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A System Approach to Investing In Uncertain Markets

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A SYSTEM APPROACH TO INVESTING IN UNCERTAIN MARKETS

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by
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to my mother,

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Table of Contents

List of Tables

List of Figures

Abstract

We consider the problem of trend-following in US stock market and propose a combined economic and technical model to approach this problem. A bank of linear and nonlinear, discrete-time, low-pass filters with different sampling rates is used to generate timing signals for US stock market indexes such as NASDAQ Composite and S&P 500. These timing signals help us find the appropriate times to step in or out of the market. Back-testing and real-time implementation results along with the risk analysis validate our model.

According to the trend of the market, we may adopt a long or short position. If we conclude that the market is in an uptrend (rising prices) then, we buy some shares of a stock to sell them for a higher price in future (long position). On the other hand, in a market downtrend (falling prices), we may borrow a number of shares and sell them outright to repurchase them for a lower price in future (short selling). The purpose of the market timing is to recognize the current trend of the market and to find the appropriate times to step in or out of the market.

We do not consider market timing for the stocks of individual companies due to the high sensitivity of daily prices to news, the performance of their competitors, the conditions of the economic sector they belong to, and many other sources of randomness. Instead, we consider the timing problem for the large market indexes such as NASDAQ Composite and S&P 500 that are weighted averages of the price of many companies from several economic sectors. Therefore, we use the daily index value and volume (total number of trades) for a large market index in place of an individual company. Such timing signals would be suitable for investing in exchange traded funds (ETFs).

Chapter 1
Introduction

1.1 Preliminaries

In finance, the word *security*, refers to a piece of paper that proves the ownership of stock, bond or other investment. Tweles and Bradley in [1], define the word *stock* as ownership or equity in a corporation. One share of stock of a company is a share of ownership in that company. There are several other kinds of securities that are not considered as ownership in the issuer corporation such as bonds, CDs, etc. Therefore, when you own a share of stock in a corporation, you marry with their profits or losses.

Security markets can be divided into two different categories: *primary* and *secondary* markets. In a primary market, seller is the issuer of a security, while in a secondary market, a security could be traded between two other counter-parties [1]. Stock markets belong to the second category.

Secondary markets include two different classes of markets: *the organized securities exchanges* and *over-the-counter* (OTC) markets. In an exchange traded market, securities are traded on an exchange such as New York Stock Exchange (NYSE), American Stock Exchange and Chicago Stock Exchange. According to [1], the trading volume in NYSE, both in terms of dollar amount and number of shares, is more than all other US security exchange markets together.

OTC markets are more flexible than exchanges to meet the needs of investors. In an OTC market, there is an intermediary party called *dealer* or *broker* who conducts each trade. An OTC market is in fact the *dealer* market. *Bid* price is the price at which a dealer buy a security, or the price you sell, and the *ask* price is

the price at which a dealer sells the security or the price you pay to buy a security. The difference between bid price and ask price is called *bid-ask spread* and that is the amount of money that a dealer always obtains from any trade.

National Association of Securities Dealers (NASD), in 1970 inaugurated NASDAQ electronic quotation system [1]. Dealers by means of computers conduct every trade. After NYSE and Tokyo Stock Exchange, NASDAQ is the third largest security market in the world [1]. The NASD determines the current median bid prices of the securities of more than 5,000 companies that are traded over the counter as part of NASDAQ market [1]. NASD then allots a weighting factor to each company, based on its market capitalization, and calculates the summation as the NASDAQ Composite Index. Base value is 100 that is calculated on Feb. 5, 1971. Currently, NASDAQ Composite Index represents a weighted average of the prices of stocks of more than 3,000 companies.

When you own a security, you are said to have a long position on that security. A person with long position in security, benefits if the price goes up. For example, when you buy a share of stock of a company, you would be in a long position on that share of stock and obviously you get benefit if the stock price of that company increases.

Now, suppose that you borrow a share of stock from someone and immediately sell it. You are supposed to return that share of stock in the future. In such a situation, you are said to have a short position on that share of stock. Here, you benefit from decline in price of that stock. The act of borrowing a security and selling it, is called *short selling*.

When prices in stock market are increasing or are expected to rise, we say the market is *bullish*. Conversely, the term *bear market* refers to the market in which prices are moving down or are expected to decline. A long term bull or bear market

is called *secular market*. An investor with a long position in a security is *bullish* on that security because he benefits from rising prices. On the other hand, a short seller is *bearish* on that security because he gains from falling prices.

1.2 Mutual Funds and Exchange Traded Funds

When you invest in an individual stock of a single company, you expose yourself to a high value of risk. Constructing a portfolio of stocks including a broad class of companies and economic sectors reduces the risk of investment. However, for small investors it is impossible to achieve this goal. Mutual funds, are investment corporations in which a *money manager* collects money from different investors to establish a broad portfolio of stock, bonds, and other securities. Each investor then achieves his/her loss or gain proportional to the amount of investment. They usually invest on stocks of some specific companies called *constituent stocks*.

When someone wants to buy some shares of a mutual fund, the investor should send his/her capital to the fund. The mutual fund then, creates new shares for the investor by purchasing appropriate number of their constituent stocks. Conversely, when shareholder decides to sell some shares of a mutual fund, the fund may have to sell appropriate number of constituent stocks for cash redemption. Therefore, every buy and sell request, results in buy and sell of the underlying securities in mutual fund.

Exchange Traded Funds (ETFs), are specific kind of investment companies in which the money manager tries to track a large market index such as NASDAQ Composite, S&P 500, Dow Jones Industrial Average, *etc*. The ETF with QQQ symbol, is provided by PowerShares Capital Management LLC for which the money managers track the NASDAQ-100 index. Another example of ETF fund is SPY offered by SPDR Company that its goal is to follow the S&P 500 index. Therefore, the gain or loss achieved by SPDR ETF fund corresponds to S&P 500 index. Shares

of stocks of ETF could be traded like stocks of any other companies in the stock exchange.

For ETFs, buy and sell processes are completely different from mutual fund. We can divide the ETF investors into two categories: *authorized participants (APs)* and *small investors*. APs hold large blocks of shares that usually include 100,000 shares and called *creation units*. Smaller investors hold fewer number of shares than a creation unit. To invest in an ETF, the AP should send a basket of constituent stocks to the fund and then, fund creates appropriate number of shares for the AP. This process is called *in-kind transaction*. Therefore, the AP does not send *cash* to the fund.

On the other hand, when an AP wants to sell some shares of creation units, the fund delivers a basket including appropriate number of constituent stocks. Unlike mutual funds, ETF does not sell stocks for cash redemption. Smaller investors can buy and sell units of shares from other shareholders in a stock exchange. So, no new share is created and no share is redeemed. For this reason, ETFs are usually exposed to less capital gain distributions and, consequently, are more tax efficient than mutual funds.[1].

A leveraged ETF is a specific ETF fund that its gain or loss is β times of its regular corresponding ETF. For example, QLD ETF fund, is an example of ETF corresponding to QQQ with $\beta = 2$. Therefore, if QQQ increases by one unit, then QLD tries to increase by two units. It is worth noting that both regular and leveraged ETF may not be able to completely achieve their tracking goal.

[1] "Exchange Traded Funds: *Tax Advantages for Shareholders*", Invesco PowerShares, *www.invescopowershares.com*

Many traders prefer ETFs over regular mutual funds for several reasons. Leslie Masonson in his excellent book named *All About Market Timing*, enumerates the following benefits for trading ETFs over regular mutual funds, [2]:

- *Transparency*: Unlike other kinds of mutual funds, the portfolio composition is known to any investor, therefore everybody exactly knows what he/she buys or sells.
- *Liquidity*: Everyday, a huge volume of buy and sell demands stabilize the ETF market. So, you can easily get in and out of the market with relatively low bid-ask spread.
- *Low cost*: You do not have to pay for money manager or market analyst. Expense fees are much lower than other mutual funds.
- *Tax efficiency*: we discussed it before.
- *Flexibility for implementing various trading strategies*: like an individual stock, you can go long, or short on ETFs, or you may also apply different hedging strategies.
- *Diversification*: there are too many ETFs in different economic sectors, with different benchmarks such as NASDAQ-100, S&P 500, Dow Jones Industrial Average, *etc.* Each of them includes a broad portfolio of stocks that reduces the risk of investment.
- *Favorable interest income and dividends*: like individual companies, ETFs may pay the shareholders some dividends.

He also states some drawbacks associated by ETF trading that are:

- *Market risk*: It always exists hand in hand with any investment in stock market.

- *Net-asset-value risk*: As we said before, an ETF may not be able to track its benchmark exactly. But it would disappear soon for if it is observed by big investors, then they try to make benefit from such a difference, like an arbitrage opportunity, and the feedback of their actions eventually, corrects the price of the ETF soon.

- *Bid-ask price spread*: for some ETFs, the gap between bid and ask prices are relatively high.

- *Sector risk*: if you invest in an ETF which belongs to a specific economic sector, then any economic malfunction in that sector may put your money in risk.

1.3 Efficient Market Hypothesis

One of the most controversial subjects about the market is its predictability. Efficient market theory (EMH) states that the best mathematical framework to analyze the price movement is random walk. The followers of this hypothesis believe that the best prediction for the next-day price is the price of today. Therefore, any amount of technical analysis, on average, cannot lead to obtain more return. Some people achieve high returns on stock market not due to their abilities in prediction of future trends, but it is just their fortune. In other words, any return on stock market is not predictable in advance. To be more precise [3]:

"*this kind of randomness comes from active participation of every investor to obtain greater wealth*".

The proponents of this hypothesis argue that [3]:

"*any advantageous information that may lead to a profit opportunity is quickly eliminated by feedback that their action has on the price.*"

However, there are some contradictory results achieved by several scholars that reject the correspondence between efficient market and random walk. Statistical results published by Lo and MacKinlay show that *financial markets are predictable to some degree!* They also analogize the predictability to the *oil* that lubricates the gears of capitalism [4]. Grossman and Stiglitz not only reject this correspondence, but they even go further and claim that, [5]:

"the perfectly informationally efficient markets are impossible, for if markets are completely efficient then, return to gathering information is nil. So, no more trade would happen and eventually they collapse."

1.4 Fractal Market Hypothesis

Edgar Peters in his book, *Fractal Market Analysis*, introduces a new predictability paradigm using chaos theory [6]. He also compares the concept of *stable market* versus *efficient market* and mentions that efficient market is not necessarily stable. Stable market is one which is liquid, while efficient market hypothesis does not consider the liquidity. He also discriminates the trading volume from liquidity. EMH always assumes that prices are *fair* whether the liquidity exists or not. That's the reason why this hypothesis is not able to explain crashes and sudden jumps [6]. He equalizes low liquidity with imbalance trading volume and reminds that the largest crashes have occurred when there has been low liquidity but high trading volume. Based on Fractal market theory, prices are fair only if market is stable, *i.e,* liquid.

Before scrutinizing on this hypothesis, we need to discuss more about the sources of liquidity. The key point here is that different investors have different investment horizons. Therefore, same information has different effect on their decisions. More precisely, a day trader should be more careful about everyday news and reports than a weekly or monthly trader. Consequently, even if market is informationally

efficient, different traders react differently. For example 0.01% drop in NASDAQ Composite index is much more important to a day trader than a monthly trader. So, the second trader may step in and provide the liquidity for the market. More interestingly, a good time for a day trader to buy a stock might be a good time for a monthly trader to sell it. These complicate sources of liquidity *stabilize* the market. When a stock market crash is going to happen, we have a huge volume of traders with different investment horizons who all want to *sell*. Therefore, we have a large selling volume with low amount of demands and it leads to *market crash*.

The EMH proponents somehow think about stock price movement like the arbitrage free market (Arbitrage opportunity is the simultaneous purchase and sale of the same security in an attempt to take advantage of price differences in different markets). Therefore, they consider two trading days of market like two different markets. But they forget the concept of investment horizon, and that's why Grossman and Stiglitz believe that based on EMH there would be no more reason for trading and such a market eventually collapse.

The Fractal Market Hypothesis (FMH), on the other hand, emphasizes the impact of liquidity and investment horizons on the behavior of investors. Markets exist to provide liquid and stable environment for trading. Investors expect to get a good price, but it would not be necessarily *fair*. Peters introduces his FMH in this way, [6]:

"... as long as another investor has a longer trading horizon than the investor in crisis, the market will stabilize itself. For this reason, investors must share the same risk levels (once an adjustment is made for the scale of the investment horizon), and the shared risk explains why the frequency distribution of returns looks the same at different investment horizons. We call this proposal the Fractal Market Hypothesis because of this self-similar statistical structure."

He also mentions that the instability of the market occurs when the fractal structure breaks down. Moreover, he distinguishes this instability from *bear market* reasoning that bear markets are based on declining fundamentals valuation whereas instability is characterized by extremely high levels of short-term volatility [6].

In this research, we follow fractal market hypothesis and therefore, we setup all of our research on predictability of the stock market. Otherwise, all of the efforts would be meaningless. Once you believe in market predictability, you may use one of these two analytical approaches for market timing and stock selection: *Technical Analysis* and *Fundamental Analysis*.

1.5 Fundamental Analysis

Suppose that you want to buy some shares of stock of a specific company. You may study their financial statements, annual reports and several other financial indicators associated with that company or that economic sector. Then, based on current state of the company, and future landscape, you decide whether or not to step in. You may need to consider the performance of their competitors as well. These data not only help you to find the more profitable one, but it can also help in market timing. This analysis is called *fundamental*.

The followers of such analysis believe that there is an equilibrium price for any stock that could be calculated by financial data. Therefore, daily price changes are some fluctuations around the equilibrium point. Consequently, the profit in a short-term trading arises by purchasing undervalued stocks and then wait for the market to set the correct price.

1.6 Technical Analysis

In technical analysis, we focus on *price* and *volume* at which a security is traded. Based on the investment strategies and investment horizons, people choose their appropriate unit of time for data analysis. It can be one minute, for day traders,

one day, one week or even one month. Corresponding to each unit of time, there are four prices: *Open, High, Low* and *Close*. Open price (O), is the price at the start of each unit of time, high (H) and low (L) are maximum and minimum prices at each time interval, and close price (C) is the price at the end of each unit of time. There are two specific chart types displaying all of these prices for each time interval: *candlestick* and *OHLC* charts. For example, Figure 1.1 shows daily OHLC chart for NASDAQ Composite Index value, IXIC, from 12/14/2012 to 12/26/2012. As you can see, each day is represented by a vertical line displaying the daily range, *i.e.* from high to low, with two nails in left and right sides representing open and close prices, respectively. The OHLC lines usually are green or red. Where, green color shows that the close price of that day is greater than the open price and conversely, we display the OHLC by red color if the close price is less than the open price. However, red and green colors, could also be used for comparison between close prices of two consecutive days, *i.e.*, red color for the case when today's close price is less than the close price of the previous day and green color otherwise.

The trading volume is usually accessible at the end of each trading day. Here, we use daily data to analyze the market data by means of several technical indicators. In the next chapter, we introduce those indicators that have been found useful in our benchmark.

1.7 Risk Analysis

In this section, we briefly introduce some fundamental concepts about risk and return analysis. First, we define risk and then we discuss about risk-return measures.

1.7.1 Measures of Risk and Return

The best fish swims near the bottom. Should you expect more return from investing in an uncertain market, you have to prone yourself to more risk of investment. An intuitive method to calculate the risk of investment is to find the standard deviation

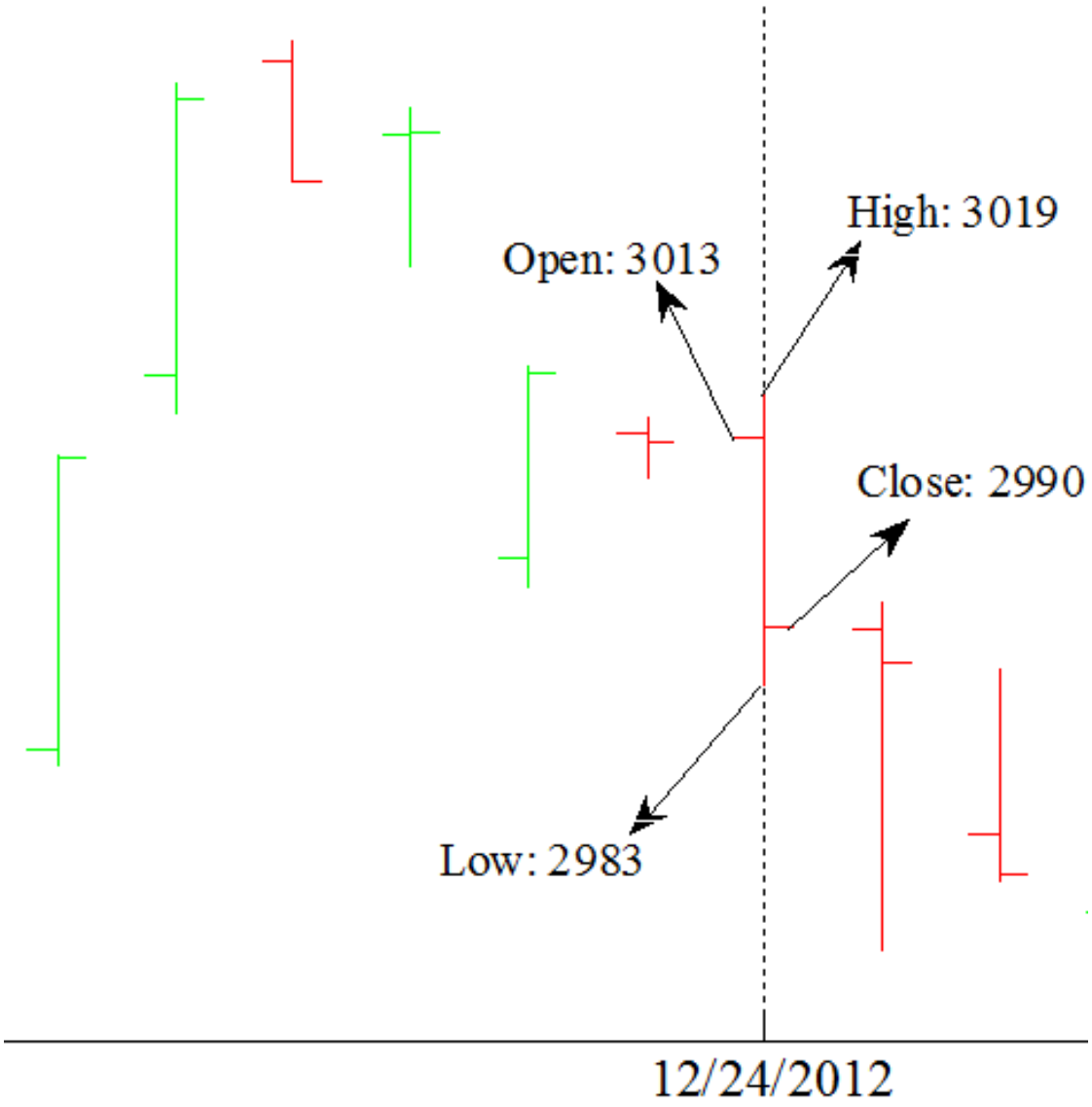

FIGURE 1.1. OHLC Daily Chart for NASDAQ Composite

of daily (or monthly) returns. For instance, suppose that you have purchased one share of the stock of companies XYZ and PQR for $1 on January 1st. Tables 1.1 and 1.2 summarize the monthly prices and returns for XYZ and PQR, respectively. On July 1st, both stocks have the same price of $1.34.

After five months, total return for both stocks is 34%. However, XYZ is more volatile than PQR in terms of monthly returns. To quantify this statement, we calculate the standard deviation of monthly returns for both of them. For XYZ,

TABLE 1.1. Monthly Price and Return on One Share of Stock XYZ

	January	**February**	**March**	**April**	**June**	**July**
Price($)	1	0.95	0.7	1.5	2	1.34
Return(%)		-5	-26	114	33	-33

TABLE 1.2. Monthly Price and Return on One Share of Stock PQR

	January	**February**	**March**	**April**	**June**	**July**
Price($)	1	1.05	1.1	1.2	1.3	1.34
Return(%)		5	5	9	8	3

the standard deviation of monthly returns is 0.6, whereas for PQR it is 0.02. It obviously shows that XYZ is more volatile than PQR. Now, let's take a look at these monthly return profiles from market timing point of view. For PQR, the stock price is strictly increasing without any up-and-down movement. Therefore, buy and hold strategy would be the best choice. However, PQR is so volatile and includes two valleys and two peaks. Therefore, PQR potentially has a lot more return if one can adopt a suitable timing strategy. Considering both long and short trades, the maximum return after five month for XYZ is 509%, whereas it is only 34% for the case of PQR. However, we have to admit a lot more risk of investment and more number of trades to achieve this higher return. This example perfectly acknowledges that risk and return go hand in hand.

However, higher volatility does not always imply higher risk of investment. Because "investors do not dislike variability per se" [7]. Suppose that we have a strictly increasing stock price with highly volatile monthly rate of return. In such a case, buy and hold strategy is the best, although the standard deviation of the monthly returns is high. Roughly speaking, we say that a stock is risky if we have to change our position consistently to achieve higher return. We may consider only the volatility of negative returns that is called "downside risk".

Another point that might be of interest in performance evaluation for mutual funds or ETFs, is to consider a reference rate(return on an index-benchmark or a "risk-free rate of return") for the underlying portfolio. If we subtract the monthly risk-free rate of returns from our fund return, we have the "fund excess return", whereas if we deduct the "return on index benchmark" from our fund return, we reach to the "benchmark excess return". An appropriate proxy for the risk-free rate of return is "90-day T-Bills"[7] and for the case of index benchmark, we may consider the monthly returns on NASDAQ Composite or S&P 500 indexes during the same period. We redefine the risk measures by using the standard deviation and downside risk of excess returns:

$$R_{fe} = R_f - R_{rf} \tag{1.1}$$

$$R_{be} = R_f - R_{ib} \tag{1.2}$$

where:

- R_{fe}:Fund Excess Return,
- R_f: Fund Return,
- R_{rf}: Risk-Free Rate of Return,
- R_{be}: Benchmark Excess Return,
- R_{ib}: Index-Benchmark Return.

The following equation gives the risk of investment using standard deviation of monthly excess returns [7]:

$$STD = \sqrt{\frac{1}{N}\sum (R_e - AR_e)^2} \tag{1.3}$$

where N is the total number of months of investment, R_e could be either R_{fe} or R_{be}, and AR_e represents the average of monthly excess returns. To find the amount of downside risk, we only consider "negative" excess returns in equations 1.1 - 1.3.

1.7.2 Risk-Adjusted Return

Is it worth investing in a specific stock or fund? Risk-adjusted return explores for a quantitative measure to answer this question. In this section we introduce two measures of risk-adjusted return: Sharpe Ratio and Modigliani Measure. In other words, these criteria tell us that how much risk one has tolerated to get that specific return.

Sharpe Ratio is the most intuitive measure of risk adjusted return. It is the ratio of the average monthly return to its standard deviation [7]:

$$SharpeRatio = \frac{fund's\ average\ excess\ return}{standard\ deviation\ of\ fund's\ excess\ return} \tag{1.4}$$

As an example, assume that the risk free rate of return is 5% flat during the investment period for PQR and XYZ stocks. Therefore, we calculate the Sharpe Ratio for each one as follows:

For XYZ:

$$R_{fe}^{XYZ} = \frac{(-5 - 26 + 114 + 33 - 33) - 5}{5} = 16.6\%$$

$$Sharpe\ Ratio = \frac{16.6}{60.20} = 0.19$$

For PQR:

$$R_{fe}^{XYZ} = \frac{(5 + 5 + 9 + 8 + 3) - 5}{5} = 6\%$$

$$Sharpe\ Ratio = \frac{6}{2.45} = 0.41$$

Therefore, PQR is more suitable for buy and hold strategy in the sense of Sharpe Ratio. However, if one can adopt an appropriate timing strategy, then XYZ would

be more lucrative. To explain it, suppose that we have a perfect timing system such that we change our position at the right moment from long to short and vice versa. The amount of Sharpe-Ratio for XYZ in this case is 0.8911 a lot more than PQR. It is worth noting that the best timing strategy for PQR is buy and hold and therefore, we may not achieve higher return than what we have got from buy and hold. Simons in [7] gives a perfect interpretation for Sharpe-Ratio:
"A high Sharpe ratio means that the fund delivers a lot of return for its level of volatility." Although Sharpe-Ratio is intuitive in definition, but it is relatively hard to give an understanding interpretation for it. Modigliani Measure, on the other hand, is not intuitive in definition, but it has a very straightforward interpretation. This measure provides the amount of return achievable from an specific fund if one would like to tolerate as much risk as the benchmark. Modigliani Measure is defined as [7]:

$$\begin{aligned} Modigliani\ Measure = & \frac{fund's\ average\ excess\ return}{standard\ deviation\ of\ fund's\ excess\ return} \\ & \times standard\ deviation\ of\ Index's\ excess\ return \end{aligned} \tag{1.5}$$

Chapter 2
Economic and Monetary Indicators

2.1 Introduction

Since we have focused on ETFs instead of individual stocks, economy plays a critical role in our trading model. Niemira and Klein in [8] discussed about business cycles and then compared them with the stock market cycles.

They mentioned that between 1946 to 1991, there have been 13 stock market cycles and 9 business cycle recessions. They notice that in eight of those nine recessions, the stock market moved in a same direction as economy. Therefore, in 62% of the time stock market follows the economy.

However, that 38% of time is usually more "interesting" and "profitable"! [8]. In this chapter, we briefly introduce the economic cycles and their relations with the stock market cycles and then, we consider three major economic and one monetary indicators that are useful in our economic trader.

2.2 Business Cycles

Burns and Mitchell in [9] define the business cycles as follows:

"Business cycles are a type of fluctuation found in the aggregate economic activity of nations that organize their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic; in duration business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar character with amplitudes and approximating their own."

