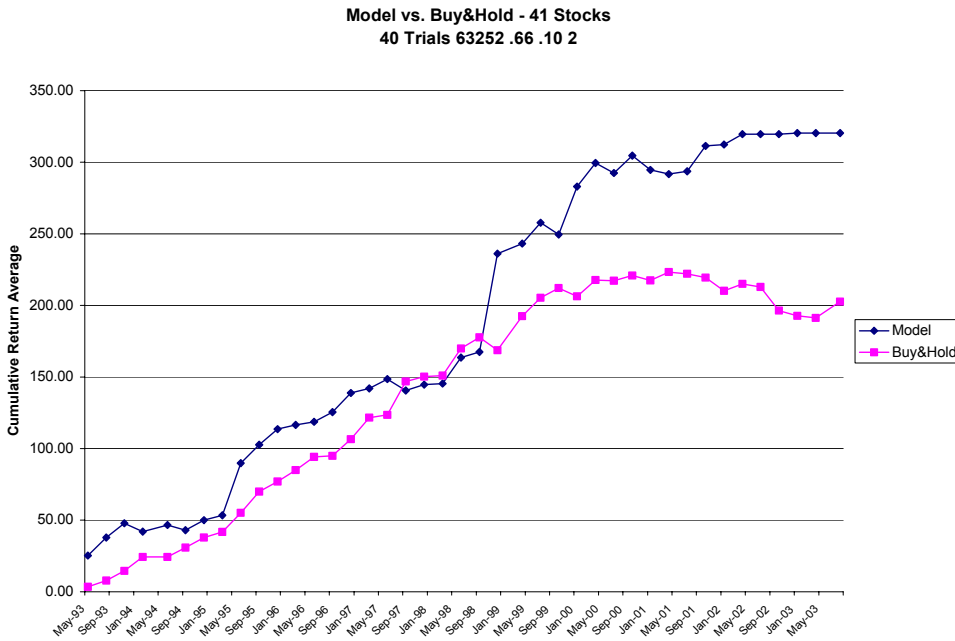


Figure 9.4 – All 41 – 40 Trials

Using the 41 securities produces a cumulative return of 320 percent. The buy and hold strategy for the same securities over this period is 203 percent. Yearly returns are 15 percent for the model and 11 percent for the buy and hold strategy over the examined time period for these 41 securities.

9.1.2 Significant Difference Experiment

The results in the last section depend on the results of 40 runs for each set of stocks. The individual high and low returns of these runs are provided on the next few pages. The “pick 10 stocks” has the largest range between the high and low return values.

The following charts give the model returns and the corresponding buy and hold strategy returns for the 10, 20, 30 and 41 stocks for each of the 40 trials. As the number of stocks selected increases the model yield performs better than the buy and hold strategy values.

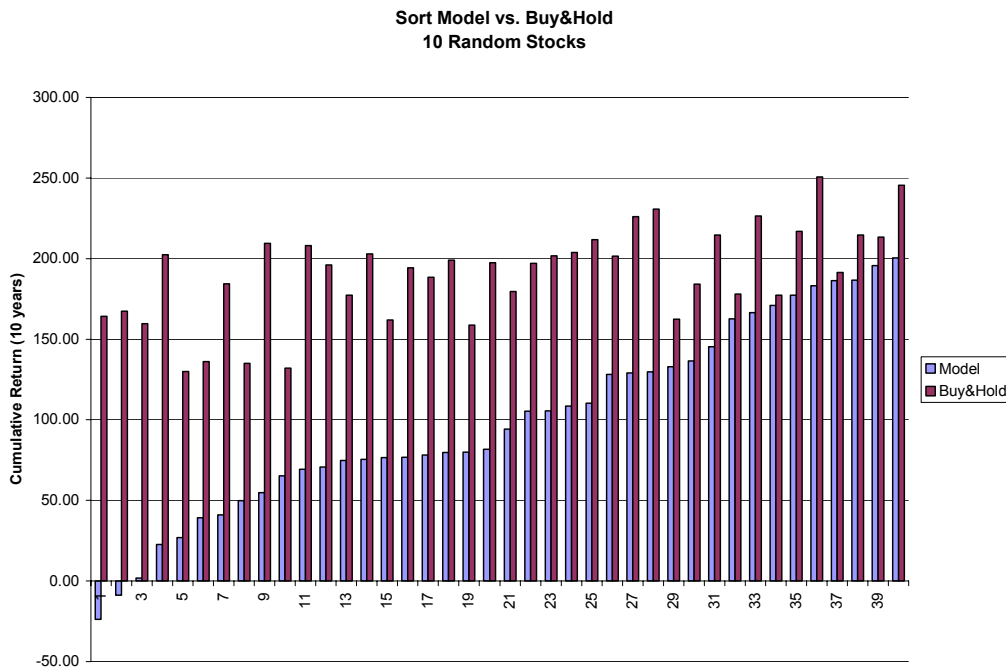


Figure 9.5 – Individual Average Return for 10 Random Securities

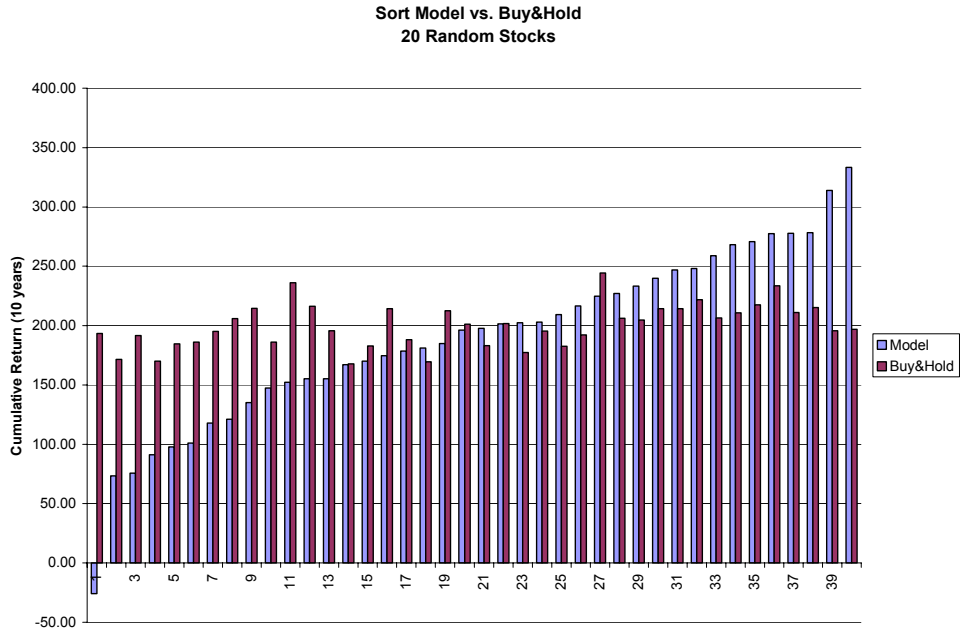


Figure 9.6 – Individual Average Return for 20 Random Securities

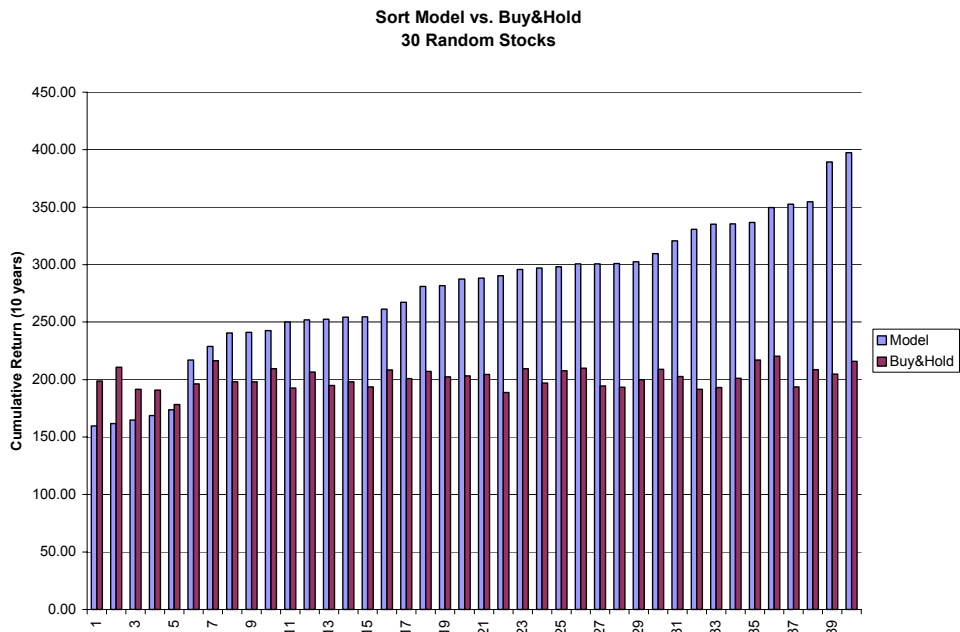


Figure 9.7 – Individual Average Return for 30 Random Securities

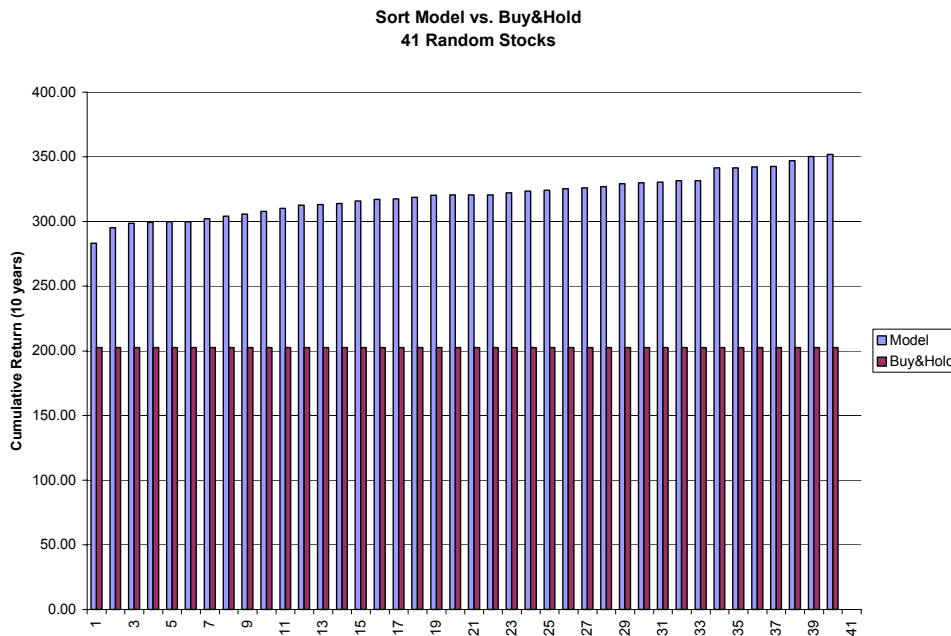


Figure 9.8 – Individual Average Return for 41 Random Securities

All of the previous figures relating to average return are plotted from lowest to highest return. The lowest yield is obtained for a group of 10 stocks. As the number of stocks increases, the lowest potential yield also increases. When the model selects 30 or more stocks, there is an 87% probability that the overall yield is better than the buy and hold of the same stocks. This supports the strength of the “weaving process” to build a successful strategy for stock investing from a group of stocks over the ten year examined life.

When 41 stocks are used, the model outperforms the buy and hold. The reason for the model providing different values for all the stocks is because the order of the stocks determines which stock is selected in a tie of characteristics passing the “green go zone test” mentioned earlier.

A simple t-test is used to determine if there is a significant difference between the returns of 10, 20, 30 and 41 stocks. The stock’s grouped returns from lowest to highest are examined. The following page provides one example of this process.

Table 9.2 – Example of T-test

Run #	Model for 10 stocks	Model for 20 stocks	Delta Diff
1	-23.77	-25.81	2.05
2	-8.89	73.53	-82.42
3	1.76	75.89	-74.13
4	22.57	91.15	-68.57
5	27.00	97.75	-70.74
6	39.10	101.03	-61.92
7	40.90	117.83	-76.93
8	49.80	121.11	-71.31
9	54.79	135.23	-80.44
10	65.21	147.36	-82.15
11	69.34	152.38	-83.03
12	70.68	155.14	-84.46
13	74.85	155.33	-80.48
14	75.45	167.12	-91.67
15	76.58	170.08	-93.50
16	76.70	174.84	-98.13
17	78.13	178.35	-100.22
18	79.64	180.98	-101.34
19	79.96	184.83	-104.87
20	81.69	196.18	-114.49
21	94.19	197.58	-103.38
22	105.41	201.60	-96.20
23	105.55	202.37	-96.82
24	108.57	202.93	-94.37
25	110.24	209.41	-99.18
26	128.22	216.60	-88.39
27	128.99	224.65	-95.66
28	129.69	226.99	-97.30
29	132.86	233.27	-100.41
30	136.49	239.97	-103.48
31	145.30	247.02	-101.72
32	162.47	248.03	-85.56
33	166.51	258.77	-92.25
34	170.94	268.07	-97.14
35	177.33	270.87	-93.53
36	183.14	277.51	-94.37
37	186.31	277.84	-91.54
38	186.60	278.21	-91.61
39	195.68	313.97	-118.29
40	200.46	333.45	-132.99

xbar	99.66	189.49	-89.82
SD	58.74	73.56	20.27

Test Hypothesis there is no difference. $H_0: E(Y) = u_1 - u_2 = 0$

$t = \text{DeltaDiff} - E(Y) / S/\text{sqrt } n \quad t = -28.0304$

$n-1 = 39$

t 95 confidence (39d.f) = 1.69

Given the absolute value of “t” is much greater than the table’s t-value for 39 degrees of freedom, then these are significantly different.

The other values have significant differences also. Thus, the model performs better with more stocks and the model’s results are significantly better than the buy and hold.

9.2 Choosing the Best Security

In this section a technique to choose securities that operate best with the model is examined. From the previous section, the largest differences in overall returns are experienced with the group of 10 stocks. These differences are a result of stocks that operated worst and best with the model. First, in all the 41 stocks, which stock is selected most often?

9.2.1 Most Selected Stocks of Group Two

As stated earlier, the security with the most characteristics in the “green go zone” for the 3-month period is the security chosen. In the event of a tie, randomness determines the selected security.

To determine the most selected security, the number of 3-month periods occupied by the security is plotted. The highest is the most requested security. The following figure provides the number of quarters a security is selected for investment.

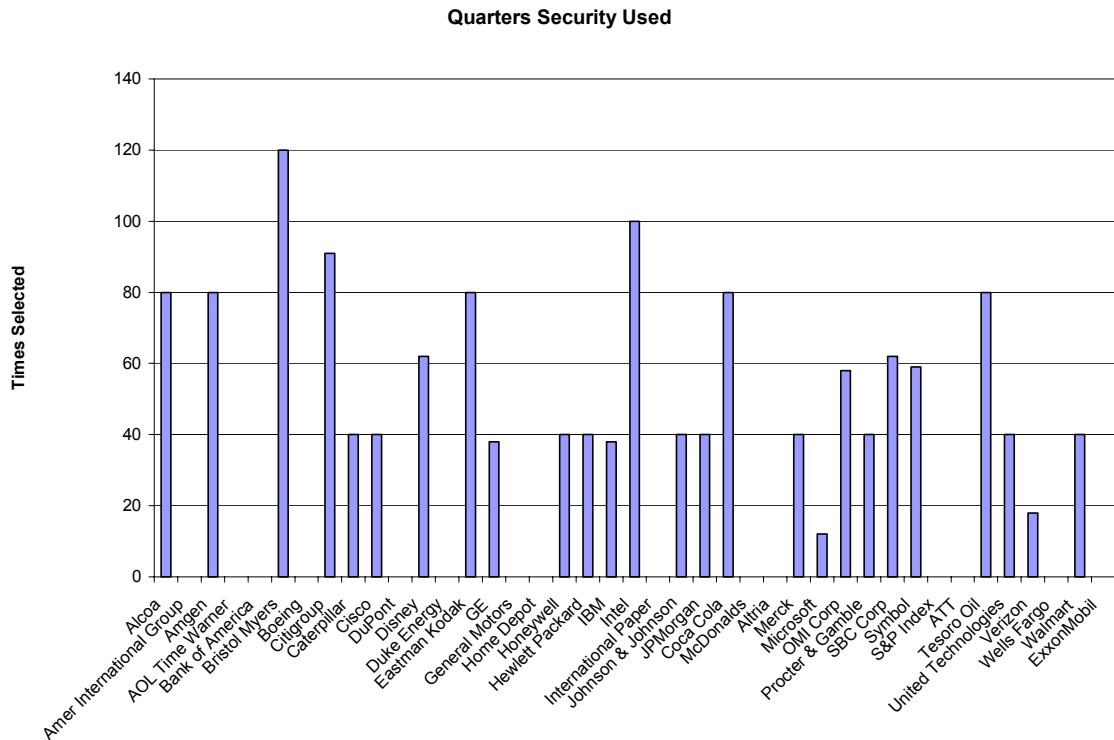


Figure 9.9 – Quarters Used for Investment

If one security is superior to all other securities, the security may be used about 1600 quarters (40 trials times 40 quarters). No security reaches above 120 times selected. From the figure above observe some securities are never selected for investment during the 10-year period. These may be good securities occupying a “number 2” position when the model chooses the best security for investment.

Another view of the data would be to sort the securities from most used to least used. The following figure provides this view.

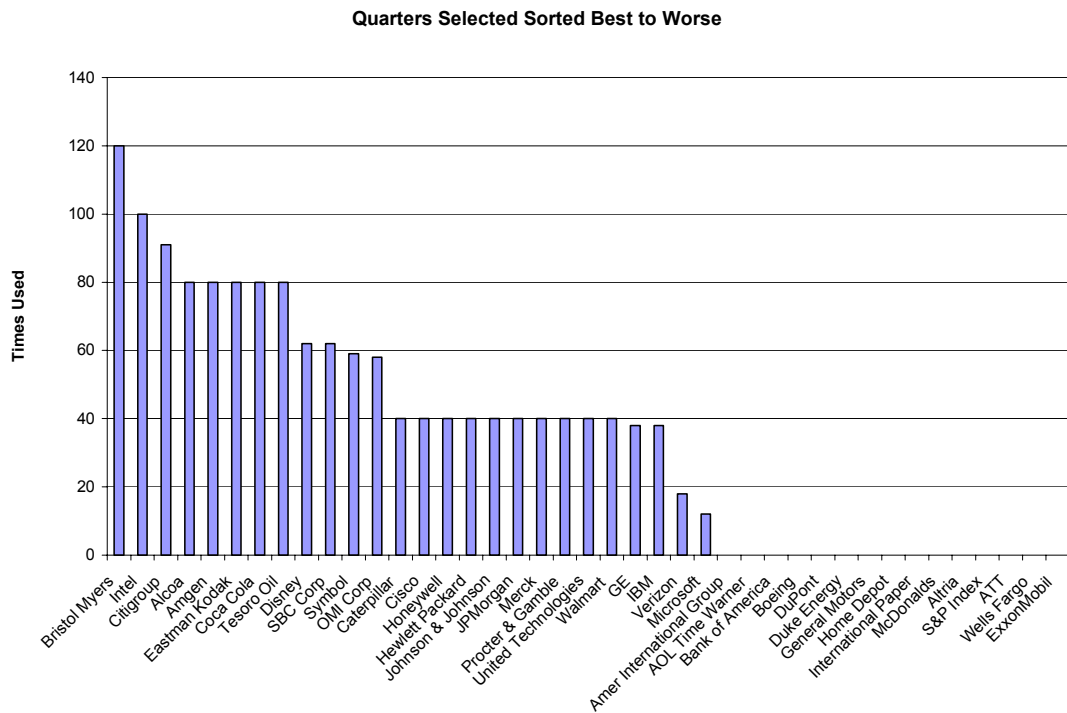


Figure 9.10 – Quarters Used Sorted

When all 41 securities are used, the weaving process selects the following securities most often.

Table 9.3 – Security Selected Most Often

Security	Quarters Selected
Bristol Myers	120
Intel	100
Citigroup	91
Alcoa	80
Amgen	80
Eastman Kodak	80
Coca Cola	80
Tesoro Oil	80

As mentioned, some securities are not selected from the 41. Those securities are as follows.

America International Group

AOL Time Warner

Bank of America

Boeing

DuPont

Duke Energy

General Motors

Home Depot

International Paper

McDonalds

Altria

S&P Index

ATT

Wells Fargo

Exxon Mobil

Chapter 10 Selecting Stocks for Performance

From the examination of the previous chapter, some securities appear to provide better yields with the model than other securities. This section provides a technique to identify ideal stocks to model.

10.1 Identification of Ideal Stocks to Model

The best technique to identify stocks functioning well with the model is to examine the stocks passing the “green go test.” To select these securities the model is processed with all 41 securities up to the point that the “green go test” is processed. At this stage the stocks are tallied with respect to the number of total characteristics passing the correlation check, improvement check, and the previous period positive check.

Stocks that had the greatest number of characteristics passing for the quarters are ranked the highest. For example, if a stock had 10 characteristics passing for the period, it would receive a score of 10. If only 3 passed, the score is 3. Since 3 of the securities only had 10 years data, they are candidates to participate for only the last 7 years. Remember 3 years are used to train. To adjust for this anomaly, the total score is divided by the number of periods the stock is a candidate for selection.

The following table gives the “strength scores” for the 41 securities.

Table 10.1 – Strength of Securities

Security	Times Considered	Total Score	100*Total Score / Times Considered
Alcoa	153	74	484
Amer International Group	132	54	409
Amgen	131	90	687
AOL Time Warner	84	39	464
Bank of America	132	73	553
Bristol Myers	132	112	848
Boeing	132	68	515
Citigroup	141	90	638
Caterpillar	144	65	451
Cisco	108	89	824
DuPont	132	42	318
Disney	132	35	265
Duke Energy	132	63	477
Eastman Kodak	132	45	341
GE	144	159	1104
General Motors	132	45	341
Home Depot	141	94	667
Honeywell	141	53	376
Hewlett Packard	141	58	411
IBM	144	81	563
Intel	144	107	743

Security	Times Considered	Total Score	100*Total Score / Times Considered
International Paper	132	23	174
Johnson & Johnson	144	62	431
JPMorgan	141	70	496
Coca Cola	141	84	596
McDonalds	132	35	265
Altria	156	45	288
Merck	132	106	803
Microsoft	144	87	604
OMI Corp	84	32	381
Procter & Gamble	141	66	468
SBC Corp	132	86	652
Symbol	132	37	280
S&P Index	72	19	264
ATT	144	48	333
Tesoro Oil	132	26	197
United Technologies	132	97	735
Verizon	141	68	482
Wells Fargo	132	45	341
Walmart	144	73	507
ExxonMobil	144	85	590

The ten top potential securities selected by this technique are as follows.

- GE
- Bristol Myers
- Cisco
- Merck
- Intel
- United Technologies
- Amgen
- Home Depot
- SBC Corp
- Citigroup

In processing the 41 stocks as a group, four of the top five most selected securities are identified by the strength technique. That is, of the 41, Bristol Myers, Intel, Citigroup and

Amgen occupied four of the top five spots. However, one of the securities identified by the strength method, Home Depot, resides in the bottom 15 as a not chosen security.

10.2 Significant Difference Experiment

Are the identified 10 stocks actually better than 10 stocks chosen at random? To answer the question an experiment is processed using only the 10 selected “strong” stocks.

If these stocks are actually better than the average stock, then the returns generated by these 10 must be significantly better than the returns generated by a larger number of stocks.

Recall, for random stocks, the proof for higher returns based on a larger number of stocks has been shown earlier.

These 10 are processed in the same manner that the 41 stocks are processed. Trials are set to 40. The cumulative returns for these ten securities vary from 298 percent to 339 percent. All of the returns are better than the cumulative buy and hold strategy return for the ten securities.

The figure on the following page provides the low to high returns using only these 10 best securities.

**Sort Model vs. Buy & Hold
10 Best Stocks from Strong Model**

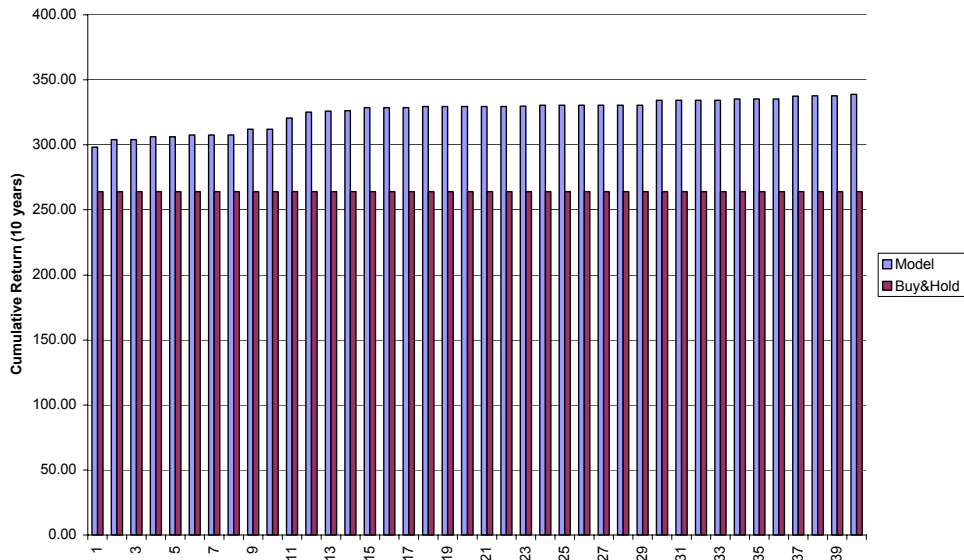


Figure 10.1 – Ten Best Stocks From Strong Model

Next, the returns of these 40 trials will be compared to the returns of the 41 stocks. The following figure shows trial returns from lowest to highest for all 41 stocks.