Here, we do not intend to anatomize the skeleton of the business cycles that is beyond the scope of this research. However, we may zoom our views out to build an economic-vigilant trading framework. The word "vigilant" here is used to discriminate the mixed model from the its "blind" predecessor. (i.e The trading model relying only on price and volume) From the definition of business cycle, it is perceived that every signal coming from economic indicators must be a long-term signal. Therefore, in short-term trading such signals are not useful due to their nature.

In fact, many economic indicators are released monthly and it, therefore, makes the short term decision making impossible. Economic revival phase usually associate with the beginning of a secular uptrend in stock market. During the expansion phase, the stock market usually accelerates and down trend (sometimes market crash) overlaps with the recession phase and will last during the contraction phase.

However, there are some major difficulties with using economic data to choose the investment strategies. First, these data are not that accurate at the time they are released and they usually being corrected in future. Second, stock market trend (as an economic indicator) is usually lead to other economic indicators. Therefore, merely relying on economic data may lead to late buy and sell signals. Moreover, economic data are usually released with delay. For example, the current rate of unemployment will be released by one month. So, we need to take all of these constraints into account in creating such a trading platform. Even most sophisticated economic models usually have troubles in recognizing the start point, duration and end point of current economic cycle before they happen.

2.2.1 Unemployment Rate

What are economic data good for? As we mentioned, many economic indicators are not lead to stock market. But when they are improving, it would be a positive long term signal for stock traders. The rate of unemployment is reversely correlated to stock market trends. Figure 2.1 displays US unemployment rate versus S&P 500 index from 1992 to 2013. The inverse relation between these two indicators is obvious as we expect. If we consider point-to-point movements, then we will find it erratic. Again, we need to stand far enough away to get a perspective of the whole.

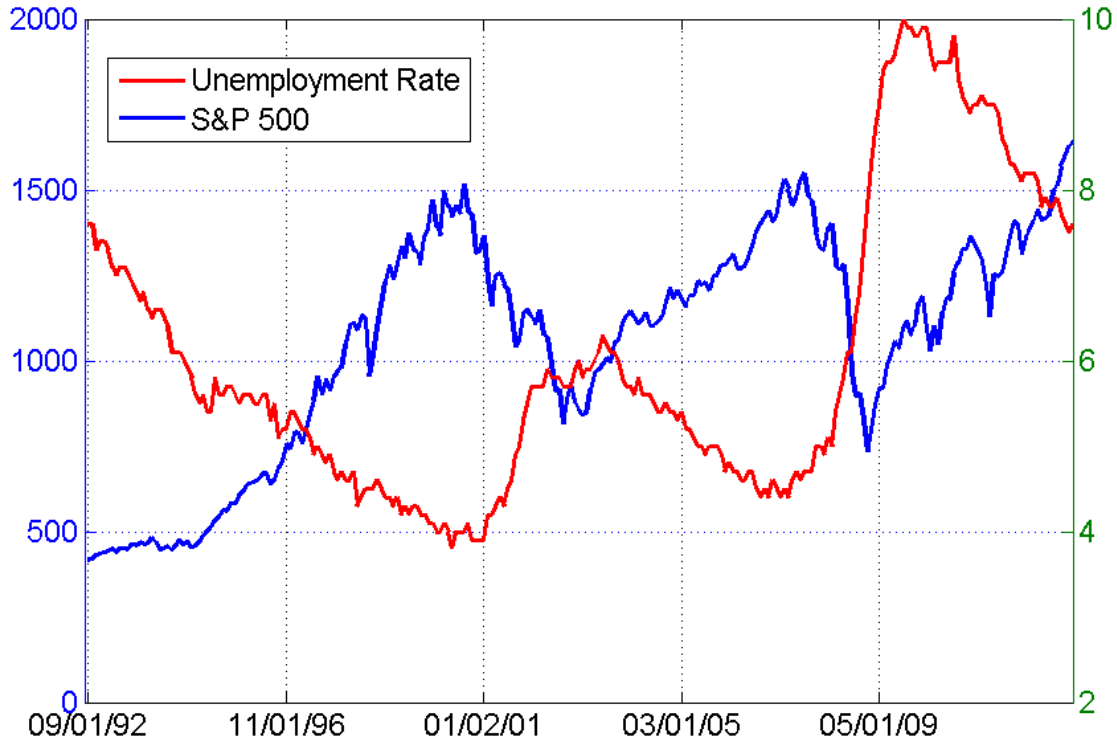

FIGURE 2.1. US Unemployment Rate versus S&P 500 Index.(*From U.S. Department of Labor: Bureau of Labor Statistics*)

2.2.2 Industrial Production Index

Another useful economic indicator is the Industrial Production Index (IPI) released monthly by Board of Governors of the Federal Reserve System. One may find all of the historical values from the website of the Federal Reserve Bank of

St. Louis. This indicator represents the real output for all manufacturing, mining, electric and gas utilities located in United States. Positive correlation between the historical trends of IPI and S&P 500 index benchmark from is completely observable in Figure 2.2. However, these data are subject to periodically revisions and corrections. Fortunately, such modifications do not change the long-term trends. Therefore, using IPI would be useful if we only follow long-term trends.

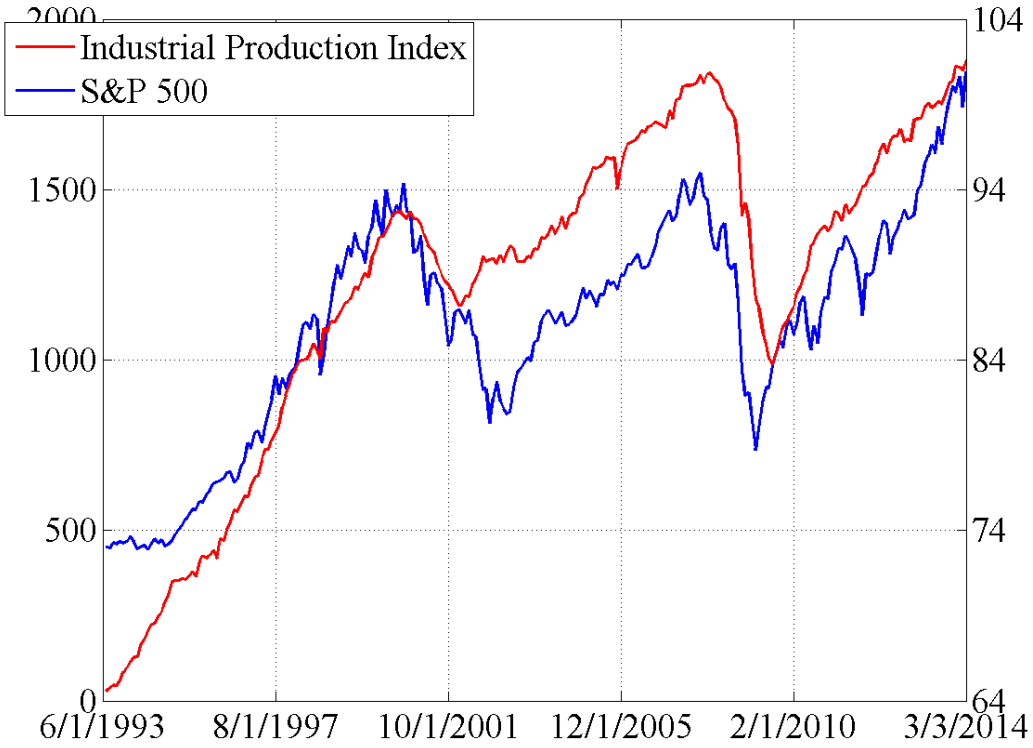

FIGURE 2.2. US Industrial Production Index versus S&P 500 Index.(*from Board of Governors of the Federal Reserve System*)

2.2.3 Commodity Market

Commodity Price Index is an economic indicator that reflects the prices of internationally traded primary commodities.[1] The IMF commodity price index (CPI)

[1]There are several proxies for measuring the commodity price index. Our data source is the International Monetary Fund (IMF).

includes the prices of the industrial metals, foodstuffs, beverages, agricultural raw materials and fuels and represents the global market.[2] Figure 2.3 graphs the CPI versus monthly index values for S&P 500 index benchmark. Two important points are worth noting:

1- Usually uptrends in CPI correspond to the uptrends of stock prices. That is due to the fact that when the prices are moving up (inflation), people are more willing to invest in high-yield and high-risk markets to compensate the effects of increasing prices. As a side-effect, the interest rates move to the higher levels and it will attract more people to lend their money by purchasing bonds. It also implies the reverse relation between the bond prices and commodity prices. It is worth noting that the uptrend in bond prices is a synonym for downtrend in bond yields[10];

2- Sharp slopes of the commodity price curve are serious signals for stock holders to end the long position.(i.e get cash or go short)

2.2.4 Margin Debt

Investors may borrow money from their brokerage accounts for which they need to provide a collateral. They usually spend this money to leverage their investment. Therefore, the amount of margin debt implies how much optimistic or pessimistic they are. Figure 2.4 displays the total amount margin debt versus the S&P 500 market index from 1993 to 2014. It is worth noting that the values of margin debts are based on the date of release not the corresponding month. For example, the last margin debt value released in March 2014 belongs to January 2014. Therefore, we actually considered the delay time in data release. As you can see in Figure 2.4, sharp drops in the amount of margin debt without enough correction in stock prices is a sell signal (look at the behavior around 2008 recession and 2000 internet bubble).

[2] *http://www.investorwords.com*

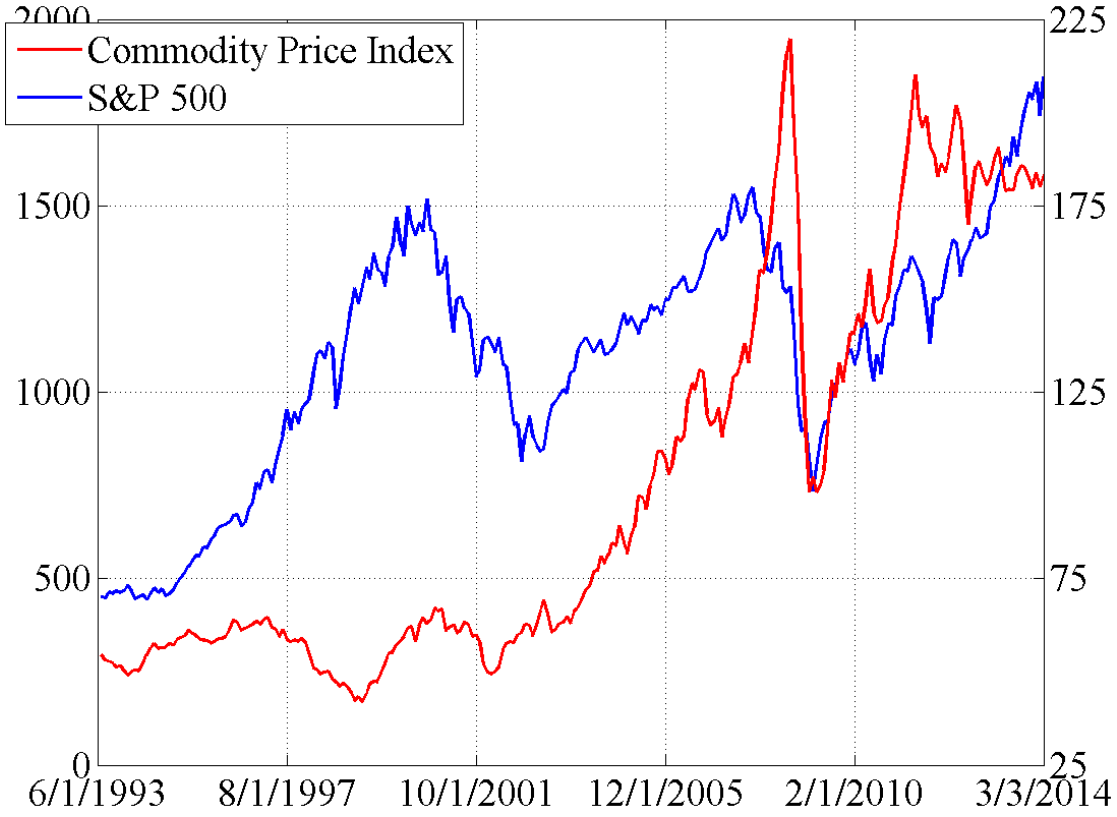

FIGURE 2.3. IMF Commodity Price Index versus S&P 500 Index.(from *International Monetary Fund*)

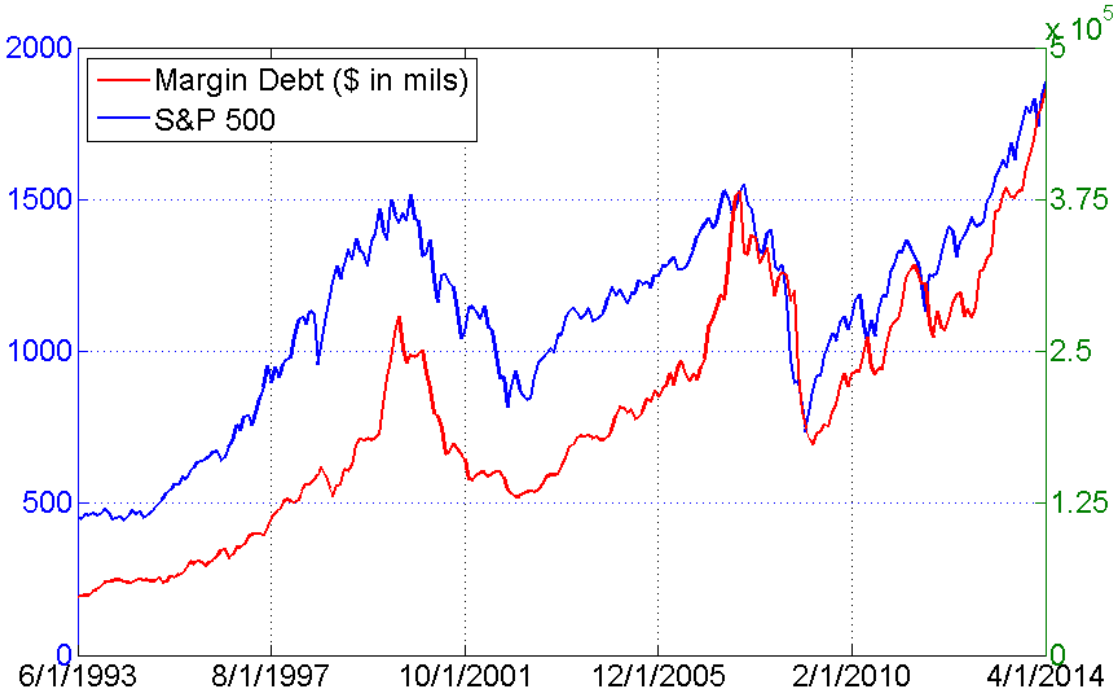

FIGURE 2.4. Amount of Margin Debt versus S&P 500 Index.(from *http://nyxdata.com*)

Chapter 3
Technical Indicators

3.1 Introduction

We can divide the market technical indicators into two large groups, [11]:

- *Trend Following Indicators or Lagging Indicators*: As their name implies, these kinds of indicators follow the current trend and do not provide any prediction about future trends. Therefore, they are suitable for long-term trends. MACD and Moving Averages are two examples of this category that will be discussed in the following sections.

- *Leading Indicators*: These indicators provide some information about upcoming market trends. More precisely, they tell us if a stock is *overbought* or it is *oversold*. Oversold means that the stock price is too low and it is anticipated that it will "bounce back". On the other hand, we say that a stock is overbought if its price gets higher after a huge amount of trading. So, its price is at a temporary peak and will be probably pulled down in next upcoming days. Stochastic oscillator and commodity channel index are two examples of such indicators.

We can categorize the market movements into *trending periods* and *trading periods*. Trending movements are either up-trend or down-trend, whereas in a trading period, the stock prices just have some sideways without any significant change in the average value. Figure 3.1 shows three market periods for NASDAQ Composite index from the middle of 2004 to the beginning of 2005.

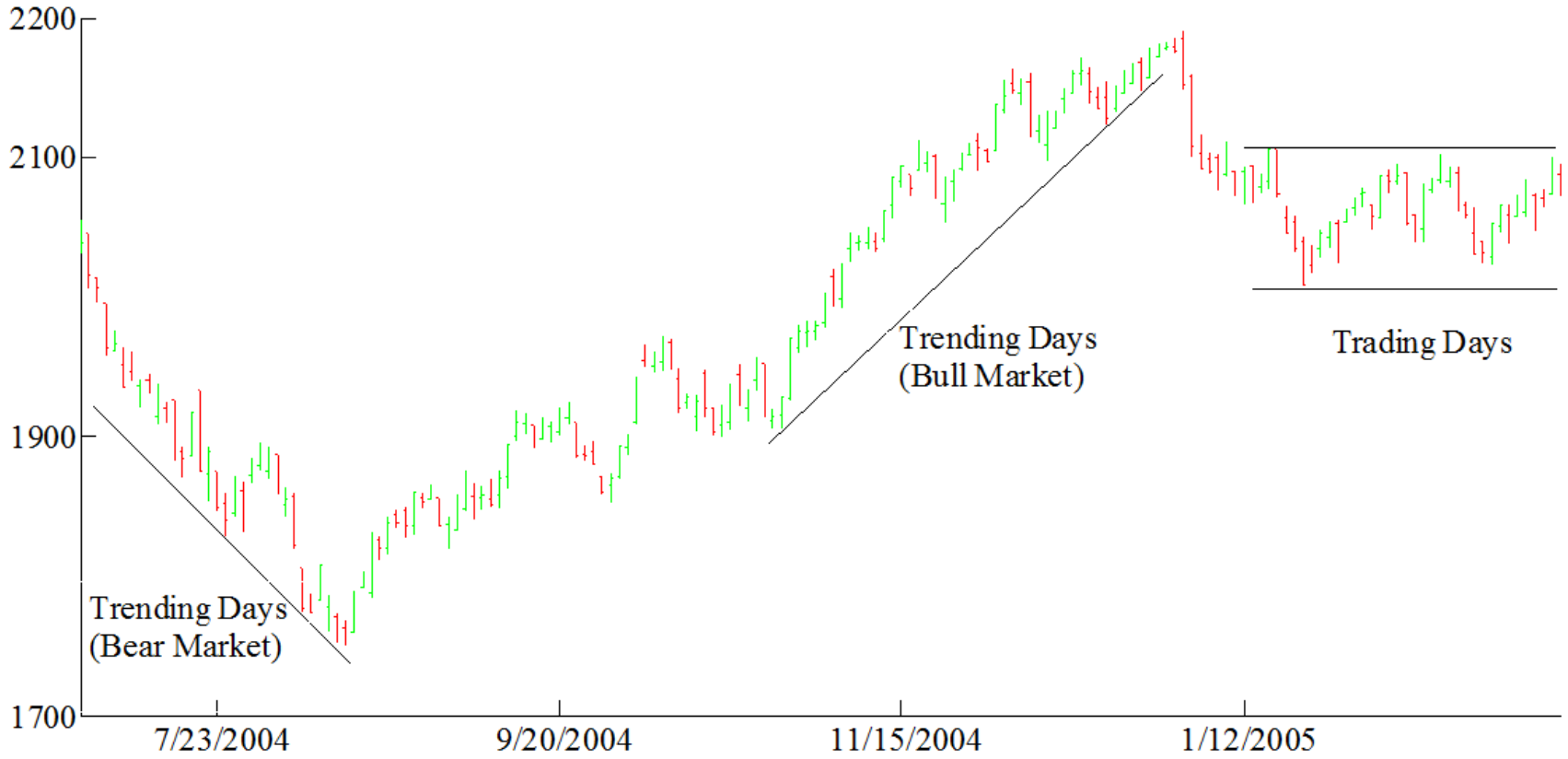

FIGURE 3.1. Bull Market, Bear Market and Trading Market Periods for NASDAQ Composite Index from July 2004 to February 2005.(from: *Yahoo Finance*)

3.2 Moving Averages

Most common indicator used in technical analysis is moving average. We can define two kinds of moving averages: *simple moving average (SMA)* and *exponential moving average (EMA)*. We usually display them with a number in subscript, representing the averaging period. For example, SMA_{20} indicates a simple moving average of 20 samples. When we want to talk about a specific value of SMA, k-th sample, we use the following symbol:

$$SMA_N(k)$$

Therefore, $SMA_{20}(125)$ represents the $125th$ element of the simple moving average signal with 20-day period. Let $S(k)$ be a general discrete-time sequence in which k denotes the day number. Simple N-day moving average of $S(k)$ is defined as:

$$SMA_N(k) = \frac{\sum_{k-N+1}^{k} S(i)}{N} \tag{3.1}$$

Exponential moving average of $S(k)$ is defined as:

$$EMA_N(k) = \alpha \cdot S(k) + (1 - \alpha) \cdot EMA_N(k-1) \tag{3.2}$$

$$EMA_N(0) = S(0)$$

where α is a coefficient that depends on N and usually calculated by the following formula:

$$\alpha = \frac{2}{N+1}$$

From geometrical point of view, $EMA(k)$ is a convex combination of $EMA(k-1)$ and $S(k)$. As you increase the period N, α become smaller and therefore the impact of previous EMA value, $EMA(k-1)$, gets stronger and so, the effect of the new signal value $S(k)$ would be weaker. Therefore, EMA with relatively large N is smoother than one with smaller N. On the other hand, EMA with smaller N is

faster in tracking of main signal $S(k)$. If we take z-transform from equation 3.2, we get the following transfer function for the EMA of a signal:

$$H(z) = \frac{EMA(z)}{S(z)} = \frac{\alpha}{1 - (1 - \alpha) \cdot z^{-1}}$$

which is a low-pass digital filter and its bandwidth is depended on α (so N). According to equations 3.1 and 3.2, to get the first value of a simple moving average of a signal with period N, we have to receive first N samples, whereas we may have EMA values from inception. This is a great advantage of using EMAs instead of SMAs. Suppose that a signal $S(k)$ is under its moving average and then pierces it upside. We can conclude that the signal is *growing up*. Conversely, when $S(k)$ slants its moving average downside, we may say that the signal $S(k)$ is in a down-trend. Using this simple logic, we may use moving averages as a technical analysis tool for market timing. Therefore, when signal $S(k)$ crosses its moving average from below, it could be interpreted as a *buy* signal and vice versa. In case that the underlying signal has too many whipsaws, we can use a so-called *dual moving average crossover system*. In this way, we ameliorate the effect of whipsaws to the detriment of the speed of tracking. Here, instead of $S(k)$, we can use another moving average of $S(k)$. As a real example of this trading strategy, let $S(k)$ be a sequence that denotes the daily close values of NASDAQ Composite Index, *i.e.*:

$$S(k) = Close(k)$$

Figure 3.2, displays NASDAQ Composite index movement and its 10-day and 20-day exponential moving averages from June 2008 to the November 2009. You can see how nicely this simple strategy works in generating buy and sell signals. However, when market doesn't follow any specific trend, moving average trading strategy may generate too many buy and sell signals without any significant return or even negative return.

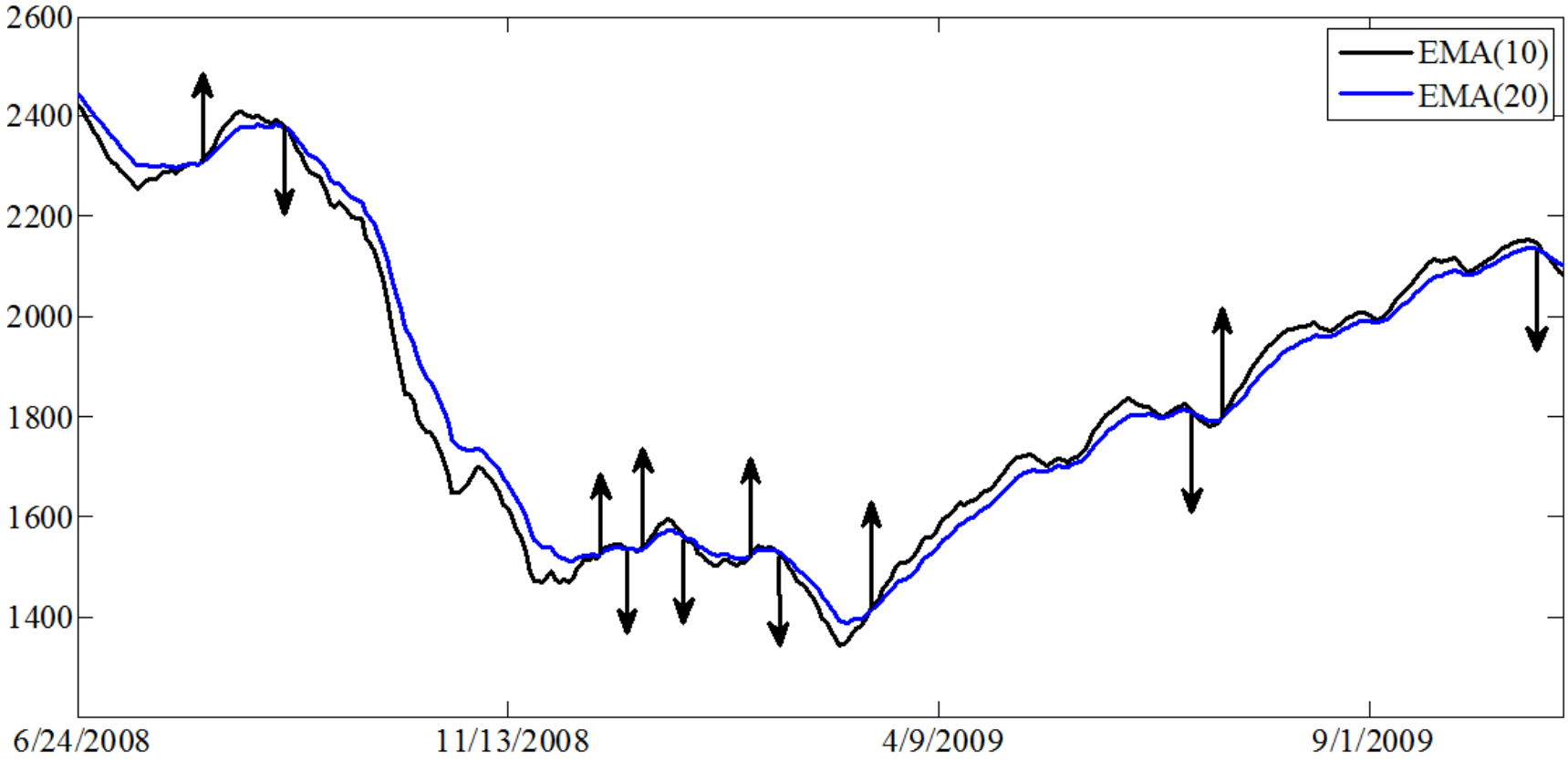

FIGURE 3.2. NASDAQ Composite Index Historical values from June 2008 to November 2009. The black and blue curves are 10-day and 20-day exponential moving averages, respectively. Upward arrows show buy signals, whereas downward arrows represent sell signals. Moving averages generated by MATLAB (Data Source:*http://www.finance.yahoo.com*)

3.3 Moving Average Convergence-Divergence(MACD)

The purpose of market timing is to recognize appropriate times to get in or out of the market. Suppose that you are given an arbitrary stock price movement and its moving average. One way to find its local maximum (minimum) is to compare it with its moving average so that when the difference between the price trajectory and its moving average reaches a local maximum and then start falling down, it is a good time to sell. In other words, instead of the signal and its moving average, we can look at the crossover points of the difference signal.