**10 Best Stocks from Strong Model
vs. Returns from 41 Stocks**

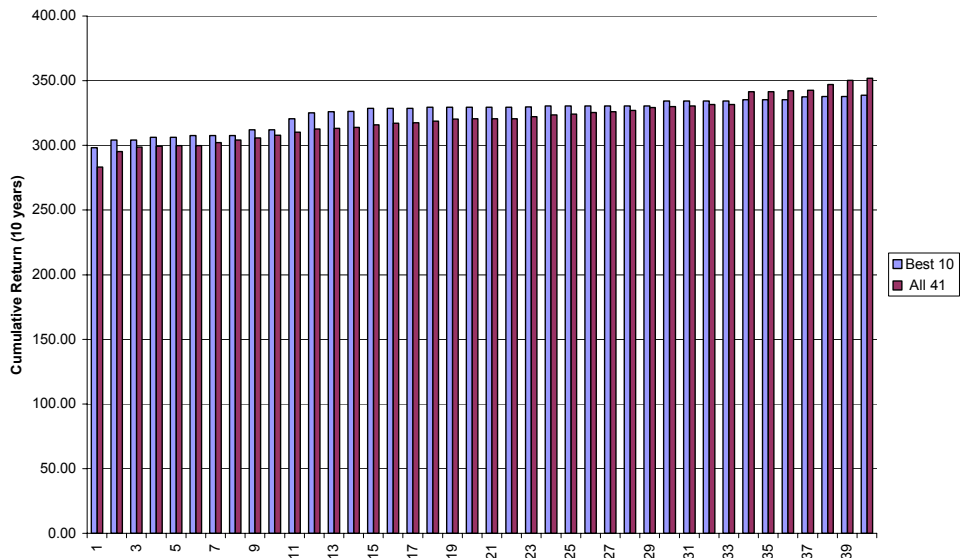


Figure 10.2 – Returns of Best 10 versus All 41

The overall average cumulative return of the 10 best is slightly better than the overall average cumulative return of all 41 stocks. To determine if the return is significantly better the t-test is again employed.

Table 10.2 – Comparison of Best 10 Returns to All 41 Returns

Run #	Model Cumulative Return for 10 Best Stocks	Model Cumulative Return for All 41 Stocks	Delta Diff
1	298.28	283.22	15.06
2	303.98	295.18	8.79
3	303.98	298.60	5.37
4	306.31	299.33	6.98
5	306.31	299.73	6.58
6	307.46	299.73	7.74
7	307.46	302.09	5.37
8	307.46	304.04	3.42
9	312.01	305.56	6.44
10	312.01	307.76	4.25
11	320.67	310.11	10.56
12	325.21	312.61	12.60
13	326.11	313.20	12.91
14	326.37	314.04	12.32
15	328.70	315.94	12.76
16	328.70	317.17	11.53
17	328.70	317.53	11.17
18	329.49	318.73	10.76
19	329.49	320.50	8.99
20	329.49	320.64	8.85
21	329.49	320.64	8.85
22	329.49	320.64	8.85
23	329.60	322.22	7.38
24	330.65	323.66	6.99
25	330.65	324.02	6.63
26	330.65	325.35	5.30
27	330.65	325.94	4.71
28	330.65	326.93	3.72
29	330.65	329.13	1.52
30	334.14	329.90	4.24
31	334.14	330.48	3.66
32	334.40	331.47	2.92
33	334.40	331.47	2.92
34	335.30	341.47	-6.17
35	335.30	341.47	-6.17
36	335.30	342.37	-7.07
37	337.52	342.59	-5.07
38	337.63	347.14	-9.51
39	337.63	350.40	-12.77
40	338.79	351.85	-13.06

xbar	325.13	320.37	4.76
SD	11.61	16.16	7.09

Test Hypothesis there is no difference. $H_0: E(Y) = u_1 - u_2 = 0$
 $t = \frac{\text{DeltaDiff} - E(Y)}{S/\sqrt{n}} = 4.246674$
 $n-1 = 39$
 $t_{95 \text{ confidence } (39d.f)} = 1.69$

Thus, the “strong model” demonstrates the ability to select the best stocks from a grouping of stocks. These ten best stocks provide a better return than a far larger number (41 stocks) provides. The significance of this difference is examined. As shown on the previous page, the t-test shows the model returns of the 10 best stocks exceed the model returns for all 41 stocks.

Chapter 11 Conclusions and Additional Research

Obviously, the importance and individual economic value of this model functioning properly is of interest to most investors. Forty-one stocks are examined with a degree of success and are presented in this paper. This chapter identifies additional proposed research to improve the model and to better understand the model's operation.

11.1 Conclusions

In this paper Markov processes are used to describe future states of the forty-one stocks with very positive results. Basically, the research shows that market timing can yield better results than simple buy and hold strategies. The Markov model coupled with the weaving routines demonstrates better yields when selecting from a larger pool of stocks. The model also significantly outperforms the buy and hold for a 10 year period. Finally, the model generates a technique to select stocks to include that provide even larger returns.

11.2 Additional Research

11.2.1 Comparison to Other Models

Another area of investigation may be to expand the comparative strategies to include other good policies in the literature. One group has recently used neural networks and pattern recognition of "bull flags" to time the market. Our model could be set to generate returns on the same securities and determine whether our model generated more or less return for the same security for the same time period. However, due to the vagueness in the published work, success in this step will be highly dependent upon the ability to fully understand and implement these policies for testing.

If clearly identified stocks, time periods and performance measures may be obtained, one possibility is to compare to the other's results. Many complications including as simple as the calculation of the return may jeopardize success in this area. If successful, investigation in this area may prove the value of our model's technique and possibly provide insight to improve our model's recommendations.

11.2.2 Non-Binary State Space

Another area of research would be to increase the snake model state space. This present research base model is built upon either "up" or "down" for the price and volume. An extension where a "large up" or "large down" would be differentiated from a "small up" or "small down" would provide 4 or 5 possible state spaces per snake length. The 5th space could be a region of "no change." Using a variable percent for the "stay the same," "going up small," and "going down small" would provide the boundaries to state space. Larger and smaller changes in price or volume would obviously occupy the upper and lower spaces.

11.2.3 Number of Securities

One may always increase the number of securities examined. Another possible area of research would include increasing the number of securities examined into the "hundreds." With a front-end routine to download the data, the model could be modified to process numerous securities and examine the results.

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Appendix A Members of the S&P 500 (as of May 23, 2002)

Symbol	S & P Group	Exchange	Issue Name
COMS	Industrial	NASD	3COM CORP
ABT	Industrial	NYSE	ABBOTT LABS
ADBE	Industrial	NASD	ADOBE SYSTEMS
AMD	Industrial	NYSE	ADVANCED MICRO DEVICES
ANV	Industrial	NYSE	AEROQUIP-VICKERS INC
AES	Utilities	NYSE	AES CORP
AET	Financial	NYSE	AETNA INC
APD	Industrial	NYSE	AIR PRODUCTS & CHEMICALS
ATI	Industrial	NYSE	AIRTOUCH COMMUNICATIONS
ACV	Industrial	NYSE	ALBERTO-CULVER
ABS	Industrial	NYSE	ALBERTSON'S
AL	Industrial	NYSE	ALCAN ALUMINUM LTD
AA	Industrial	NYSE	ALCOA INC
ALT	Industrial	NYSE	ALLEGHENY TELEDYNE INC
AGN	Industrial	NYSE	ALLERGAN INC
ALD	Industrial	NYSE	ALLIEDSIGNAL INC
ALL	Financial	NYSE	ALLSTATE CORP
AT	Industrial	NYSE	ALLTEL CORP DEL
AZA	Industrial	NYSE	ALZA CORP
AHC	Industrial	NYSE	AMERADA HESS CORP
AEE	Utilities	NYSE	AMEREN CORP
AOL	Industrial	NYSE	AMERICA ONLINE
AEP	Utilities	NYSE	AMERICAN ELEC PWR CO INC
AXP	Financial	NYSE	AMERICAN EXPRESS CO
AGC	Financial	NYSE	AMERICAN GENERAL CORP
AM	Industrial	NYSE	AMERICAN GREETINGS CL A
AHP	Industrial	NYSE	AMERICAN HOME PRODS CORP
AIG	Financial	NYSE	AMERICAN INTL GROUP INC
ASC	Industrial	NYSE	AMERICAN STORES CO
AIT	Utilities	NYSE	AMERITECH CORP DE
AMGN	Industrial	NASD	AMGEN INC
AMP	Industrial	NYSE	AMP INC PENNSYLVANIA

AMR	Transportation	NYSE	AMR CORP
APC	Industrial	NYSE	ANADARKO PETROLEUM
ANDW	Industrial	NASD	ANDREW CORP
BUD	Industrial	NYSE	ANHEUSER BUSCH COS INC
AOC	Financial	NYSE	AON CORP
APA	Industrial	NYSE	APACHE CORP
AAPL	Industrial	NASD	APPLE COMPUTER INC
AMAT	Industrial	NASD	APPLIED MATERIALS INC
ADM	Industrial	NYSE	ARCHER DANIELS MIDLAND CO
ACK	Industrial	NYSE	ARMSTRONG WORLD INDS INC
AR	Industrial	NYSE	ASARCO INC
ASND	Industrial	NASD	ASCEND COMMUNICATIONS
ASH	Industrial	NYSE	ASHLAND INC
AFS	Financial	NYSE	ASSOCIATES FIRST CAPITAL
T	Industrial	NYSE	AT&T CORP
ARC	Industrial	NYSE	ATLANTIC RICHFIELD CO
ADSK	Industrial	NASD	AUTODESK INC
AUD	Industrial	NYSE	AUTOMATIC DATA PROCSG INC
AZO	Industrial	NYSE	AUTOZONE
AVY	Industrial	NYSE	AVERY DENNISON CORP
AVP	Industrial	NYSE	AVON PRODUCTS INC
BHI	Industrial	NYSE	BAKER HUGHES INC
BLL	Industrial	NYSE	BALL CORP
BGE	Utilities	NYSE	BALTIMORE G & E C
BK	Financial	NYSE	BANK OF NEW YORK
ONE	Financial	NYSE	BANK ONE CORP
BAC	Financial	NYSE	BANKAMERICA CORP
BKB	Financial	NYSE	BANKBOSTON CORP
BT	Financial	NYSE	BANKERS TRUST N Y CORP
BCR	Industrial	NYSE	BARD C R INC
ABX	Industrial	NYSE	BARRICK GOLD CORP
BMG	Industrial	NYSE	BATTLE MOUNTAIN GOLD
BOL	Industrial	NYSE	BAUSCH & LOMB INC
BAX	Industrial	NYSE	BAXTER INTERNATIONAL INC
BBT	Financial	NYSE	BB&T CORP

BSC	Financial	NYSE	BEAR STEARNS COS
BDX	Industrial	NYSE	BECTON DICKINSON & CO
BEL	Utilities	NYSE	BELL ATLANTIC CORP
BLS	Utilities	NYSE	BELLSOUTH CORP
BMS	Industrial	NYSE	BEMIS CO INC
BFO	Industrial	NYSE	BESTFOODS INC
BS	Industrial	NYSE	BETHLEHEM STEEL CORP
BMET	Industrial	NASD	BIOMET INC
BDK	Industrial	NYSE	BLACK & DECKER CORP
HRB	Industrial	NYSE	BLOCK H & R INC
BMCS	Industrial	NASD	BMC SOFTWARE
BA	Industrial	NYSE	BOEING CO
BCC	Industrial	NYSE	BOISE CASCADE CORP
BSX	Industrial	NYSE	BOSTON SCIENTIFIC CORP
BGG	Industrial	NYSE	BRIGGS & STRATTON CORP
BMY	Industrial	NYSE	BRISTOL MYERS SQUIBB CO
BF.B	Industrial	NYSE	BROWN-FORMAN CORP
BFI	Industrial	NYSE	BROWNING FERRIS INDS INC
BC	Industrial	NYSE	BRUNSWICK CORP
BNI	Transportation	NYSE	BURLINGTON NTHRN SANTA FE
BR	Industrial	NYSE	BURLINGTON RESOURCES INC
CS	Industrial	NYSE	CABLETRON SYSTEMS
CPB	Industrial	NYSE	CAMPBELL SOUP CO
COF	Financial	NYSE	CAPITAL ONE FINANCIAL
CAH	Industrial	NYSE	CARDINAL HEALTH, INC
CCL	Industrial	NYSE	CARNIVAL CORP
CPL	Utilities	NYSE	CAROLINA POWER & LIGHT CO
CSE	Industrial	NYSE	CASE CORP
CAT	Industrial	NYSE	CATERPILLAR INC
CBS	Industrial	NYSE	CBS CORP
CD	Industrial	NYSE	CENDANT CORPORATION
CTX	Industrial	NYSE	CENTEX CORP
CSR	Utilities	NYSE	CENTRAL & SOUTH WEST CORP
CEN	Industrial	NYSE	CERIDIAN CORP
CHA	Industrial	NYSE	CHAMPION INTL CORP

SCH	Financial	NYSE	CHARLES SCHWAB
CMB	Financial	NYSE	CHASE MANHATTAN CORP
CHV	Industrial	NYSE	CHEVRON CORP
CB	Financial	NYSE	CHUBB CORP
CI	Financial	NYSE	CIGNA CORP
CINF	Financial	NASD	CINCINNATI FINANCIAL
CIN	Utilities	NYSE	CINERGY CORP
CC	Industrial	NYSE	CIRCUIT CITY STORES INC
CSCO	Industrial	NASD	CISCO SYSTEMS INC
C	Financial	NYSE	CITIGROUP INC
CCU	Industrial	NYSE	CLEAR CHANNEL COMMUNICATIONS
CLX	Industrial	NYSE	CLOROX CO
CGP	Utilities	NYSE	COASTAL CORP
KO	Industrial	NYSE	COCA COLA CO
CCE	Industrial	NYSE	COCA-COLA ENTERPRISES
CL	Industrial	NYSE	COLGATE PALMOLIVE CO
CG	Utilities	NYSE	COLUMBIA ENERGY GROUP
COL	Industrial	NYSE	COLUMBIA HCA HLTHCRE CORP
CMCSK	Industrial	NASD	COMCAST CORP
CMA	Financial	NYSE	COMERICA INC
CPQ	Industrial	NYSE	COMPAQ COMPUTER CORP
CA	Industrial	NYSE	COMPUTER ASSC INTL INC
CSC	Industrial	NYSE	COMPUTER SCIENCES CORP
CPWR	Industrial	NASD	COMPUWARE CORP
CAG	Industrial	NYSE	CONAGRA INC
CNC	Financial	NYSE	CONSECO INC
ED	Utilities	NYSE	CONSOLIDATED EDISON CO
CNG	Utilities	NYSE	CONSOLIDATED NAT GAS CO
CNS	Industrial	NYSE	CONSOLIDATED STORES
CBE	Industrial	NYSE	COOPER INDUSTRIES INC
CTB	Industrial	NYSE	COOPER TIRE & RUBBER CO
ACCOB	Industrial	NASD	COORS ADOLPH CO
GLW	Industrial	NYSE	CORNING INC
COST	Industrial	NASD	COSTCO CO
CCR	Financial	NYSE	COUNTRYWIDE CREDIT INDUSTRIES

CR	Industrial	NYSE	CRANE CO
CCK	Industrial	NYSE	CROWN CORK & SEAL INC PA
CSX	Transportation	NYSE	CSX CORP
CUM	Industrial	NYSE	CUMMINS ENGINE CO INC
CVS	Industrial	NYSE	CVS CORP
CYM	Industrial	NYSE	CYPRUS AMAX MINERALS CO
DCN	Industrial	NYSE	DANA CORP
DHR	Industrial	NYSE	DANAHER CORP
DRI	Industrial	NYSE	DARDEN RESTAURANTS
DGN	Industrial	NYSE	DATA GENERAL CORP
DH	Industrial	NYSE	DAYTON HUDSON CORP
DE	Industrial	NYSE	DEERE & CO
DELL	Industrial	NASD	DELL COMPUTER
DAL	Transportation	NYSE	DELTA AIR LINES INC
DLX	Industrial	NYSE	DELUXE CORP
DDS	Industrial	NYSE	DILLARD DEPT STORES CL A
DG	Industrial	NYSE	DOLLAR GENERAL
D	Utilities	NYSE	DOMINION RESOURCES INC VA
DNY	Industrial	NYSE	DONNELLEY R R & SONS CO
DOV	Industrial	NYSE	DOVER CORP
DOW	Industrial	NYSE	DOW CHEMICAL CO
DJ	Industrial	NYSE	DOW JONES & CO INC
DTE	Utilities	NYSE	DTE ENERGY CO
DD	Industrial	NYSE	DU PONT (E.I.)
DUK	Utilities	NYSE	DUKE ENERGY
DNB	Industrial	NYSE	DUN & BRADSTREET CORP
EGG	Industrial	NYSE	E G & G INC
EFU	Utilities	NYSE	EASTERN ENTERPRISES
EMN	Industrial	NYSE	EASTMAN CHEMICAL CO
EK	Industrial	NYSE	EASTMAN KODAK CO
ETN	Industrial	NYSE	EATON CORP
ECL	Industrial	NYSE	ECOLAB INC
EIX	Utilities	NYSE	EDISON INTERNATIONAL INC
EDS	Industrial	NYSE	ELECTRONIC DATA SYSTEMS
EMC	Industrial	NYSE	EMC CORP

EMR	Industrial	NYSE	EMERSON ELECTRIC CO
EC	Industrial	NYSE	ENGELHARD CORP
ENE	Utilities	NYSE	ENRON CORP
ETR	Utilities	NYSE	ENTERGY CORP
EFX	Financial	NYSE	EQUIFAX INC
XON	Industrial	NYSE	EXXON CORP
FNM	Financial	NYSE	FANNIE MAE
FDX	Transportation	NYSE	FEDERAL EXPRESS CORP
FRE	Financial	NYSE	FEDERAL HOME LOAN MTG
FD	Industrial	NYSE	FEDERATED DEPT STORES DE
FITB	Financial	NASD	FIFTH THIRD BANCORP
FDC	Industrial	NYSE	FIRST DATA CORP
FTU	Financial	NYSE	FIRST UNION CORP
FSR	Financial	NYSE	FIRSTAR CORPORATION
FE	Utilities	NYSE	FIRSTENERGY CORP
FLT	Financial	NYSE	FLEET FINANCIAL GROUP
FLE	Industrial	NYSE	FLEETWOOD ENTERPRISES INC
FLR	Industrial	NYSE	FLUOR CORP
FMC	Industrial	NYSE	FMC CORP
F	Industrial	NYSE	FORD MOTOR CO
FJ	Industrial	NYSE	FORT JAMES CORP
FO	Industrial	NYSE	FORTUNE BRANDS, INC
FWC	Industrial	NYSE	FOSTER WHEELER CORP
FPL	Utilities	NYSE	FPL GROUP INC
BEN	Financial	NYSE	FRANKLIN RESOURCES INC
FCX	Industrial	NYSE	FREEMPORT-MCMORAN COPPER & GOLD
FRO	Utilities	NYSE	FRONTIER CORP
FTL	Industrial	NYSE	FRUIT OF THE LOOM
GCI	Industrial	NYSE	GANNETT CO INC
GPS	Industrial	NYSE	GAP INC
GTW	Industrial	NYSE	GATEWAY 2000 INC
GD	Industrial	NYSE	GENERAL DYNAMICS CORP
GE	Industrial	NYSE	GENERAL ELECTRIC CO
GIC	Industrial	NYSE	GENERAL INSTRUMENT CORP
GIS	Industrial	NYSE	GENERAL MILLS INC

GM	Industrial	NYSE	GENERAL MOTORS CORP
GPC	Industrial	NYSE	GENUINE PARTS CO
GP	Industrial	NYSE	GEORGIA PACIFIC CORP
G	Industrial	NYSE	GILLETTE CO
GDW	Financial	NYSE	GOLDEN WEST FINANCIAL
GR	Industrial	NYSE	GOODRICH B F CO
GT	Industrial	NYSE	GOODYEAR TIRE & RUBBER CO
GPU	Utilities	NYSE	GPU INC
GRA	Industrial	NYSE	GRACE W R & CO HLDG CO
GWW	Industrial	NYSE	GRAINGER W W INC
GAP	Industrial	NYSE	GREAT ATLANTIC & PAC TEA
GLK	Industrial	NYSE	GREAT LAKES CHEMICAL CORP
GTE	Utilities	NYSE	GTE CORP
GDT	Industrial	NYSE	GUIDANT CORP
HAL	Industrial	NYSE	HALLIBURTON CO
H	Industrial	NYSE	HARCOURT GENERAL INC
HPH	Industrial	NYSE	HARNISCHFEGER INDS INC
HET	Industrial	NYSE	HARRAHS ENT INC
HRS	Industrial	NYSE	HARRIS CORP
HIG	Financial	NYSE	HARTFORD FINANCIAL SVC GP
HAS	Industrial	AMEX	HASBRO INC
HBOC	Industrial	NASD	HBO & COMPANY
HCR	Industrial	NYSE	HCR MANOR CARE
HRC	Industrial	NYSE	HEALTHSOUTH CORP
HNZ	Industrial	NYSE	HEINZ H J CO
HP	Industrial	NYSE	HELMERICH & PAYNE INC
HPC	Industrial	NYSE	HERCULES INC
HSY	Industrial	NYSE	HERSHEY FOODS CORP
HWP	Industrial	NYSE	HEWLETT PACKARD CO
HLT	Industrial	NYSE	HILTON HOTELS CORP
HD	Industrial	NYSE	HOME DEPOT INC
HM	Industrial	NYSE	HOMESTAKE MINING CO
HON	Industrial	NYSE	HONEYWELL INC
HI	Financial	NYSE	HOUSEHOLD INTL INC
HOU	Utilities	NYSE	HOUSTON INDUSTRIES INC

HUM	Industrial	NYSE	HUMANA INC
HBAN	Financial	NASD	HUNTINGTON BANCSHARES
IKN	Industrial	NYSE	IKON OFFICE SOLUTIONS
ITW	Industrial	NYSE	ILLINOIS TOOL WORKS INC
RX	Industrial	NYSE	IMS HEALTH INC
N	Industrial	NYSE	INCO LTD
IR	Industrial	NYSE	INGERSOLL RAND CO
INTC	Industrial	NASD	INTEL CORP
IBM	Industrial	NYSE	INTERNATIONAL BUSINESS MACHINES
IFF	Industrial	NYSE	INTERNATIONAL FLAV & FRAG
IP	Industrial	NYSE	INTERNATIONAL PAPER CO
IPG	Industrial	NYSE	INTERPUBLIC GROUP COS INC
IIN	Industrial	NYSE	ITT INDUSTRIES INC
JP	Financial	NYSE	JEFFERSON PILOT CORP
JNJ	Industrial	NYSE	JOHNSON & JOHNSON
JCI	Industrial	NYSE	JOHNSON CONTROLS INC
JOS	Industrial	NYSE	JOSTENS INC
KM	Industrial	NYSE	K MART CORP
KBH	Industrial	NYSE	KAUFMAN & BROAD HOME CORP
K	Industrial	NYSE	KELLOGG CO
KMG	Industrial	NYSE	KERR MCGEE CORP
KEY	Financial	NYSE	KEYCORP
KMB	Industrial	NYSE	KIMBERLY CLARK CORP
KWP	Industrial	NYSE	KING WORLD PRODS INC
KLAC	Industrial	NASD	KLA-TENCOR CORP
KRI	Industrial	NYSE	KNIGHT RIDDER INC
KSS	Industrial	NYSE	KOHL'S CORP
KR	Industrial	NYSE	KROGER CO
LDW	Industrial	NYSE	LAIDLAW INC
LEH	Financial	NYSE	LEHMAN BROS HL DGS
LLY	Industrial	NYSE	LILLY ELI & CO
LTD	Industrial	NYSE	LIMITED INC
LNC	Financial	NYSE	LINCOLN NATIONAL CORP
LIZ	Industrial	NYSE	LIZ CLAIBORNE INC
LMT	Industrial	NYSE	LOCKHEED MARTIN CORP

LTR	Financial	NYSE	LOEWS CORP
LDG	Industrial	NYSE	LONGS DRUG STORES CORP
LPX	Industrial	NYSE	LOUISIANA PACIFIC CORP
LOW	Industrial	NYSE	LOWES COS INC
LSI	Industrial	NYSE	LSI LOGIC CORP
LU	Industrial	NYSE	LUCENT TECHNOLOGIES
MKG	Industrial	NYSE	MALLINCKRODT GROUP INC
MAR	Industrial	NYSE	MARRIOTT INTL INC
MMC	Financial	NYSE	MARSH & MCLENNAN
MAS	Industrial	NYSE	MASCO CORP
MAT	Industrial	NYSE	MATTEL INC
MAY	Industrial	NYSE	MAY DEPT STORES CO
MYG	Industrial	NYSE	MAYTAG CORP
MBI	Financial	NYSE	MBIA INC
KRB	Financial	NYSE	MBNA CORP
MDR	Industrial	NYSE	MCDERMOTT INTL INC
MCD	Industrial	NYSE	MCDONALDS CORP
MHP	Industrial	NYSE	MCGRAW HILL COS INC
WCOM	Industrial	NASD	MCI WORLDCOM
MEA	Industrial	NYSE	MEAD CORP
UMG	Industrial	NYSE	MEDIAONE GROUP INC
MDT	Industrial	NYSE	MEDTRONIC INC
MEL	Financial	NYSE	MELLON BANK CORP
MTL	Financial	NYSE	MERCANTILE BANCORP
MRK	Industrial	NYSE	MERCK & CO INC
MDP	Industrial	NYSE	MEREDITH CORP
MER	Financial	NYSE	MERRILL LYNCH & CO INC
FMY	Industrial	NYSE	MEYER (FRED) INC
MTG	Financial	NYSE	MGIC INVESTMENT
MU	Industrial	NYSE	MICRON TECHNOLOGY INC
MSFT	Industrial	NASD	MICROSOFT CORP
MZ	Industrial	NYSE	MILACRON INC
MIL	Industrial	NYSE	MILLIPORE CORP
MMM	Industrial	NYSE	MINNESOTA MNG & MFG CO
MIR	Industrial	NYSE	MIRAGE RESORTS

MOB	Industrial	NYSE	MOBIL CORP
MTC	Industrial	NYSE	MONSANTO CO
MCL	Industrial	NYSE	MOORE CORP LTD
JPM	Financial	NYSE	MORGAN J P & CO INC
MWD	Financial	NYSE	MORGAN STANLEY, DEAN WITTER & CO
MII	Industrial	NYSE	MORTON INTL INC IND
MOT	Industrial	NYSE	MOTOROLA INC
NC	Industrial	NYSE	NACCO INDUSTRIES INC
NLC	Industrial	NYSE	NALCO CHEMICAL CO
NCC	Financial	NYSE	NATIONAL CITY CORP
NSM	Industrial	NYSE	NATIONAL SEMICONDUCTOR CO
NSI	Industrial	NYSE	NATIONAL SERVICE INDS INC
NAV	Industrial	NYSE	NAVISTAR INTL CORP
NCE	Utilities	NYSE	NEW CENTURY ENERGIES
NYT	Industrial	NYSE	NEW YORK TIMES CL A
NWL	Industrial	NYSE	NEWELL CO
NEM	Industrial	NYSE	NEWMONT MINING CORP
NXTL	Industrial	NASD	NEXTEL COMMUNICATIONS
NMK	Utilities	NYSE	NIAGARA MOHAWK POWER CORP
GAS	Utilities	NYSE	NICOR INC
NKE	Industrial	NYSE	NIKE INC CL B
NOBE	Industrial	NASD	NORDSTROM INC
NSC	Transportation	NYSE	NORFOLK SOUTHERN CORP
NSP	Utilities	NYSE	NORTHERN STES PWR CO MN
NT	Industrial	NYSE	NORTHERN TELECOM LTD
NTRS	Financial	NASD	NORTHERN TRUST CORP
NOC	Industrial	NYSE	NORTHROP GRUMMAN CORP
NOVL	Industrial	NASD	NOVELL INC
NUE	Industrial	NYSE	NUCOR CORP
OXY	Industrial	NYSE	OCCIDENTAL PETROLEUM CORP
OMC	Industrial	NYSE	OMNICOM GROUP
OKE	Utilities	NYSE	ONEOK INC
ORCL	Industrial	NASD	ORACLE CORP
ORX	Industrial	NYSE	ORYX ENERGY CO
OWC	Industrial	NYSE	OWENS CORNING

OI	Industrial	NYSE	OWENS-ILLINOIS
PCAR	Industrial	NASD	PACCAR INC
PPW	Utilities	NYSE	PACIFICORP
PLL	Industrial	NYSE	PALL CORP
PMTC	Industrial	NASD	PARAMETRIC TECHNOLOGY
PH	Industrial	NYSE	PARKER HANNIFIN CORP
PAYX	Industrial	NASD	PAYCHEX INC
PE	Utilities	NYSE	PECO ENERGY CO
JCP	Industrial	NYSE	PENNEY J C CO INC
PGL	Utilities	NYSE	PEOPLES ENERGY CORP
PSFT	Industrial	NASD	PEOPLESOFT INC
PBY	Industrial	NYSE	PEP BOYS MANNY MOE & JACK
PEP	Industrial	NYSE	PEPSICO INC
PKN	Industrial	NYSE	PERKIN ELMER CORP
PFE	Industrial	NYSE	PFIZER INC
PCG	Utilities	NYSE	PG&E CORP
PNU	Industrial	NYSE	PHARMACIA & UPJOHN INC
PD	Industrial	NYSE	PHELPS DODGE CORP
MO	Industrial	NYSE	PHILIP MORRIS COS INC
P	Industrial	NYSE	PHILLIPS PETROLEUM CO
PHB	Industrial	NASD	PIONEER HI BRED INTL INC
PBI	Industrial	NYSE	PITNEY BOWES INC
PDG	Industrial	NYSE	PLACER DOME INC
PNC	Financial	NYSE	PNC BANK CORP
PRD	Industrial	NYSE	POLAROID CORP
PCH	Industrial	NYSE	POTLATCH CORP
PPL	Utilities	NYSE	PP & L RESOURCES INC
PPG	Industrial	NYSE	PPG INDUSTRIES INC
PX	Industrial	NYSE	PRAXAIR INC
PG	Industrial	NYSE	PROCTER & GAMBLE CO
PGR	Financial	NYSE	PROGRESSIVE CORP
PVT	Financial	NYSE	PROVIDENT COMPANIES INC
PVN	Financial	NYSE	PROVIDIAN CORP
PEG	Utilities	NYSE	PUBLIC SERVICE ENTPR GRP
PHM	Industrial	NYSE	PULTE CORP

OAT	Industrial	NYSE	QUAKER OATS CO
RAL	Industrial	NYSE	RALSTON-RALSTN PURINA GRP
RYC	Industrial	NYSE	RAYCHEM CORP
RTN.B	Industrial	NYSE	RAYTHEON CO
RBK	Industrial	NYSE	REEBOK INTL LTD
RGBK	Financial	NASD	REGIONS FINANCIAL CORP
RNB	Financial	NYSE	REPUBLIC NEW YORK
RLM	Industrial	NYSE	REYNOLDS METALS CO
RAD	Industrial	NYSE	RITE AID CORP
RN	Industrial	NYSE	RJR NABISCO HOLDINGS CORP
ROK	Industrial	NYSE	ROCKWELL INTL CORP
ROH	Industrial	NYSE	ROHM & HAAS CO
RDC	Industrial	NYSE	ROWAN COS INC
RD	Industrial	NYSE	ROYAL DUTCH PETROLEUM CO
RBD	Industrial	NYSE	RUBBERMAID INC
RML	Industrial	NYSE	RUSSELL CORP
R	Transportation	NYSE	RYDER SYSTEM INC
SAFC	Financial	NASD	SAFECO CORP
SWY	Industrial	NYSE	SAFEWAY INC
SLE	Industrial	NYSE	SARA LEE CORP
SBC	Utilities	NYSE	SBC COMMUNICATIONS INC
SGP	Industrial	NYSE	SCHERING-PLOUGH
SLB	Industrial	NYSE	SCHLUMBERGER LTD
SFA	Industrial	NYSE	SCIENTIFIC ATLANTA INC
SEG	Industrial	NYSE	SEAGATE TECHNOLOGY
VO	Industrial	NYSE	SEAGRAM CO LTD
SEE	Industrial	NYSE	SEALED AIR CORP
S	Industrial	NYSE	SEARS ROEBUCK & CO
SRE	Utilities	NYSE	SEMPRA ENERGY
SRV	Industrial	NYSE	SERVICE CORP INTL
SMS	Industrial	NASD	SHARED MEDICAL SYS CORP
SHW	Industrial	NYSE	SHERWIN WILLIAMS CO
SIAL	Industrial	NASD	SIGMA ALDRICH CORP
SGI	Industrial	NYSE	SILICON GRAPHICS INC
SLM	Financial	NYSE	SLM HOLDING CORP

SNA	Industrial	NYSE	SNAP ON INC HOLDING CO
SLR	Industrial	NYSE	SOLETRON
SNT	Utilities	NYSE	SONAT INC
SO	Utilities	NYSE	SOUTHERN CO
LUV	Transportation	NYSE	SOUTHWEST AIRLINES CO
SMI	Industrial	NYSE	SPRINGS INDUSTRIES INC
FON	Industrial	NYSE	SPRINT CORP FON GROUP
PCS	Industrial	NYSE	SPRINT CORP PCS GROUP
STJ	Industrial	NASD	ST JUDE MEDICAL INC
SPC	Financial	NYSE	ST PAUL COS INC
SWK	Industrial	NYSE	STANLEY WORKS
SPLS	Industrial	NASD	STAPLES INC
STT	Financial	NYSE	STATE STREET CORP
SUB	Financial	NYSE	SUMMIT BANCORP
SUNW	Industrial	NASD	SUN MICROSYSTEMS INC
SUN	Industrial	NYSE	SUNOCO INC
STI	Financial	NYSE	SUNTRUST BANKS
SVU	Industrial	NYSE	SUPERVALU INC
SNV	Financial	NYSE	SYNOVUS FINANCIAL
SYX	Industrial	NYSE	SYSCO CORP
TAN	Industrial	NYSE	TANDY CORP
TEK	Industrial	NYSE	TEKTRONIX INC
TCOMA	Industrial	NASD	TELE-COMMUNICATIONS
TLAB	Industrial	NASD	TELLABS INC
TIN	Industrial	NYSE	TEMPLE INLAND INC
THC	Industrial	NYSE	TENET HEALTHCARE CORP
TEN	Industrial	NYSE	TENNECO INC HLDG CO
TX	Industrial	NYSE	TEXACO INC
TXN	Industrial	NYSE	TEXAS INSTRUMENTS INC
TXU	Utilities	NYSE	TEXAS UTILITIES CO
TXT	Industrial	NYSE	TEXTRON INC
TMO	Industrial	NYSE	THERMO ELECTRON
TNB	Industrial	NYSE	THOMAS & BETTS CORP
TWX	Industrial	NYSE	TIME WARNER INC
TMC	Industrial	NYSE	TIMES MIRROR CO

TKR	Industrial	NYSE	TIMKEN CO
TJX	Industrial	NYSE	TJX COMPANIES INC
TMK	Financial	NYSE	TORCHMARK CORP
TOY	Industrial	NYSE	TOYS R US INC
TA	Financial	NYSE	TRANSAMERICA CORP
TRB	Industrial	NYSE	TRIBUNE CO
YUM	Industrial	NYSE	TRICON GLOBAL RESTAURANTS
TRW	Industrial	NYSE	TRW INC
TUP	Industrial	NYSE	TUPPERWARE CORP
TYC	Industrial	NYSE	TYCO INTERNATIONAL LTD
USB	Financial	NASD	U.S. BANCORP
UCM	Utilities	NYSE	UNICOM CORP HOLDING CO
UN	Industrial	NYSE	UNILEVER N V
UCC	Industrial	NYSE	UNION CAMP CORP
UK	Industrial	NYSE	UNION CARBIDE CORP
UNP	Transportation	NYSE	UNION PACIFIC
UPR	Industrial	NYSE	UNION PACIFIC RESOURCES GROUP
UPC	Financial	NYSE	UNION PLANTERS
UIS	Industrial	NYSE	UNISYS CORP
UNH	Industrial	NYSE	UNITED HEALTHCARE CORP
UTX	Industrial	NYSE	UNITED TECHNOLOGIES CORP
UCL	Industrial	NYSE	UNOCAL CORP
UNM	Financial	NYSE	UNUM CORP
USW	Utilities	NYSE	US WEST INC
U	Transportation	NYSE	USAIR GROUP INC
UST	Industrial	NYSE	UST INC
MRO	Industrial	NYSE	USX-MARATHON GROUP
X	Industrial	NYSE	USX-U.S. STEEL GROUP
VFC	Industrial	NYSE	V F CORP
VIA.B	Industrial	AMEX	VIACOM INC
WB	Financial	NYSE	WACHOVIA CORP
WMT	Industrial	NYSE	WAL MART STORES INC
WAG	Industrial	NYSE	WALGREEN CO
DIS	Industrial	NYSE	WALT DISNEY CO
WLA	Industrial	NYSE	WARNER LAMBERT CO

WM	Financial	NYSE	WASHINGTON MUTUAL INC
WMI	Industrial	NYSE	WASTE MANAGEMENT
WFC	Financial	NYSE	WELLS FARGO & CO
WEN	Industrial	NYSE	WENDYS INTERNATIONAL INC
W	Industrial	NYSE	WESTVACO CORP
WY	Industrial	NYSE	WEYERHAEUSER CO
WHR	Industrial	NYSE	WHIRLPOOL CORP
WLL	Industrial	NYSE	WILLAMETTE INDUSTRIES
WMB	Utilities	NYSE	WILLIAMS COS
WIN	Industrial	NYSE	WINN DIXIE STORES INC
WTHG	Industrial	NASD	WORTHINGTON INDS INC
WWY	Industrial	NYSE	WRIGLEY WM JR CO
XRX	Industrial	NYSE	XEROX CORP

Appendix B Beta Measure

Risk Measures

Beta

The Capital Asset Pricing Model (CAPM) divides equity risk into two components:

- 1 Specific Risk: Risk arising from causes that are unique to individual stocks.
- 2 Systematic Risk: Risk relating to general market movements.

For example, if the stock market rises upon the release of good economic news, all stocks are more or less affected. This is systematic risk. On the other hand, if a company's stock rises upon the success of a new product line, that is specific risk. It affects only that company's stock.

Specific risk can be diversified away. As more and more different stocks are added to a portfolio, the random fluctuations unique to each stock start to offset one another. If diversification is taken to an extreme, the investor is left with a portfolio whose composition corresponds identically to that of the overall market. Such a portfolio has no specific risk. Because its composition is the same as the market's, by definition, all of its risk is systematic. Systematic risk can never be diversified away.

Beta measures a portfolio's (or an individual stock's) systematic risk. It is defined as:

$$\text{beta} = \frac{\sigma_p}{\sigma_m} \rho_{p,m} \quad [1]$$

Where σ_p and σ_m are the return volatilities of the portfolio and market respectively, and $\rho_{p,m}$ is their correlation. Beta is usually calculated from daily return data. For this

purpose, a broad market index such as the S&P 500 is often used as a proxy for the market.

Beta measures the tendency of a portfolio to participate in market moves. For Example, suppose a portfolio is 1.5 times as volatile as the market, and has a correlation of .4 with the market. Then, by Equation [1], the portfolio's beta will be 0.6. The portfolio will tend to gain 6% for each 10% gain in the market—or lose 3% for each 5% loss in the market.

Suppose a portfolio has twice the volatility of the market and has a correlation of .8 with the market. Then its beta will be 1.6. It will tend to participate in market moves 160% of the extent to which the market moves.

Obviously, the beta of the market is exactly 1.0.

The Capital Asset Pricing Model states that, because specific risk can be diversified away, the market will not compensate investors for taking it. A stock's excess expected return (above the risk free rate) will be proportional to its systematic risk—its beta. This is expressed mathematically:

$$E(R_p) = R_f + \text{beta}(E(R_m) - R_f) \quad [2]$$

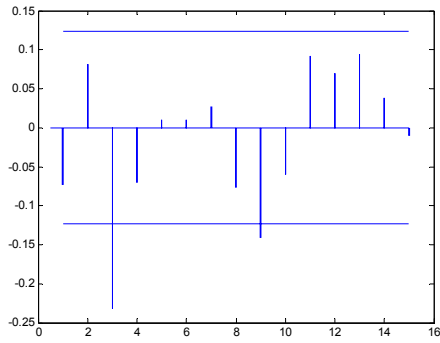
Where R_f is the risk free rate, and $E(R_p)$ and $E(R_m)$ are the expected returns on the portfolio and the market respectively.

Beta is sometimes used as a measure of a portfolio's risk. For highly diversified portfolios, this can be appropriate because systematic risk is the primary source of risk for such portfolios. For less diversified portfolios, however, specific risk is more significant. For such portfolios, beta can be a misleading measure of total risk.

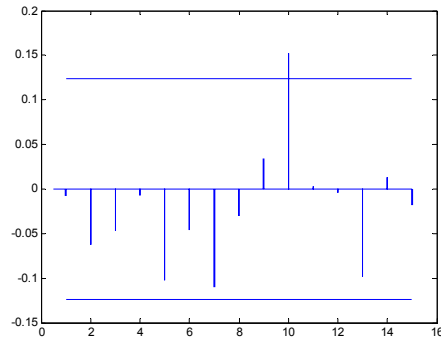
Although the Capital Asset Pricing Model states that the market will not compensate investors for taking specific risk, this does not mean that specific risk is not real. A dollar lost to specific risk costs just as much as a dollar lost to systematic risk.

Appendix C Correlation Plots

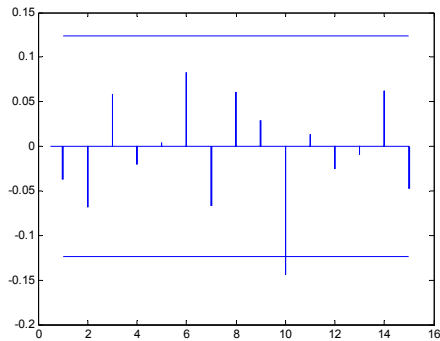
S&P Start 302 End 554
Box-Pierce = 31.33



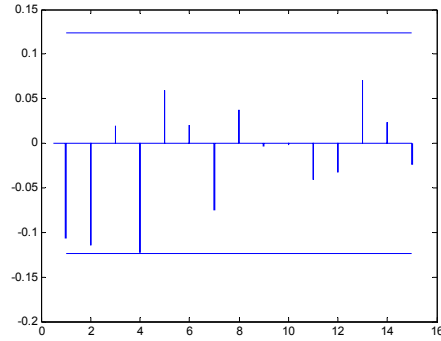
S&P Start 1058 End 1310
Box-Pierce = 16.71



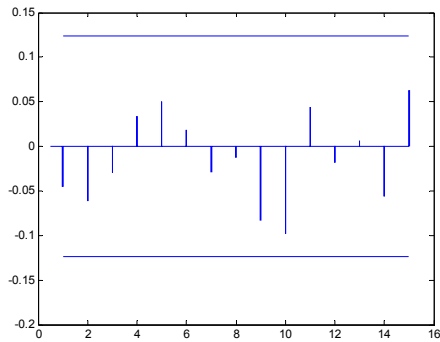
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Box-Pierce = 13.49



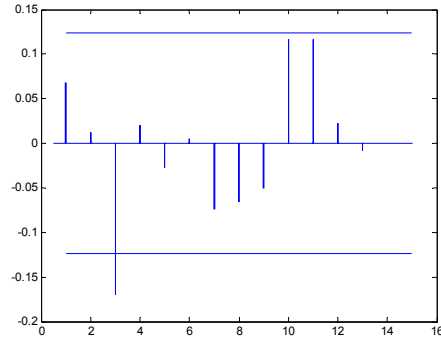
S&P Start 1310 End 1562
Box-Pierce = 14.99



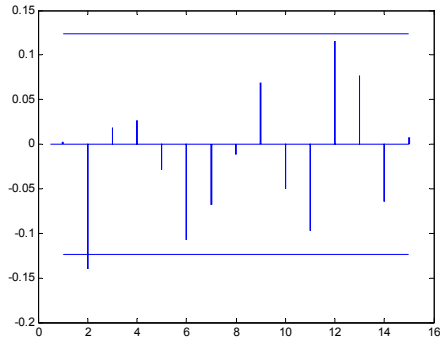
S&P Start 806 End 1058
Box-Pierce = 9.45



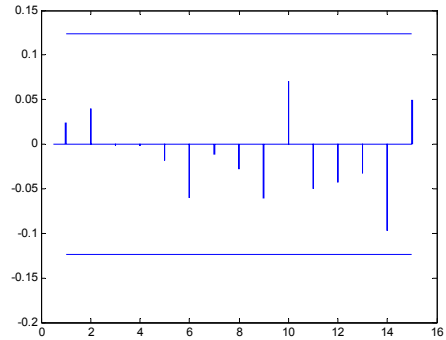
S&P Start 1562 End 1814
Box-Pierce = 18.81



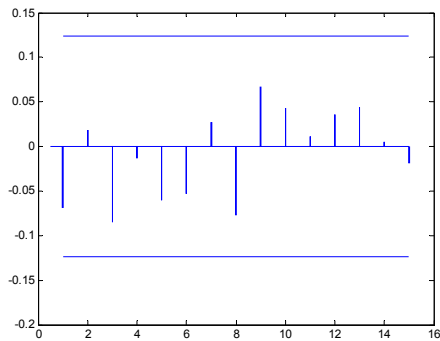
S&P Start 1814 End 2066
Box-Pierce = 19.63



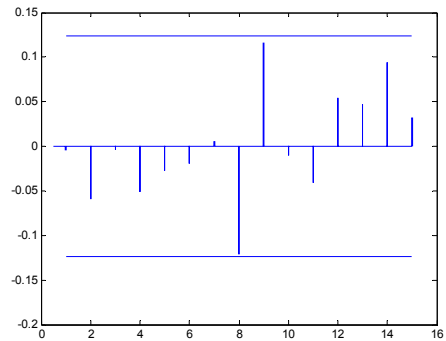
ITWO Start 504 End 756
Box-Pierce = 8.29



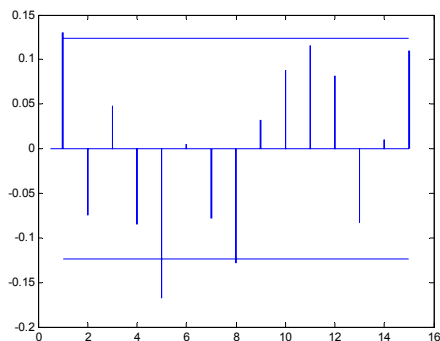
S&P Start 2066 End 2318
Box-Pierce = 8.92



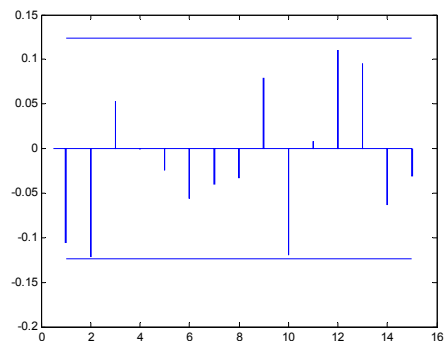
ITWO Start 756 End 1008
Box-Pierce = 13.18



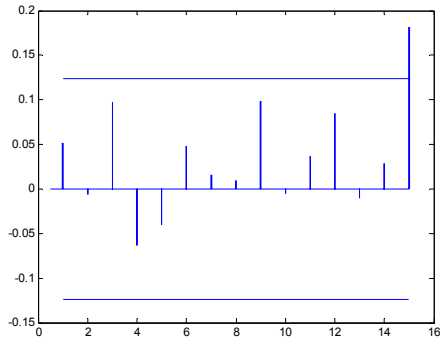
ITWO Start 252 End 504
Box-Pierce = 32.83



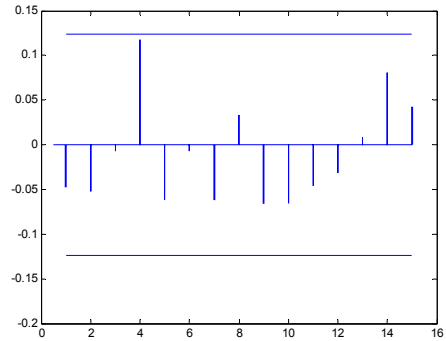
ITWO Start 1008 End 1260
Box-Pierce = 20.67



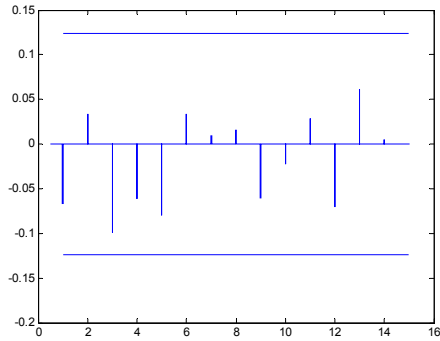
ITWO Start 1260 End 1512
Box-Pierce = 18.25



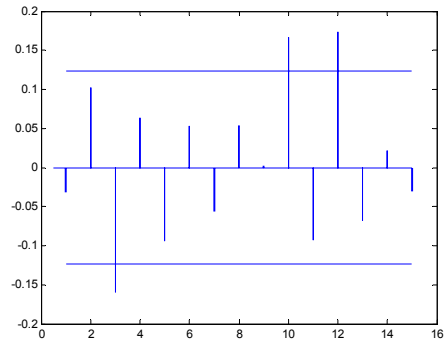
TSO Start 840 End 1092
Box Pierce= 11.96



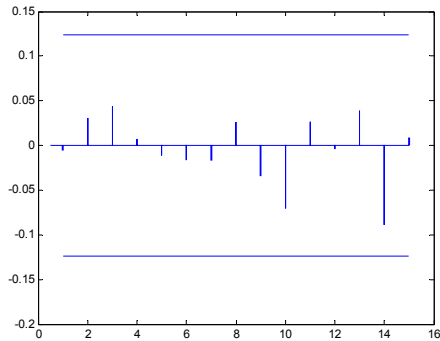
TSO Start 336 End 588
Box-Pierce = 10.26



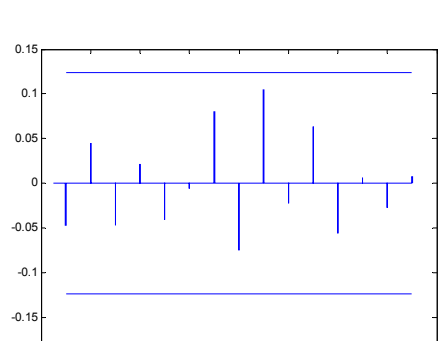
TSO Start 1092 End 1344
Box-Pierce = 33.06



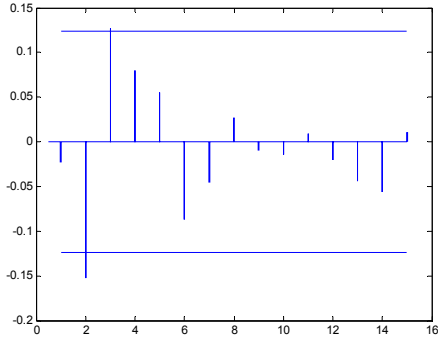
TSO Start 588 End 840
Box-Pierce = 5.20



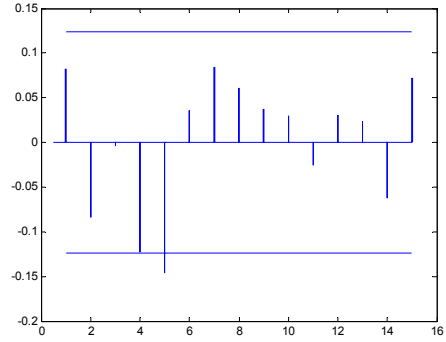
TSO Start 1344 End 1596
Box-Pierce = 10.07



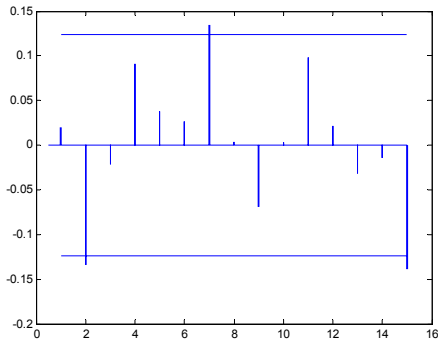
TSO Start 1596 End 1848
Box-Pierce = 16.54



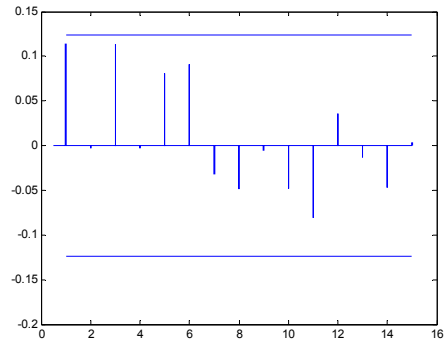
TSO Start 2352 End 2604
Box-Pierce = 19.07



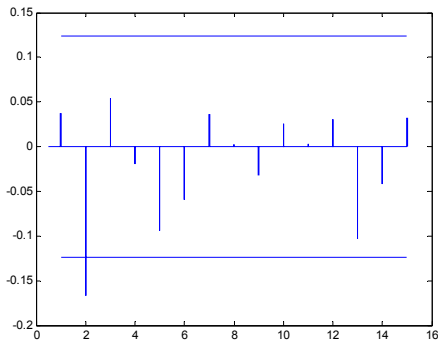
TSO Start 1848 End 2100
Box-Pierce = 20.71