Now, suppose that we use a fast moving average, usually 12-day EMA, instead of the main stock price data. Then, we subtract it from another moving average, usually 26-day EMA, and find the difference between these two moving averages. We call this difference as MACD. When the MACD is positive and in local maxima then, it's a good time to sell. Conversely, when the MACD is negative and in local minima then, it would be a good time to buy the underlying stock. That's why we call this indicator the MACD as moving average convergence-divergence. So, MACD is nothing but the difference of a fast and a slow moving averages of the close prices.

Here, the problem is: how can we find the local maxima and minima of the MACD? The answer is easy! One way to find the local maxima and minima of such a signal is to find the crossovers of the signal with its moving average. The moving average of the MACD is called "Signal". Therefore, when the MACD is positive and crosses its 9-day moving average(signal) downside, this indicator generates a "sell" signal. When MACD is negative and its 9-day moving average crosses it upside, a buy signal is generated.

We usually use the symbol $MACD(N_{fast}, N_{slow})$ to represent an MACD indicator:

$$MACD(N_{fast}, N_{slow}) = EMA_{N_{fast}}(Price) - EMA_{N_{slow}}(Price)$$

$$Signal = EMA_{N_{signal}}(MACD)$$

3.4 Stochastic Oscillators

So far, in both moving average and MACD indicators, we only use the daily close prices of stocks. However, there should be lots of information in open, high and low prices as well. Stochastic oscillators consider high, low and close prices over a specific number of days to find whether a stock is overbought or oversold. Stochastic oscillator includes two signals named $\%K$ and $\%D$. To calculate these signals, we may use the following steps:

- Calculate the stochastic signal, using the following formula:

$$Stochastic(k) = \frac{Close(k) - LL}{HH - LL}$$

  Where LL and HH are lowest low and highest high prices over the last $N_{\%K}$ periods, respectively.

- The $\%K$ signal is obtained by calculating $EMA_3(Stochastic)$.

- The $\%D$ signal achieved by finding $EMA_{N_D}(\%K)$.

As you can see, stochastic oscillator signals, $\%K$ and $\%D$, are always between 0 and 100. We can interpret them in this way: if $\%K$ and $\%D$ are both under %20 and $\%K$ crosses $\%D$ upside, then a buy signal is generated because it shows the oversold situation and would be a signal of upcoming bull market. Conversely, if $\%K$ and $\%D$ are both above %80 and $\%K$ pierces $\%D$ downside, then a sell signal

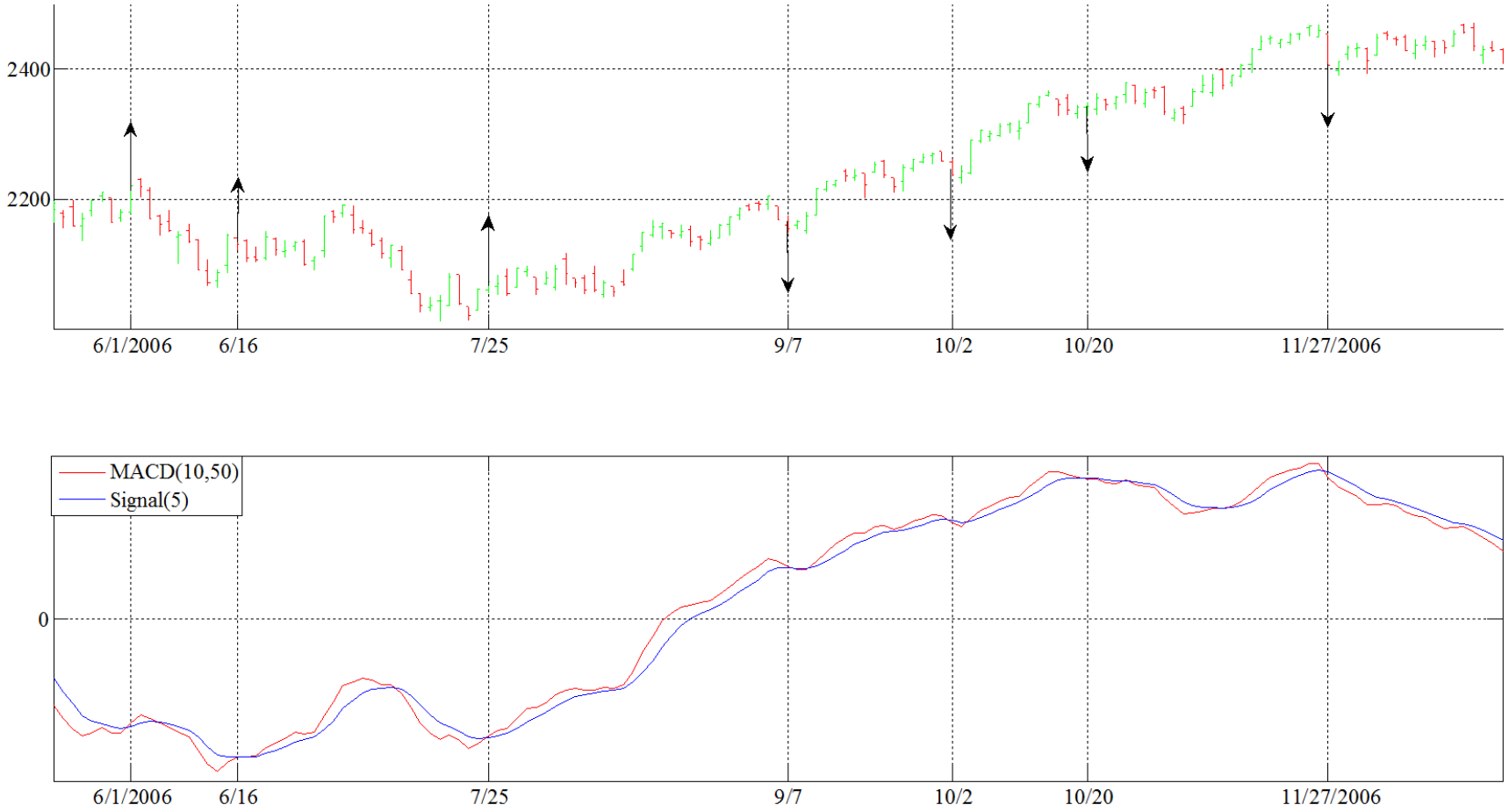

FIGURE 3.3. NASDAQ Composite Index Historical values from June to December 2006. The blue and red curves are its $MACD(10, 50)$ and $Signal_5$, respectively. Upward arrows correspond to buy signals and downward arrows show sell signals. Charts generated by MATLAB (Data Source: *http://www.finance.yahoo.com*)

is generated. Since, it shows overbought situation for the underlying stock and it would be a signal for upcoming downtrend. Figure 3.4 depicts stochastic lines $\%K$ and $\%D$ with $N_K = 15$ and $N_D = 5$ for NASDAQ Composite index values from August 2010 to December 2010. Buy and sell signals are displayed with upside and downside arrows, respectively.

3.5 NASDAQ Summation Index

NASDAQ Summation Index (NASI), is a cumulative index achieved by subtraction of the number of advancing and declining issues in NASDAQ stock market. Cumulative index means that the next-day value achieved by adding the value of the previous day and the new subtraction number:

$$NASI_{today} = NASI_{yesterday} + [ADV_{today} - DEC_{today}]$$

This indicator provides us a lot of information regarding overall market condition. When it is too negative, we may conclude that the overall market components, specifically NASDAQ Composite components, are oversold. On the other hand, highly positive values of NASI are signs of growing market. However, we should keep in mind a key difference between the speed of uptrends and downtrends. Bull markets are so lethargic, whereas the bear markets are usually faster. Using a 5-day EMA combined with daily values of NASI, we implement a non-trivial trading strategy to produce buy and sell signals.

Trivially, when NASI is negative and crosses its 5-day EMA upward should be interpreted as a buy signal and when it is positive and pierces the EMA_5 downward, must be a sell signal. But, our statistical results show that if we consider those buy signals associated with highly negative values of NASI, usually less than -400, we get better timing strategy. On the other hand, it is more appropriate to consider those sell signals that are generated when NASI is negative.

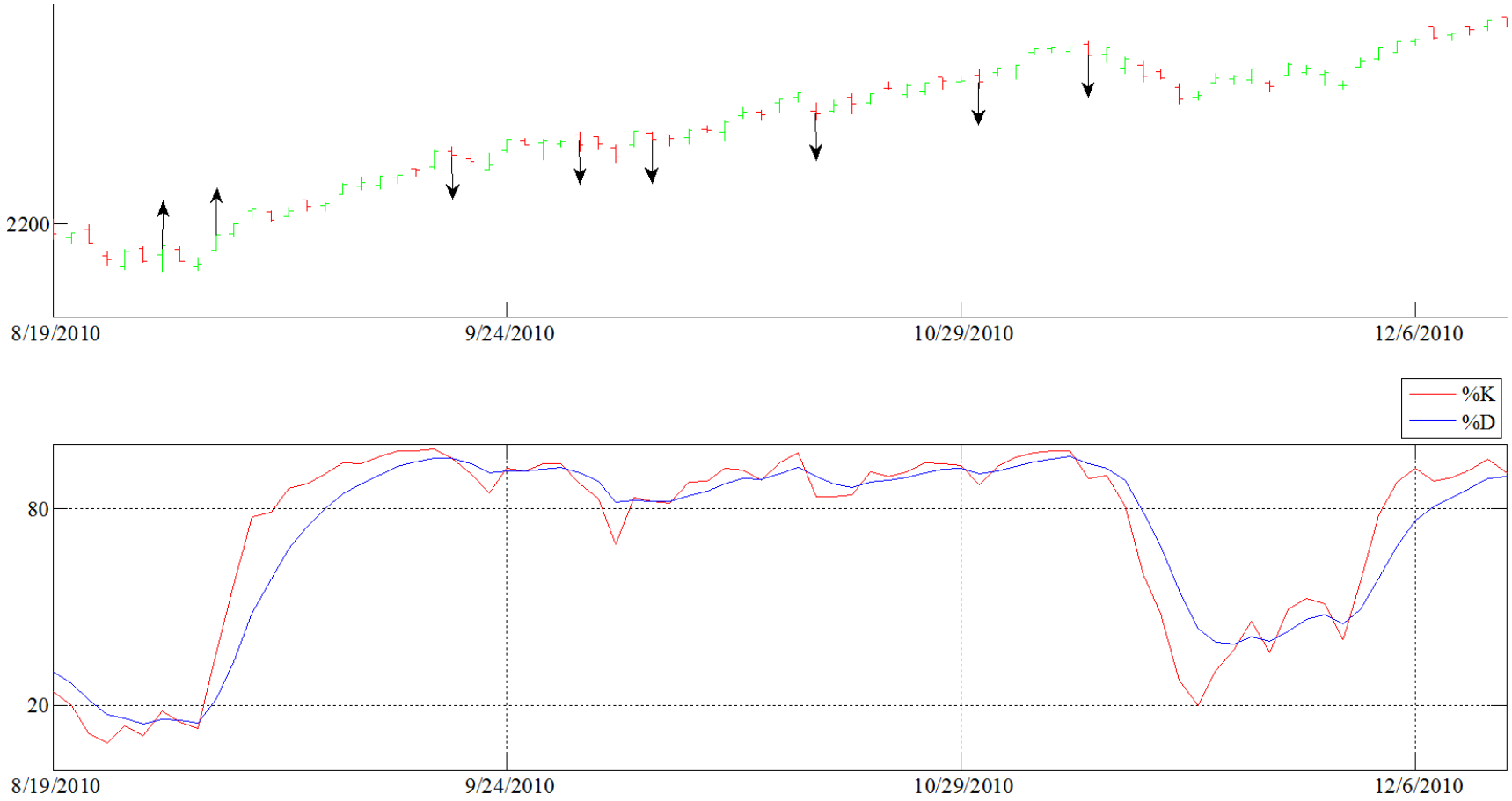

FIGURE 3.4. NASDAQ Composite Index Historical values from August to December 2010. The blue and red curves are $\%D$ and $\%K$ stochastic oscillators, respectively. Charts generated by MATLAB (Data Source: *http://www.finance.yahoo.com*)

The non-trivial part of such a strategy is selling at negative values of NASI! Here is an experimental reason for it. We do not like to get out of an uptrend soon. Therefore, we wait until we make sure that the uptrend has come to an end. The downtrend for NASI usually starts sooner and when it reaches zero, the bear market has been confirmed. However, it might be risky to stay in a bear market specifically when stock market crashes happen, but statistically, this nontrivial strategy renders higher returns because the first days of falling NASI correspond to trading market not the bear market. This strategy is partially consistent with the Martin Zweig's quote from his professor in the University of Miami [12]: *"Buy on strength and sell on weakness"*. Figure 3.5 shows how well this method worked from March 2003 to August 2004.

3.6 Chaiking Money Flow Index

All of the technical indicators that we have introduced so far use only daily prices. Another important market data is the trading volume. Volume contains a lot of information about the behavior of the investors. For example, when the price falls down and volume is relatively high, it means that the investors tend to sell their equities. One of the indicators that consider both volume and price is Chainkin Money Flow Index. The money flow multiplier (MFM) for each trading day is defined by [11]:

$$MFM = \frac{(C - L) - (H - C)}{H - L}$$

The amount of money flow volume (MFV) is achieved from the multiplication of each day's volume (V) by its multiplier:

$$MFV = MFM \times V$$

Finally, the 21-day Chaikin Money Flow Index(CMF) is given by:

$$CMF = \frac{\sum_{N=21} MFV}{\sum_{N=21} V}$$

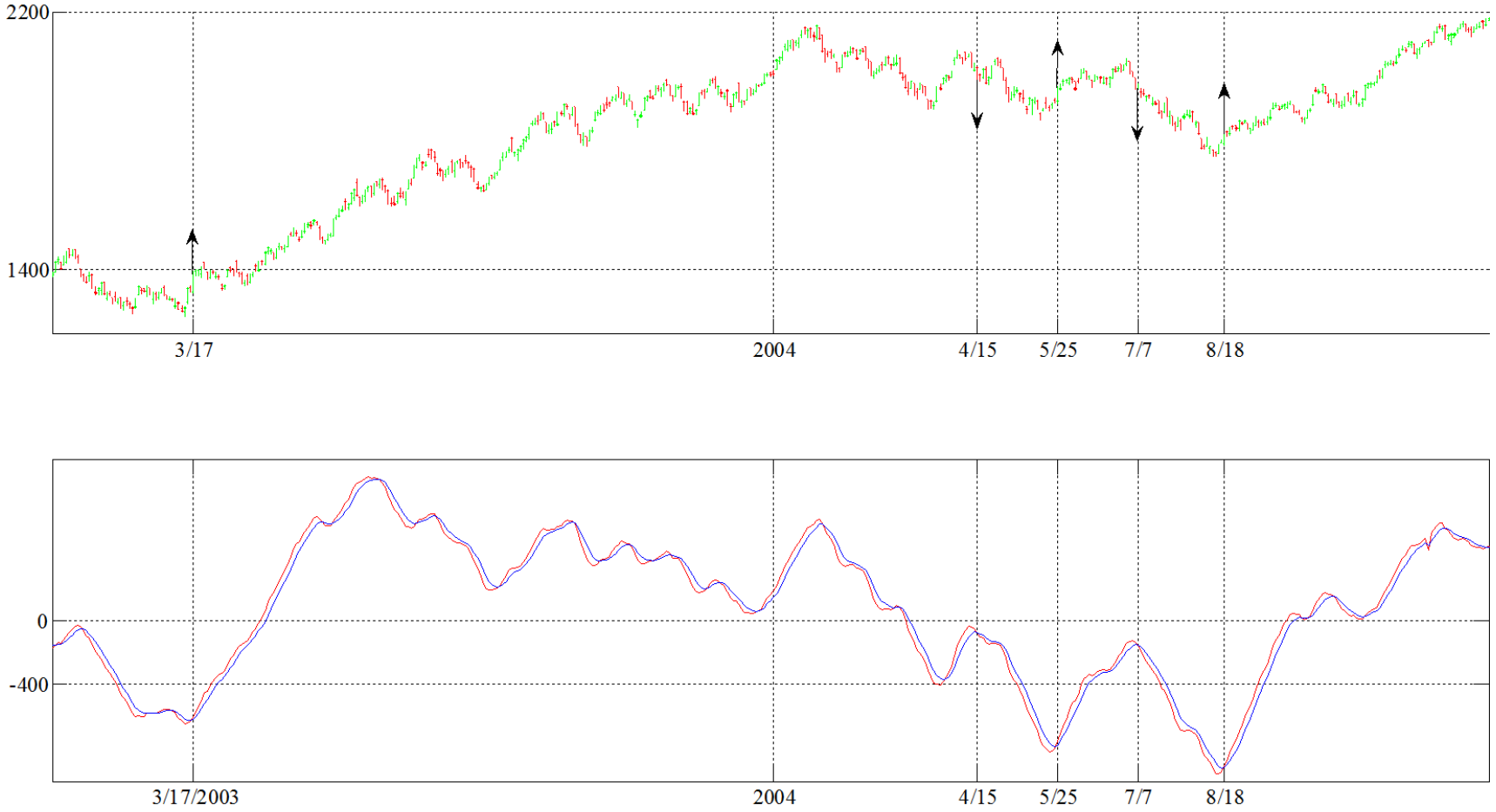

FIGURE 3.5. NASDAQ Composite Index Historical Values from March 2003 to September 2004. The blue and red curves are NASI and its 5-day exponential moving averages, respectively. Charts generated by MATLAB (Data Source: *http://www.finance.yahoo.com, http://www.stockcharts.com*)

We use CMF as a sell indicator. When CMF is positive, it is an overbought signal. So, we use a dual simple moving average crossover system combined with NASI to generate sell signals. If CMF is positive, NASI is negative and fast moving average, $N_{fast} = 5$, crosses the slow moving average, $N_{slow} = 15$, downside then, a sell signal is generated. Figure 3.6 shows how well this indicator worked during the economic crash 2008 in generating sell signals. It is worth noting that the value of NASI is also negative during this period.

3.7 Distribution Days

If a stock price drops by more than 0.2% down and the trading volume increases with respect to the previous day then, we call that day as a "distribution day". When the number of distribution days during a specific period, usually 20 days, exceeds 5 days, we can conclude that the downtrend has been started. Therefore, it would generate a sell signal. However, we make our filter narrower and consider those distribution days for which the today's close price is higher than the close price of the 20 days before.

Figure 3.7 displays the number of distribution days and sell signals generated by this indicator during 2007. Distribution days usually provide good signals at the end of an uptrend. However, in a trading market, they may produce sell signals without any significant returns.

3.8 Force Index

Force index (FI) is a simple informative indicator which shows the strength of an uptrend or downtrend. The calculation of FI is easy and obtained by the following formula:

$$FI_{today} = V_{today} \times (C_{today} - C_{yesterday})$$

When FI is highly positive, it's a signal for strong uptrend and conversely, when FI is highly negative, downtrend is strong. Figure 3.8 displays the NASDAQ Com-

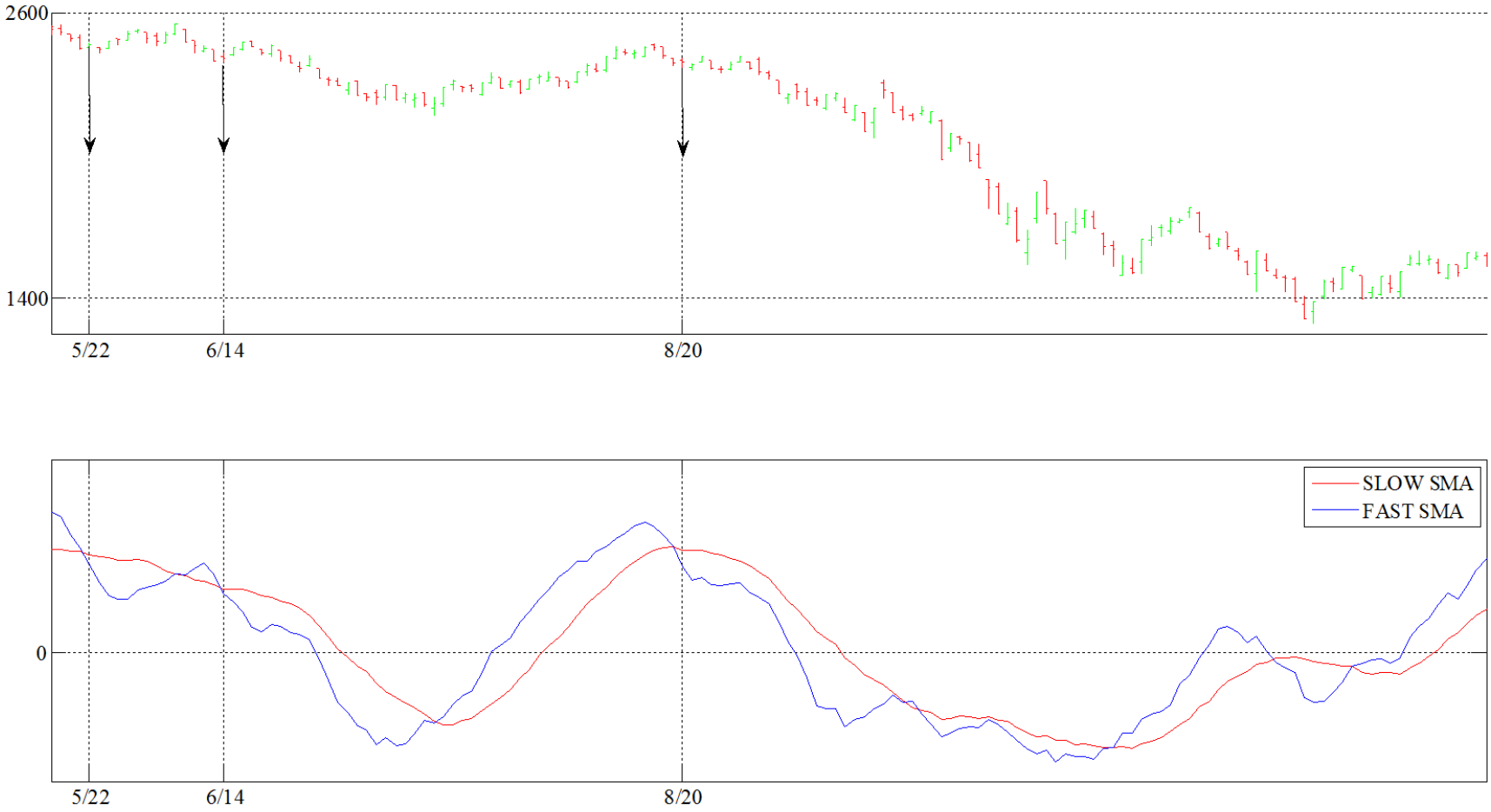

FIGURE 3.6. NASDAQ Composite Index Historical values from May to September 2009, during the stock market crash. The blue and red curves are 5-day and 15-day simple moving averages of Chaikin Money Flow Index, respectively. Moving averages generated by MATLAB (Data Source: *http://www.finance.yahoo.com*)

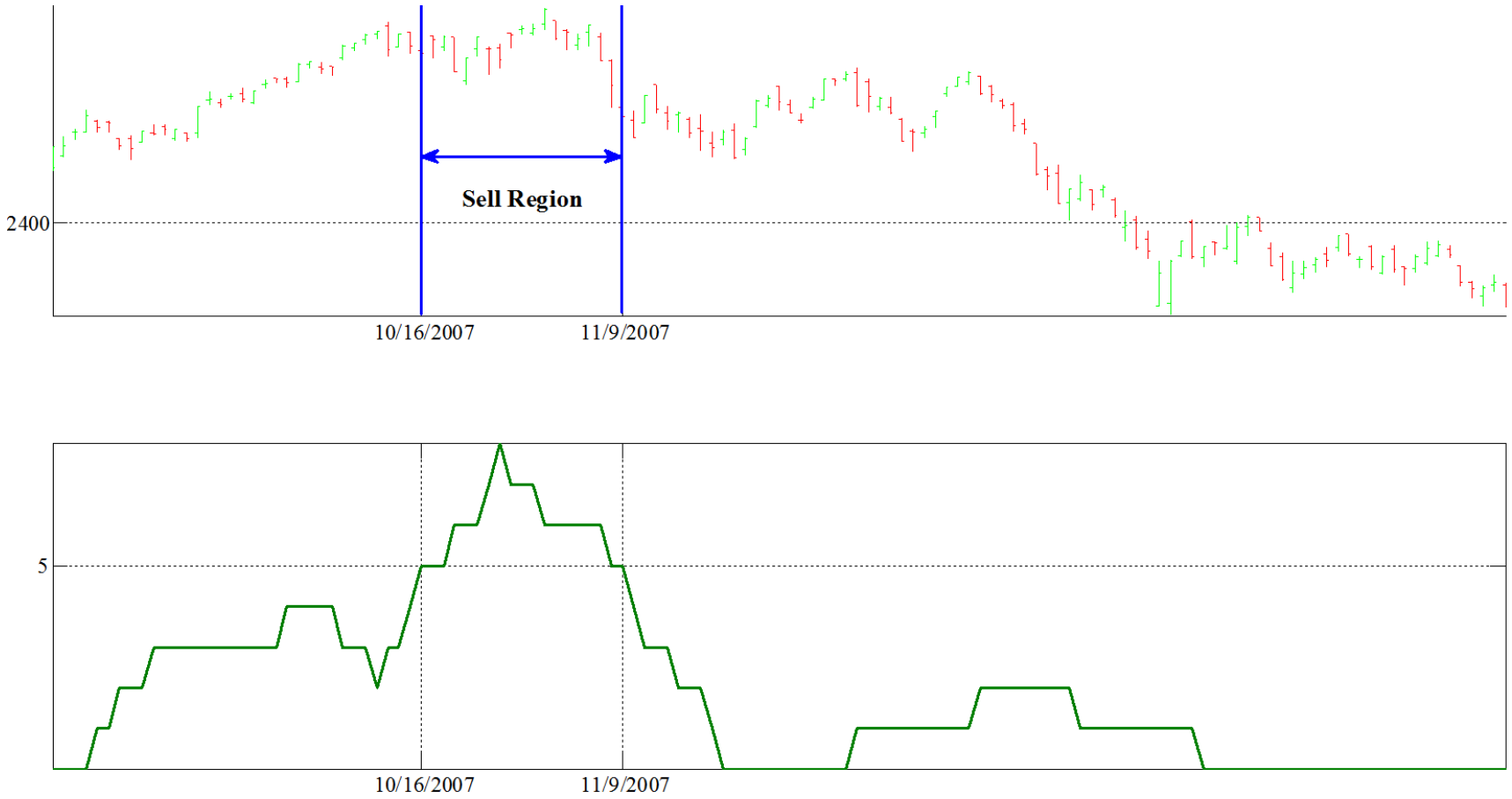

FIGURE 3.7. NASDAQ Composite Index Historical values in 2007. The green chart repsresents the number of distribution days in a 21-day window. Sell signals generated when the number of distribution days is greater or equal 5. Charts produced by MATLAB program.

posite Index values from 2008 to 2010, starting before the market crash of 2008. Two specific zero crossovers of force index correspond to start of the market crash in 8/25/2008, and start of a secular bull market in 3/10/2009. However, there are a lot of undesirable crossovers corresponding to short-term uptrends or downtrends. They are not desirable and demanding more confirming indicators to make buy and sell decisions.

3.9 Vortex Indicator

Vortex indicator in financial markets is first introduced by Botes and Siepman in an article published on January 2010, in the magazine named *Technical Analysis of Stocks and Commodities*. However, the main idea has been inspired from Viktor Schauberger in analyzing the fluidic vortexes.

Vortex indicator includes two lines named VI^+ and VI^-. If VI^+ is above the VI^- then, the market trend is bullish and when VI^+ is under VI^-, the market trend is bearish. So, any intersection of VI^+ and VI^- could be interpreted as the change of direction. To find VI^+ and VI^-, we may use the following steps:

- Define "true range" as:

$$TR = Max(|H_{today} - L_{today}|, |L_{today} - C_{yesterday}|, |H_{today} - C_{yesterday}|)$$

- Calculate the "upward vortex movement" as:

$$VM^+ = |H_{today} - L_{yesterday}|$$

- Calculate "downward vortex movement" as:

$$VM^- = |L_{today} - H_{yesterday}|$$

- Calculate the sum of last 14 days values of TR, VM^+ and VM^-

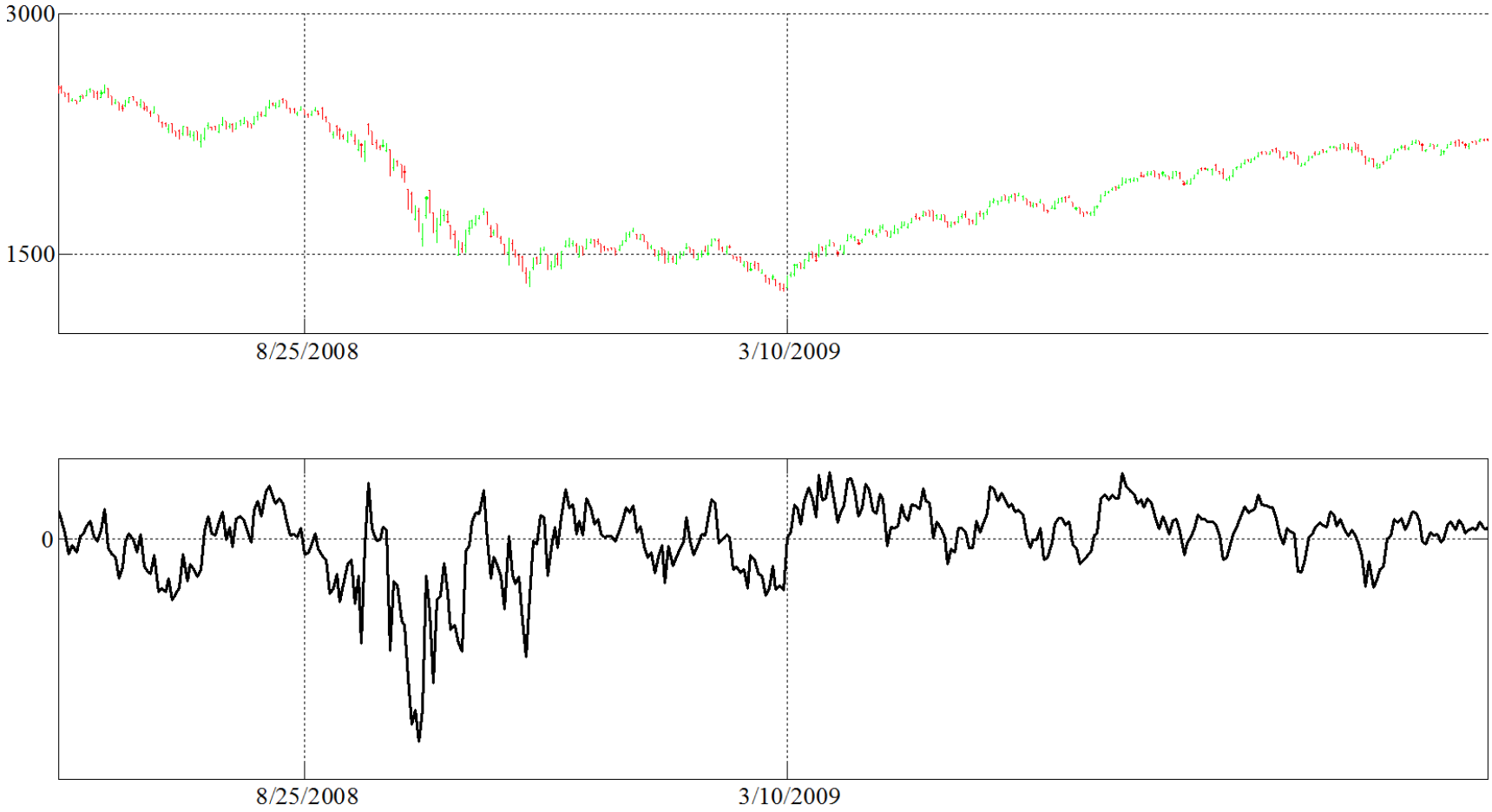

FIGURE 3.8. NASDAQ Composite Index Historical values from 2008 to 2010. The black chart represents the force index values. Start of the market crash associated with zero a crossover for force index. Bull market after the crash is associated with positive values for force index. Charts produced by MATLAB program. (Data Source:*http://www.finance.yahoo.com*)

- Now, we can calculate VI^+ and VI^- as:

$$VI^+ = \frac{\sum VM^+}{\sum TR}$$
$$VI^- = \frac{\sum VM^-}{\sum TR}$$

Figure 3.9 displays the VI^+ and VI^- lines from January 2012 to February 2013 for NASDAQ Composite Index. As you can see, when VI^+, the green line, is above the VI^-, red line, market is bullish and so for the bear market we see VI^- above VI^+. However, this indicator does not work well in trading market periods.

Moreover, the performance of vortex usually is determined when a long-term trade is passed. Therefore, it may produce several inappropriate buy and sell signals. We usually use this indicator combined with other indicators to generate buy and sell signals.

3.10 Commodity Channel Index

Commodity Channel Index (CCI), is another momentum indicator that study the price variations. To calculate CCI, you can follow these steps:

- Find *typical price* (TP) of each day as:

$$TP = \frac{H + L + C}{3}$$

- Find simple moving average of the last $N = 15$ typical prices,

- Find *mean* of typical prices at each day as: $m(TP) = SMA_{today}(TP)$,

- Find *mean absolute deviation* of the last $N = 15$ days of typical prices as:

$$\sigma(TP) = \frac{\sum_N |TP_i - m(TP)|}{n}$$

- CCI is achieved by following formula:

$$CCI = \frac{1}{0.015} \cdot \frac{TP - SMA(TP)}{\sigma(TP)}$$

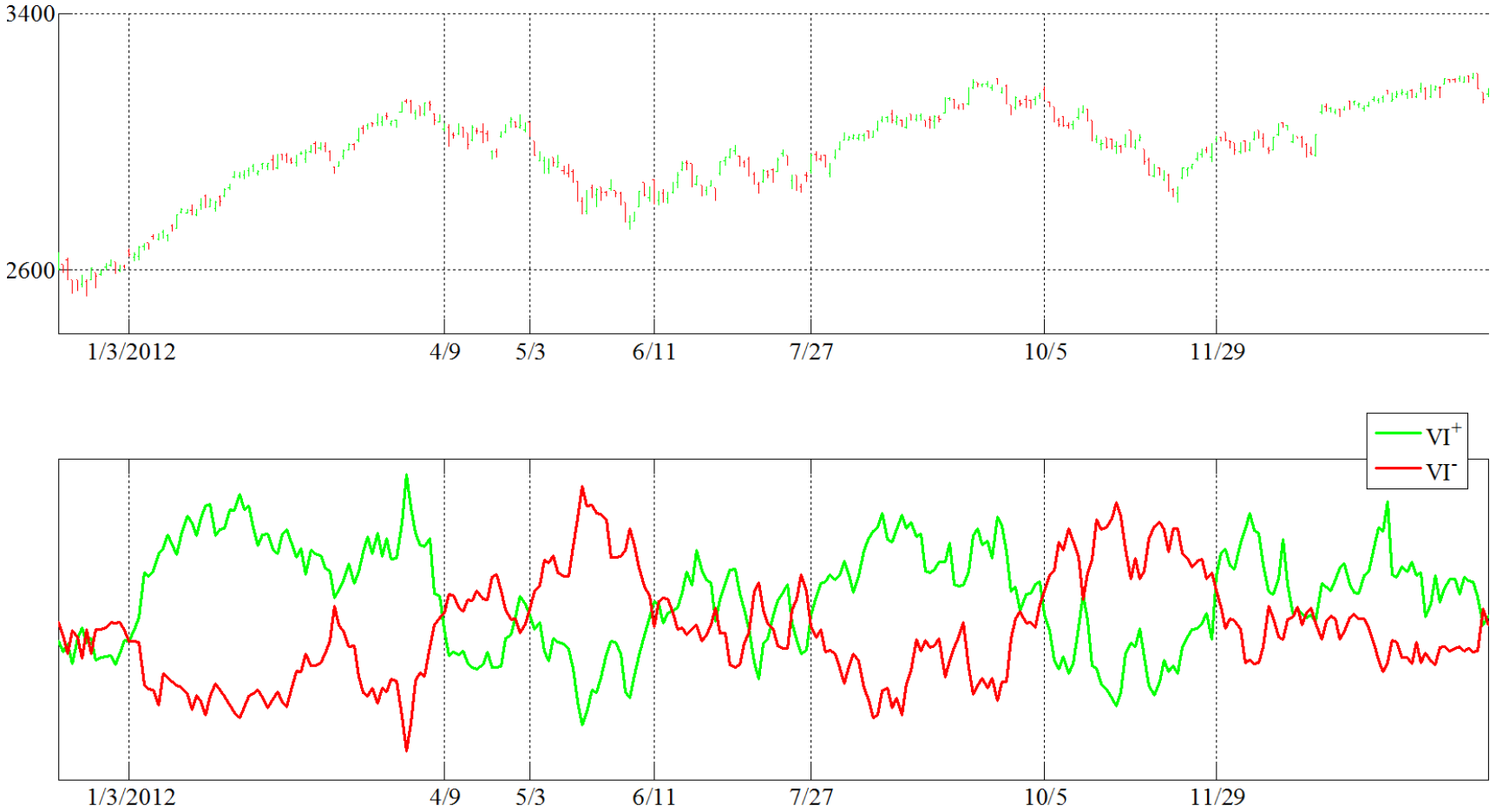

FIGURE 3.9. NASDAQ Composite Index Historical values from January 2012 to February 2013. The green and red lines represent the VI^+ and VI^-, respectively. Charts produced by MATLAB program. (Data Source: *http://www.finance.yahoo.com*)

Normalizing factor, 0.015, has been proposed by Lambert who first developed this indicator. When CCI is above +100, it's a bullish market signal and bear market signal is perceived when CCI is below -100.

3.11 Keman-Mixed Trading System

Fig. 3.11 depicts the outline of our mechanical trading system. As it is shown, our model includes two different traders with different sampling rates. Here, index k represent the day number and index j stands for month number. The technical trader is a set of linear and nonlinear low-pass filters that use the daily price and volume and NASDAQ Summation Index (NASI) from stock market (Vector S_k). The index benchmark for this trader is NASDAQ Composite index. Our data sources for this trader are Yahoo Finance and Stockcharts.com. The output of this trader is a daily signal D_k which may contain buy, sell or hold signals.

The economic observer exploit several monthly economic indicators including unemployment rate, commodity price index, margin debt, and industrial production index (Vector E_j). These economic signals are then sent to a set of low-pass filters and compared with monthly data for S&P 500 index benchmark to generate monthly buy and sell signals (Signal M_j). Since the rate of signals coming from this trader is monthly, its signals last for the whole days of the upcoming month. The data sources for this trader are Federal Reserve Bank of St. Louis, NYSE Technologies and International Monetary Fund (IMF) websites.

The central decision making unit collects the buy and sell signals coming from economy observer and technical trader and then determines the investment policy. In fact, technical trader is the main processor for generating buy and sell signals and economy observer informs us about the whole economic conditions and produces long-term investment signals. For example, a downtrend in the rate of unemployment is a sign of healthy economy that is usually associated with uptrend

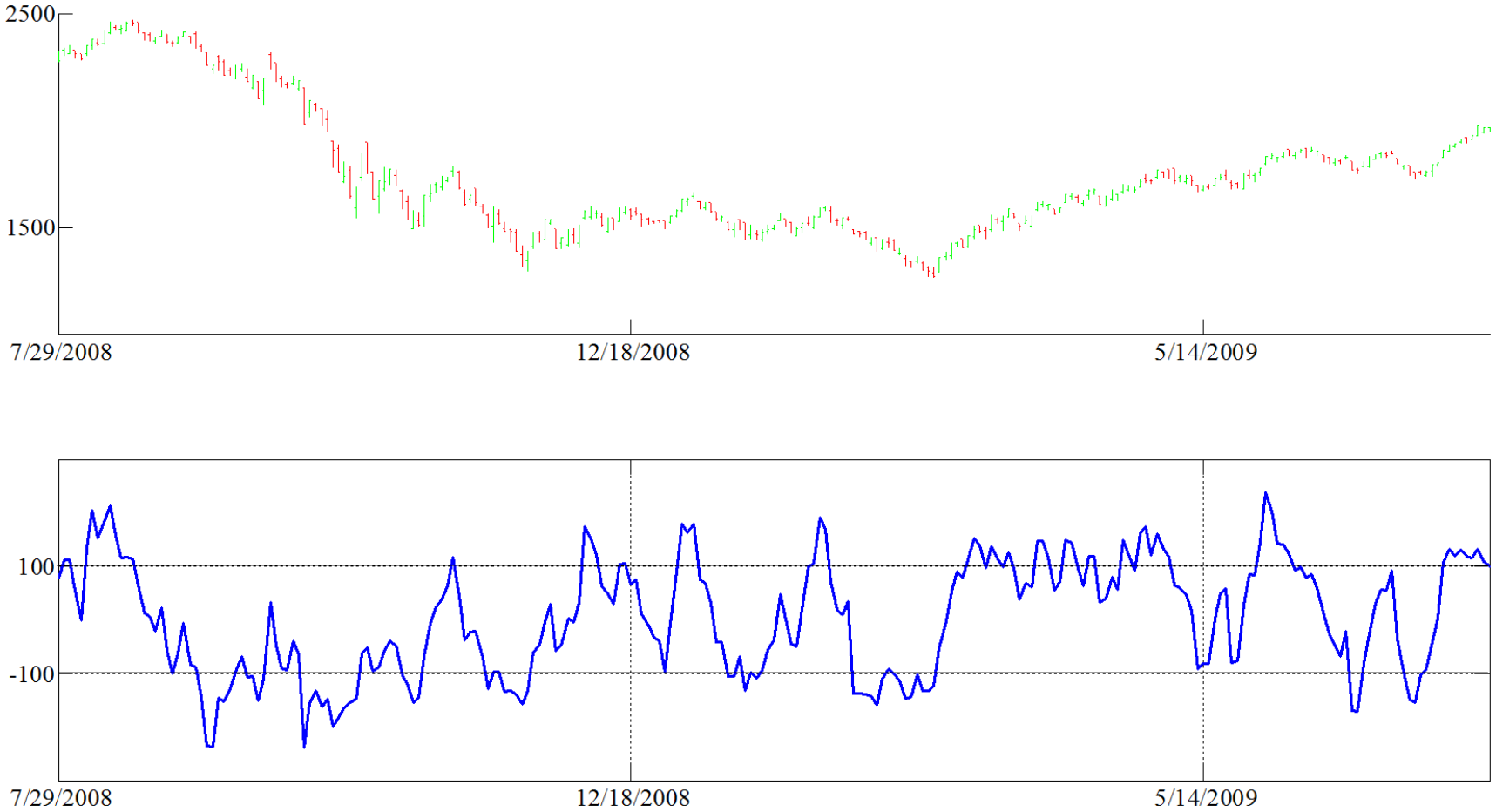

FIGURE 3.10. NASDAQ Composite Index Historical values from January 2012 to February 2013. The green and red lines represent the VI^+ and VI^-, respectively. Charts produced by MATLAB program. (Data Source: *http://www.finance.yahoo.com*)

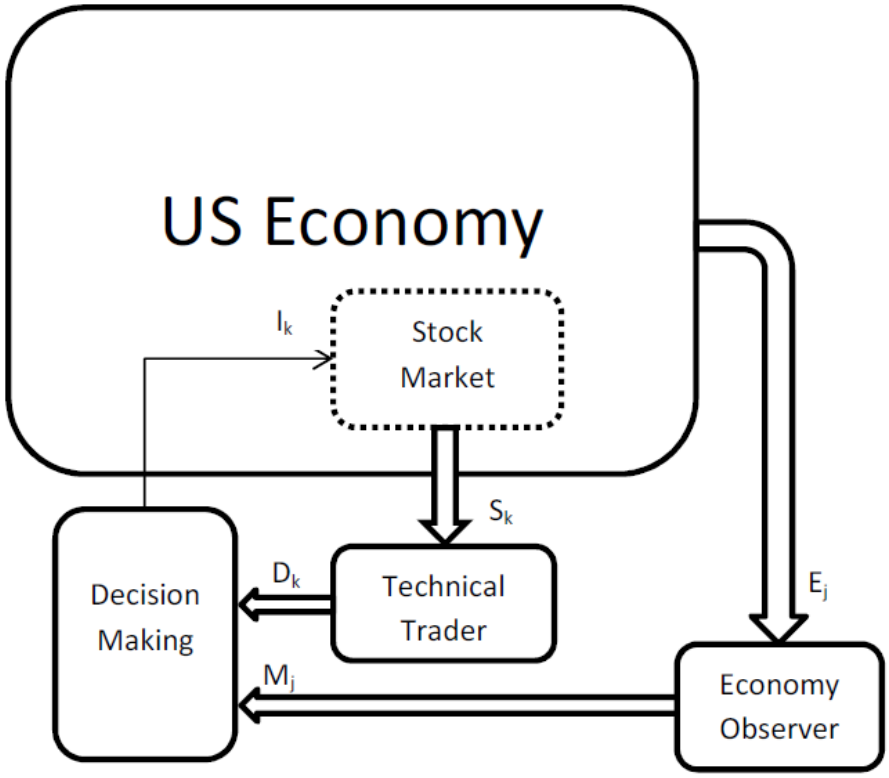

FIGURE 3.11. Keman-Mixed Trading System

in stock market (Fig.2.1). It is worth noting that the unemployment data usually released by more than a month delay and we considered such a delay in our trading system. Therefore, any buy signal coming from technical trader will be magnified by economy observer in such a situation. Stock market crashes usually go hand in hand with uptrends in unemployment rate and downtrend in industrial production level (IPI). Uptrends and downtrends in the level of margin debt usually help us to understand the optimism or pessimism of people for investing in stock market, respectively. Commodity price index (CPI) is a leading indicator for the inflation that could be useful to understand the economic conditions. High level of inflation is not acceptable as well as very low or negative inflation (deflation). Healthy economy usually shows few percent of inflation rate (between 0.7% and 1.4%) [13].

Chapter 4

Spectral Technical Analysis: A New Paradigm

4.1 Simple Idea

The main idea behind the Spectral Technical Analysis (STA) is simple and could be perceived intuitively. To understand the concept, let's start with a simple example. Suppose that we are given a price and its exponential moving average. Based on traditional technical analysis (TTA), buy signal is generated when the price chart pierces its moving average upside. Therefore, buy signal $B(k)$ could be achieved by the following algorithm:

if $P(k-1) < EMA(k-1)$ & $P(k) > EMA(k)$ **then**

$B(k) \leftarrow 1$

else

$B(k) \leftarrow 0$

end if

Figure 4.1 displays the buy and sell signals coming from this algorithm. As you can see, no buy signal is generated utill a *crossover* happens. Therefore, in some cases two charts may get closer, but the output of the algorithm does not show any signal.

Now, consider the following function:

$$f(x,y) = 1(x) \cdot 1(-y) + \frac{x-y}{x} \cdot 1(x) \cdot 1(y) \cdot 1(x-y)$$

Where 1(.) is the unit step Heaviside function. Let's see how this function works. If $x > 0$ and $y < 0$ then $f(x,y) = 1$. Because the first multiplication term would

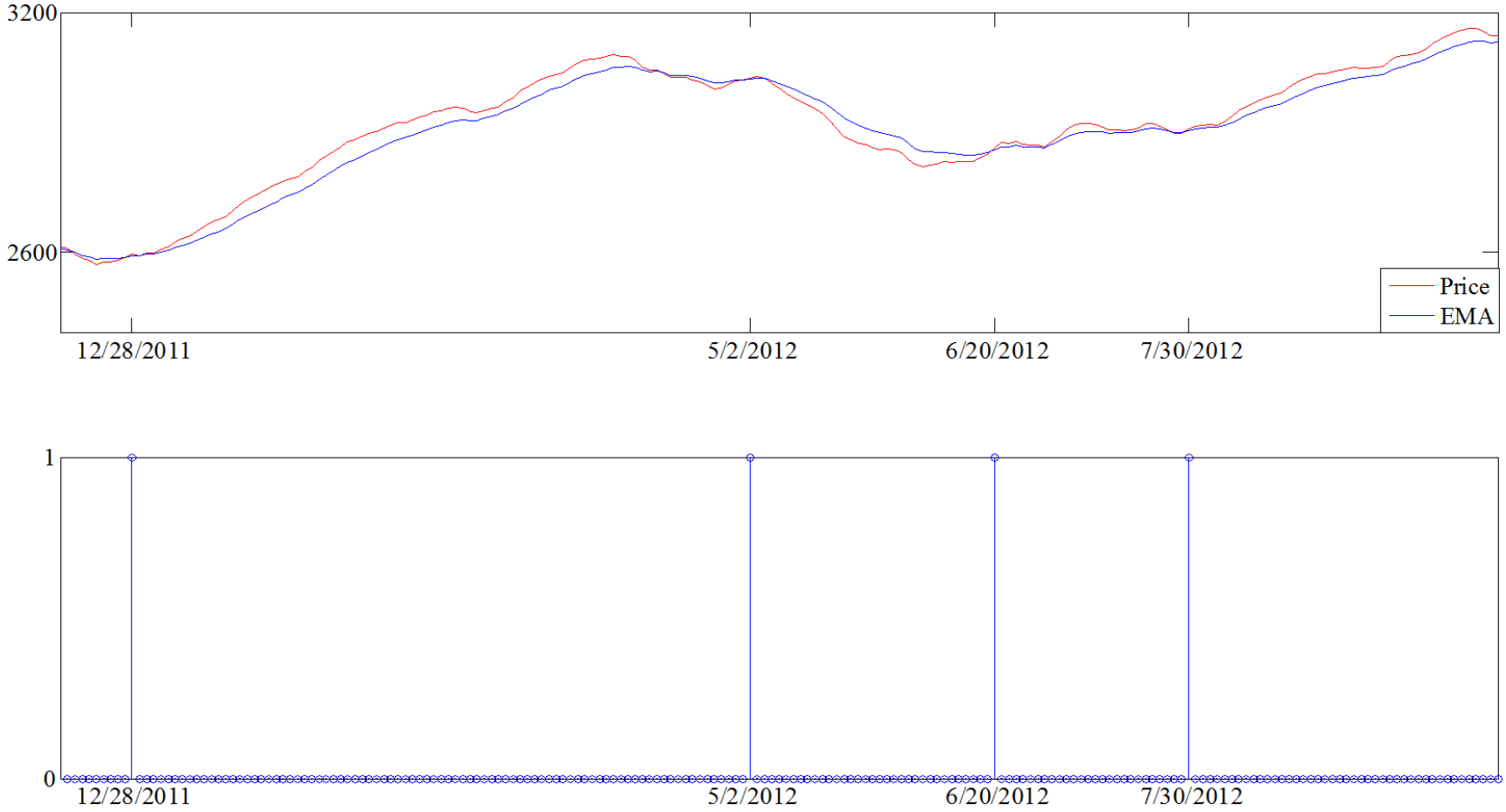

FIGURE 4.1. Buy Signals of EMA Crossover System

be one. If $x > y > 0$ then the output would be nonzero and its amplitude depends on the difference between x and y. Otherwise the output would be zero.