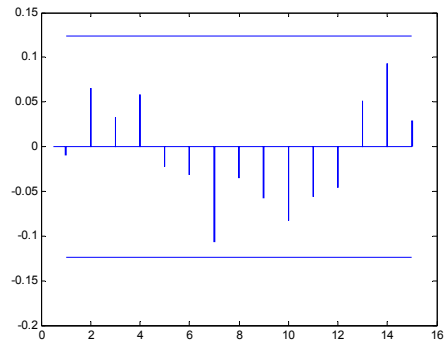
TSO Start 2604 End 2856
Box-Pierce = 14.28



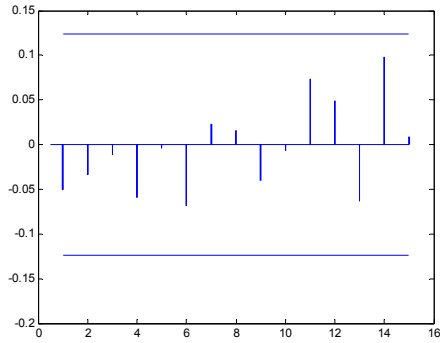
TSO Start 2100 End 2352
Box-Pierce = 15.75



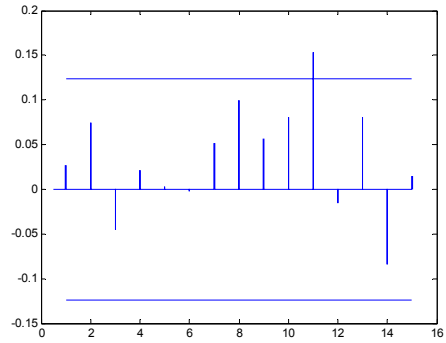
TSO Start 2856 End 3108
Box-Pierce = 12.71



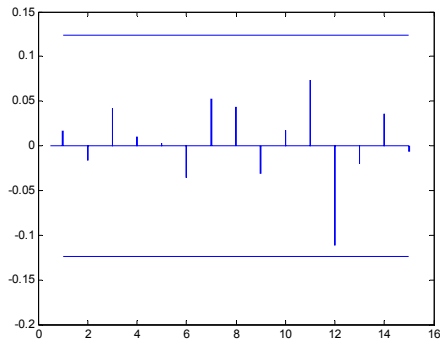
TSO Start 3108 End 3360
Box-Pierce = 9.03



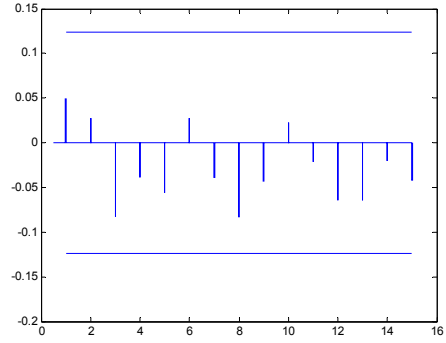
SBL Start 496 End 748
Box-Pierce = 17.27



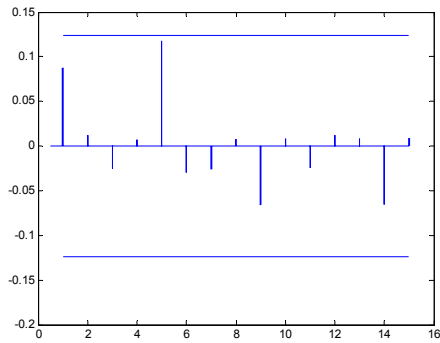
TSO Start 3360 End 3612
Box-Pierce = 7.33



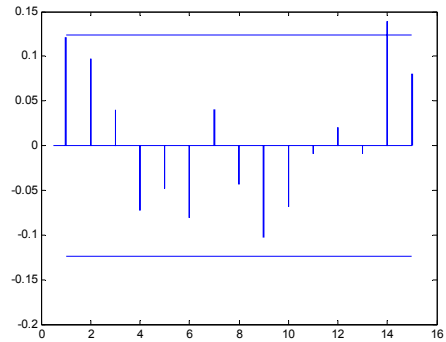
SBL Start 748 End 1000
Box-Pierce = 9.38



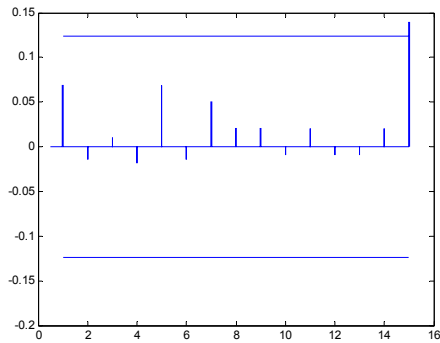
SBL Start 244 End 496
Box-Pierce = 8.41



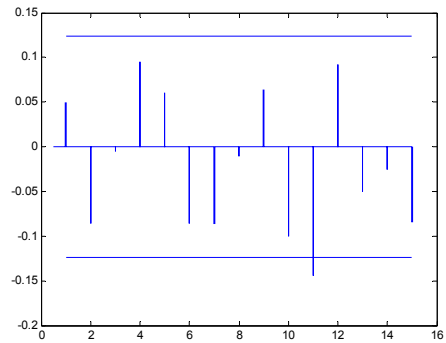
SBL Start 1000 End 1252
Box-Pierce = 21.40



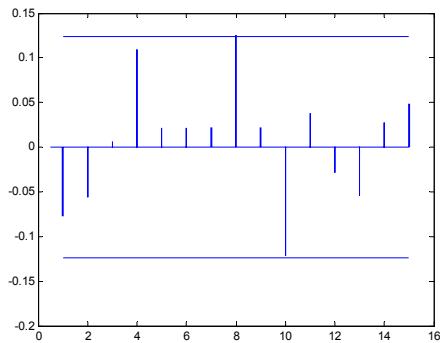
SBL Start 1252 End 1504
Box-Pierce = 8.63



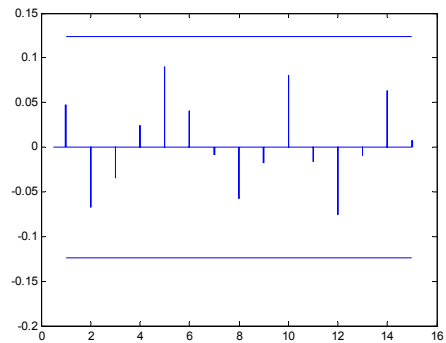
SBL Start 2008 End 2260
Box-Pierce = 22.98



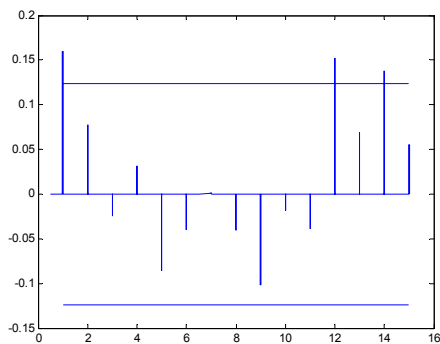
SBL Start 1504 End 1756
Box-Pierce = 15.54



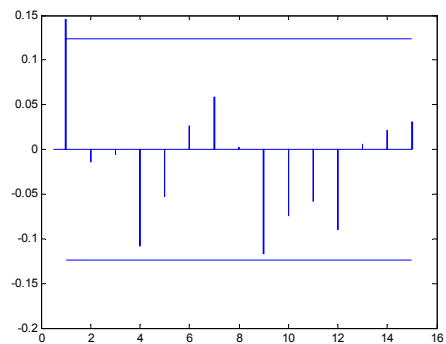
SBL Start 2260 End 2512
Box-Pierce = 9.77



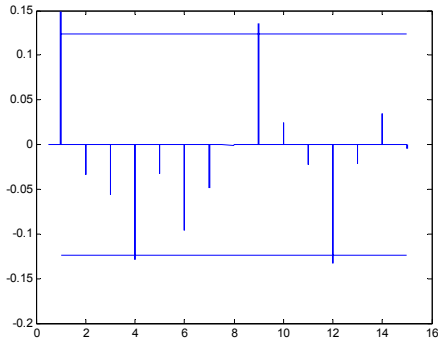
SBL Start 1756 End 2008
Box-Pierce = 26.68



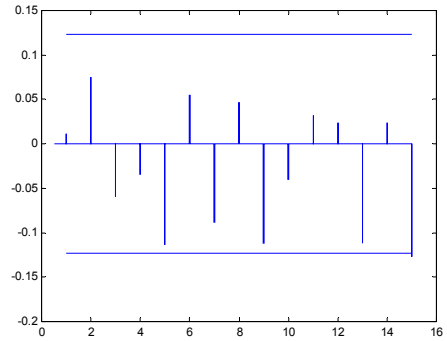
SBL Start 2512 End 2764
Box-Pierce = 18.21



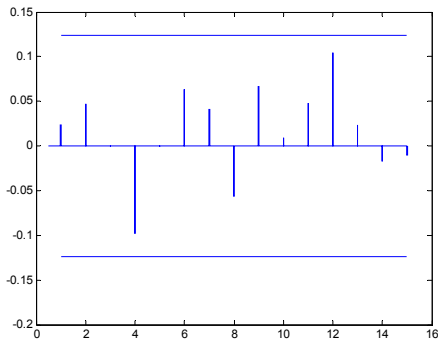
SBL Start 2764 End 3016
Box-Pierce = 23.82



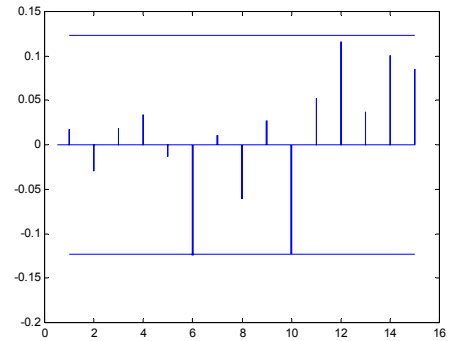
Dow Jones Index Start 261 End 513
Box Pierce = 20.45



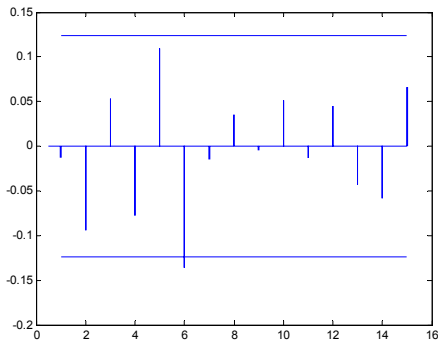
SBL Start 3016 End 3268
Box-Pierce = 10.07



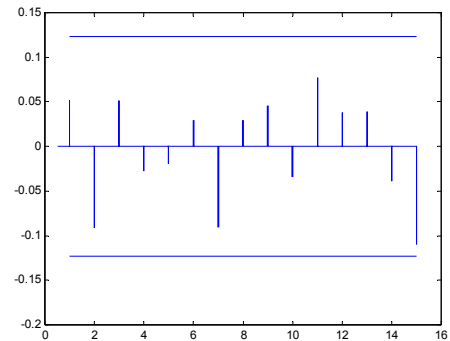
Dow Jones Index Start 513 End 765
Box Pierce = 18.31



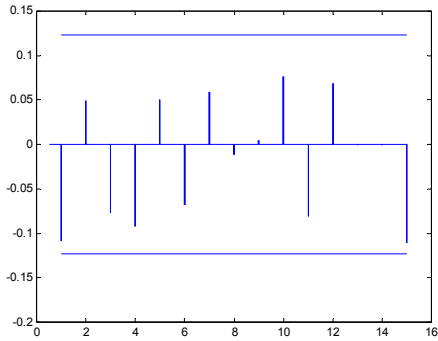
SBL Start 3268 End 3520
Box-Pierce = 16.12



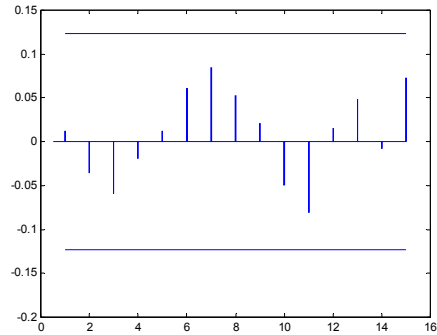
Dow Jones Index Start 765 End 1017
Box Pierce = 12.61



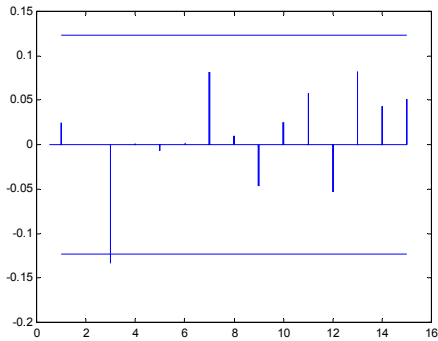
Dow Jones Index Start 1017 End 1269
Box Pierce = 17.35



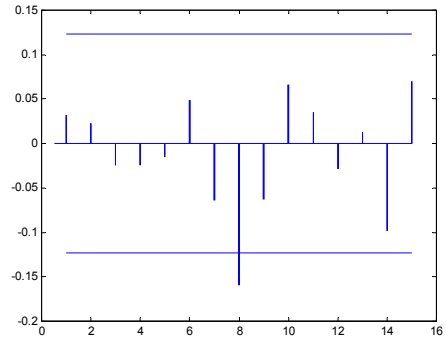
Dow Jones Index Start 1773 End 2025
Box Pierce = 9.20



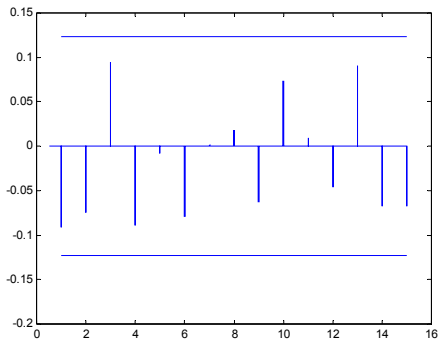
Dow Jones Index Start 1269 End 1521
Box Pierce = 16.71



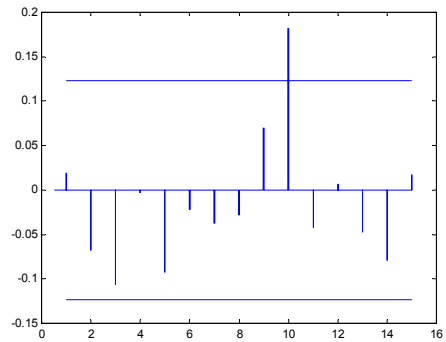
Dow Jones Index Start 2025 End 2277
Box Pierce = 14.98



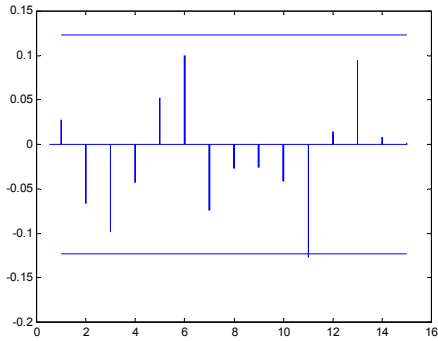
Dow Jones Index Start 1521 End 1773
Box Pierce = 11.42



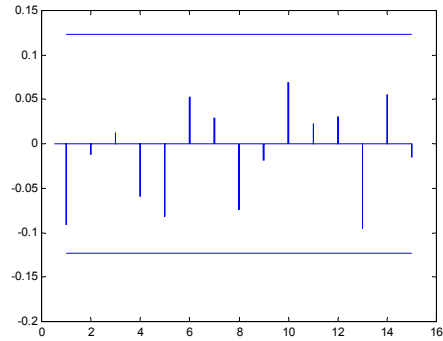
Dow Jones Index Start 2277 End 2529
Box Pierce = 19.21



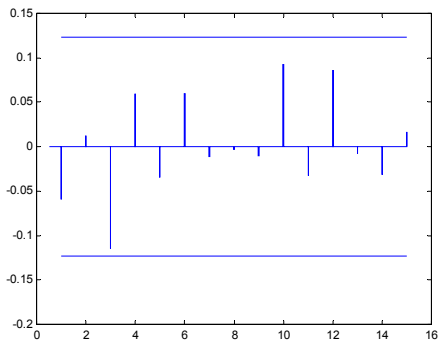
Dow Jones Index Start 2529 End 2781
Box Pierce = 15.97



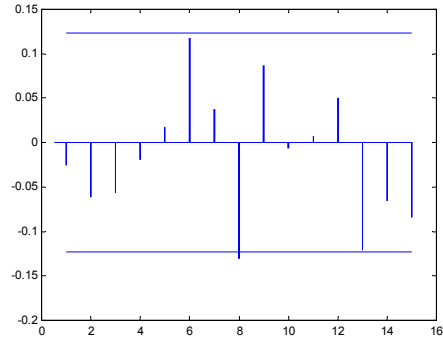
Dow Jones Index Start 3285 End 3537
Box Pierce = 11.75



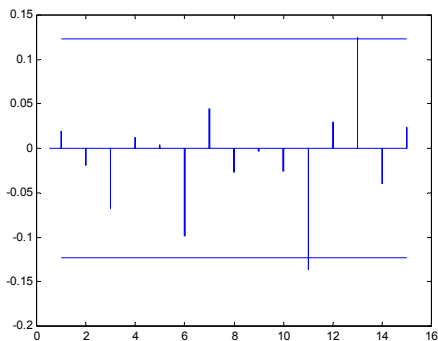
Dow Jones Index Start 2781 End 3033
Box Pierce = 11.03



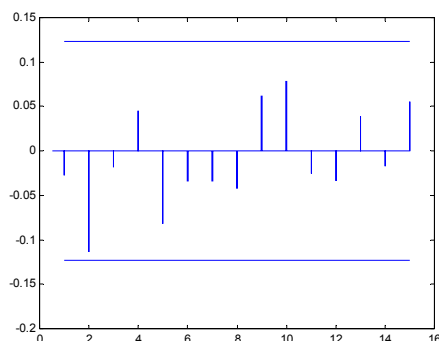
Bristol Myers Start 261 End 513
Box Pierce = 19.21



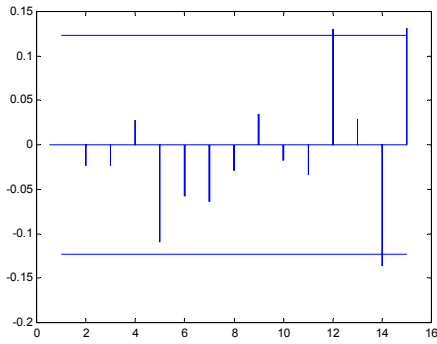
Dow Jones Index Start 3033 End 3285
Box Pierce = 14.04



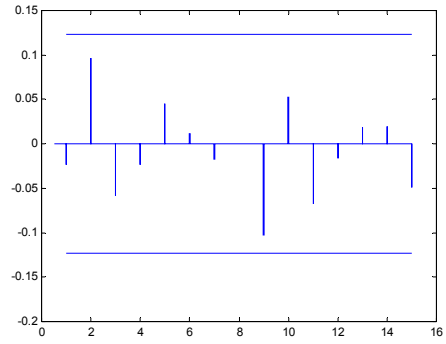
Bristol Myers Start 513 End 765
Box Pierce = 11.01



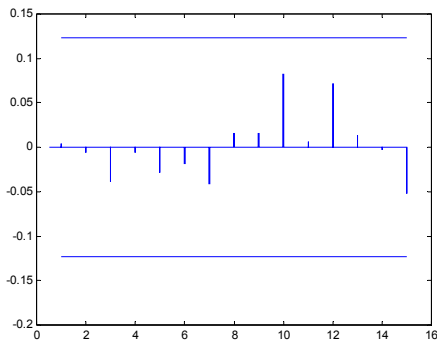
Bristol Myers Start 765 End 1017
Box Pierce = 19.71



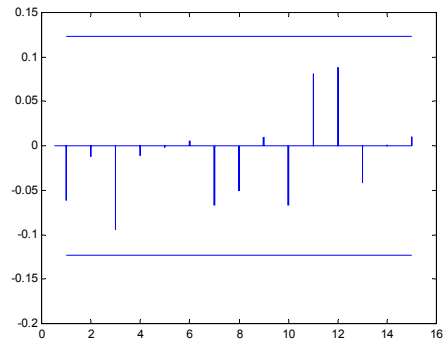
Bristol Myers Start 1521 End 1773
Box Pierce = 9.48



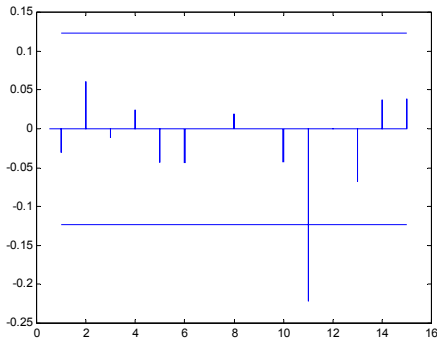
Bristol Myers Start 1017 End 1269
Box Pierce = 5.00



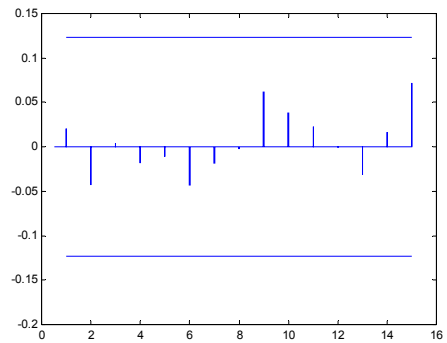
Bristol Myers Start 1773 End 2025
Box Pierce = 10.28



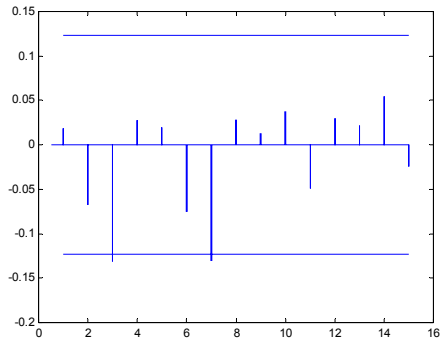
Bristol Myers Start 1269 End 1521
Box Pierce = 17.16



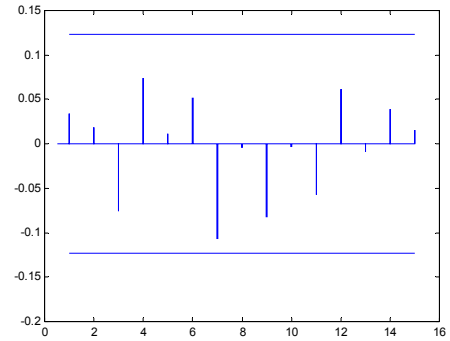
Bristol Myers Start 2025 End 2277
Box Pierce = 4.31



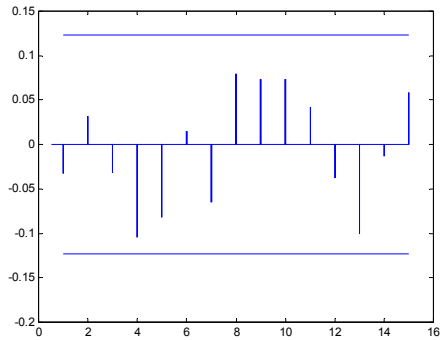
Bristol Myers Start 2277 End 2529
Box Pierce = 13.98



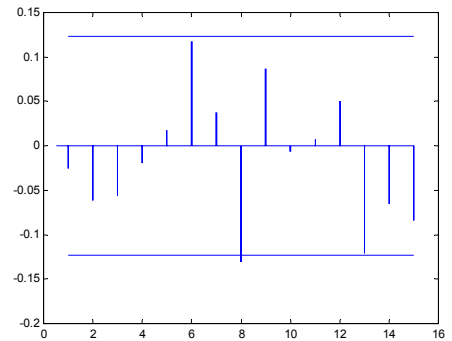
Bristol Myers Start 3033 End 3285
Box Pierce = 10.75



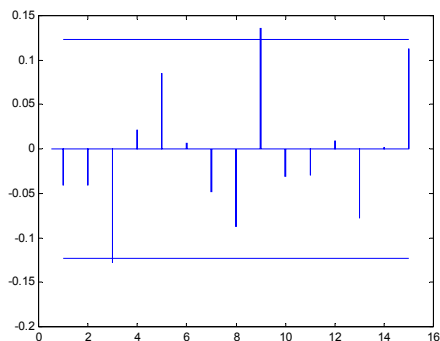
Bristol Myers Start 2529 End 2781
Box Pierce = 14.88



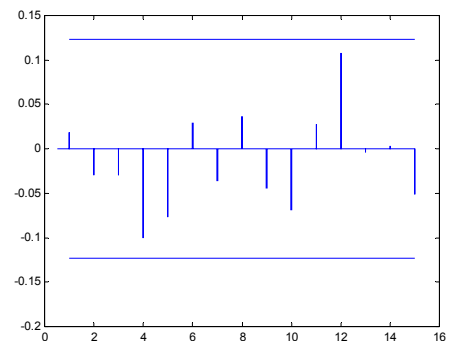
Bristol Myers Start 3285 End 3537
Box Pierce = 10.91



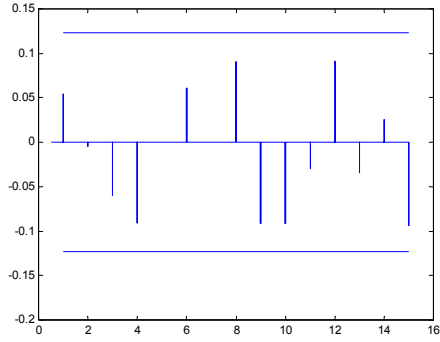
Bristol Myers Start 2781 End 3033
Box Pierce = 19.34



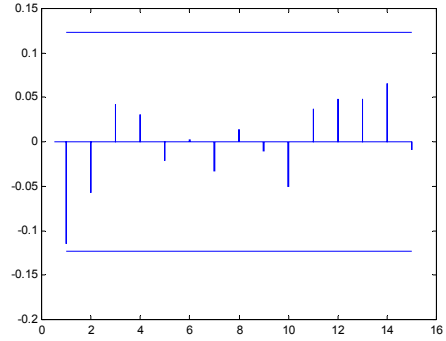
Duke Power Start 261 End 513
Box Pierce = 15.98