Now, take:

$$x = P(k) - EMA(k), \quad y = P(k-1) - EMA(k-1)$$

Therefore, the output would be one if P crosses its EMA upside. Moreover, if P is below the EMA and gets closer to it, then a nonzero output is generated.The output magnitude in this case would be less than one and depends on the decrement in distance between two function from sample $k-1$ to sample k. In other words, as P gets closer to EMA, the output tends to 1. Figure 4.2 shows the output of this function for the same charts as in Figure 4.1. We call this kind of crossover system as *Relative Crossover System (RCS)* and its corresponding technical analysis approach as *Spectral Technical Analysis (STA)*. As you can see in Figure 4.2, the RCS has some kind of prediction on future movements of prices. Furthuremore, it is less sensitive to the choice of moving average period, because it usually starts to generate buy or sell signal when two charts start approaching together. The output of RCS begins from low and then gets stronger as two charts get closer. So the output signals are not just 0 or 1, but they can get any value between 0 and 1. That's why we call this approach as spectral technical analysis.

We can generalize such an idea to generate other buy and sell signals from other indicators. Therefore, we use RCS to get buy and sell signals for stochastic, MACD, NASI, Chaikin money flow, *etc.* After that, we would have a set of indicators that for each of them, there exists a buy and a sell signal. Spectral technical analysis approach finds a linear combination of these signals to generate total buy and sell signals. What we are going to propose is a set of simple rules combined with historical observations that help an investor to make his/her decision in such a stochastic,

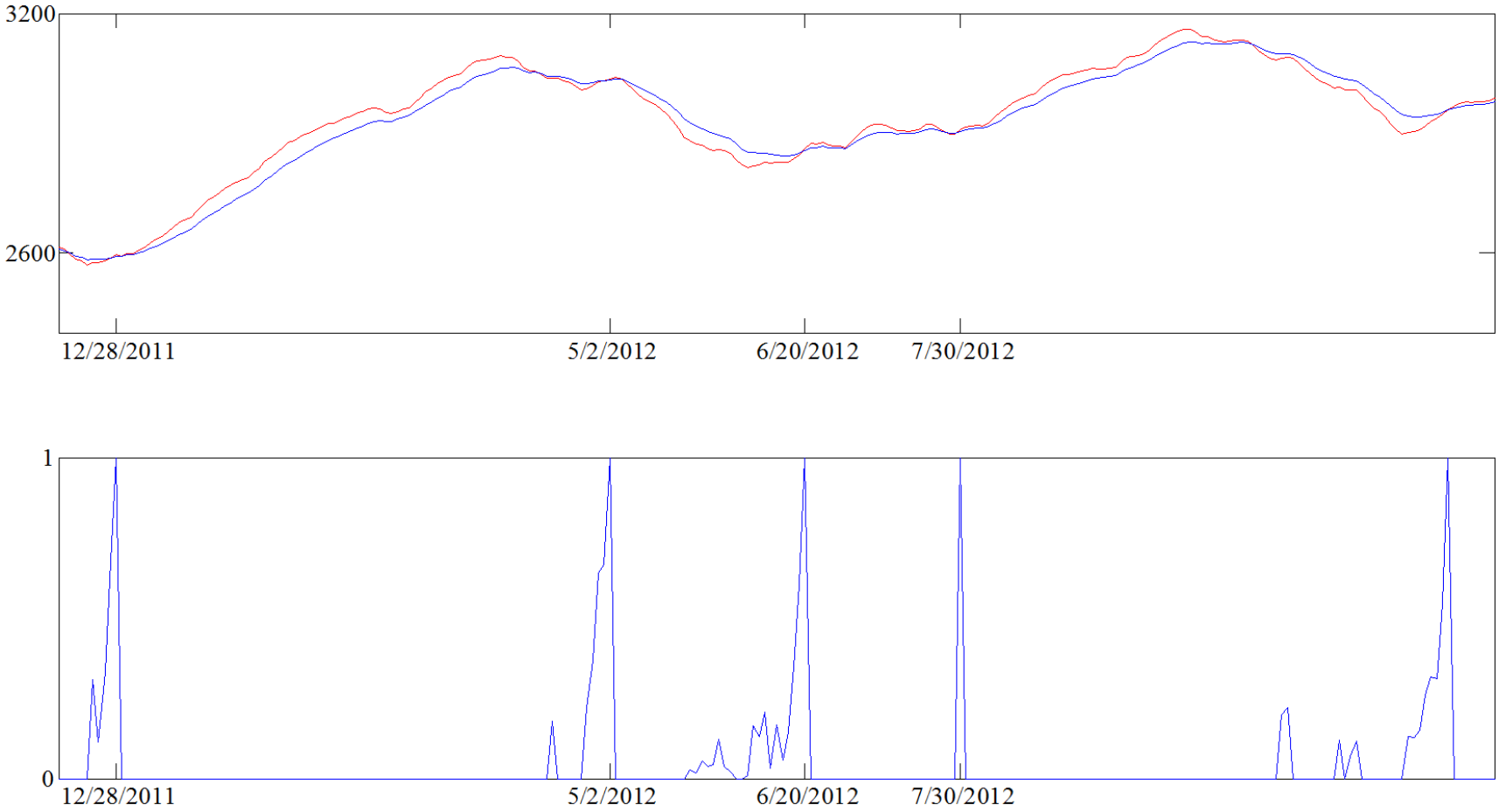

FIGURE 4.2. Buy Signals of Relative Crossover System

nonlinear, time-varying and uncontrollable system. Since our proposed algorithm focuses on large market indices and ETFs, our approach is based on technical analysis. We do not follow everyday-market news that may change the prices in short term and does not usually affect large indexes like NASDAQ Composite. To avoid emotional trading, sometimes it seems logical to ignore some market news, magazines and other people's predictions.

The key feature in spectral technical analysis is its relatively low sensitivity to choice of the parameters of indicators such as period of moving averages or levels of decision making. Spectral technical analysis in contrast with traditional technical analysis may produce partial buy and sell signals even if no crossover really happened. Therefore, the investor often received partial signals about the market conditions.

In our benchmark, we divide the market into two states: High Volatile and Low Volatile. The criterion to distinguish these two states is the relative volatility. We can define the absolute volatility (AV) as standard deviation of 10-day close prices $STD_{10}(close)$. Now, relative volatility (RV) is defined as:

$$RV_{today} = AV_{today}/C_{today}$$

For NASDAQ Composite, if $RV > 3\%$ then we say that the market is highly volatile and we consider each trading day with $RV < 3\%$ as a low volatile day.

4.2 Buy and Sell Criteria

We use symbol B for buy signal and define it as a linear combination of the following buy indicators:

$$B(k) = \alpha_1 \cdot B_{STC}(k) + \alpha_2 \cdot B_{MACD}(k) + \alpha_3 \cdot B_{EMA}(k) + \alpha_4 \cdot B_{NASI}(k) \quad (4.1)$$

where each buy signal is generated by the RCS that has been described before and $\{\alpha_i\}_{i=1}^{4}$ are some constant coefficients such that:

$$\sum_{i=1}^{4} \alpha_i = 10$$

For sell signal, S, we have:

$$\begin{aligned} S(k) = \beta_1 \cdot S_{STC}(k) + \beta_2 \cdot S_{MACD}(k) + \beta_3 \cdot S_{EMA}(k) \\ + \beta_4 \cdot S_{NASI}(k) + \beta_5 \cdot S_{CMF}(k) + \beta_6 \cdot S_{DIST}(k) \end{aligned} \tag{4.2}$$

where:

$$\sum_{i=1}^{6} \beta_i = 10$$

We also define the strength signals UTS and DTS for uptrends and downtrends, respectively as:

$$UTS(k) = UTS_{VPT}(k) + UTS_{CCI}(k) + UTS_{FI}(k) \tag{4.3}$$

$$DTS(k) = DTS_{VPT}(k) + DTS_{CCI}(k) + DTS_{FI}(k) \tag{4.4}$$

We also define a specific buy signal by combining CCI and VPT. Let's first state this signal in TTA benchmark:

if $CCI(k-1) < 100$ & $CCI(k) > 100$ & $VI^{+}(k) > VI^{-}(k)$ **then**

$B_s(k) \leftarrow 3.5$

else

$B_s(k) \leftarrow 0$

end if

Now, we are ready to state our experimental buy and sell model. Although we will revise this model and add more considerations, but the brian of our mechanical trader is based on the following buy and sell criteria:

- In a low volatile market, $RV(k) < 3\%$, we buy the underlying stock if:

$$B(k) \cdot UTS(k) > 4.5$$

- In a high volatile market, $RV(k) > 3\%$, we buy the underlying stock if either one of the following conditions is satisfied:

$$B(k) > 5$$

or

$$B_s(k) > 3$$

- In a low volatile market, $RV < 3\%$, we sell the underlying stock if:

$$S(k) < -3$$

- In a high volatile market, $RV > 3\%$, we sell the underlying stock if:

$$S(k) \cdot UTS(k) < -3$$

4.3 Parameters Tuning

The only unknown part of our main model is the set of coefficients of buy and sell signals, $\{\alpha_i\}_{i=1}^{4}$ and $\{\beta_i\}_{i=1}^{6}$. To find these parameters, we run a back-testing experiment on our uderlying market index, *i.e* NASDAQ Composite. To find the associated score with each indicator, we use 10-year price and volume of NASDAQ Composite from December 2002 to November 2012 to the following algorithm:

- step 1: Choose one of the momentum indicators used in computing buy or sell signals, *e.g* B_{STC}.

- step 2: Set $H = 25$ as a trading horizon.

- step 3: Calculate sum of the all values of the underlying buy or sell indicator over the ten year period and name it STR:

$$STR_{STC} = \sum_{k} B_{STC}(k)$$

- step 4: If the underlying indicator is a buy indicator, at each sample find the maximum ($M(k)$)of the stock price in the next upcoming H trading days, *i.e.*:

$$M(k) = max\{C(i)\}_{i=k}^{k+H}$$

If the underlying indicator is a sell indicator, at each sample find the minimum ($L(k)$) of the stock price in the previous H trading days, *i.e.*:

$$L(k) = min\{C(i)\}_{i=k-H}^{k}$$

- step 5: Calculate the trade score for each sample k using the following score function for buy indicator:

$$Score(k) = 100 \cdot B(k) \cdot \frac{M(k) - C(k)}{|STR \cdot C(k)|}$$

Calculate the trade score for each sample k using the following score function for sell indicator:

$$Score(k) = 100 \cdot S(k) \cdot \frac{C(k) - L(k)}{|STR \cdot C(k)|}$$

- step 6: Score of the underlying indicator is achieved from summation of all sample-scores:

$$Score_{STC} = \sum_{k} Score(k)$$

- Repeat the following algorithm for $H = 50, 75, 100$ and for every indicator.

Now, we calculate buy (sell) ratio associated with each indicator by dividing its score by the sum of the scores of all buy(sell) indicators at each trading horizons. We then scale it from 0 to 10. The results of these calculations are shown in Table 4.1. As you can see, for each buy or sell indicator there are four rows in the table representing the results for each trading horizons.

At this step, we can calculate two sets of coefficients $\{\alpha_i\}_{i=1}^{4}$ and $\{\beta_i\}_{i=1}^{6}$. Each coefficient is achieved by taking the average of its ratios over different horizons. For example, α_1 equals:

$$\alpha_1 = \frac{2.568 + 2.502 + 2.403 + 2.36}{4} = 2.458$$

All of the indicators could be found by the same methods. Final results are as follow:

$$\alpha_1 = 2.458, \alpha_2 = 2.472, \alpha_3 = 2.465$$

$$\alpha_4 = 2.605, \beta_1 = 1.381, \beta_2 = 1.35$$

$$\beta_3 = 2.296, \beta_4 = 1.532, \beta_5 = 1.455, \beta_6 = 1.985$$

Therefore, our initial STA model is completed. In the next section we discuss on some issues and add some other sell criterion to our model to achieve a complete model.

4.4 Revised Model

After running the STA model achieved in the previous section, we faced with some selling issues. There are still some situations for which this model does not give appropriate sell signals and every amount of technical analysis effort based on the underlying indicators cannot give rise to better results. So far, we could not find appropriate indicators such that they can solve these issues and also do not deteriorate other good trades. We may need to add some sentimental or monetary indicators to our current model.

You should also keep this point in your mind that there is no market indicator or trading strategy that never fails. Even the best professionals in Wall Street experience negative returns. Therefore, it seems that we need to revise our model and consider such situations in which our model cannot render on-time sell signals.

TABLE 4.1. Back-Testing Results for the Score of Buy and Sell Indicators for NASDAQ Composite Index From December 2002 to November 2012.

Indicator	**Horizon**	**Buy Score**	**Sell Score**	**Buy Ratio**	**Sell Ratio**
Stochastic	25	0.0246	0.017	2.568	1.301
Stochastic	50	0.0367	0.0261	2.502	1.391
Stochastic	75	0.0469	0.0318	2.403	1.428
Stochastic	100	0.056	0.0364	2.36	1.404
MACD	25	0.0235	0.017	2.453	1.301
MACD	50	0.0361	0.0252	2.461	1.343
MACD	75	0.0487	0.0304	2.495	1.365
MACD	100	0.059	0.0361	2.479	1.393
NASI	25	0.0235	0.0314	2.453	2.402
NASI	50	0.036	0.0437	2.454	2.328
NASI	75	0.0483	0.0489	2.474	2.196
NASI	100	0.0588	0.0585	2.479	2.257
EMA	25	0.0242	0.0203	2.526	1.553
EMA	50	0.0379	0.0287	2.584	1.529
EMA	75	0.0513	0.0342	2.628	1.536
EMA	100	0.0636	0.0391	2.681	1.508
Dist	25	0	0.0195	0	1.492
Dist	50	0	0.0264	0	1.406
Dist	75	0	0.0331	0	1.486
Dist	100	0	0.0373	0	1.439
CMF	25	0	0.0255	0	1.951
CMF	50	0	0.0376	0	2.003
CMF	75	0	0.0443	0	1.989
CMF	100	0	0.0518	0	1.998

We need to define some stop points for those specific trades. Here are some of these sell signals.

We ran a non-parametric statistical analysis on over 3600 daily close values of NASDAQ Composite Index values from 1998 to 2012 to find internal non-periodic cycles inside it. The results are not clearly confirming, but showing some periodic cycles of length 125-days in daily close index prices. We may expect that on average 60 days after each buy signal, we should have at least positive return, otherwise that trade could not be considered a successful trade and should be terminated.

Adding this sell criterion to our initial model, we have our STA model completed. In the next section, we will show our back-testing results plus several comparisons with other trading strategies and mutual funds performances. At the end, we represent the results of real market implementation in more than 18 months started from November 2012.

Chapter 5
Back-Testing Results and Comparison

5.1 Introduction

In this chapter, we present our back-testing results over more than 14 years of stock market. Our benchmark is NASDAQ Composite index (IXIC) and its related ETFs such as QQQ, QLD and TNA. We will also compare our results with other trading strategies in the same period. An appropriate timing algorithm must be efficient in both long and short trades.

To check our proposed algorithm, we also find the results by including short sales. At the end of this chapter, we briefly introduced a fuzzy trading strategy in which we use partial investment instead of all-in strategy.

5.2 Back-Testing Results

We test our proposed algorithm on NASDAQ Composite Index as the main benchmark and then we turn our attention to ETF trading for QQQ, QLD($\beta = 2$) and TNA($\beta = 3$). The first two are tracking NASDAQ-100 index while, TNA follows Russell-2000® Index.

Testing period would be from the middle of 1998 to the end of February 2013. Actually, our back-testing has been completed in November 2012 and since then the results are real-time market tracking performance for Keman Mixed Algorithm.

We also study two trading strategies. Only-long strategy for conservative traders and combined long/short strategy for more aggressive traders. In the former, we just buy and then sell the stock whereas in the later, by each sell signal we go short on stock. Combined strategy gives much more return on capital to the sacrifice of investment safety. Actually each buy or sell signal represents one trade for which

we have to pay the transaction fees. However, for long trading strategy, we define a couple of consecutive buy and sell signals as one trade and for combined long/short strategy, we consider each buy or sell signal as one trade. The reason for such a definition is that our account value changes with only sell signals in former whereas in later, it changes by every buy or sell signal.

5.2.1 NASDAQ Composite Test 1998-2014 for Long Trades

First, we consider trading for NASDAQ Composite Index. Since the index-trading is not possible, this test only gives us a perspective of the whole market performance. We consider back-testing and real-time test for IXIC from 08/26/1998 to 03/22/2014 the last day for back-testing. Actually from 11/12/2012 until now, this algorithm has been running on real-time market data. We will discuss on result of real-time trading at the end of this section.

Over a period of 15 years and 7 months, based on Keman Mixed Algorithm, we got 49 buys, and 48 sells for the total number of 97 signals. Therefore, the average time between two consecutive signals is 40 trading days for which we do not count weekends and holidays. Here we just consider long trades *i.e.* buy and sell. Therefore, we get out of the market at the day of a sell signal and get back by the next buy signal. Total return ratio over this period is 20.63 whereas the buy and hold strategy had a return ratio of 2.608. It means that $\$100,000$ at 08/26/1998 turns to $\$2,180,000$ today while using buy and hold strategy only turns it to $\$241,900$. It implies that the average annual yield rate is 21.74%. Among 48 pairs of consecutive buy-and-sell signals, 35 trades got positive yield and 13 trades yielded negative return (The amount of return on the last trade is positive at the time of writing this dissertation). Therefore, 72.92% of trades have been wining trades.

It is worth noting that we cannot trade at the day in which we get a buy or sell signal. So, we use the close price (index) of the next day as the index value for that trade. The last signal we have got so far is a buy signal achieved on Monday 12/16/2013. So, its corresponding trading-day was Tuesday 12/17/2012. Close value on December 17 was 4023.68 and now that we are writing this dissertation, Saturday 03/22/2014, the last close of NASDAQ is 4276.79 which is equal to 6.29% return. Performance summary for Keman-Mixed approach to NASDAQ Composite Index from 1998 to 2013 has been given in Table 5.1. We consider $\$100,000$ as initial capital at 08/26/1998. To see how initial investment of $\$100,000$ changes after each trade to reach its final value, you can look at the equity curve in Figure 5.5 in which the corresponding curve for only-long strategy is displayed by dashed line. Equity curve for a good trading strategy should be increasing with few drawdowns, as it is in Figure 5.5.

Figures 5.1 to 5.4 show buy and sell signals on historical charts of typical price of NASDAQ Composite Index. Buy and sell signals have been displayed by green and red circles, respectively. We divided our back-testing period into four time intervals:

- From 1998 before the internet bubble to 2002 after the crash of 2002,
- Secular bull market starting from October 2002 to November 2007,
- Secular bear market starting from November 2007 to February 2009 after stock market crash of 2008,
- Secular bull market starting from March 2009 and continuing so far (March 2014).

TABLE 5.1. Performance Summary of Keman-Mixed Strategy for NASDAQ Composite Index from September 1998 to March 2014.(Long Trades)

Total Net Profit	$\$2,080,000$
Annual Rate of Return	21.74%
Total Number of Trades	49
Percent Profitable	72.92%
Wining Trades	35
Losing Trades	14
Return on Initial Capital	2080%
Buy/Hold Return	142%
Trading Period	$15Yrs, 7Mths$
Annualized Excess Return Over Benchmark	11.85%
Annualized Excess Return Over Risk Free Rate	17.46%
Annual Tracking Error (w.r.t S&P 500)	17.67%
Annual Downside Risk	-3.46%
Annual Sharpe Ratio	1.06
Annual Modigliani Measure	18.82%

Each time interval includes sub-periods of short-term bull and bear markets. We will discuss about the drawbacks and features of our Keman-Mixed algorithm in the rest of this section and Section 6.

5.2.2 NASDAQ Composite Test 1998-2014 for Combined Long/Short Trades

The main driving-force for investing in a high risk market is the human greed. Now, let's turn our attention to a more aggressive trading strategy including both long and short trades. In other words, by each buy signal we go long on IXIC and by each sell signal we go short. We expect to earn more return by trading both long and short. We go short after closing a long position only if some economic criteria are met. Table 5.2 includes the performance summary for short trades as well as long trades and combined strategy. Here, the number of trades is 119.

The equity curve for this trading strategy is shown in Figure 5.5(solid curve). We again have an almost increasing curve in terms of number of trades. As you can see, there are only few drawdowns over the 66 samples. We began with $\$100,000$ in

FIGURE 5.1. NASDAQ Composite Index Typical Prices and Buy/Sell Signals Generated by Keman-Mixed Mechanical Trader During the Internet Bubble and its Following Market Crash (from November 13, 1998 to October 1, 2002). Chart produced using *Highcharts.com* benchmark

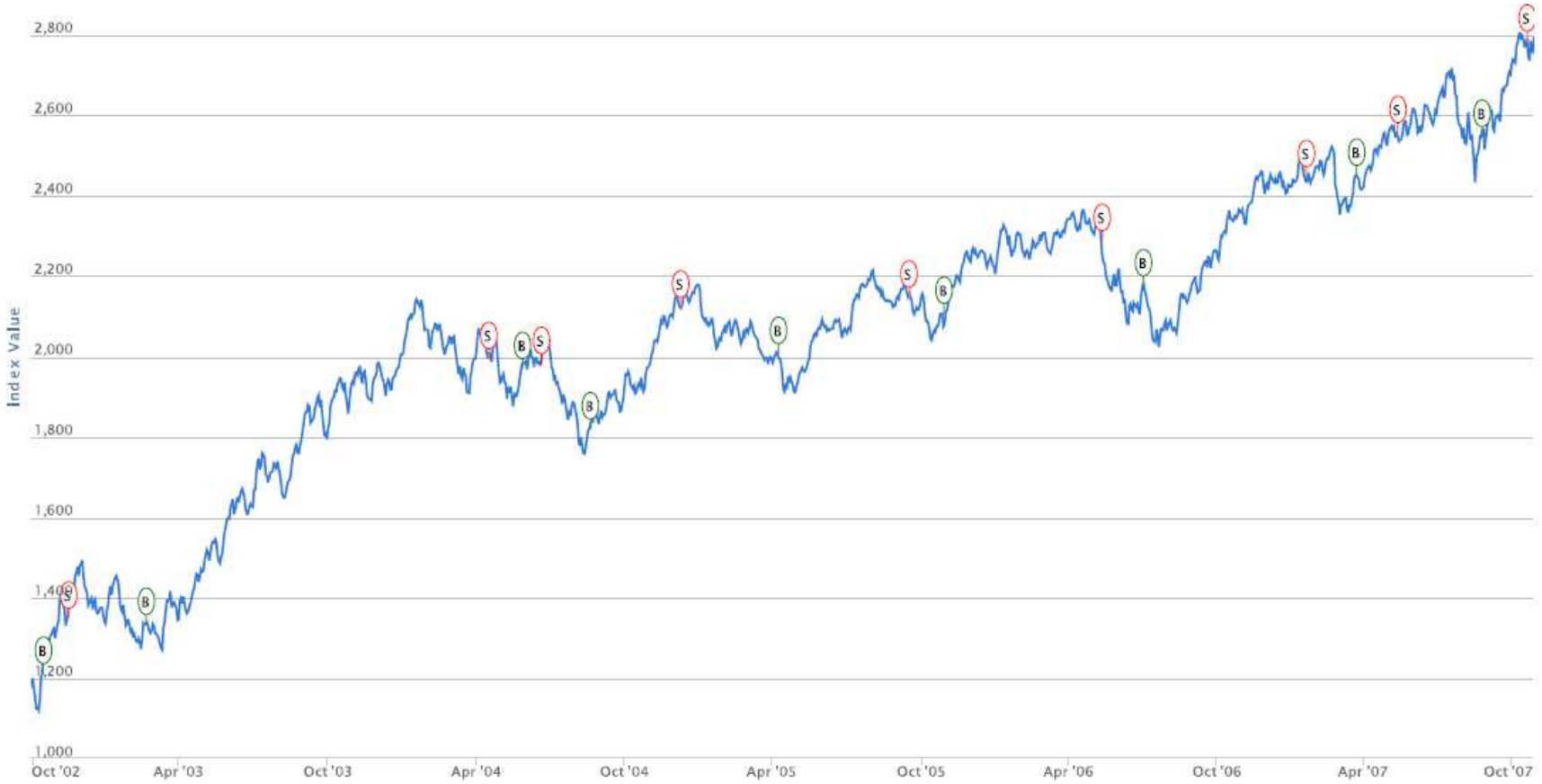

FIGURE 5.2. NASDAQ Composite Index Typical Prices and Buy/Sell Signals Generated by Keman-Mixed Mechanical Trader During Secular Bullish Market (from October 1, 2002 to November 1, 2007). Chart is Available Online in Our Trading Website:http://ikmarketanalyzer.eu.pn/Trades.htm and produced using *Highcharts.com* benchmark

FIGURE 5.3. NASDAQ Composite Index Typical Prices and Buy/Sell Signals Generated by Keman-Mixed Mechanical Trader During Bear Market (from November 1, 2007 to February 28, 2009). Chart is Available Online in Our Trading Website:http://ikmarketanalyzer.eu.pn/Trades.htm and produced using *Highcharts.com* benchmark

FIGURE 5.4. NASDAQ Composite Index Typical Prices and Buy/Sell Signals Generated by Keman-Mixed Mechanical Trader During Bull Market (from March 1, 2009 to March 22, 2014). Charts Available Online in Our Trading Website:http://ikmarketanalyzer.eu.pn/Trades.htm and produced using *Highcharts.com* benchmark

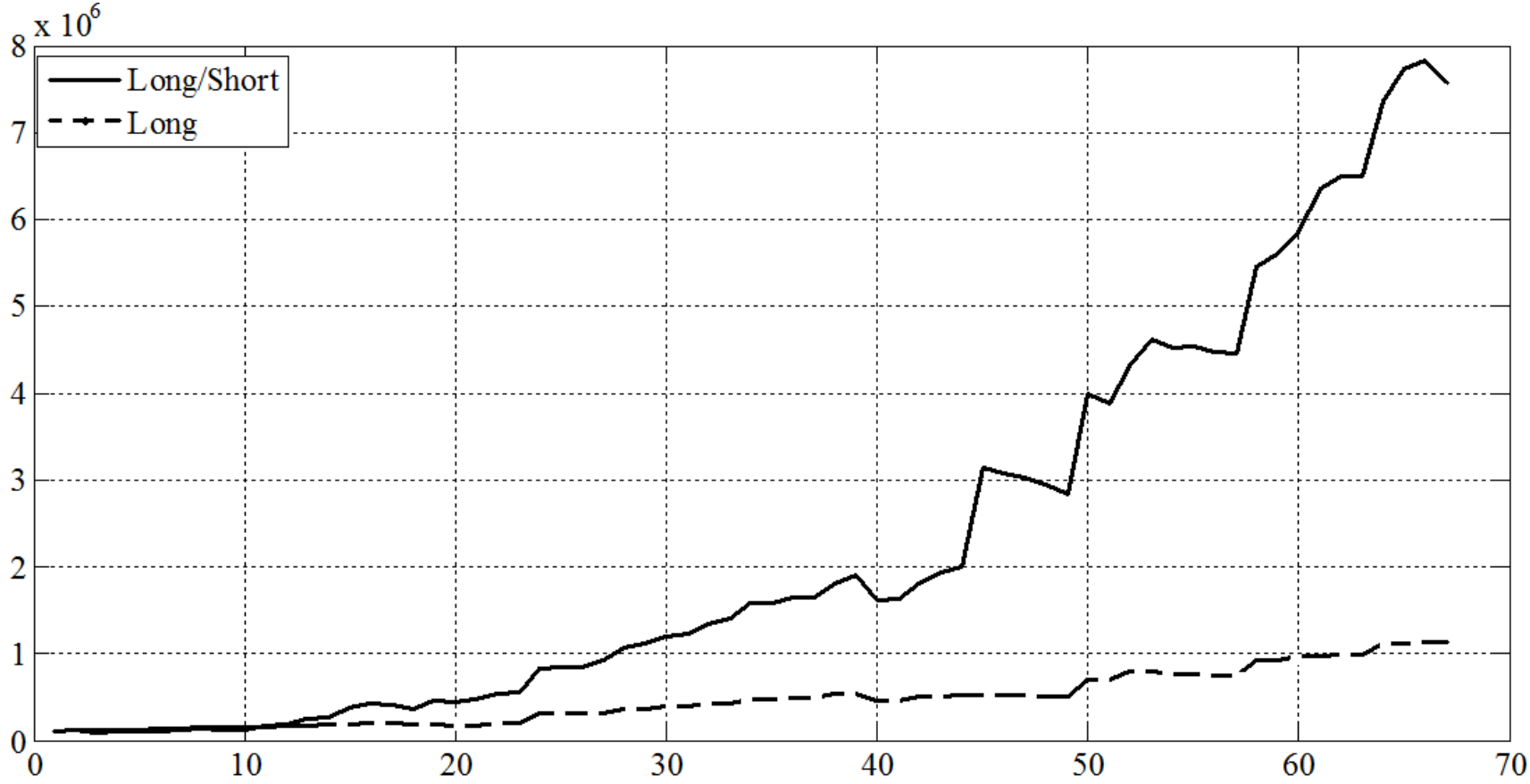

FIGURE 5.5. Equity Curve for Keman-Mixed Strategy on NASDAQ Composite Index From 1998-2014. Solid line displays the equity curve for combined long/short strategy whereas, dashed line represents the equity curve for only-long strategy.

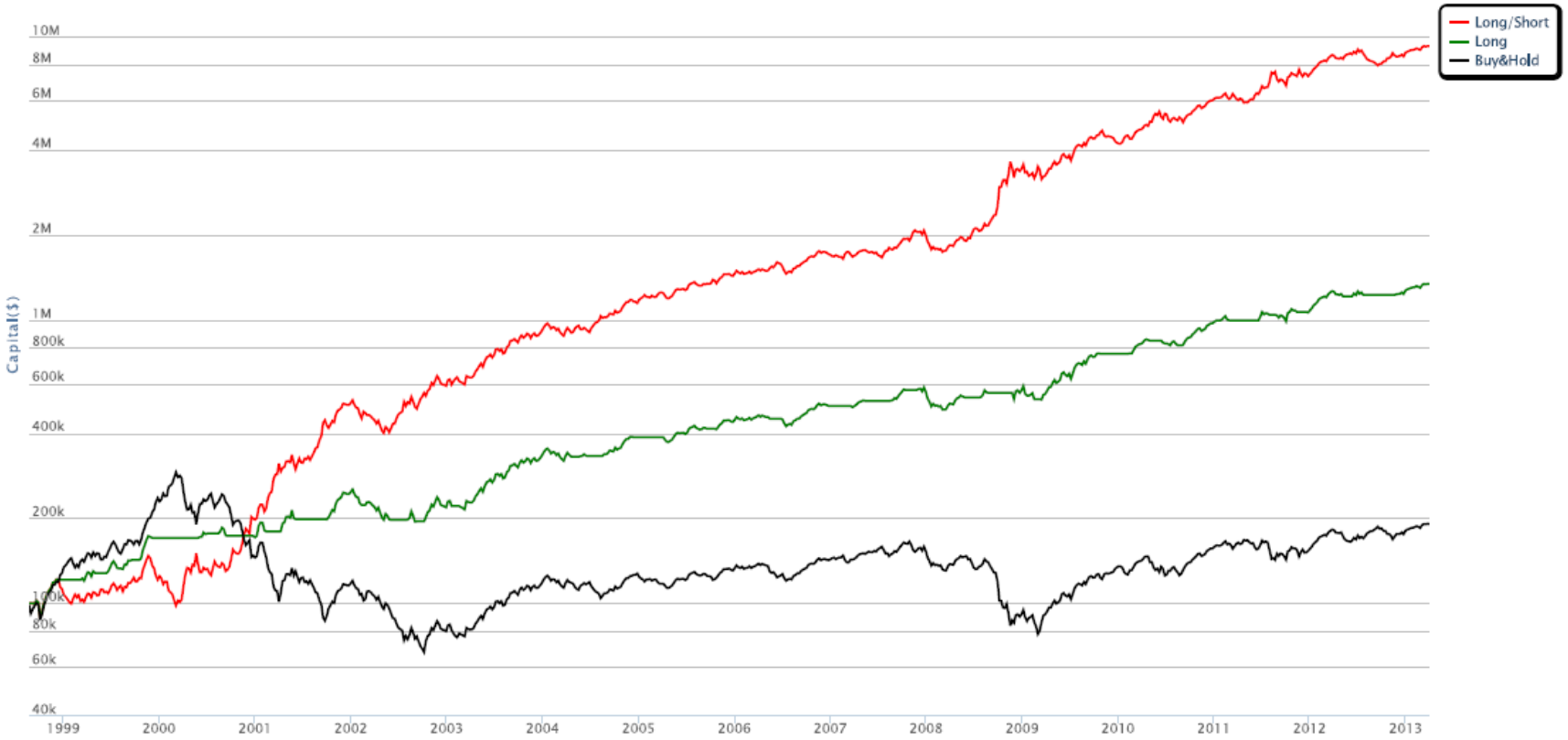

FIGURE 5.6. Growth of Capital for Long, Combined Long/Short and Buy&Hold Strategies on NASDAQ Composite Index (from March 1, 2009 to March 28, 2013). Charts Produced By *Highcharts.com*

TABLE 5.2. Performance Summary of Keman-Mixed Strategy for NASDAQ Composite Index from September 1998 to March 2014. (Long/Short Trades)

Total Net Profit	$\$20,510,000$
Annual Rate of Return	40.5%
Total Number of Trades	69
Number of Long Trades	49
Number of Short Trades	20
Percent of Profitable Short Trades	75%
Percent of Profitable Long Trades	72.92%
Percent of Profitable Trades	73.53%
Wining Trades	50
Losing Trades	19
Return on Initial Capital	$20,510\%$
Buy/Hold Return	142%
Trading Period	$15Yrs, 7Mths$
Annualized Excess Return Over Benchmark	30.22%
Annualized Excess Return Over Risk Free Rate	37%
Annual Tracking Error (w.r.t S&P 500)	31.95%
Annual Downside Risk	-3.28%
Annual Sharpe Ratio	1.59
Annual Modigliani Measure	50.66%

1998 and ended up with $\$20,610,000$ on March 2014 which is equal to spectacular yield of return 40.5% per annum. The amount of time in the market is more than the previous one, because we may go short after closing the long position. It again shows that *risk* and *return* go hand in hand. Figure 5.6 displays the growth of initial capital of $\$100,000$ during this period.

5.2.3 QQQ Test 1999-2014 for Keman-Mixed Long Strategy

Now, to have a real stock trading example, we use a highly liquid ETF from PowerShares Capital Management LLC named QQQ. PowerShares QQQ also known as *NASDAQ-100 Tracking Stock*. NASDAQ-100 is a stock market index that includes 100 of largest non-financial domestic and international companies in NASDAQ Stock Market[1]. When we talk about the *largest* companies, we rank them based

[1] http://www.invescopowershares.com/products/overview.aspx?ticker=QQQ

on the market capitalization.[2] Since, NASDAQ-100 approximately follow NASDAQ Composite Index, therefore, we can use the buy and sell signals that we got for NASDAQ Composite for trading a real ETF that follows NASDAQ-100 Index.

In this way, the dates for buy/sell signal would be same as the dates we achieved for NASDAQ Composite. Table 5.3 summarizes the 14-year trading results for QQQ from the middle of 1999 to March 2014. First, we use simple long-trading strategy. In the next section, we will see the trading results for combined long and short trades. Figure 5.7 depicts the growth of capital for initial investment of $\$100,000$. Annual rate of return for long stock trading from 1999 to 2014 is 19.67% that is close to what we achieved for NASDAQ Composite. It shows how much it is reasonable to apply buy and sell signals of NASDAQ Composite to an index tracking ETF. It is worth noting that the trading period is less than what we had for NASDAQ Composite, but the parameters of Tables 5.3 and 5.1 are close together. According to Table 5.3, we can see again how poor is the performance of buy and hold strategy over a long period of 14 years that renders only 4.3% annual yield rate. Considering the inflation rate, you can perceive how poor would be the buy and hold strategy!

5.2.4 QQQ Test 1999-2014 for Keman-Mixed Combined Long/Short Strategy

As a real aggressive trading strategy, we test our Keman-Mixed algorithm for both long and short trades. We previously showed that the return on capital and its corresponding annual rate of return significantly increase by trading both long and short. In fact, when the performance of an algorithm improves from long trade to long-and-short, we can conclude that the timing is right. A good timing algorithm is not just to sell at a higher price than buy price, but it also requires

[2]Market capitalization is the product of the number of shares by the stock price. For example, if company XYZ issued 1000 shares of stock for $5 then its market capitalization is $5000.

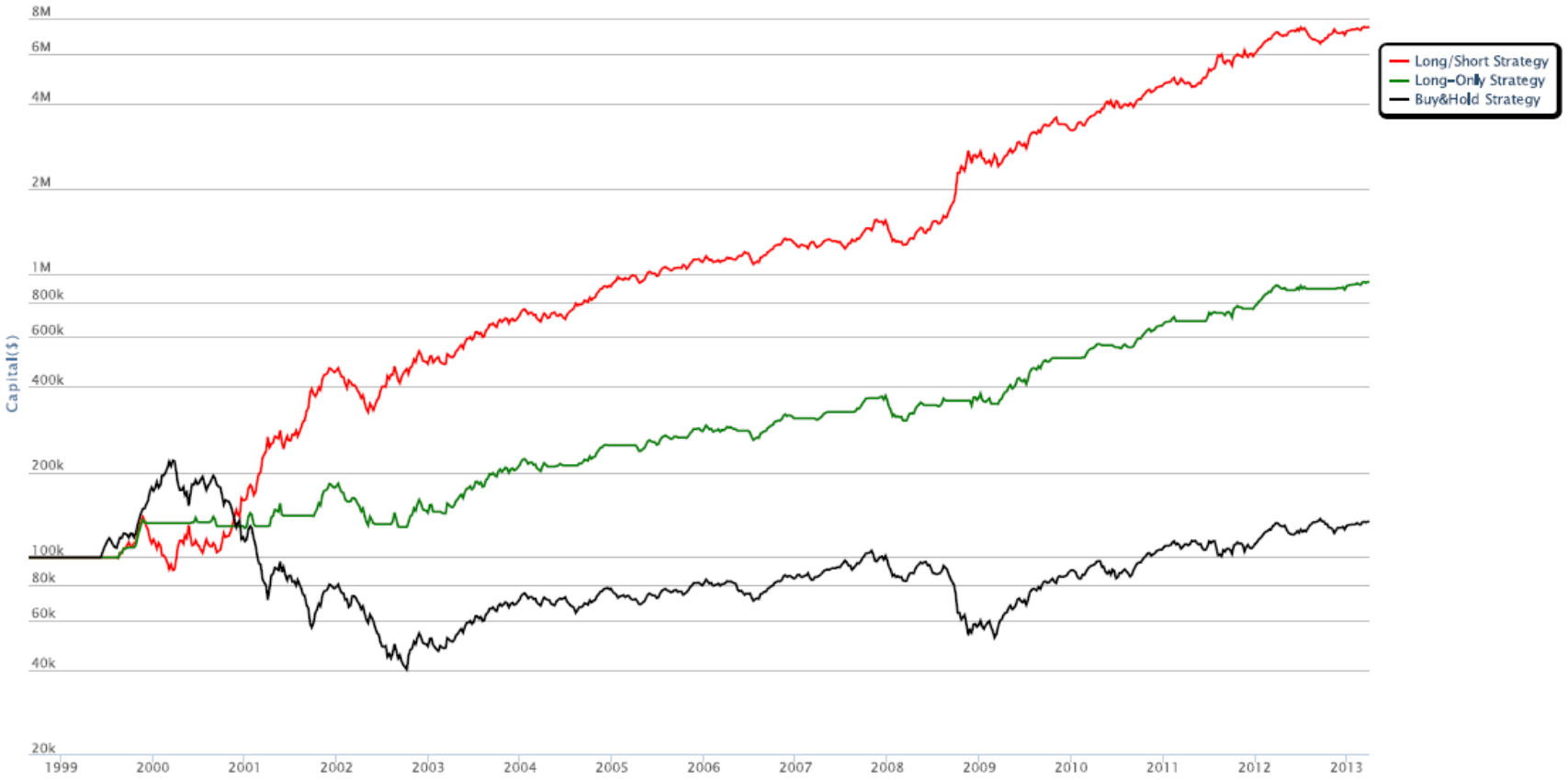

FIGURE 5.7. Growth of capital for Keman-Mixed long, combined long/short strategy and buy&hold on QQQ From 1999-2013

TABLE 5.3. Performance Summary of Keman-Mixed Strategy for QQQ from June 14, 1999 to March 21, 2014.(Long Trades)

Total Net Profit	$\$1,344,000$
Annual Rate of Return	19.67%
Total Number of Trades	47
Percent Profitable	69.57%
Wining Trades	33
Losing Trades	14
Return on Initial Capital	1,344%
Buy/Hold Return	84.57%
Trading Period	$14Yrs, 8Mths$
Annualized Excess Return Over Benchmark	14.03%
Annualized Excess Return Over Risk Free Rate	16.07%
Annual Tracking Error (w.r.t S&P 500)	17.68%
Annual Downside Risk	−4.04%
Annual Sharpe Ratio	0.85
Annual Modigliani Measure	15.03%

sell signals that are approximately at the end of each uptrend. If you get out of the market in the middle of an uptrend or miss it from inception then, it would be so difficult to come back to the trend without losing benefits. Martin Zweig in [12] truely describe such a situation:

"*One of the frustrating things for people who miss the first rally in a bull market is that they wait for the big correction and it never comes. The market just keeps climbing and climbing. It feeds itself in frenzied fashion and propels prices considerably higher for six months or so, and sometimes longer.*"

Therefore a good timing algorithm should achieve positive returns on both uptrends and downtrends. Table 5.4 summarizes the trading results for a combined long and short Keman-Mixed. Annual rate of return for the Keman-Mixed long/short strategy is 40.95% slightly higher than what we got for the same strategy applied to NASDAQ Composite Index. Equity curve is also displayed in Figure 5.7.

TABLE 5.4. Performance Summary of Keman-Mixed Strategy for QQQ from 1999 to 2014.(Long/Short Trades)

Total Net Profit	$\$1,636,000$
Annual Rate of Return	40.95%
Total Number of Trades	66
Number of Long Trades	46
Number of Short Trades	20
Percent of Profitable Short Trades	70%
Percent of Profitable Long Trades	71.11%
Percent of Profitable Trades	70.77%
Wining Trades	47
Losing Trades	19
Return on Initial Capital	16,360%
Buy/Hold Return	84.57%
Trading Period	$14Yrs, 8Mths$
Annualized Excess Return Over Benchmark	35.89%
Annualized Excess Return Over Risk Free Rate	38.29%
Annual Tracking Error (w.r.t S&P 500)	34.24%
Annual Downside Risk	−3.81%
Annual Sharpe Ratio	1.45
Annual Modigliani Measure	49.63%

5.2.5 QLD Test 2007-2014 for Keman-Mixed Combined Long/Short Strategy

We go further, and test our algorithm on a leveraged ETF QLD with $\beta = 2$. Therefore, QLD is twice more aggressive than QQQ. It is worth noting that the fund goal is to get the performance with $\beta = 2$, but it is not always achievable. Leveraged ETFs are exposed to higher risk since their uptrends and downtrends have β times sharper slope than their corresponding regular ETFs. Since QLD fund has been launched in June 2006, our back-testing includes 6-years data from 03/20/2007 to 03/21/2014. The results of this trading strategy are outstanding and significantly profitable. Table 5.5 contains the results of combined long/short Keman-Mixed strategy applied to QLD from 2007 to 2013.

Annual rate of return for this strategy equals to 94.24%. The rate of profitable trades is 78.13% for QLD which is 80.95% for long positions and 72.73% for short

TABLE 5.5. Performance Summary of Keman-Mixed Strategy for QLD from 2007 to 2014.(Long/Short Trades)

Total Net Profit	$\$10,760,000$
Annual Rate of Return	94.24%
Total Number of Trades	33
Number of Long Trades	22
Number of Short Trades	11
Percent of Profitable Short Trades	78.13%
Percent of Profitable Long Trades	80.95%
Percent of Profitable Trades	72.73%
Wining Trades	26
Losing Trades	7
Return on Initial Capital	10,760%
Buy/Hold Return	167%
Trading Period	$7Yrs$
Annualized Excess Return Over Benchmark	90.11%
Annualized Excess Return Over Risk Free Rate	101.37%
Annual Tracking Error (w.r.t S&P 500)	46.98%
Annual Downside Risk	−5.42%
Annual Sharpe Ratio	1.84
Annual Modigliani Measure	86.64%

positions. The trade-off between risk and return is absolutely observable here. Figure 5.8 depicts the growth of capital for 30 long and short trades that have been done during this period. Note that the annualized excess return over risk free rate of 5% is 101.37% which is even more than annual yield rate of 94.24%. It is due to the fact that this number is being calculated as the annualized the arithmetic average of monthly excess returns over the risk free rate of return. Since, our ETF is so volatile, the amount of annualized excess return is even more than the real annual yield by itself.

5.2.6 TNA Test 2007-2014 for Keman-Mixed Long/Short Strategy

Our last back-testing is performed for a highly leveraged ETF with $\beta = 3$. Therefore, we should expect high profits and losses for wining and losing trades, respectively. Table 5.6 summarizes trading results for a trading period starting in 2009 so far. We again remind that we do not consider the result of the very last

FIGURE 5.8. Growth of Capital for Keman-Mixed Long Strategy, Long/Short Strategy and Buy&Hold on QLD From 2007-2014

TABLE 5.6. Performance Summary of Keman-Mixed Strategy for TNA from 2009 to 2014.(Long/Short Trades)

Total Net Profit	$\$2,110,000$
Annual Rate of Return	80.29%
Total Number of Trades	18
Number of Long Trades	13
Number of Short Trades	5
Percent of Profitable Short Trades	80.0%
Percent of Profitable Long Trades	66.67%
Percent of Profitable Trades	70.59%
Wining Trades	13
Losing Trades	5
Return on Initial Capital	$2,110\%$
Buy/Hold Return	422.2%
Trading Period	$5Yrs, 3Mnths$
Annualized Excess Return Over Benchmark	77.29%
Annualized Excess Return Over Risk Free Rate	105.94%
Annual Tracking Error (w.r.t S&P 500)	60.92%
Annual Downside Risk	-13.48%
Annual Sharpe Ratio	1.17
Annual Modigliani Measure	71.54%

trade with buy signal in November 26, 2012. Annual yield rate for TNA is 80.29% which is fascinating to any investor. However, we should keep in mind that the risk of trading for such an ETF is too high. Since our buy and sell signals nicely correspond to main up and down trends, it works for even other large indexes such as Russell-2000® that is the TNA's benchmark. Figure 5.9 shows the growth of capital for TNA from 2009 to 2014.

5.3 Comparison

Now, we compare our back-testing results with other trading strategies. First, we compare our historical signals with two famous trading systems: *VectorVest Market Timing system* and *Investor Business Daily Market Outlook*. Then, we consider several other mutual fund performances during the last 14 years and compare their returns with ours. At the end of this section, we will also compare our real-time results with other available results.

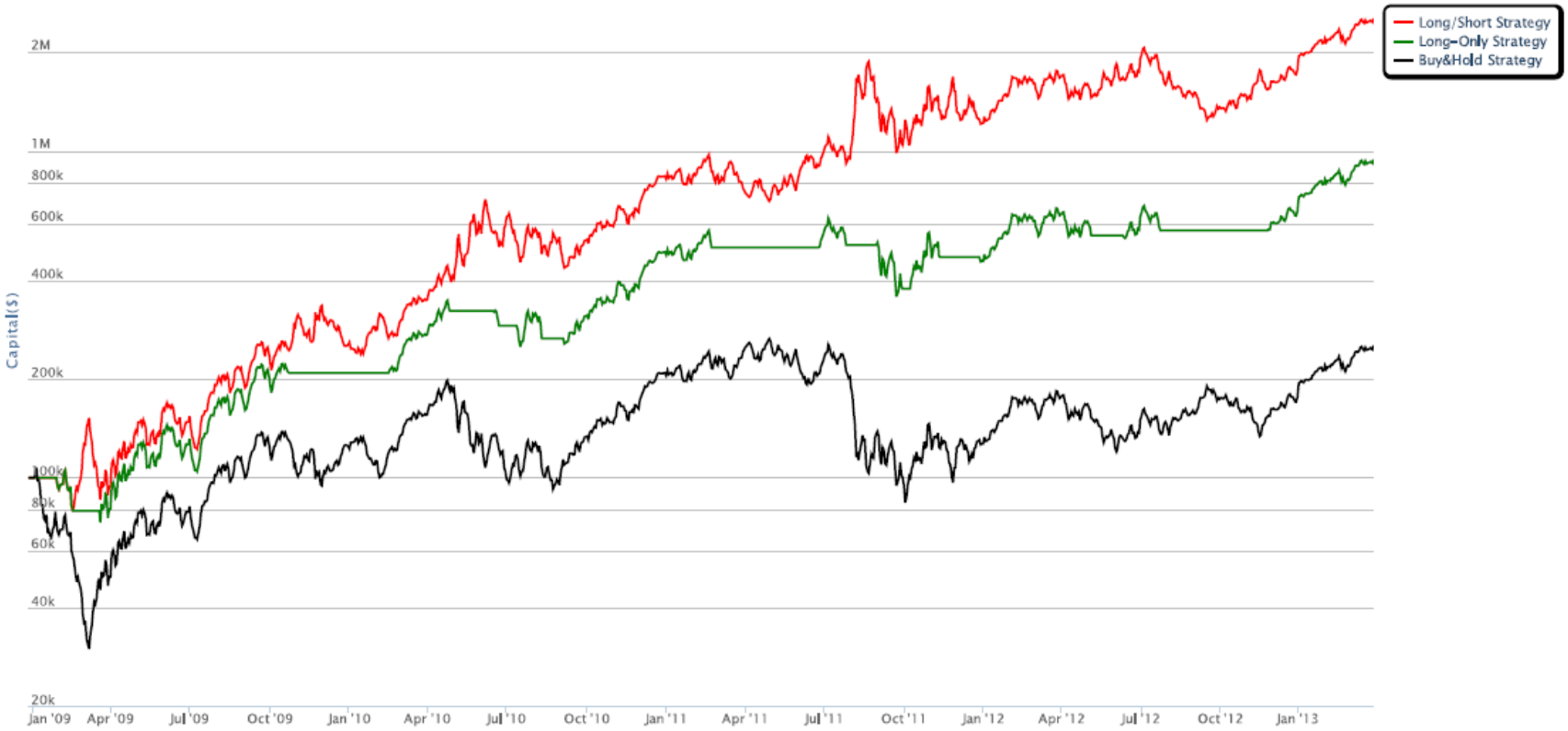

FIGURE 5.9. Growth of Capital for Keman-Mixed Long Strategy, Combined Long/Short Strategy and Buy&Hold on TNA From 2009-2014

5.3.1 Comparison with IBD Signals

Investor Bussiness Daily (IBD) is a daily newsletter that covers financial and economic news. They allot several pages to stock market and similar other markets such as bond market. They devote a special section to assess the market outlook named *Big Picture*. Based on their own criteria, they attribute different signals to each trading day as a *market outlook*. First, we use the following long-only strategy based on the IBD market outlook:

- Buy when IBD market outlook turns *Confirmed Uptrend*.
- Sell when IBD market outlook turns *Uptrend Under Pressure* or *Market in Correction*, either one comes sooner.