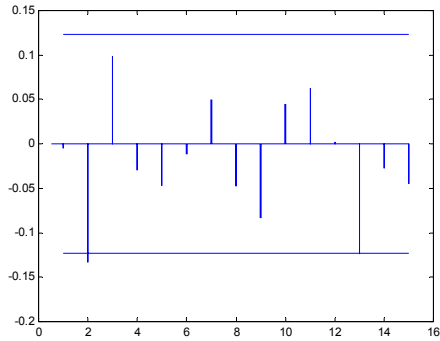
Duke Power Start 513 End 765
Box Pierce = 20.19



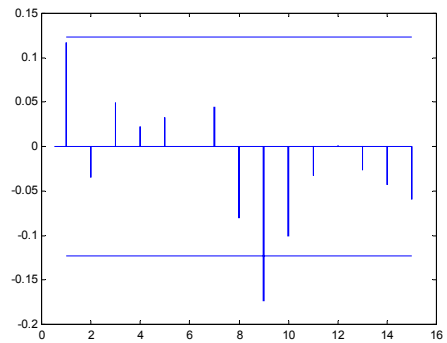
Duke Power Start 1269 End 1521
Box Pierce = 8.57



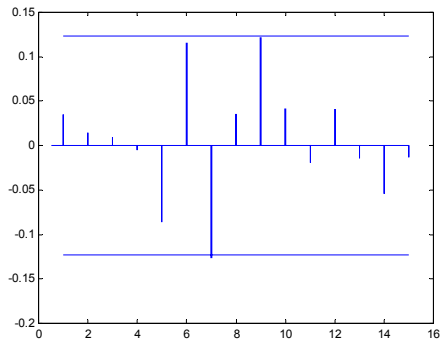
Duke Power Start 765 End 1017
Box Pierce = 16.73



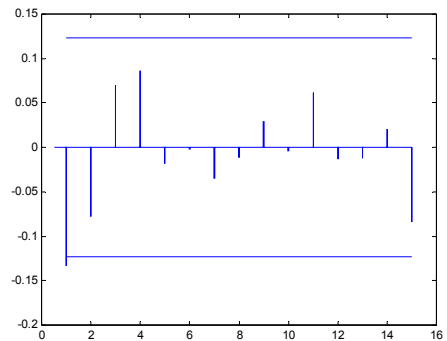
Duke Power Start 1521 End 1773
Box Pierce = 18.78



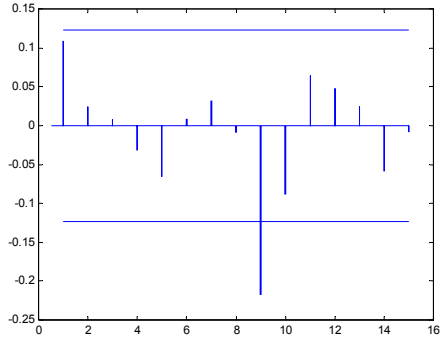
Duke Power Start 1017 End 1269
Box Pierce = 15.40



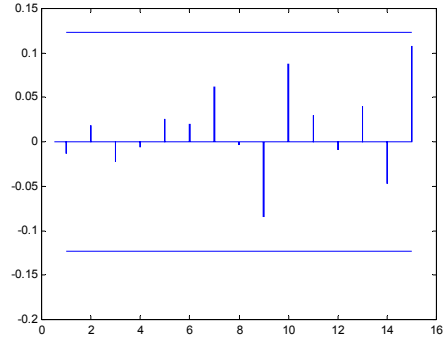
Duke Power Start 1773 End 2025
Box Pierce = 12.59



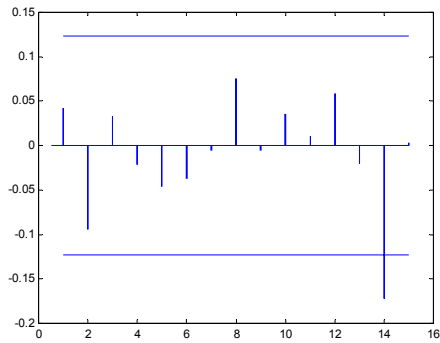
Duke Power Start 2025 End 2277
Box Pierce = 21.36



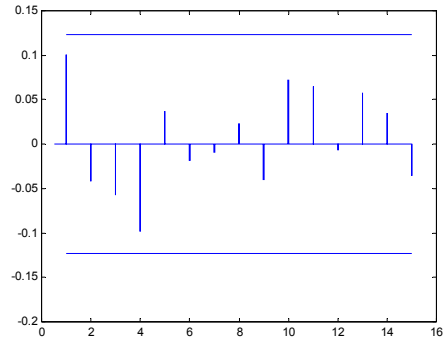
Duke Power Start 2781 End 3033
Box Pierce = 9.34



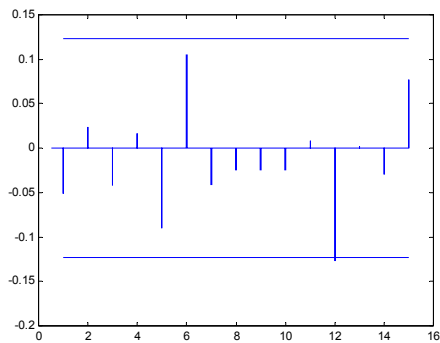
Duke Power Start 2277 End 2529
Box Pierce = 14.23



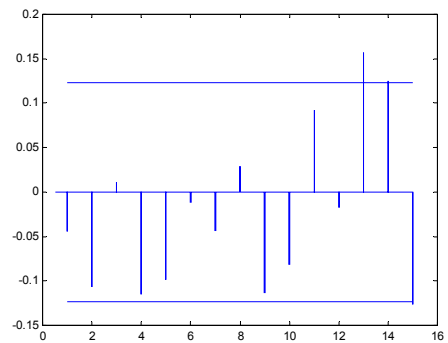
Duke Power Start 3033 End 3285
Box Pierce = 11.05



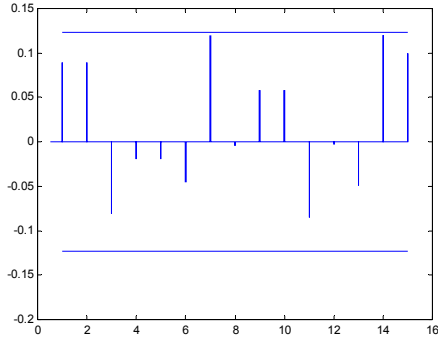
Duke Power Start 2529 End 2781
Box Pierce = 12.89



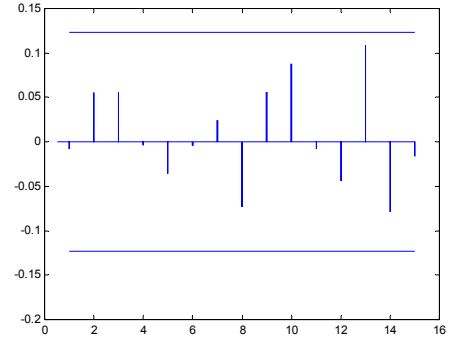
Duke Power Start 3285 End 3537
Box Pierce = 31.18



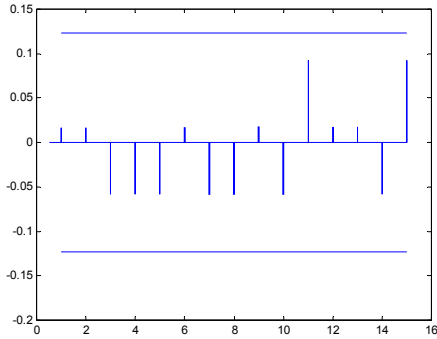
Intel Start 261 End 513
Box Pierce = 15.18



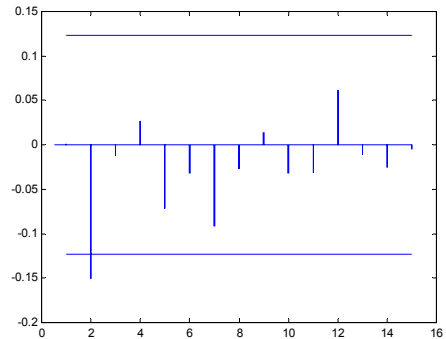
Intel Start 1017 End 1269
Box Pierce = 11.23



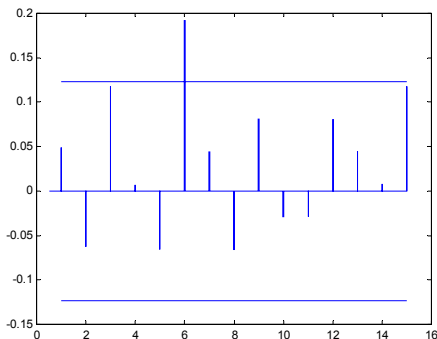
Intel Start 513 End 765
Box Pierce = 10.82



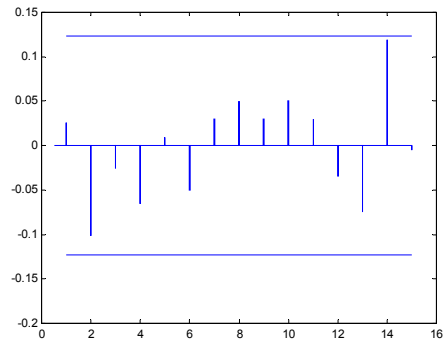
Intel Start 1269 End 1521
Box Pierce = 11.40



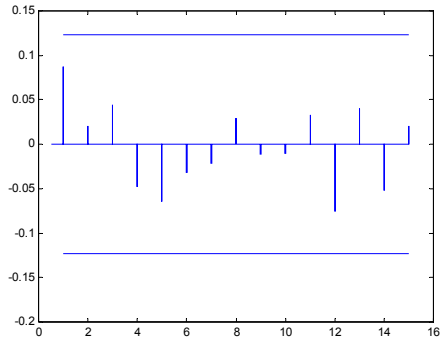
Intel Start 765 End 1017
Box Pierce = 24.81



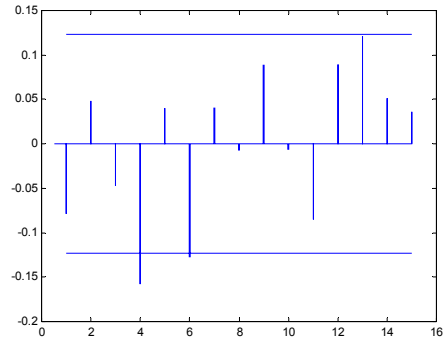
Intel Start 1521 End 1773
Box Pierce = 11.87



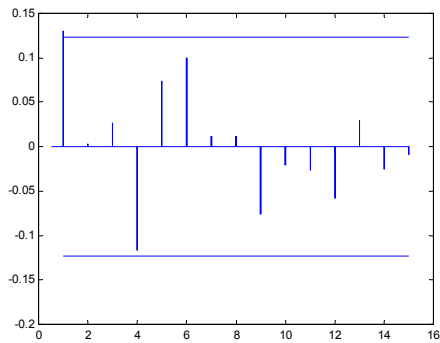
Intel Start 1773 End 2025
Box Pierce = 7.64



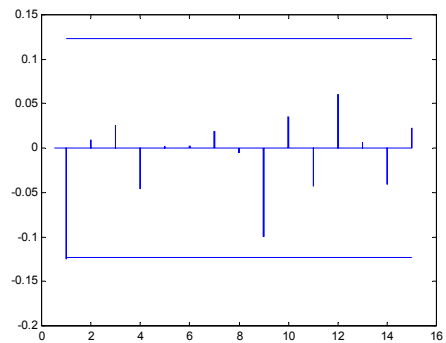
Intel Start 2529 End 2781
Box Pierce = 24.42



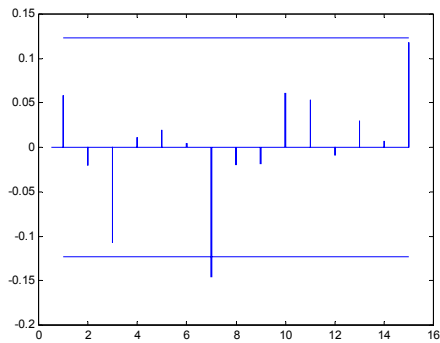
Intel Start 2025 End 2277
Box Pierce = 14.87



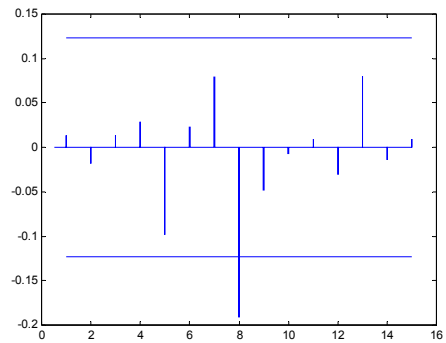
Intel Start 2781 End 3033
Box Pierce = 9.52



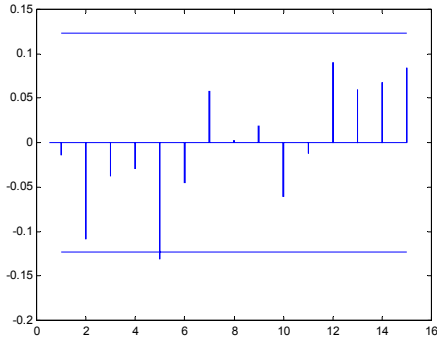
Intel Start 2277 End 2529
Box Pierce = 14.95



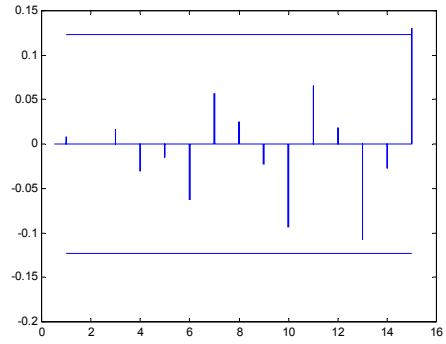
Intel Start 3033 End 3285
Box Pierce = 16.25



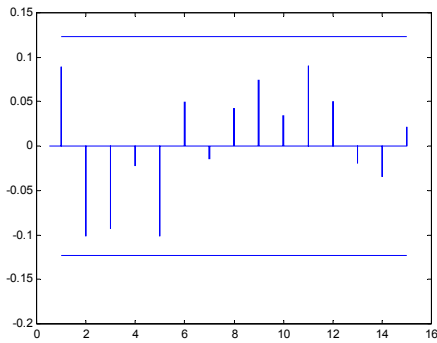
Intel Start 3285 End 3537
Box Pierce = 16.28



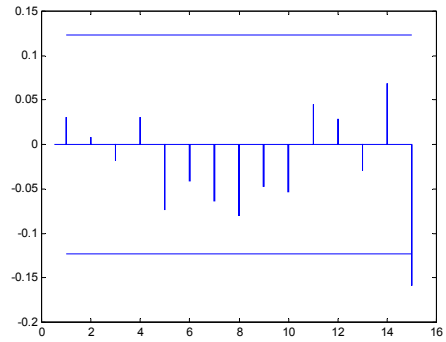
Lucent Technologies Start 756 End 1008
Box Pierce = 13.21



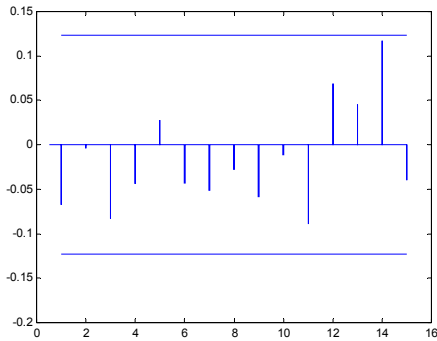
Lucent Technologies Start 252 End 504
Box Pierce = 15.48



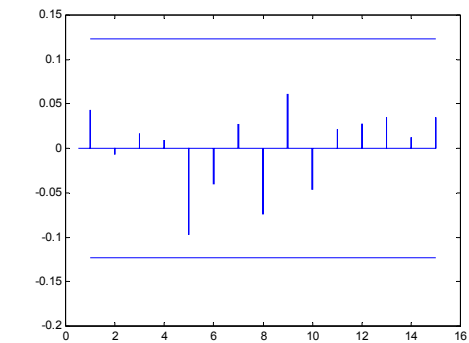
Lucent Technologies Start 1008 End 1260
Box Pierce = 14.78



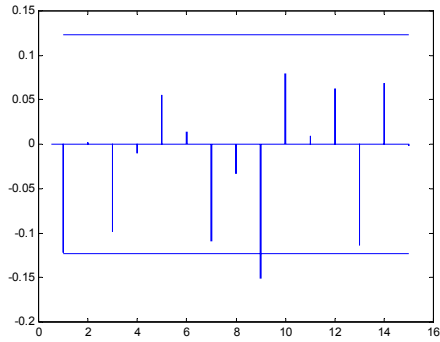
Lucent Technologies Start 504 End 756
Box Pierce = 13.40



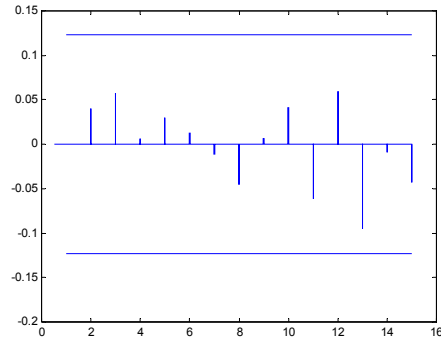
Lucent Technologies Start 1260 End 1512
Box Pierce = 7.33



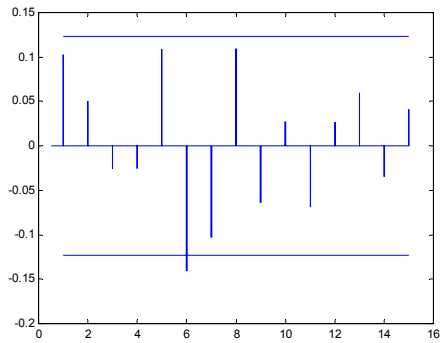
OMI Corporation Start 274 End 526
Box Pierce = 23.09



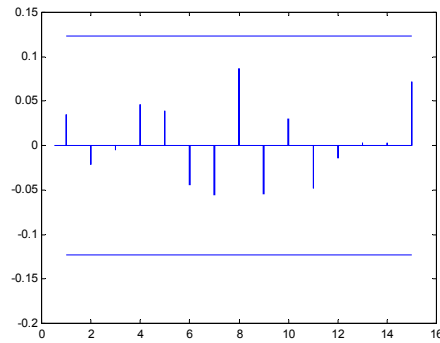
OMI Corporation Start 1030 End 1282
Box Pierce = 7.18



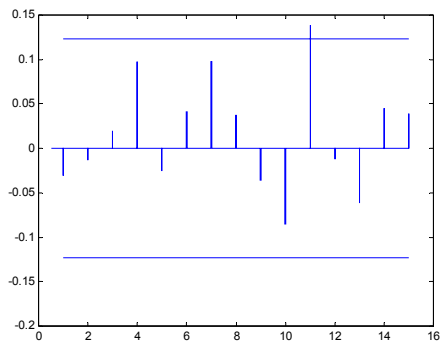
OMI Corporation Start 526 End 778
Box Pierce = 21.39



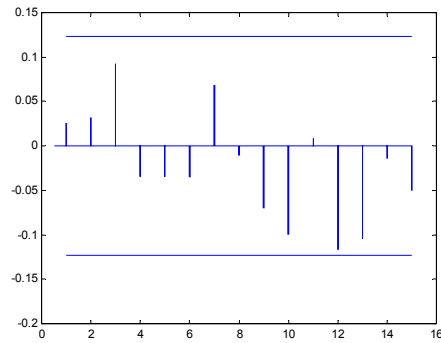
OMI Corporation Start 1282 End 1534
Box Pierce = 7.42



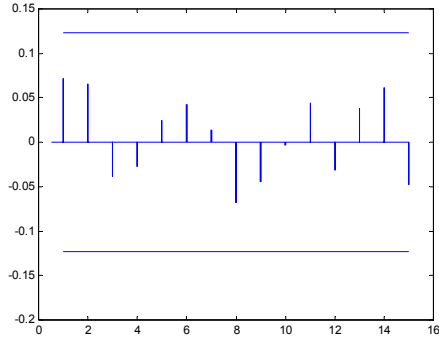
OMI Corporation Start 778 End 1030
Box Pierce = 15.02



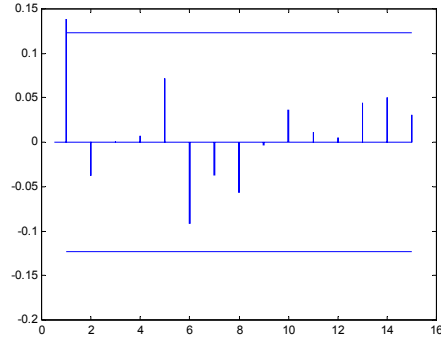
OMI Corporation Start 1534 End 1786
Box Pierce = 15.28



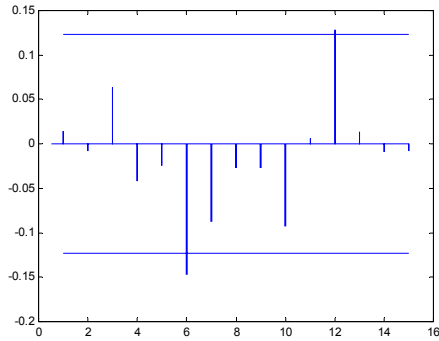
OMI Corporation Start 1786 End 2038
Box Pierce = 7.93



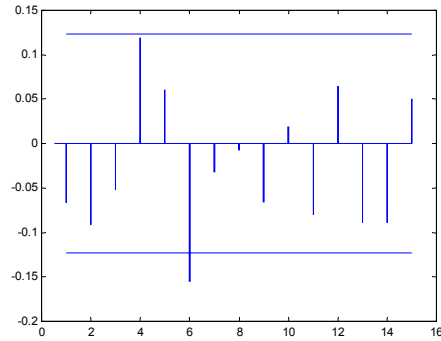
America On Line Start 771 End 1073
Box Pierce = 11.51



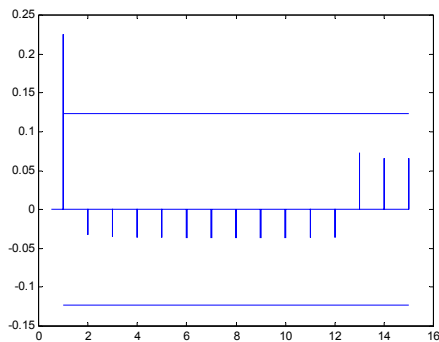
OMI Corporation Start 2038 End 2290
Box Pierce = 15.77



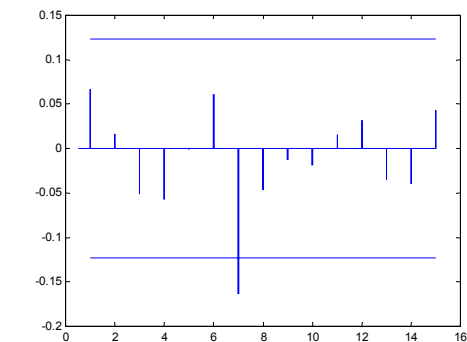
America On Line Start 1023 End 1275
Box Pierce = 23.22



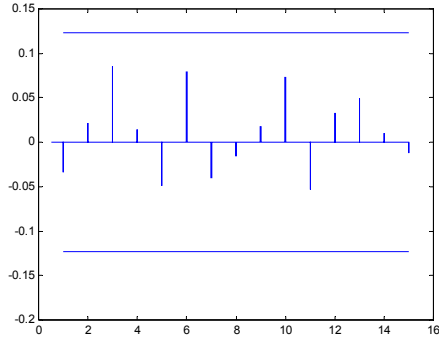
America On Line Start 519 End 771
Box Pierce = 19.95



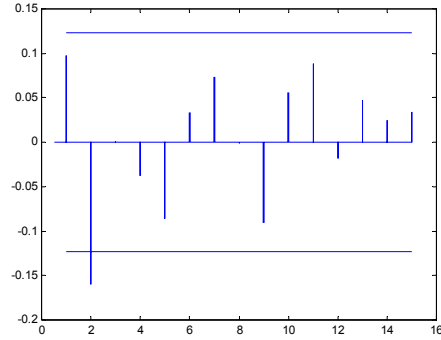
America On Line Start 1275 End 1527
Box Pierce = 12.48



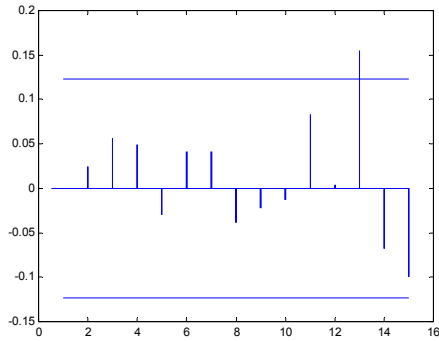
America On Line Start 1527 End 1779
Box Pierce = 8.00



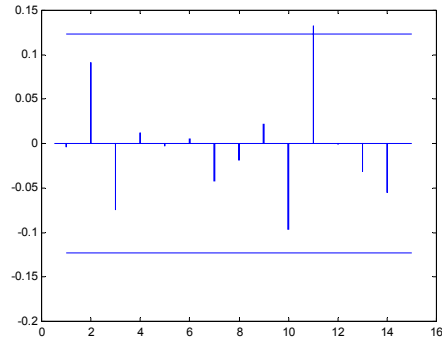
America On Line Start 2283 End 2535
Box Pierce = 18.60



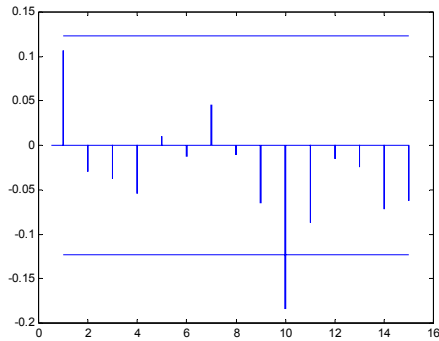
America On Line Start 1779 End 2031
Box Pierce = 14.64



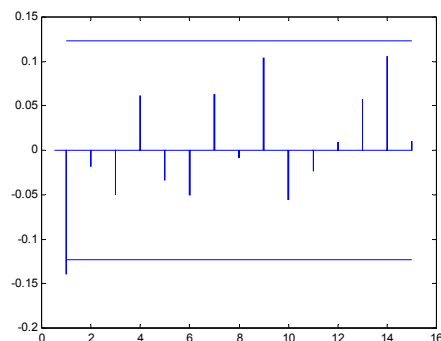
AT&T Start 261 End 513
Box Pierce = 12.00



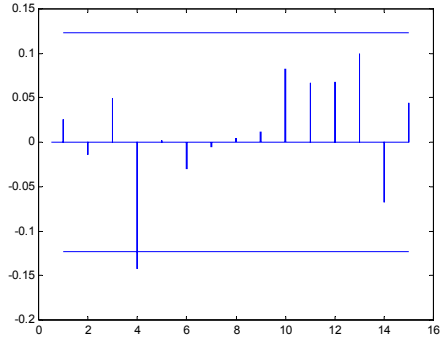
America On Line Start 2031 End 2283
Box Pierce = 18.67



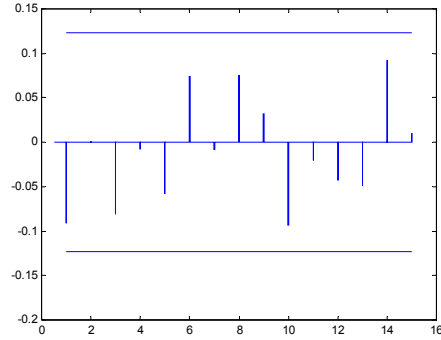
AT&T Start 513 End 765
Box Pierce = 15.86



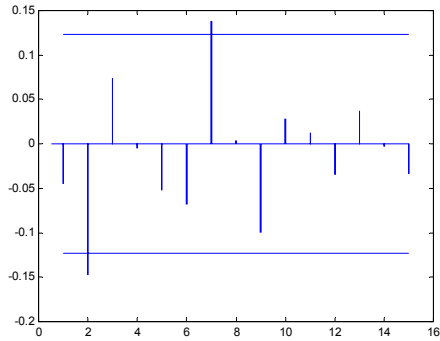
AT&T Start 765 End 1017
Box Pierce = 14.37



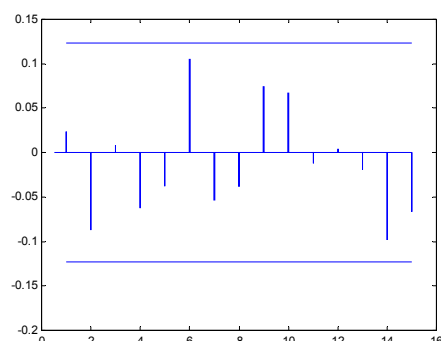
AT&T Start 1521 End 1773
Box Pierce = 13.32



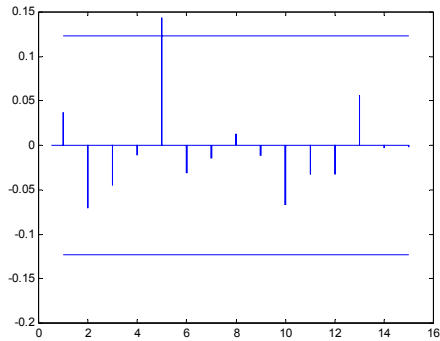
AT&T Start 1017 End 1269
Box Pierce = 17.70



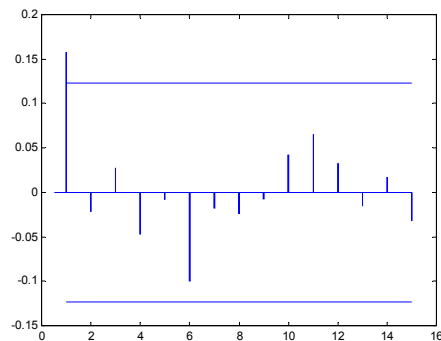
AT&T Start 1773 End 2025
Box Pierce = 13.43



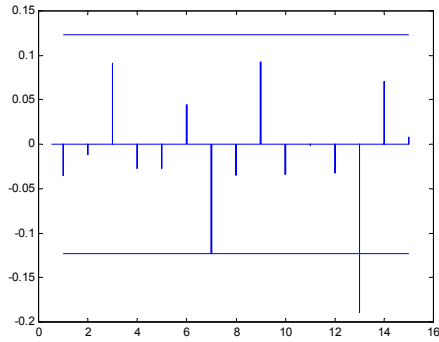
AT&T Start 1269 End 1521
Box Pierce = 10.16



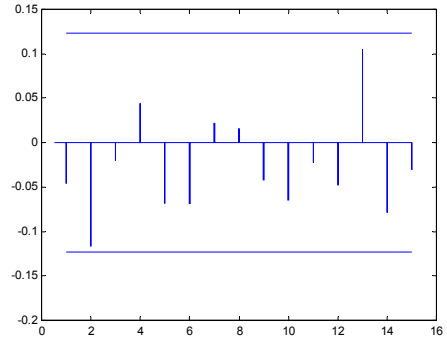
AT&T Start 2025 End 2277
Box Pierce = 12.12



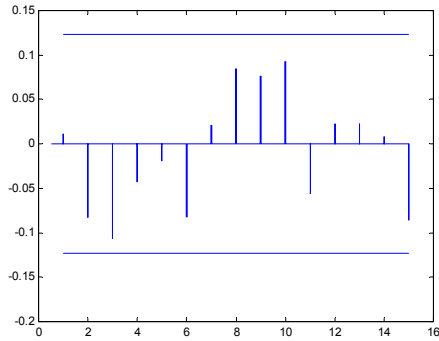
AT&T Start 2277 End 2529
Box Pierce = 20.41



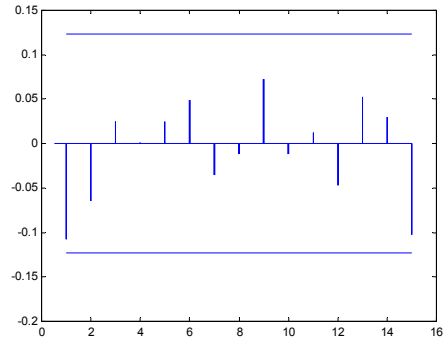
AT&T Start 3033 End 3285
Box Pierce = 13.91



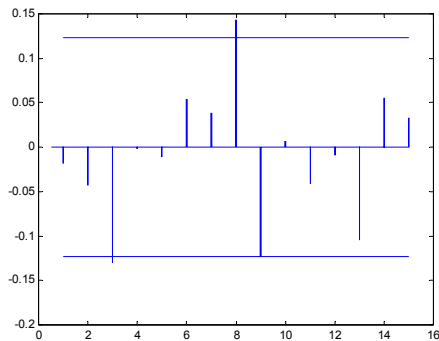
AT&T Start 2529 End 2781
Box Pierce = 15.37



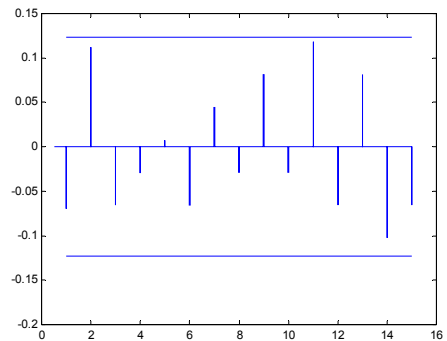
AT&T Start 3285 End 3537
Box Pierce = 10.70



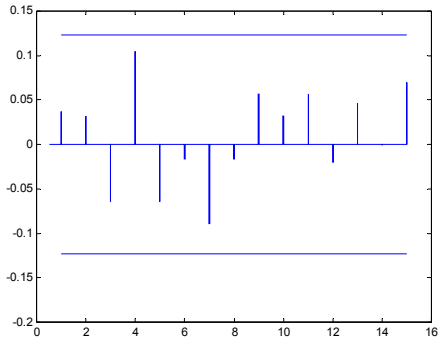
AT&T Start 2781 End 3033
Box Pierce = 19.13



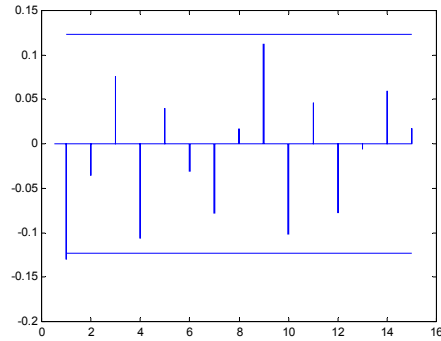
General Electric Start 261 End 513
Box Pierce = 19.36



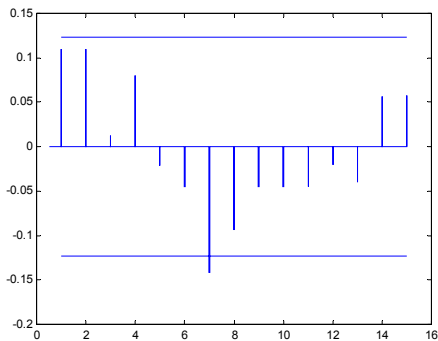
General Electric Start 513 End 765
Box Pierce = 11.37



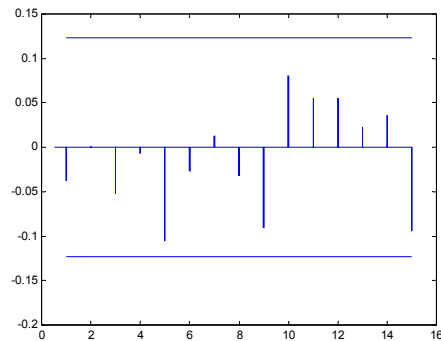
General Electric Start 1269 End 1521
Box Pierce = 19.93



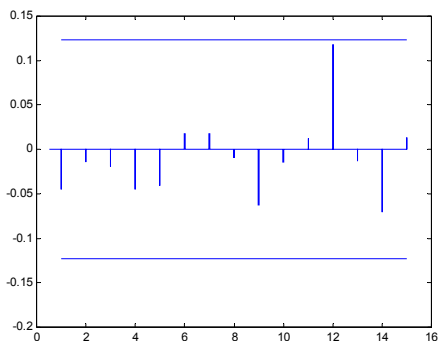
General Electric Start 765 End 1017
Box Pierce = 19.28



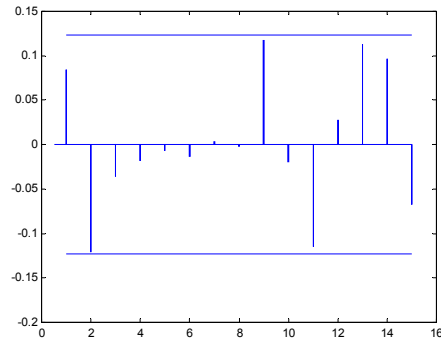
General Electric Start 1521 End 1773
Box Pierce = 12.31



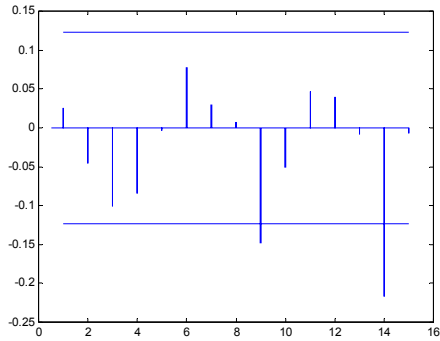
General Electric Start 1017 End 1269
Box Pierce = 7.67



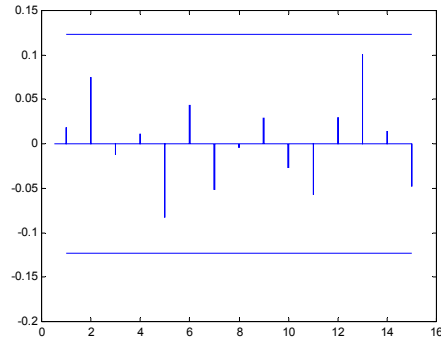
General Electric Start 1773 End 2025
Box Pierce = 19.75



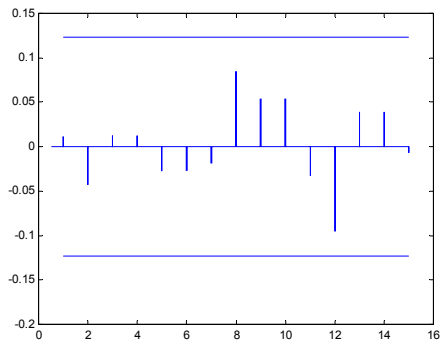
General Electric Start 2025 End 2277
Box Pierce = 25.92



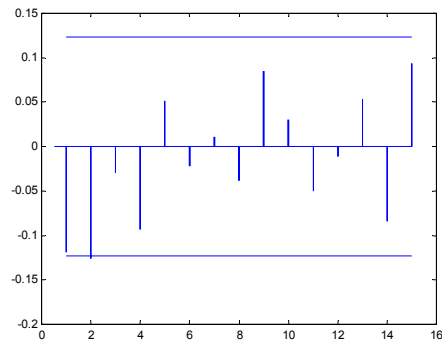
General Electric Start 2781 End 3033
Box Pierce = 9.11



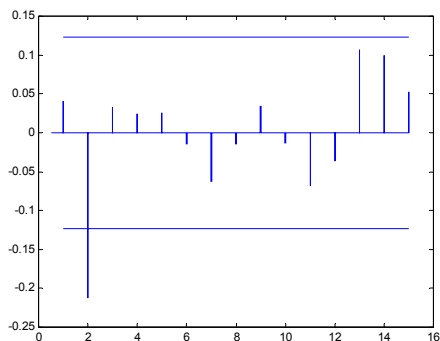
General Electric Start 2277 End 2529
Box Pierce = 7.63



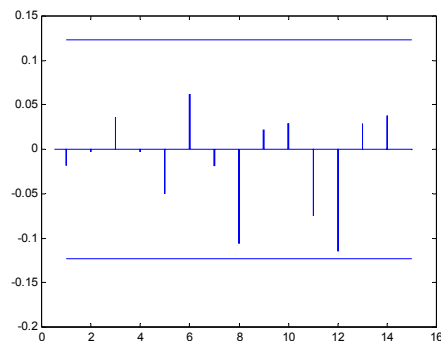
General Electric Start 3033 End 3285
Box Pierce = 18.50



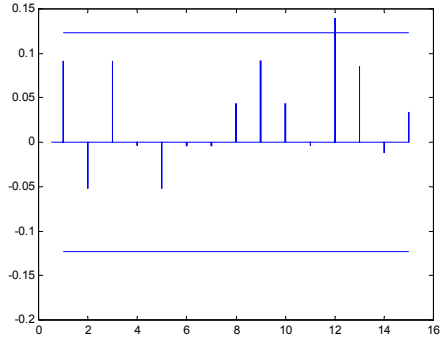
General Electric Start 2529 End 2781
Box Pierce = 21.42



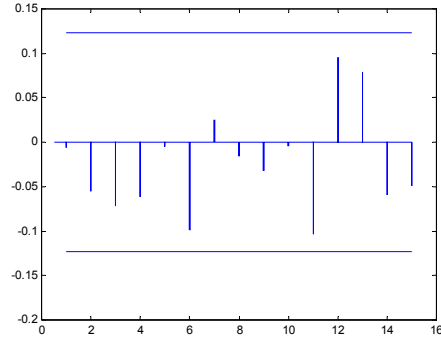
General Electric Start 3285 End 3537
Box Pierce = 10.55



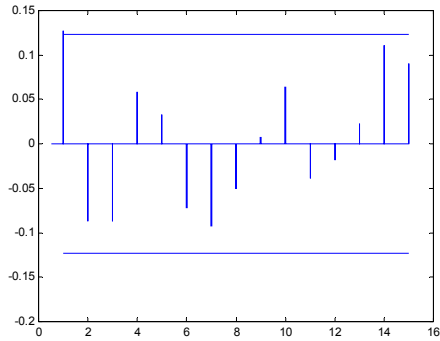
Home Depot Start 259 End 511
Box Pierce = 15.73



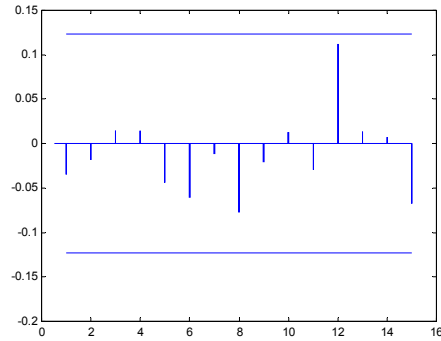
Home Depot Start 1015 End 1267
Box Pierce = 14.07



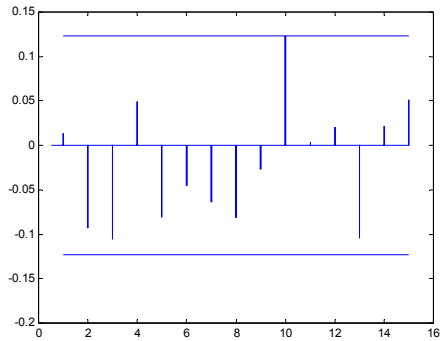
Home Depot Start 511 End 763
Box Pierce = 19.99



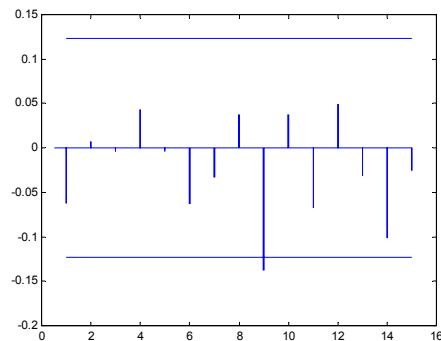
Home Depot Start 1267 End 1519
Box Pierce = 8.18



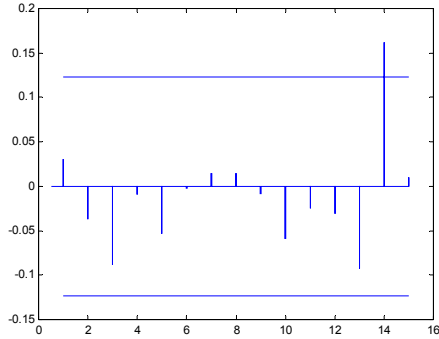
Home Depot Start 763 End 1015
Box Pierce = 18.14



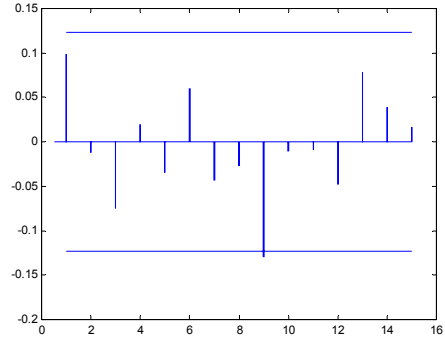
Home Depot Start 1519 End 1771
Box Pierce = 12.96



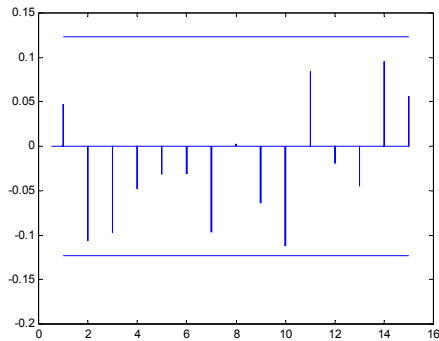
Home Depot Start 1771 End 2023
Box Pierce = 13.48



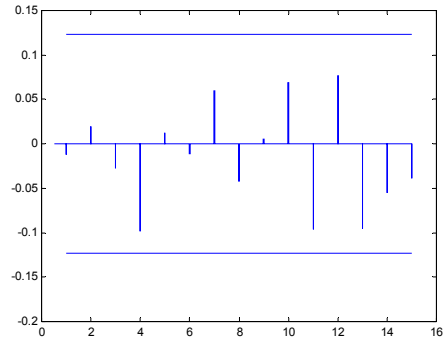
Home Depot Start 2527 End 2779
Box Pierce = 12.67



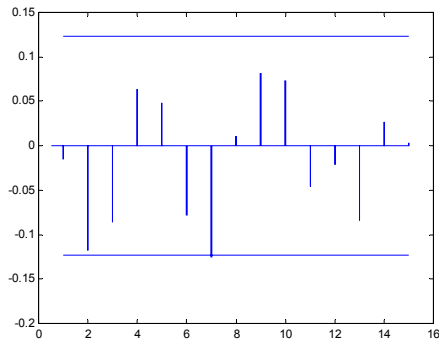
Home Depot Start 2023 End 2275
Box Pierce = 18.87



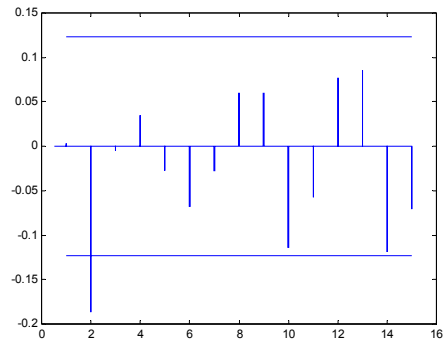
Home Depot Start 2779 End 3031
Box Pierce = 12.73



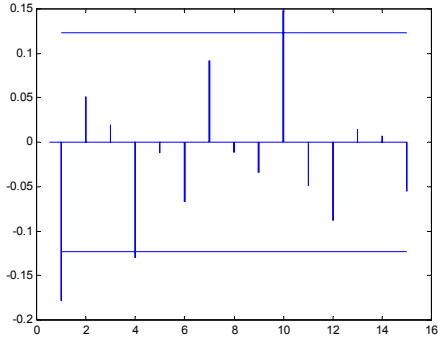
Home Depot Start 2275 End 2527
Box Pierce = 18.21



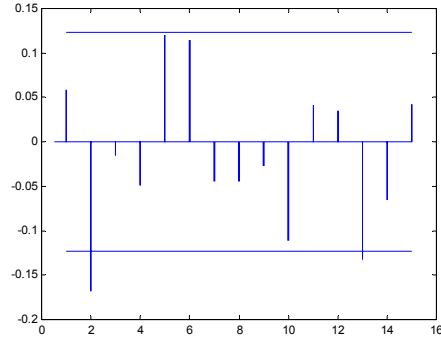
Home Depot Start 3031 End 3283
Box Pierce = 24.66



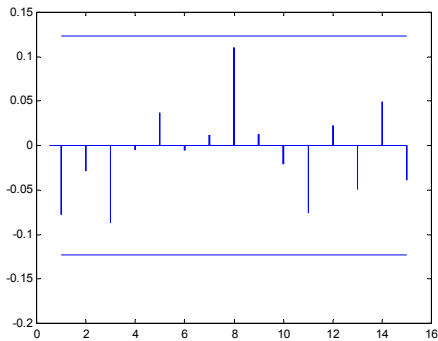
Home Depot Start 3283 End 3535
Box Pierce = 25.55



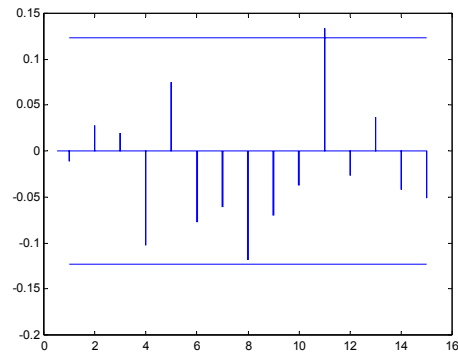
IBM Corporation Start 765 End 1017
Box Pierce = 26.47



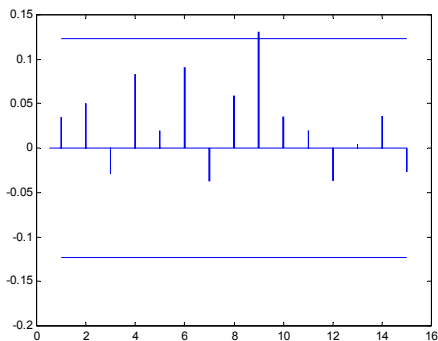
IBM Corporation Start 261 End 513
Box Pierce = 10.36



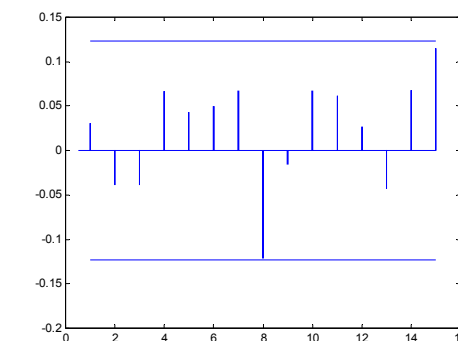
IBM Corporation Start 1017 End 1269
Box Pierce = 17.94



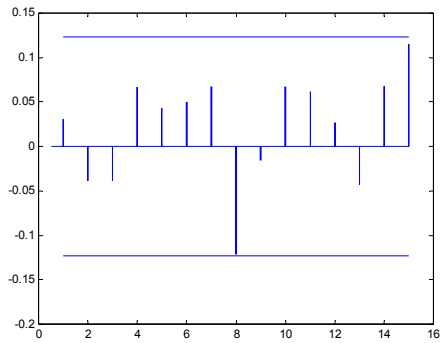
IBM Corporation Start 513 End 765
Box Pierce = 11.85



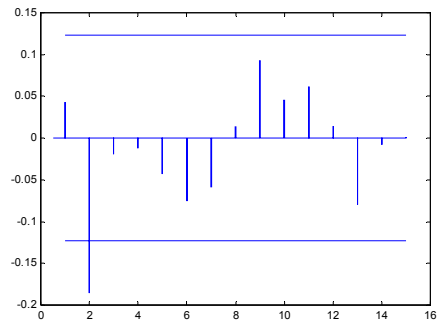
IBM Corporation Start 1269 End 1521
Box Pierce = 15.33



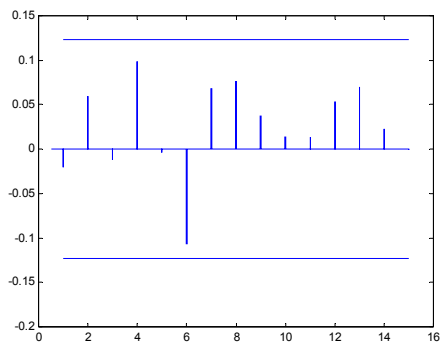
IBM Corporation Start 1521 End 1773
Box Pierce = 13.35



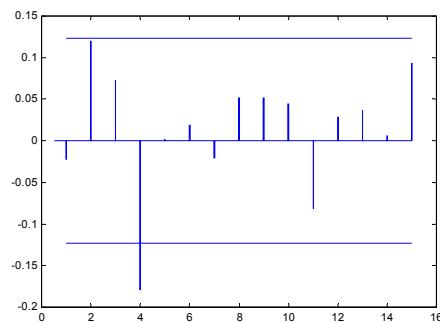
IBM Corporation Start 2277 End 2529
Box Pierce = 17.38