To have a combined long-short strategy, we use the following algorithm:

- Buy stock when IBD market outlook changes to *Confirmed Uptrend*.
- Sell stock when IBD market outlook changes to either *Uptrend Under Pressure* or *Market in Correction*.
- Go short only if market outlook changes to *Market in Correction*.

Our comparison period is from the middle of May 2008 so far. Figures 5.10 to 5.17 display our Keman-Mixed signals versus IBD signals. We represent our buy and sell signals with green and red circles respectively. IBD signals are shown by rectangular flags with different colors as follows:

- Green rectangles with symbol "CUp" represent *Confirmed Uptrend* or buy signal;
- Yellow rectangles with symbol "UUp" stand for *Uptrend Under Pressure* or sell signal without short selling;

- Pink rectangles with symbol "Cor" display *Market in Correction* or sell signals with short selling command.

As you can see, IBD market signals are much more than Keman-Mixed trading system and one has to do more trades and therefore transaction fees are much higher than what we have to pay by Keman-Mixed timing system. In a secular market, Keman-Mixed algorithm is more profitable than IBD timing strategy. However, in some cases, the Keman-Mixed algorithm may miss few short-term trends whereas, the IBD timing system is more sensitive to short-term trends. Tables 5.7 and 5.8 compare the results of these two algorithms together for only-long and combined long/short strategies respectively. Figure 5.18 nicely compares all of the strategies together for growth of capital.

TABLE 5.7. Performance Comparison between IBD Market signals and Keman-Mixed timing System for Trading Period from May 2008 to March 2013 (Only-long Trades)

	Keman-Mixed	**IBD**
Total Number of Trades	13	30
Percent of Profitable Trades	69%	50%
Return on Initial Capital	153.66%	64.05%
Annual Return	20.46%	10.41%

TABLE 5.8. Performance Comparison between IBD Market signals and Keman-Mixed timing System for Trading Period from May 2008 to March 2013 (Combined long/short Trades)

	Keman-Mixed	**IBD**
Total Number of Trades	26	61
Percent of Profitable Trades	62%	52%
Return on Initial Capital	381.79%	74.71%
Annual Return	36.96%	11.81%

5.3.2 Comparison with VectorVest Timing Signals

Another market timing system is provided by VectorVest which is a stock market trend analysis system stablished by Dr. Bart Diliddo. He is a trained mathemati-

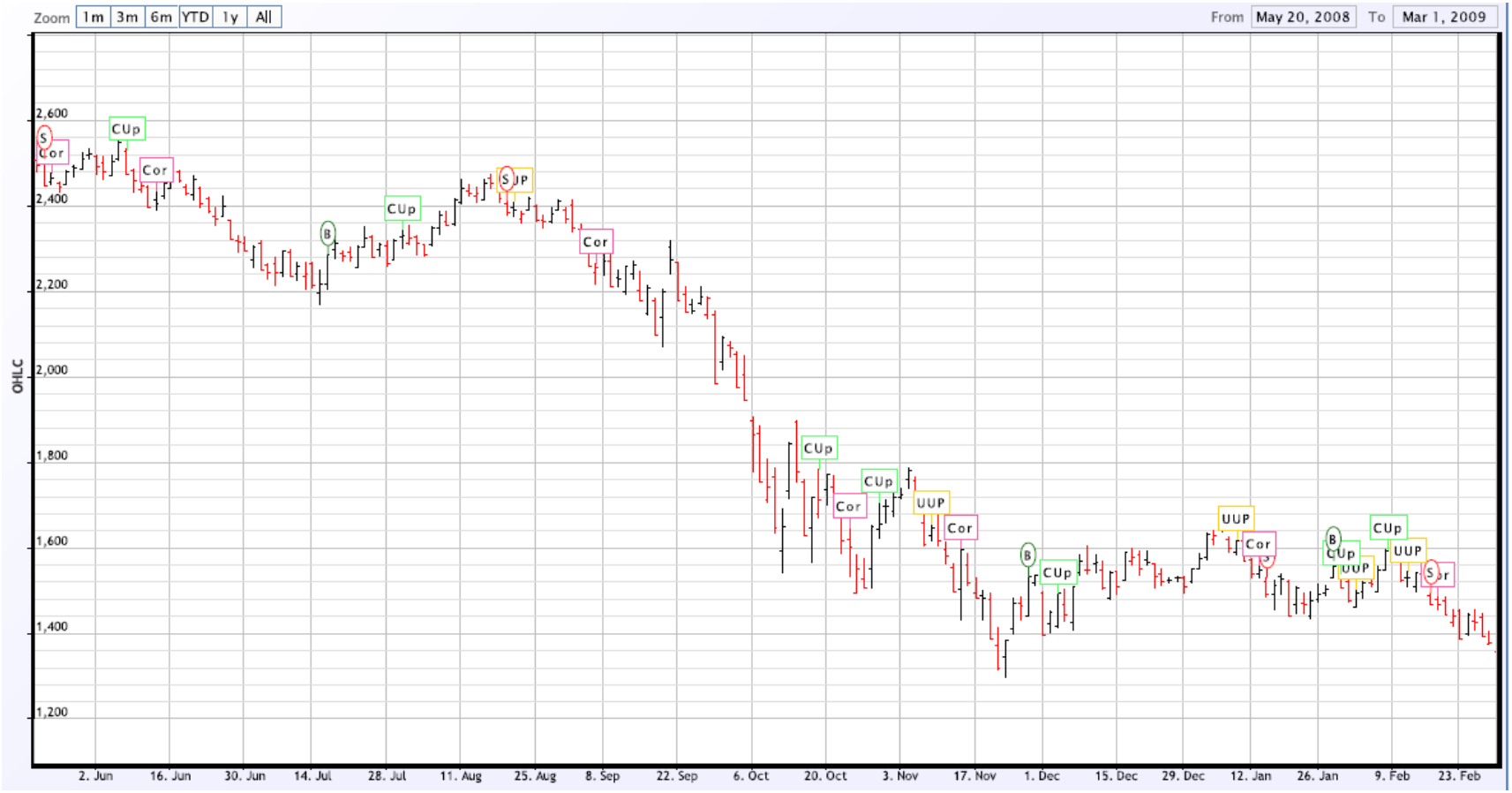

FIGURE 5.10. IBD Market Signals versus Keman-Mixed Market Signals from May 15, 2008 to March 1, 2009.

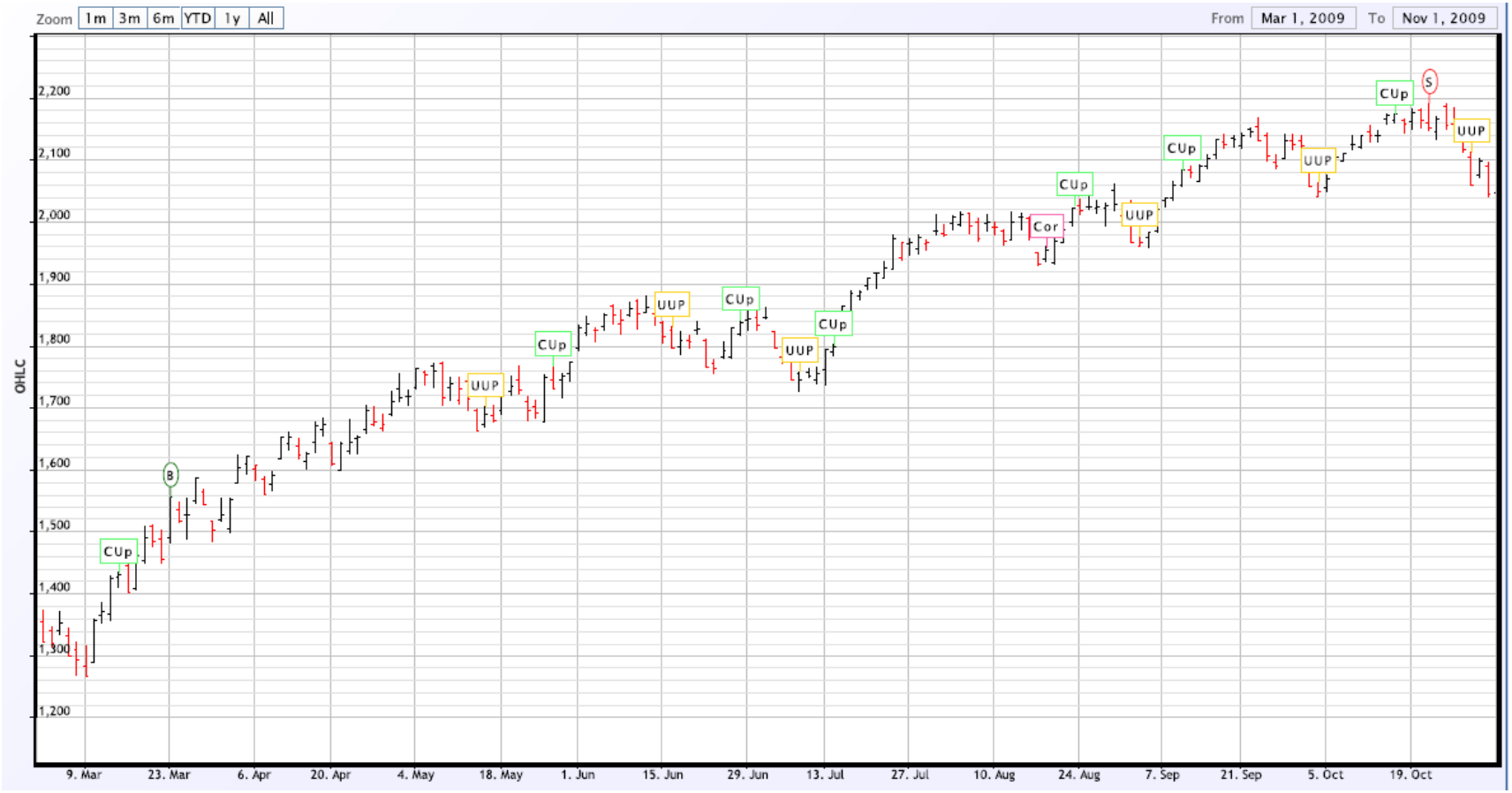

FIGURE 5.11. IBD Market Signals versus Keman-Mixed Market Signals from March 1, 2009 to November 1, 2009.

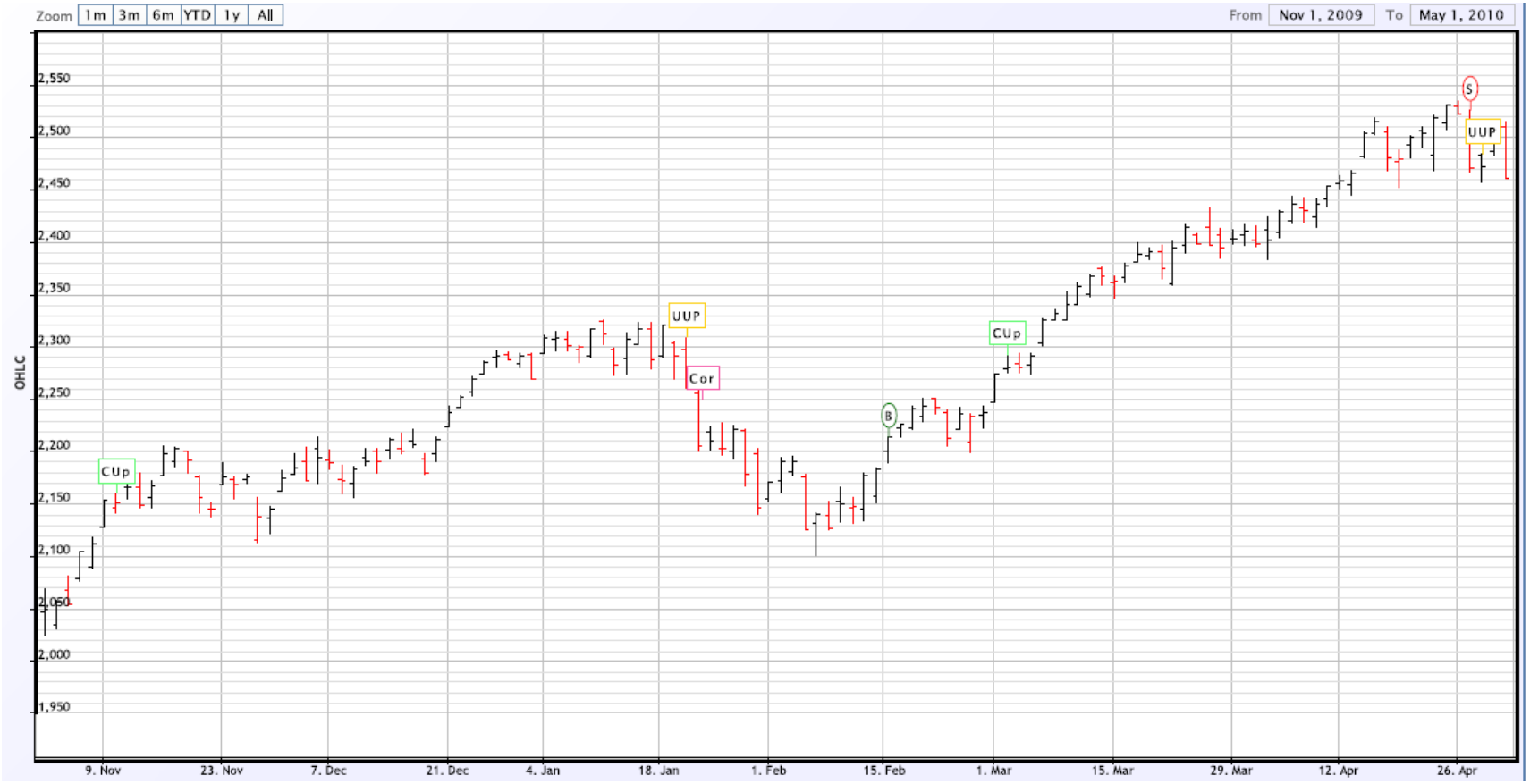

FIGURE 5.12. IBD Market Signals versus Keman-Mixed Market Signals from November 1, 2009 to May 1, 2010.

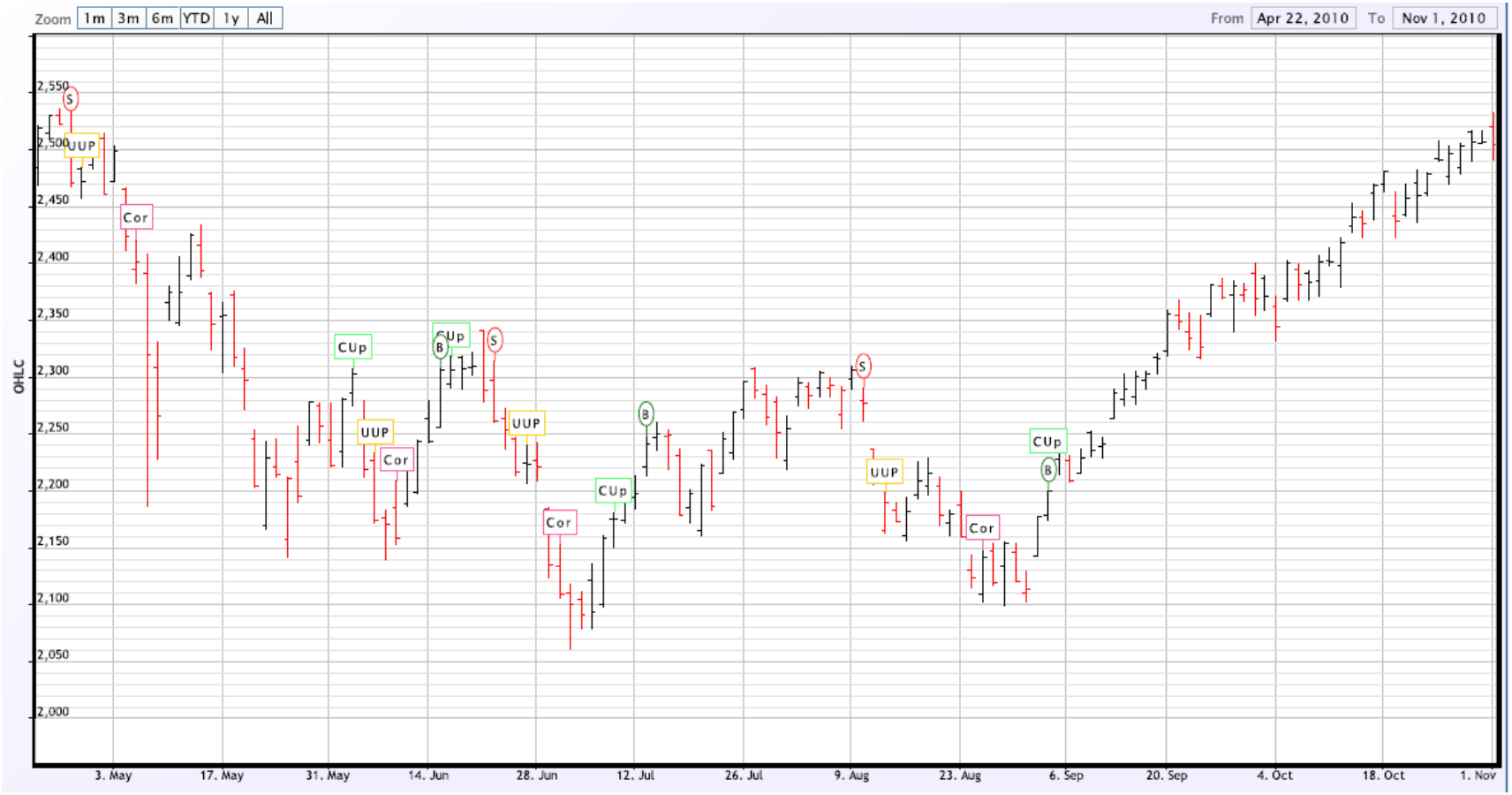

FIGURE 5.13. IBD Market Signals versus Keman-Mixed Market Signals from April 22, 2010 to November 1, 2010.

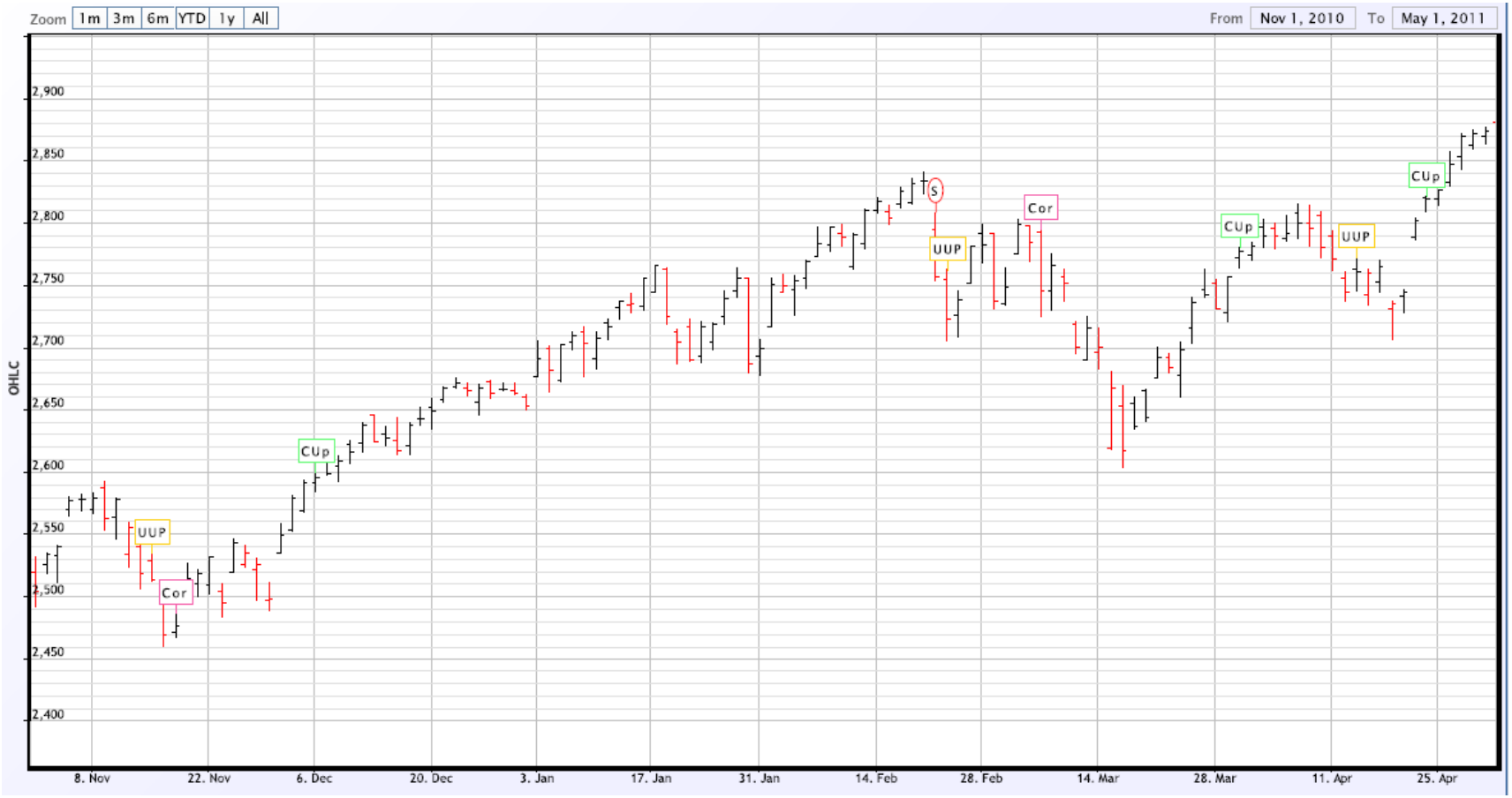

FIGURE 5.14. IBD Market Signals versus Keman-Mixed Market Signals from November 1, 2010 to May 1, 2011.

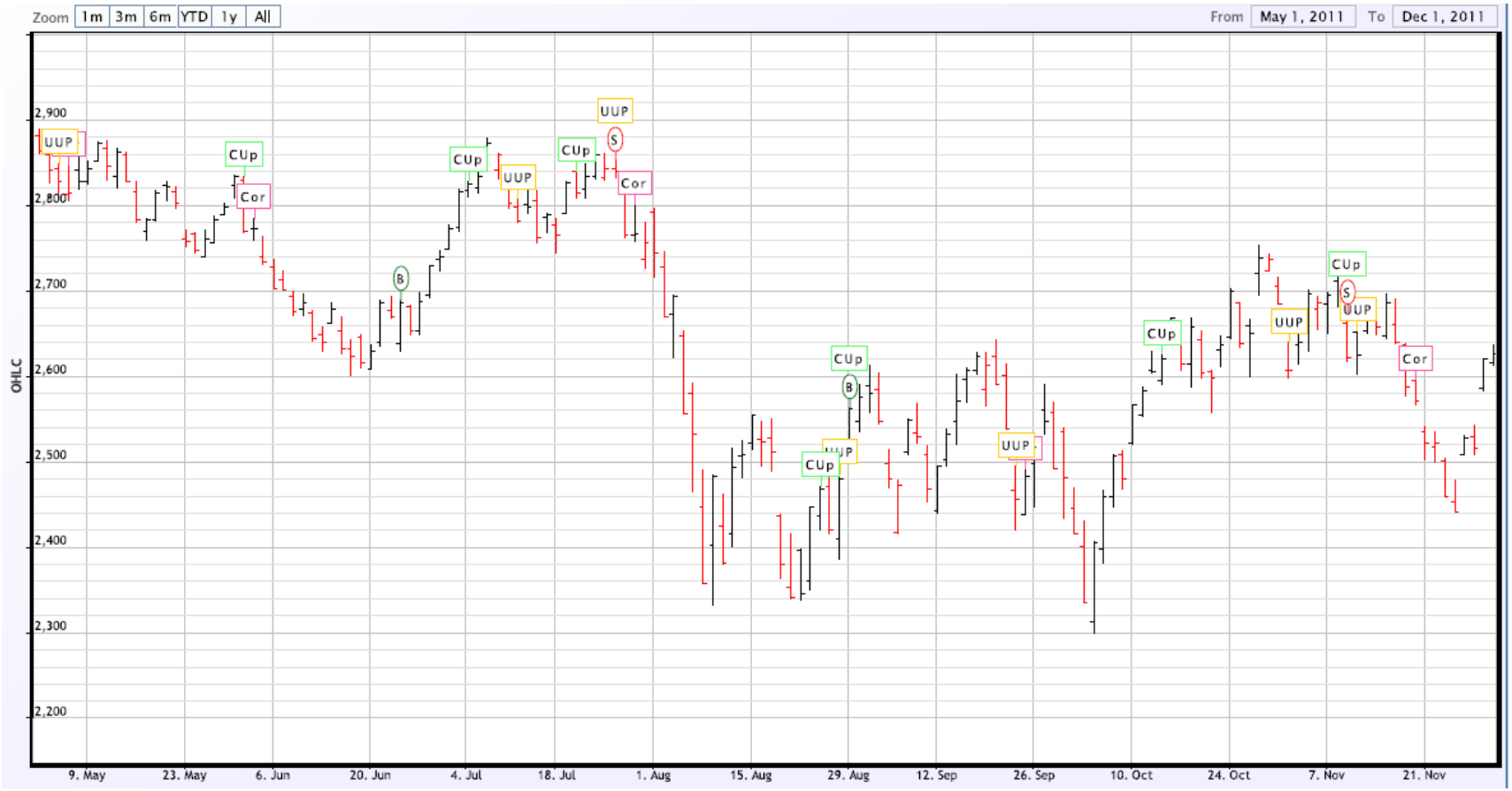

FIGURE 5.15. IBD Market Signals versus Keman-Mixed Market Signals from May 1, 2010 to December 1, 2011.