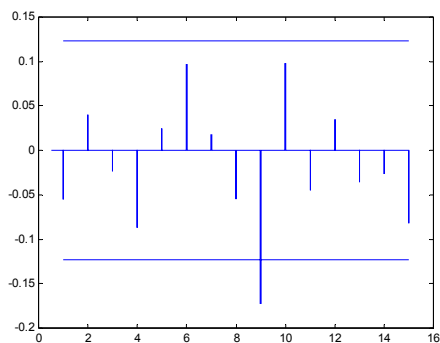
IBM Corporation Start 1773 End 2025
Box Pierce = 11.44



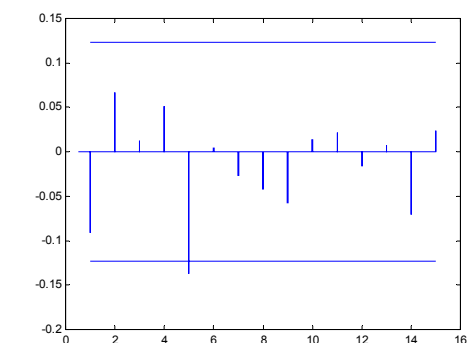
IBM Corporation Start 2529 End 2781
Box Pierce = 19.81



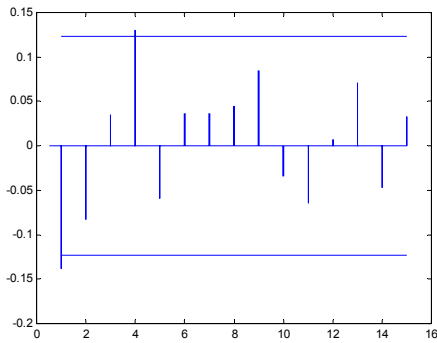
IBM Corporation Start 2025 End 2277
Box Pierce = 19.39



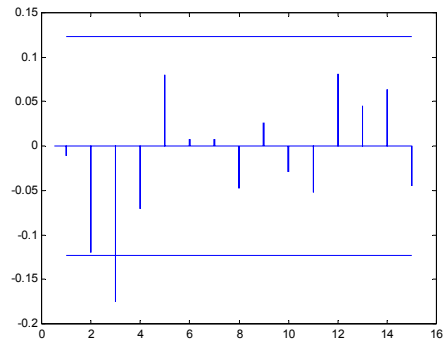
IBM Corporation Start 2781 End 3033
Box Pierce = 11.84



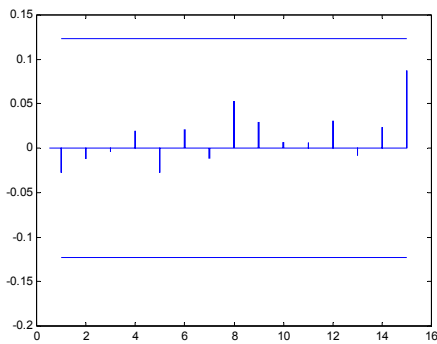
IBM Corporation Start 3033 End 3285
Box Pierce = 18.44



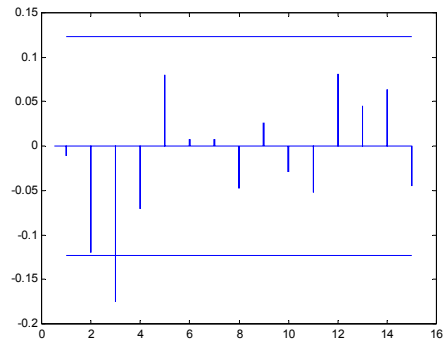
Johnson and Johnson Start 511 End 763
Box Pierce = 19.64



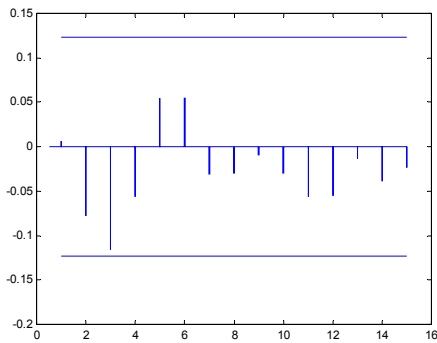
IBM Corporation Start 3285 End 3537
Box Pierce = 3.90



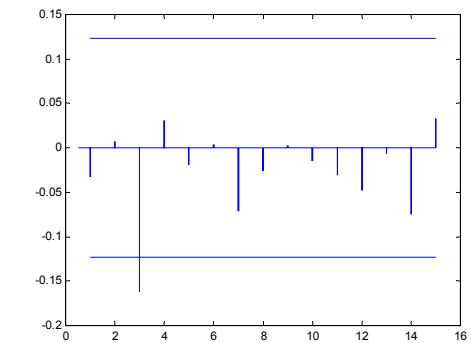
Johnson and Johnson Start 763 End 1015
Box Pierce = 10.47



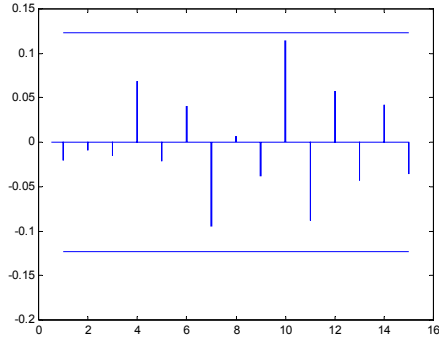
Johnson and Johnson Start 259 End 511
Box Pierce = 10.06



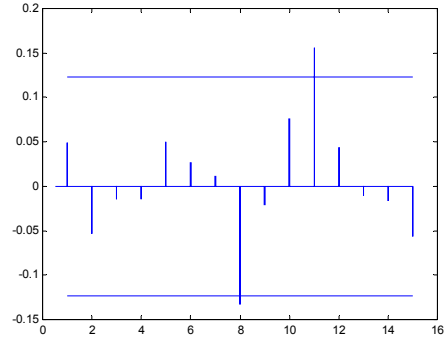
Johnson and Johnson Start 1015 End 1267
Box Pierce = 11.22



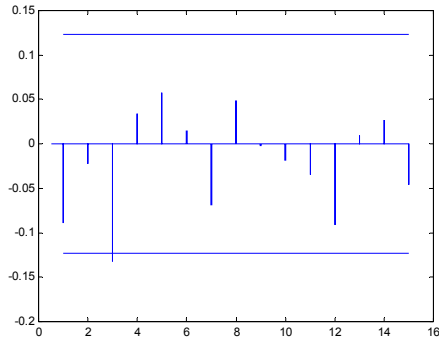
Johnson and Johnson Start 1267 End 1519 Box Pierce = 11.85



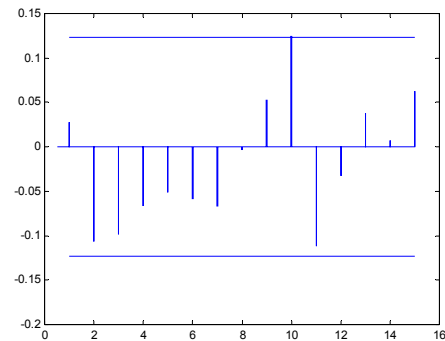
Johnson and Johnson Start 2023 End 2275 Box Pierce = 15.73



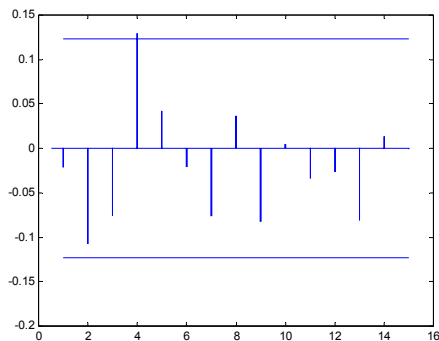
Johnson and Johnson Start 1519 End 1771 Box Pierce = 12.71



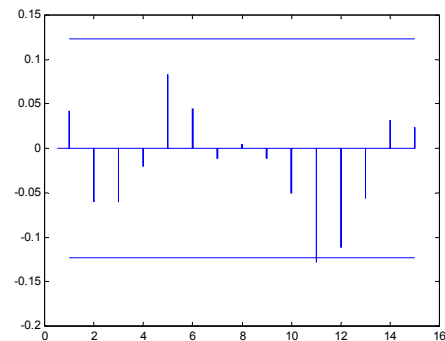
Johnson and Johnson Start 2275 End 2527 Box Pierce = 18.66



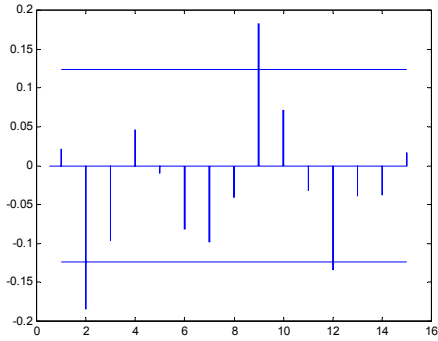
Johnson and Johnson Start 1771 End 2023 Box Pierce = 14.96



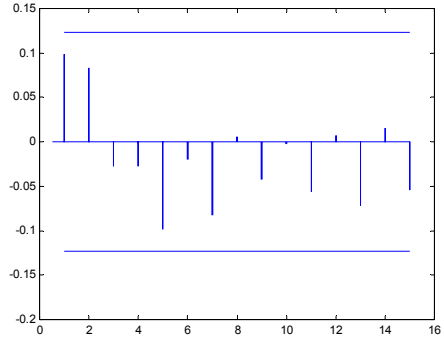
Johnson and Johnson Start 2527 End 2779 Box Pierce = 13.80



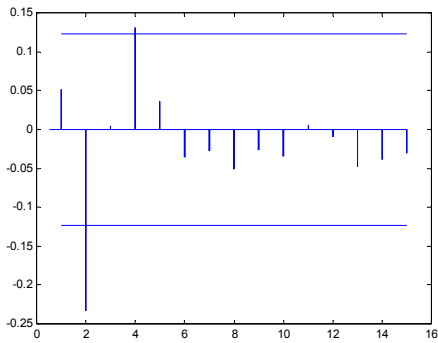
Johnson and Johnson Start 2779 End 3031
Box Pierce = 31.45



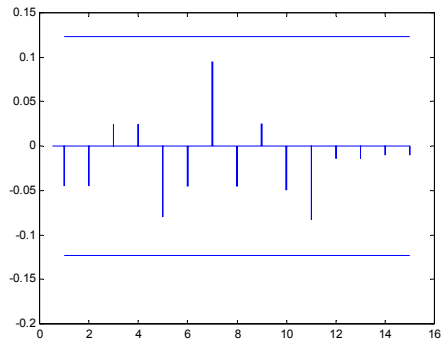
Cisco Start 517 End 769
Box Pierce = 12.48



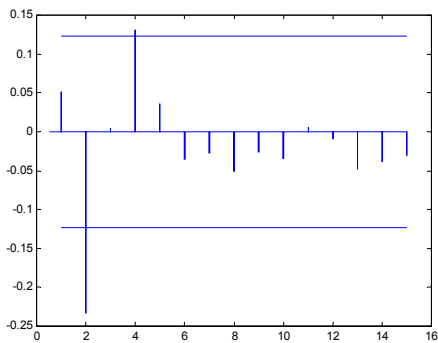
Johnson and Johnson Start 3031 End 3283
Box Pierce = 21.82



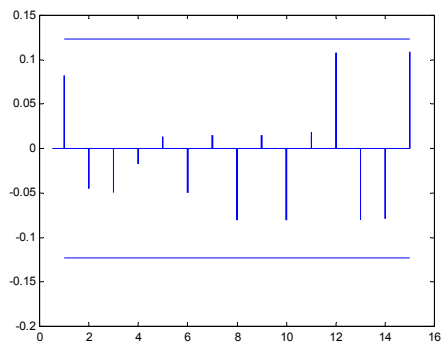
Cisco Start 769 End 1021
Box Pierce = 8.89



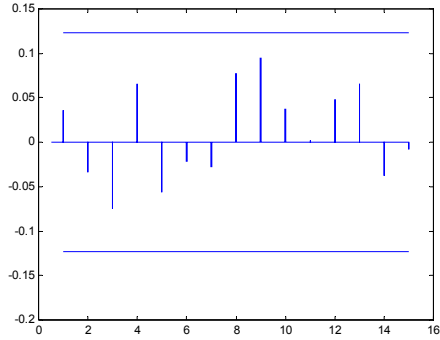
Johnson and Johnson Start 3283 End 3535
Box Pierce = 12.14



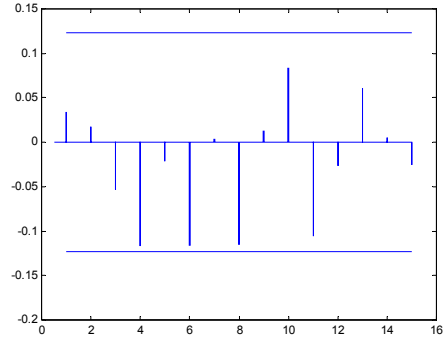
Cisco Start 1021 End 1273
Box Pierce = 16.01



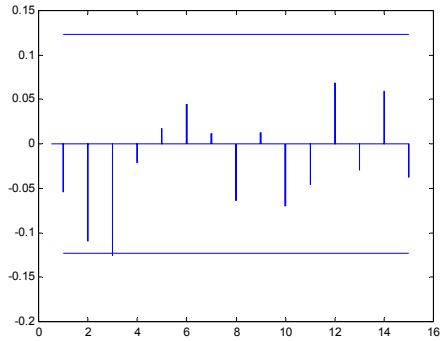
Cisco Start 1273 End 1525
Box Pierce = 10.38



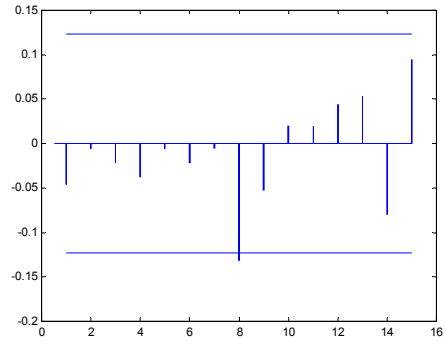
Cisco Start 2029 End 2281
Box Pierce = 17.23



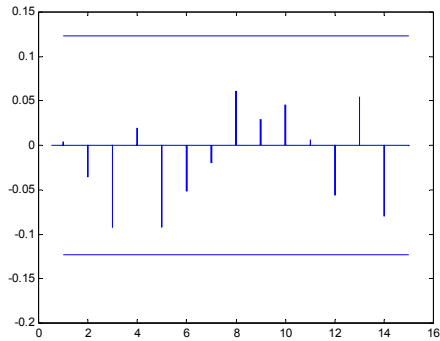
Cisco Start 1525 End 1777
Box Pierce = 14.00



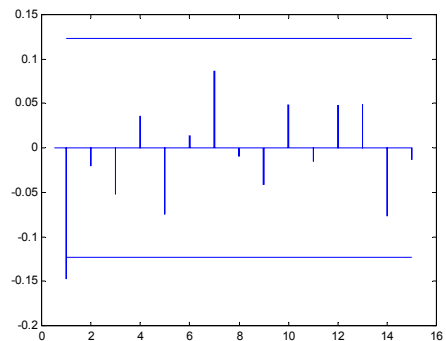
Cisco Start 2281 End 2533
Box Pierce = 11.41



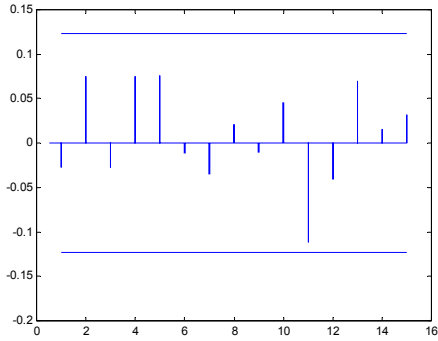
Cisco Start 1777 End 2029
Box Pierce = 10.34



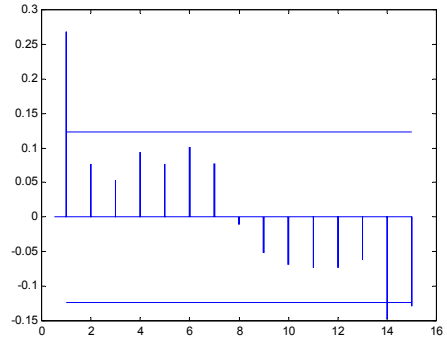
Cisco Start 2533 End 2785
Box Pierce = 13.77



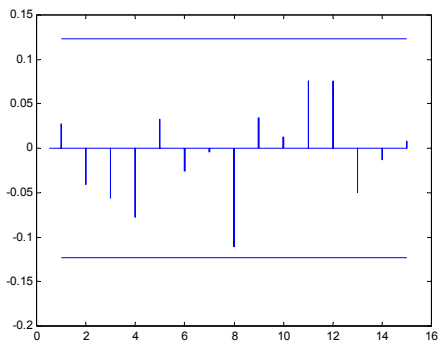
Cisco Start 2785 End 3037
Box Pierce = 10.81



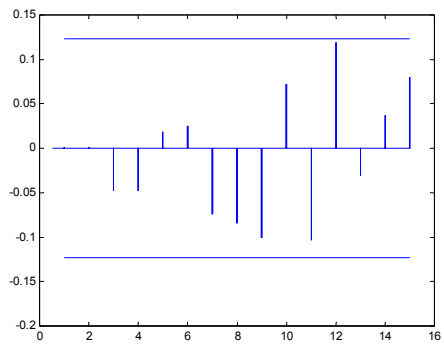
JP Morgan Start 763 End 1015
Box Pierce = 43.21



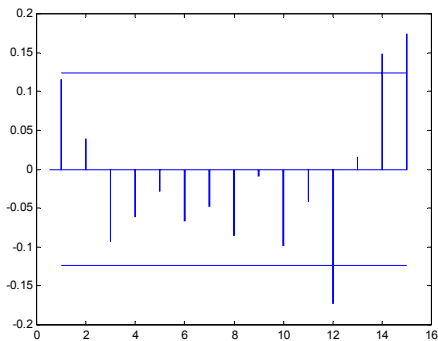
JP Morgan Start 259 End 511
Box Pierce = 10.44



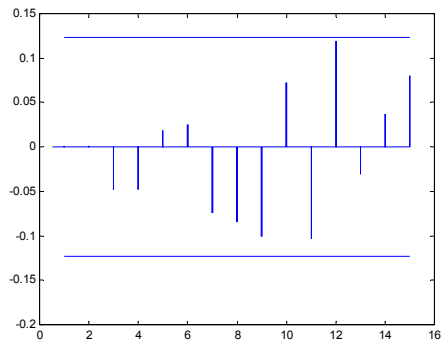
JP Morgan Start 1015 End 1267
Box Pierce = 16.88



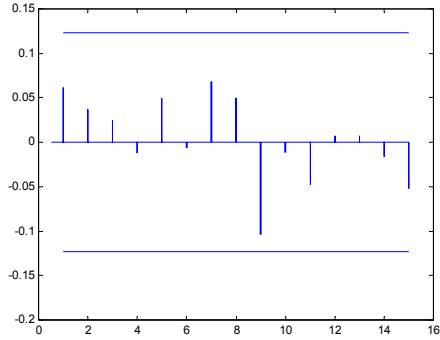
JP Morgan Start 511 End 763
Box Pierce = 34.30



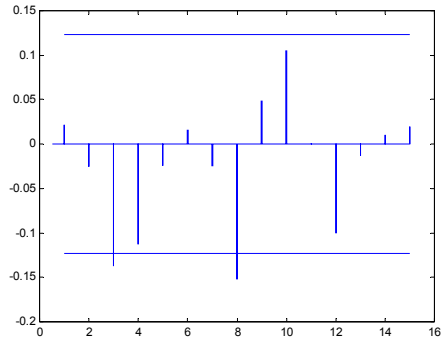
JP Morgan Start 1267 End 1519
Box Pierce = 18.02



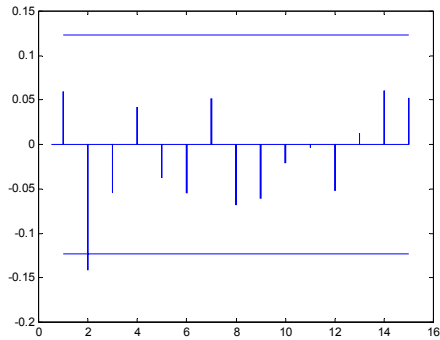
JP Morgan Start 1519 End 1771
Box Pierce = 7.97



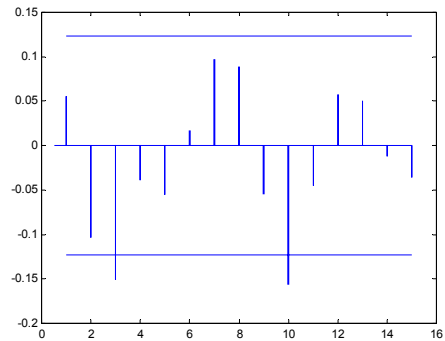
JP Morgan Start 2275 End 2527
Box Pierce = 20.41



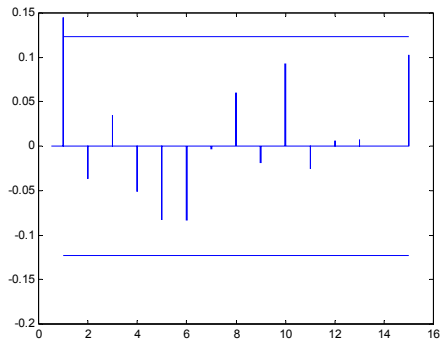
JP Morgan Start 1771 End 2023
Box Pierce = 13.47



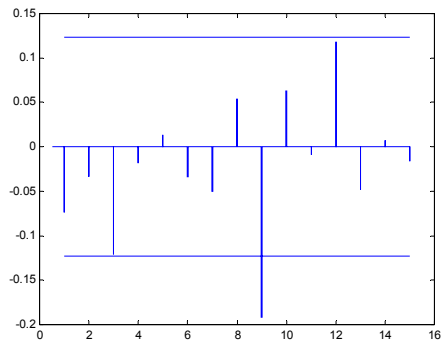
JP Morgan Start 2527 End 2779
Box Pierce = 23.95



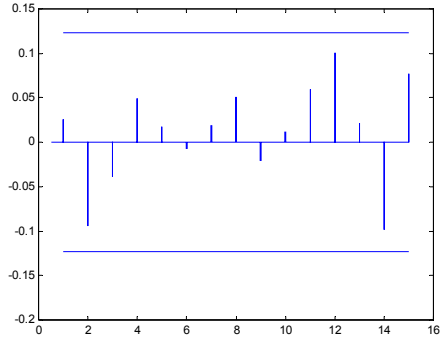
JP Morgan Start 2023 End 2275
Box Pierce = 16.07



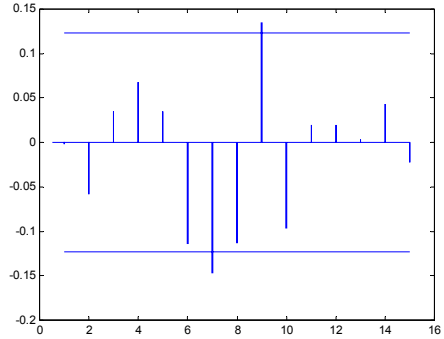
JP Morgan Start 2779 End 3031
Box Pierce = 21.61



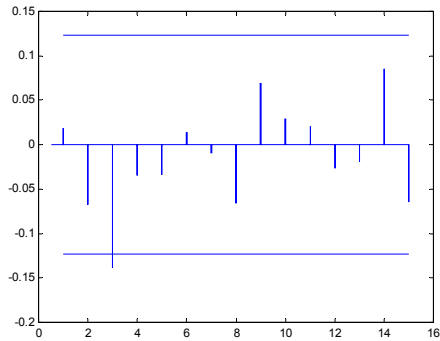
JP Morgan Start 3031 End 3283
Box Pierce = 11.90



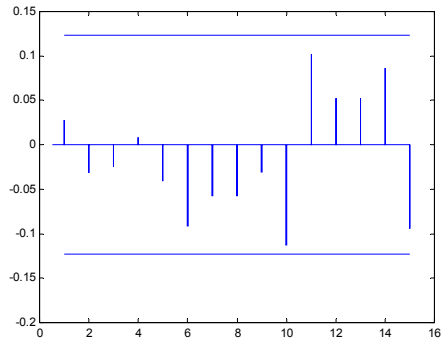
Coca Cola Start 513 End 765
Box Pierce = 22.17



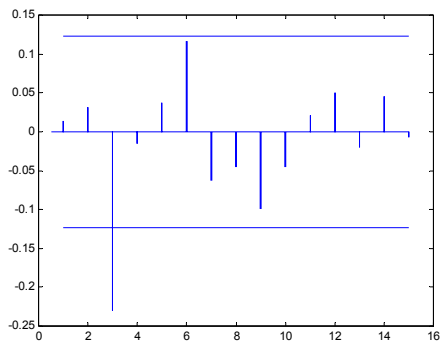
JP Morgan Start 3283 End 3535
Box Pierce = 12.54



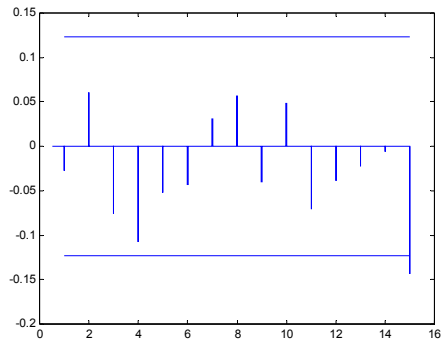
Coca Cola Start 765 End 1017
Box Pierce = 16.36



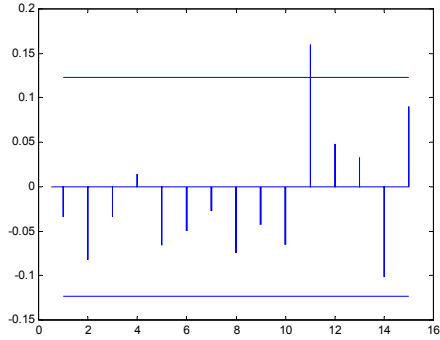
Coca Cola Start 261 End 513
Box Pierce = 23.20



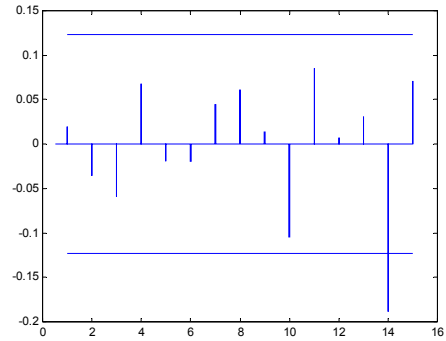
Coca Cola Start 1017 End 1269
Box Pierce = 15.61



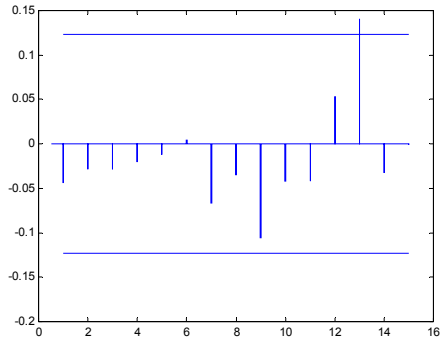
Coca Cola Start 1269 End 1521
Box Pierce = 19.07



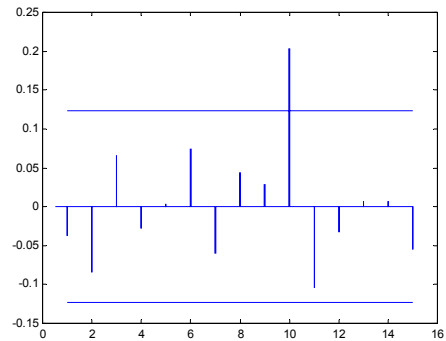
Coca Cola Start 2025 End 2277
Box Pierce = 19.21



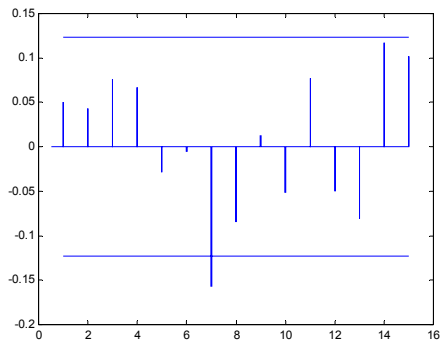
Coca Cola Start 1521 End 1773
Box Pierce = 12.12



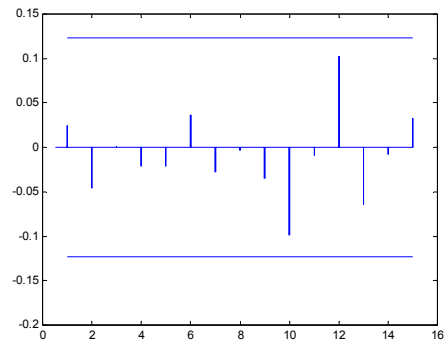
Coca Cola Start 2277 End 2529
Box Pierce = 20.61



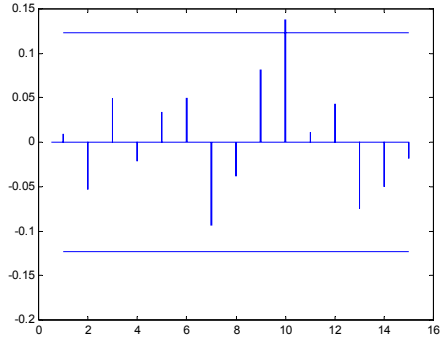
Coca Cola Start 1773 End 2025
Box Pierce = 22.49



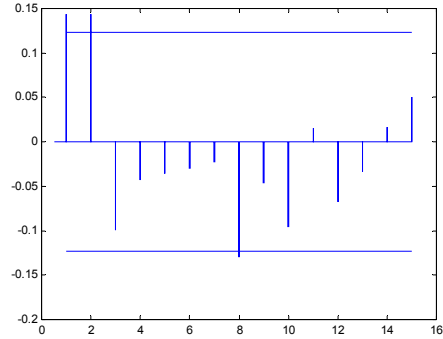
Coca Cola Start 2529 End 2781
Box Pierce = 8.18



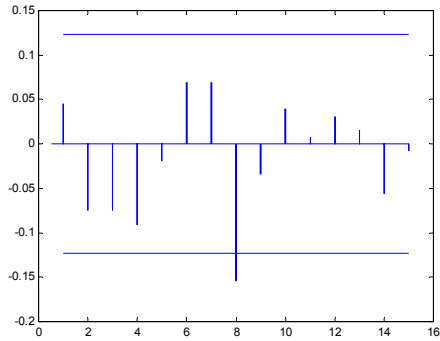
Coca Cola Start 2781 End 3033
Box Pierce = 13.92



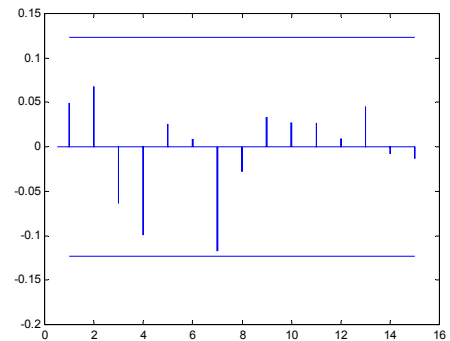
SBC Corporation Start 261 End 513
Box Pierce = 23.29



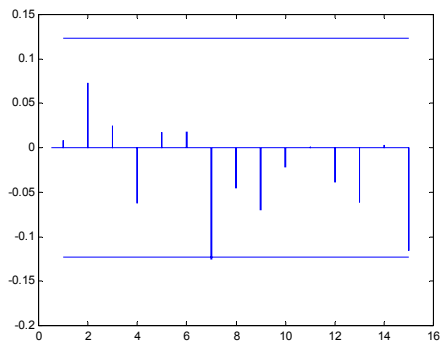
Coca Cola Start 3033 End 3285
Box Pierce = 15.66



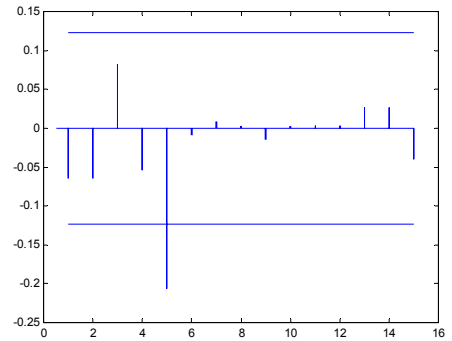
SBC Corporation Start 513 End 765
Box Pierce = 10.30



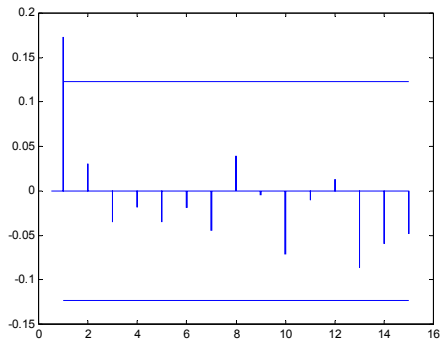
Coca Cola Start 3285 End 3537
Box Pierce = 13.17



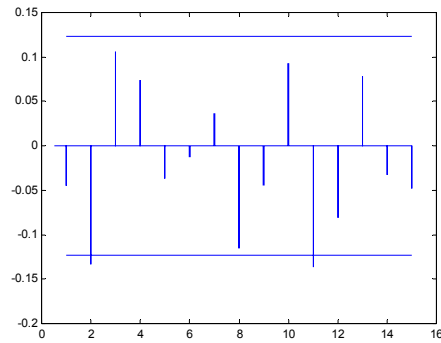
SBC Corporation Start 765 End 1017
Box Pierce = 16.20



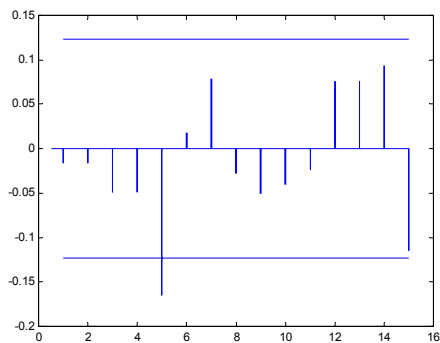
SBC Corporation Start 1017 End 1269
Box Pierce = 14.17



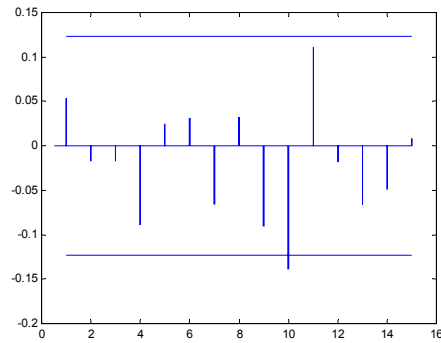
SBC Corporation Start 1773 End 2025
Box Pierce = 24.67



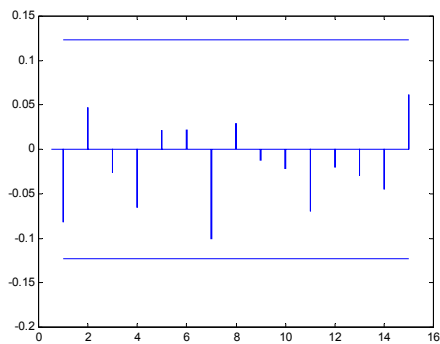
SBC Corporation Start 1269 End 1521
Box Pierce = 19.67



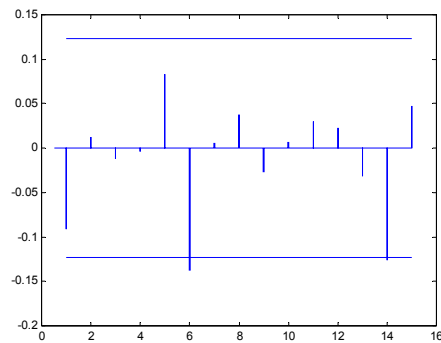
SBC Corporation Start 2025 End 2277
Box Pierce = 16.42



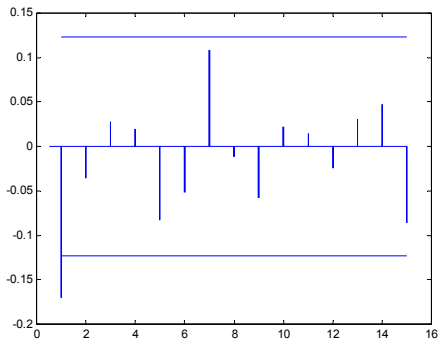
SBC Corporation Start 1521 End 1773
Box Pierce = 9.71



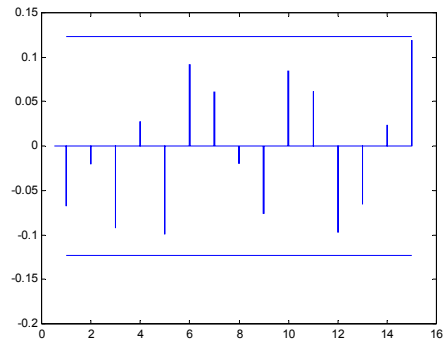
SBC Corporation Start 2277 End 2529
Box Pierce = 14.40



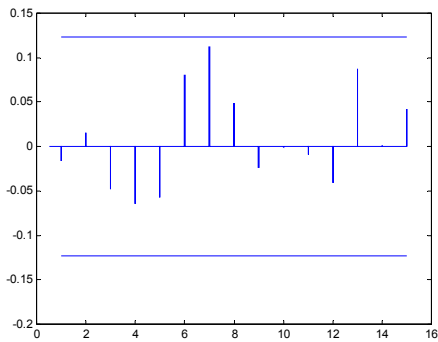
SBC Corporation Start 2529 End 2781
Box Pierce = 17.04



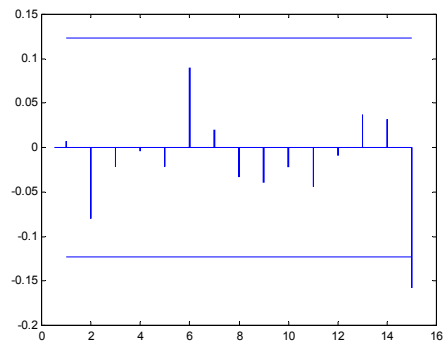
SBC Corporation Start 3285 End 3537
Box Pierce = 20.60



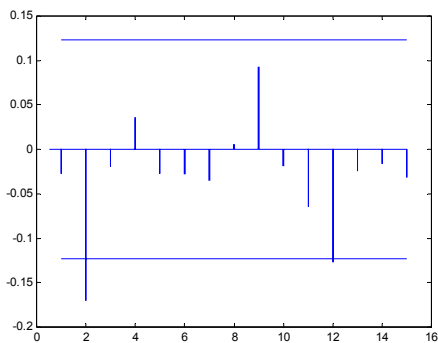
SBC Corporation Start 2781 End 3033
Box Pierce = 10.94



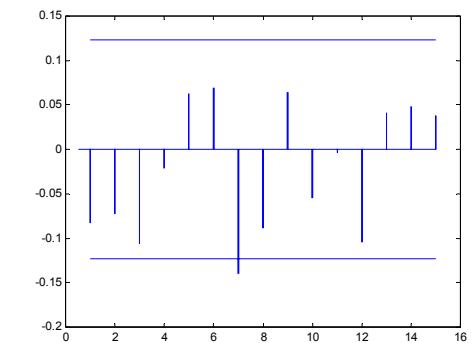
EXXON Corporation Start 261 End 513
Box Pierce = 12.18



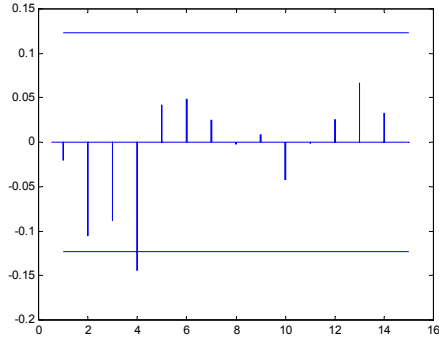
SBC Corporation Start 3033 End 3285
Box Pierce = 16.43



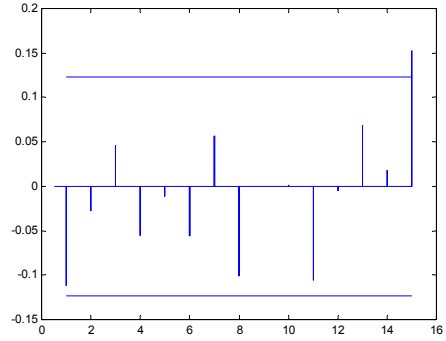
EXXON Corporation Start 513 End 765
Box Pierce = 21.00



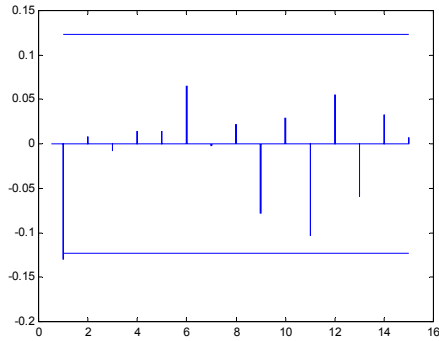
EXXON Corporation Start 765 End 1017
Box Pierce = 13.35



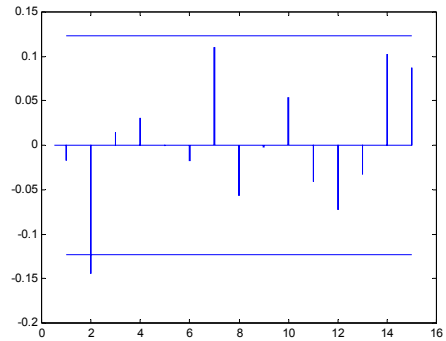
EXXON Corporation Start 1521 End 1773
Box Pierce = 18.86



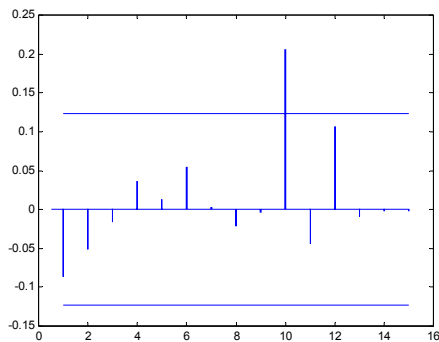
EXXON Corporation Start 1017 End 1269
Box Pierce = 12.03



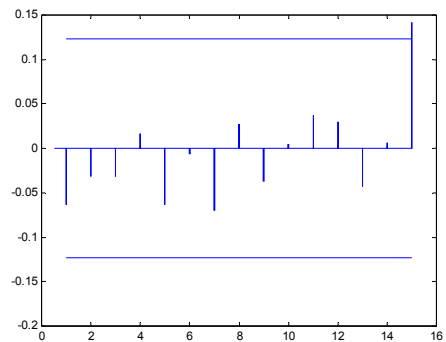
EXXON Corporation Start 1773 End 2025
Box Pierce = 16.97



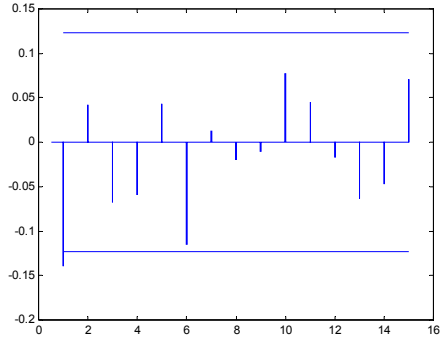
EXXON Corporation Start 1269 End 1521
Box Pierce = 17.90



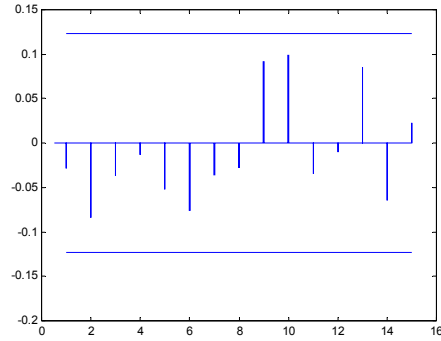
EXXON Corporation Start 2025 End 2277
Box Pierce = 10.47



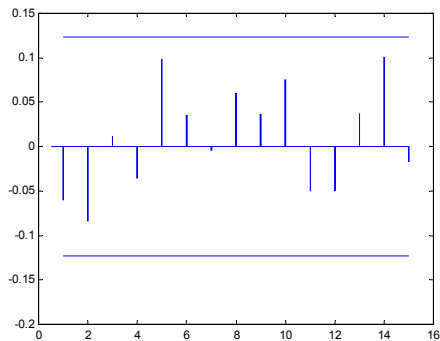
EXXON Corporation Start 2277 End 2529 Box Pierce = 16.30



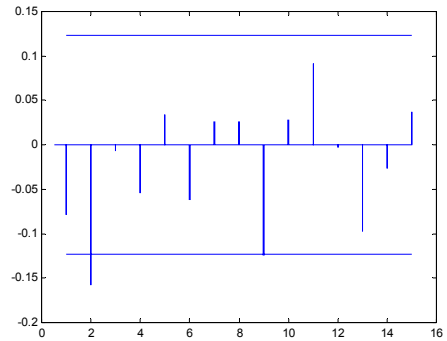
EXXON Corporation Start 3033 End 3285 Box Pierce = 19.25



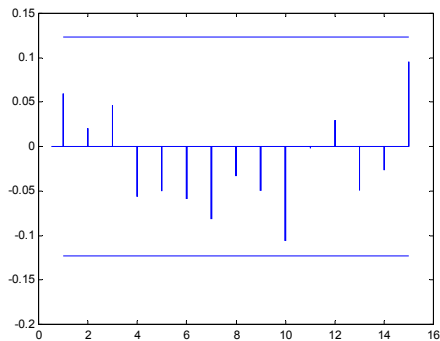
EXXON Corporation Start 2529 End 2781 Box Pierce = 12.54



EXXON Corporation Start 3285 End 3537 Box Pierce = 12.70

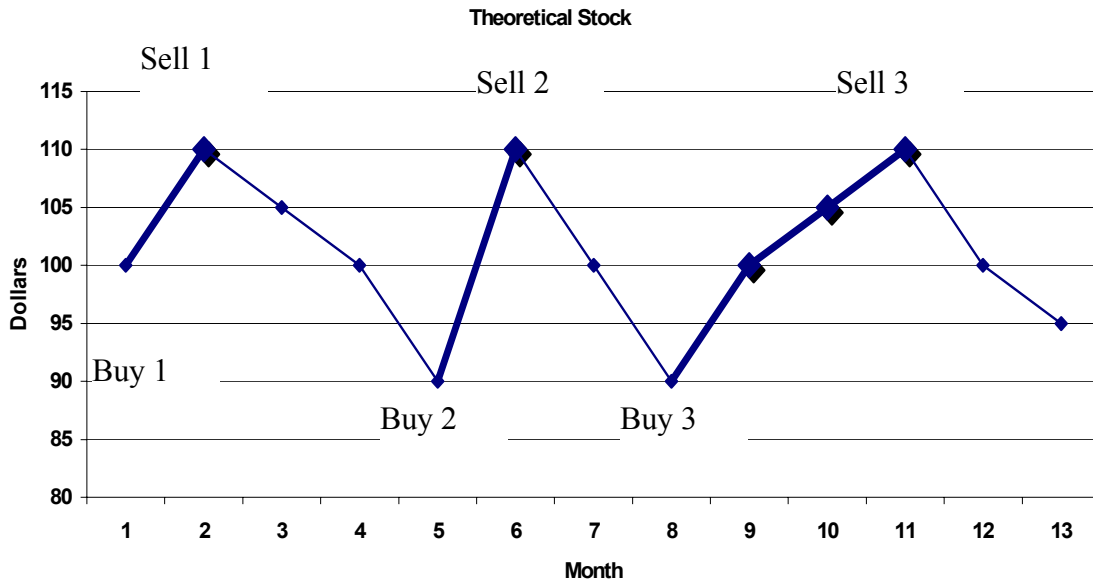


EXXON Corporation Start 2781 End 3033 Box Pierce = 12.88



Appendix D Example with Perfect Information

The following provides the example given previously in the paper. The calculations used by



the model will be performed on this example to demonstrate the operation of the return generation.

For the example assume the investor bought and sold on the following six points.

Buy 1 Point

The model begins with cash to purchase one thousand shares of stock at the first closing price. That is for this example, the model would begin with the following initial capital..

$$IC = 1000 \times 100$$

where

$$IC = \$100,000 .$$

For this example shares are purchased immediately as follows.

$$NS = \left\lceil \frac{\$100,000 - \$10}{100} \right\rceil$$

where

NS = Number of shares initially purchased, or 999 shares.

Since fractional shares are not allowed, the quantity purchased is rounded down to 999.

A small amount of money is not invested and tracked. This small amount receives a small daily interest. The model will assume ½% yearly compounded daily. The following is the cash not invested which draws interest.

$$CC = [\$100,000] - \$10 - [999 \times \$100]$$

where

CC = Cash Carried or \$90 .

Sell 1 Point

Including the interest for the one month will yield the following.

$$CCWI = \$90 \times [1 + (.005 / 252)]^{21}$$

where

CCWI = Cash carried with interest, or \$90.04 .

When the model recommends leaving the stock market, the cash position is increased by the number of shares times the share price less the commission. At Sell 1 point the cash will include both the sale of stock and the cash carried as shown below.

$$CCAS = [999 \times \$110] - \$10 + \$90.04 = \$109,970$$

where

CCAS = Cash at sale date, or \$109,970 .

Buy 2 Point

The cash obtained at Sell 1 date accumulates interest until the cash is reinvested in stock. This occurs 3 months later. Thus, cash is calculated as

$$CCN = \$109,970 \times [1 + (.005 / 252)]^{63}$$

where

CCN = New cash position at Buy 2 point or \$110,107 .

Now the “new cash position,” CCN, assumes the position of the “initial capital” and the model buys at Buy 2.

At the Buy 2 point the following number of shares are purchased.

$$NS = \left\lceil \frac{\$110,107 - \$10}{\$90} \right\rceil$$

where

NS = Number of shares initially purchased, or 1223 shares.

The small amount of money remaining generated by purchasing even shares of stock is given below.

$$CC = [\$110,107] - \$10 - [1223 \times \$90] = \$27$$

where

CC = Cash Carried or \$27 .

Sell Point 2

Including the interest for the one month yields.

$$CCWI = \$27 \times [1 + (.005 / 252)]^{21}$$

where

CCWI = Cash carried with interest, or \$27.01 .

Cash from the sale of the stock at Sell 2 point is

$$CashFromStockSale = [1223 \times \$110] - \$10 = \$134,520 .$$

Add the cash from the stock sale to the small amount of cash carried for the total cash after sale as follows.

$$CCAS = CashFromStockSale + \$27 .$$

The cash after the sale of stock at Sell Point 2 is \$134,547.

Buy 3 Point

At Buy 3 point the \$134,547 would have accumulated two month's interest. Thus, the following equation is used.

$$CCN = \$134,547 \times [1 + (.005 / 252)]^{42} = \$134,659 .$$

Or cash carried would be \$134,659.

At the Buy 3 point the following number of shares are purchased.

$$NS = \left\lceil \frac{\$134,659 - \$10}{\$90} \right\rceil$$

where

NS = Number of shares purchased, or 1496 shares.

Now,

$$CC = [\$134,659 - \$10] - [1496 \times \$90] = \$9.18 .$$

Cash at Sell 3, 3 months later is

$$CCWI = \$9.18 \times [1 + (.005 / 252)]^{63} = \$9.19 .$$

Sell 3 Point

Cash from the sale of the stock at Sell 3 point combined with carried cash is

$$CCAS = [1495 \times \$110] - \$10 + \$9 = \$164,559 .$$

That is the cash at Sell 3 is \$164,559.

The model continues to the end of the year and finds the situation to be one of “out of the market.” Since the investor is in a cash position (situation 1), credit must be given for the interest earned from Sell 3 position to the end of the year.

To gain the two months’ interest, the following formula is used.

$$CCN_f = \$164,559 \times [1 + (.005 / 252)]^{42} = \$164,687 .$$

Thus the final cash position is \$164,687.

Yearly Return

The return is “final cash position” less the initial cash divided by the initial cash. The return is expressed as follows.

$$RET = 100 \times \left[\left[1 + \frac{CCN_f - IC}{IC} \right] - 1 \right] .$$

Substitution yields the following.

$$RET = 100 \times \left[\left[1 + \frac{\$64,687}{\$100,000} \right] - 1 \right]$$

where

RET = Return expressed as a percentage, or approximately 65% .