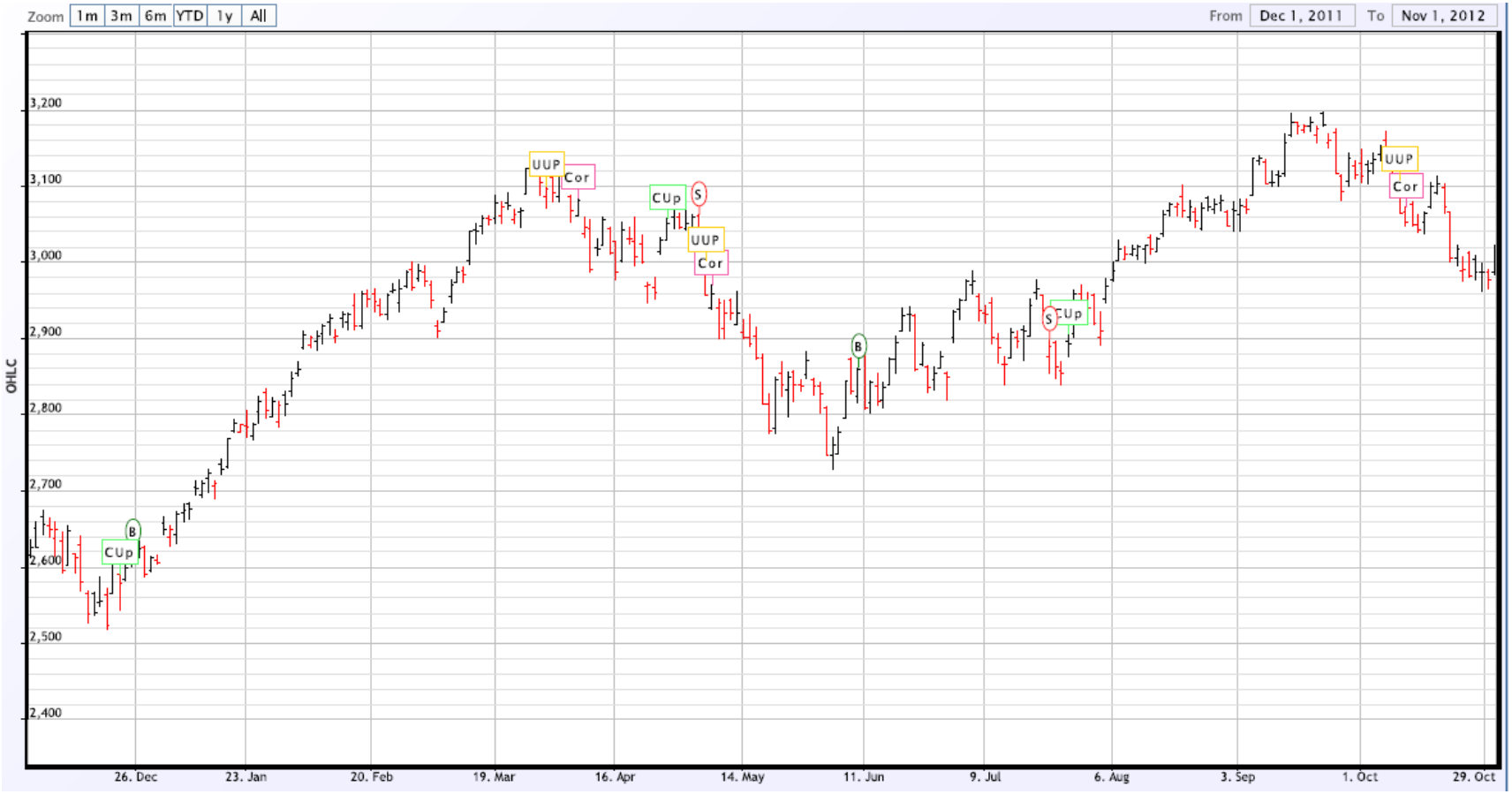

FIGURE 5.16. IBD Market Signals versus Keman-Mixed Market Signals from December 1, 2011 to November 1, 2012.

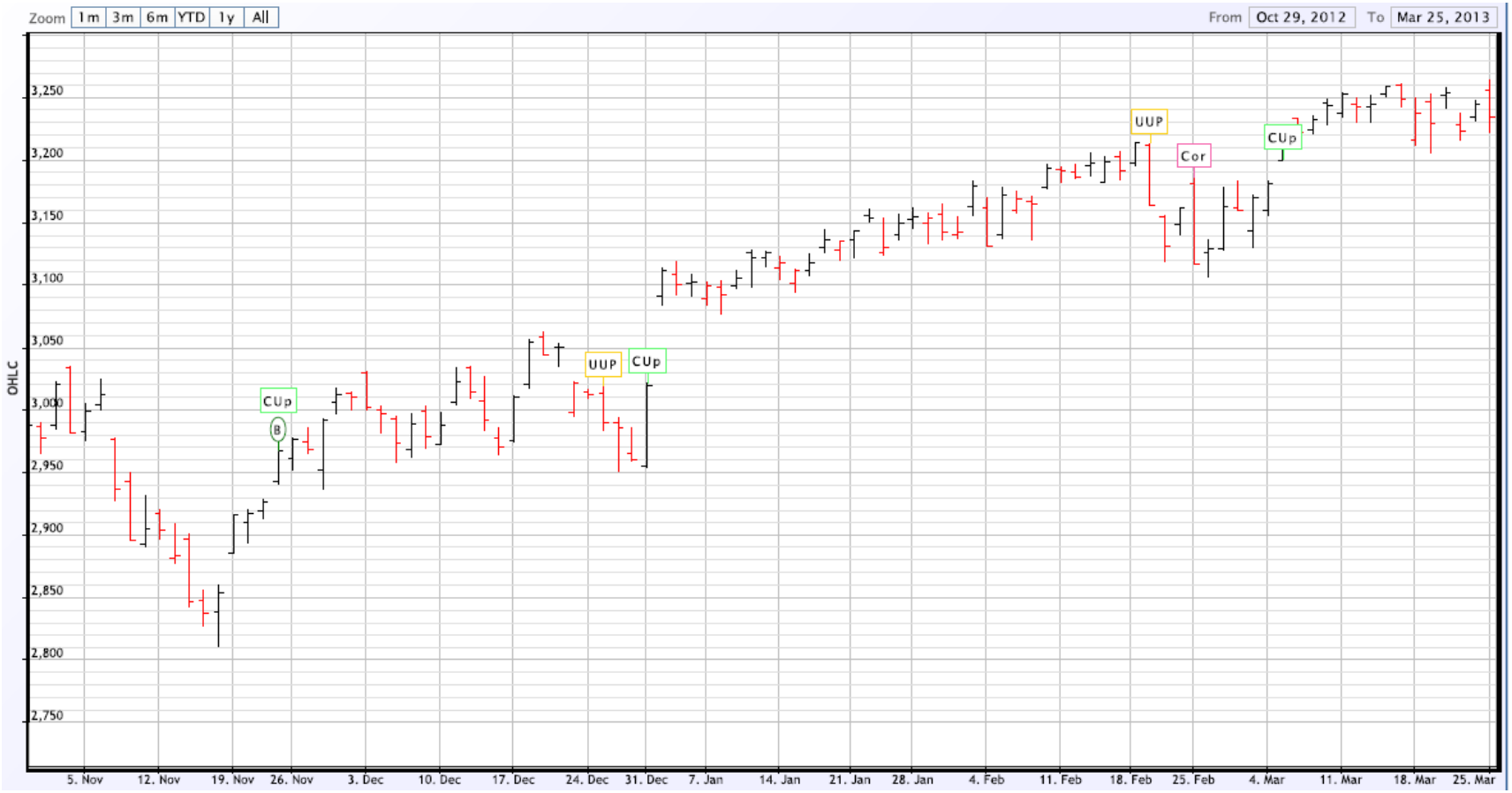

FIGURE 5.17. IBD Market Signals versus Keman-Mixed Real-Time Market Signals from November 1, 2012 to March 28, 2013.

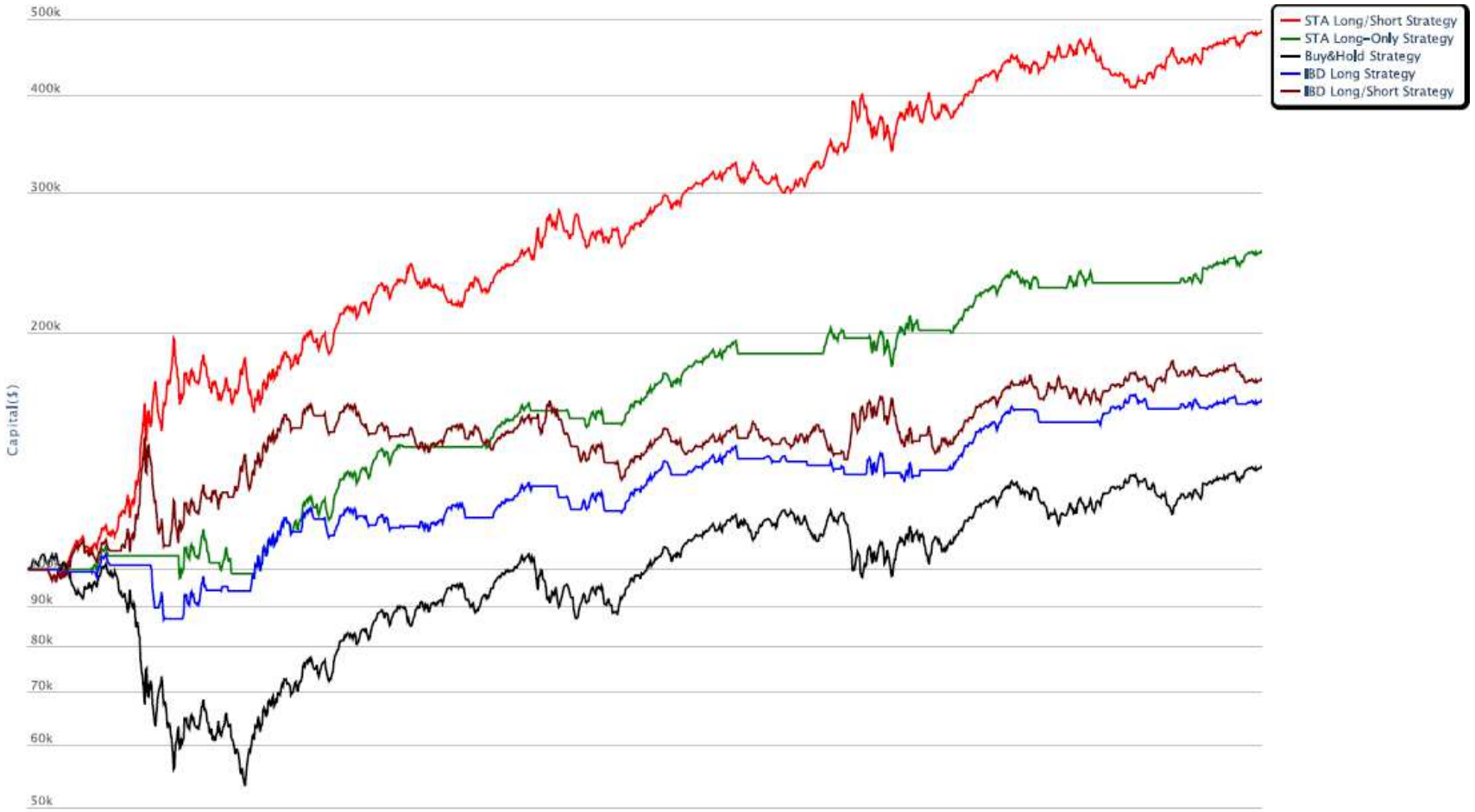

FIGURE 5.18. Growth of Capital for Keman-Mixed Long and Long/Short Strategies Compared with IBD Long, Long/Short Strategies and Buy&Hold from April 25, 2008 to March 28, 2013.

cian with PhD from Case Western Reserve and also a graduate from Sloan School of Management at MIT. [3] He created the VectorVest software using his own mathematical model that tries to define what causes a stock price to fall or to rise. Since we do not have access to all of their historical signals, we just compare our timing system performance with what is available for free in VectorVest's Website for a specific period starting from April 2008 to May 2010. This period includes the last economic crash. Figures 5.19 to 5.22 display buy and sell signals generated by these two different timing systems. We represent our buy(B) and sell(S) signals with green and red circles respectively. Buy(Bv) and sell(Sv) signals of VectorVest timing system are shown by blue and black rectangles respectively. Table 5.3.2 compares the trading results of these two timing systems together. As you can see, during the bull market starting from March 2009, the performance of Keman-Mixed timing system is much better than VectorVest in following the major uptrends. Keman-Mixed system is faster than VectorVest timing system in generating buy and sell signals. Keman-Mixed system does not miss the major uptrends to the detriment of few short-term trends. In terms of total number of trades, two timing systems are comparable. However, Keman-Mixed algorithm generate fewer buy and sell commands than VectorVest. Figure 5.23 compares the growth capital for Keman-Mixed strategies with VectorVest timing system.

TABLE 5.9. Performance Comparison between VectorVest Timing System and Keman timing System for Trading Period from May 2008 to May 2010

	Keman-Mixed	**VectorVest**
Total Number of Trades	12	14
Percent of Profitable Trades	55%	50%
Return on Initial Capital	163.13%	34.19%
Annual Return	62.17%	15.84%

[3] http://www.vectorvest.com/whyvv/DrBartDiLiddo.aspx

FIGURE 5.19. VectorVest Market Signals versus Keman-Mixed Market Signals from March 1, 2008 to September 1, 2008.

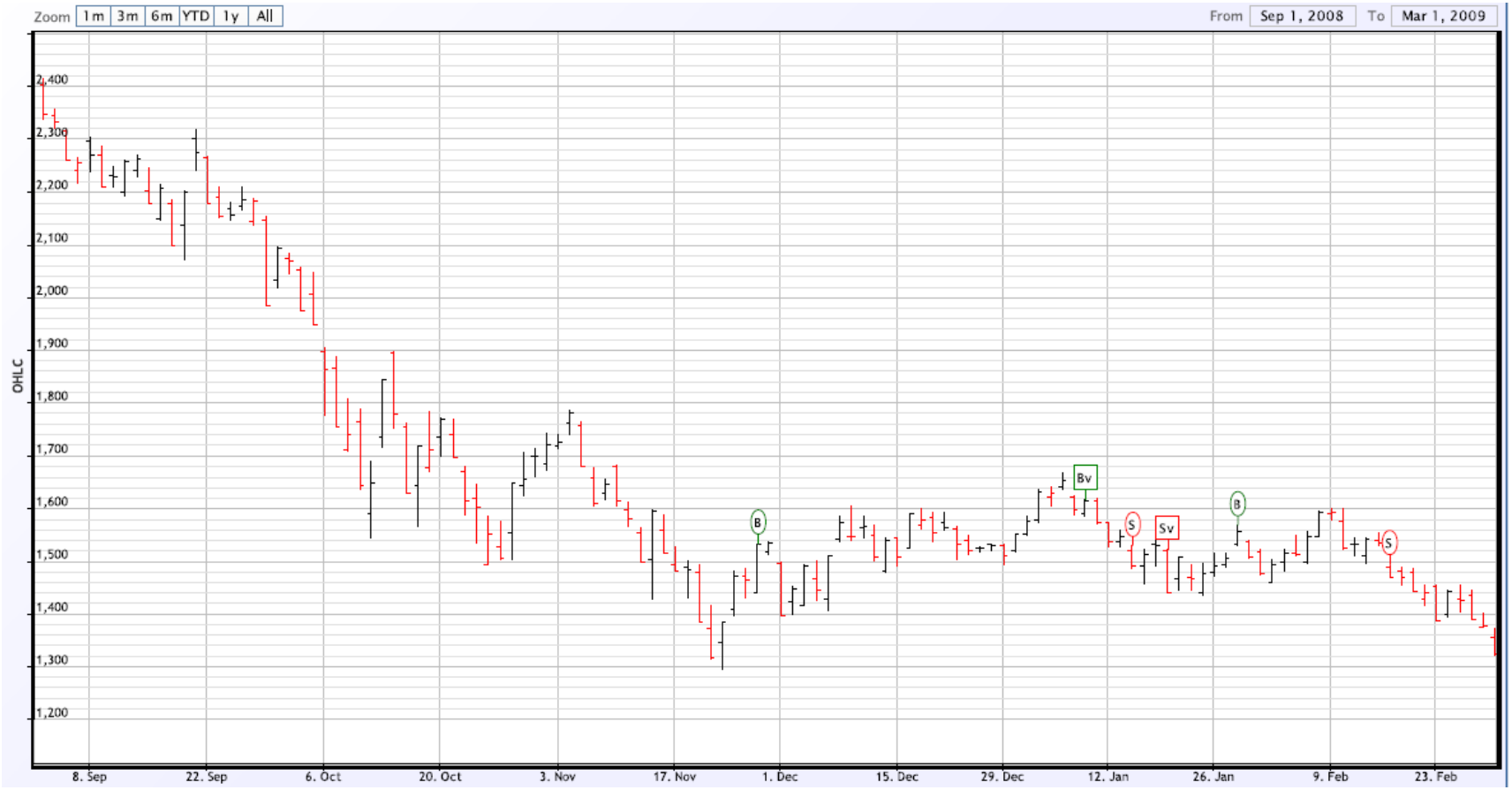

FIGURE 5.20. VectorVest Market Signals versus Keman-Mixed Market Signals from September 1, 2008 to March 1, 2009.

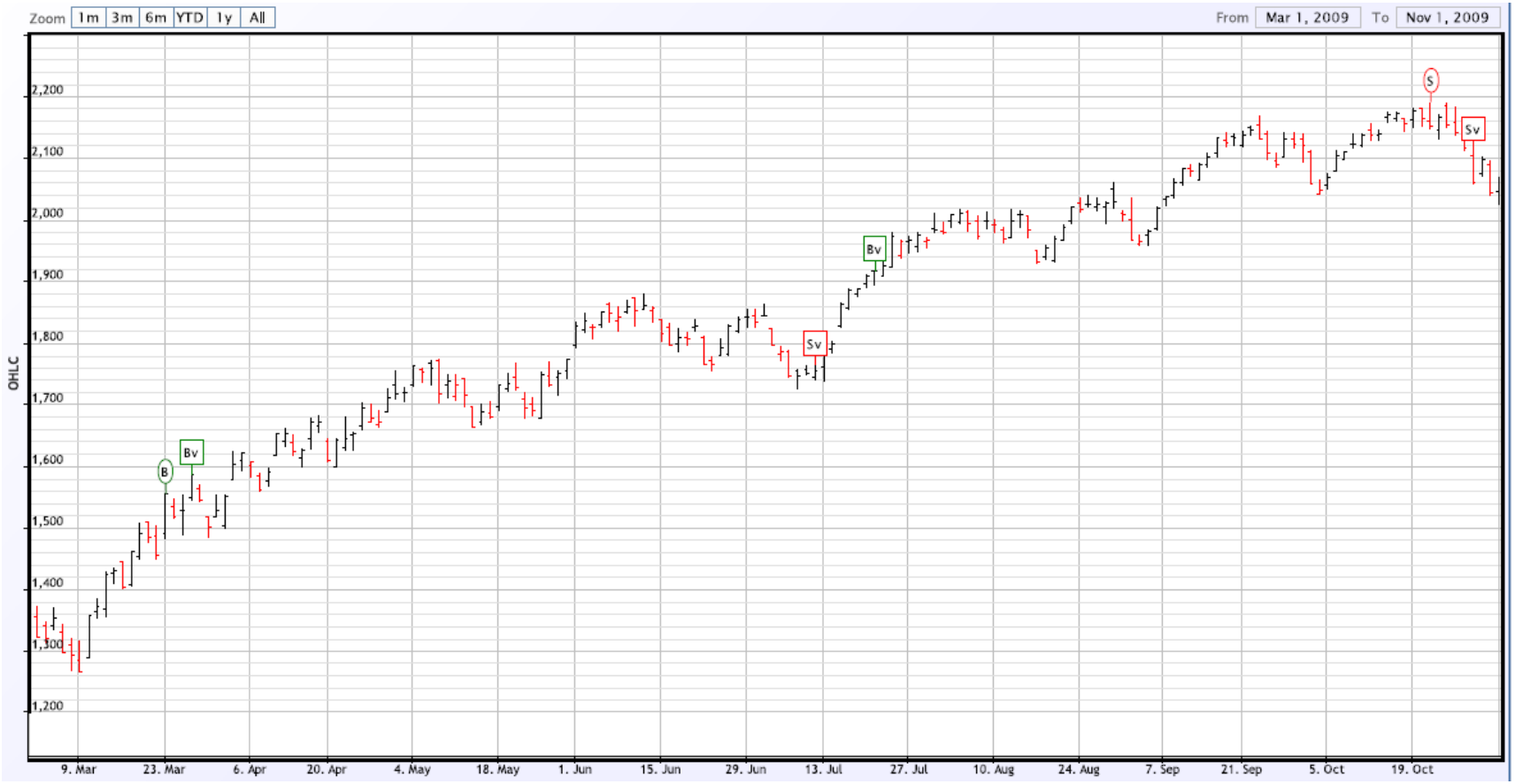

FIGURE 5.21. VectorVest Market Signals versus Keman-Mixed Market Signals from March 1, 2009 to November 1, 2009.

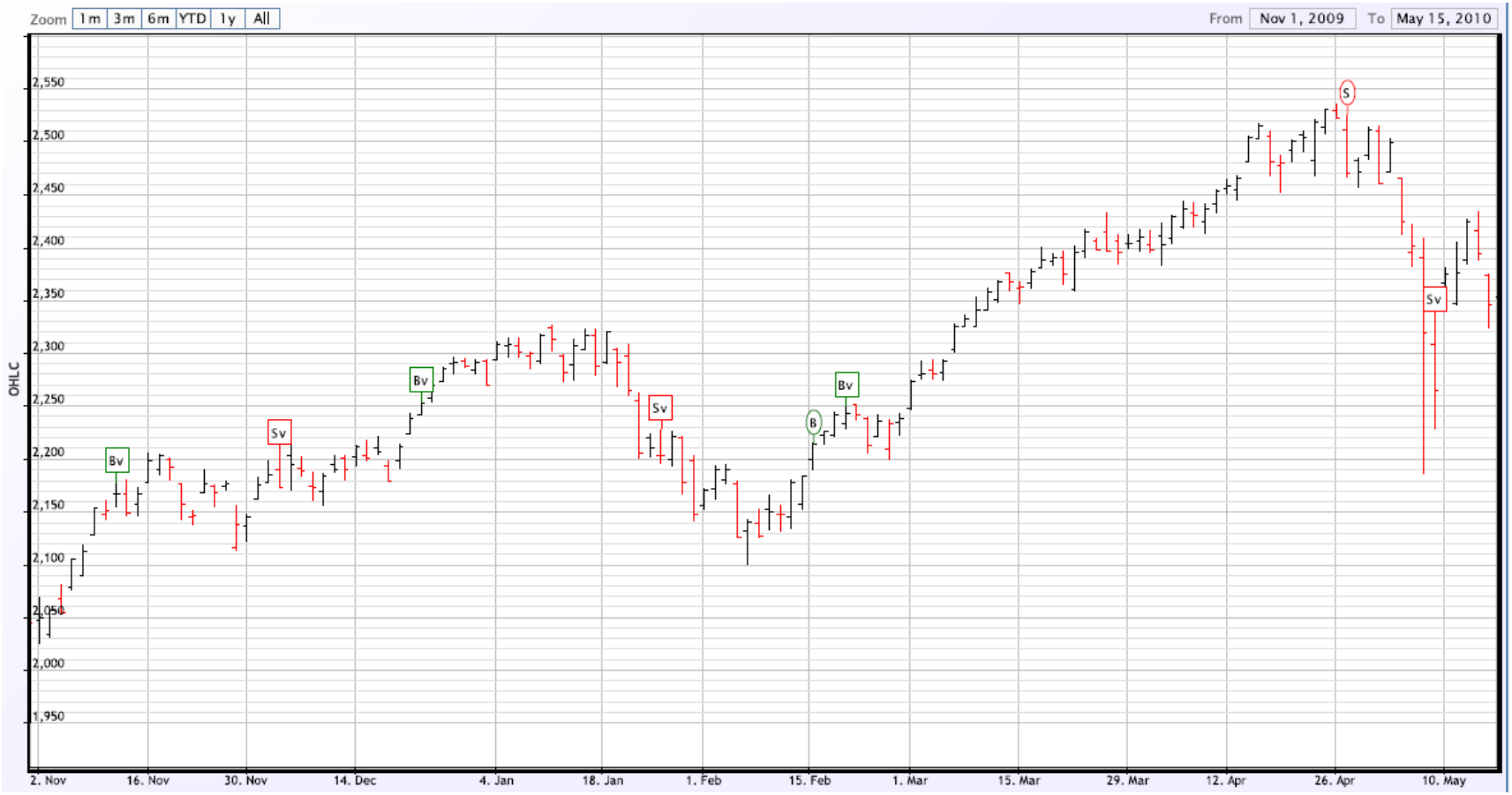

FIGURE 5.22. VectorVest Market Signals versus Keman-Mixed Market Signals from November 1, 2009 to May 15, 2010.

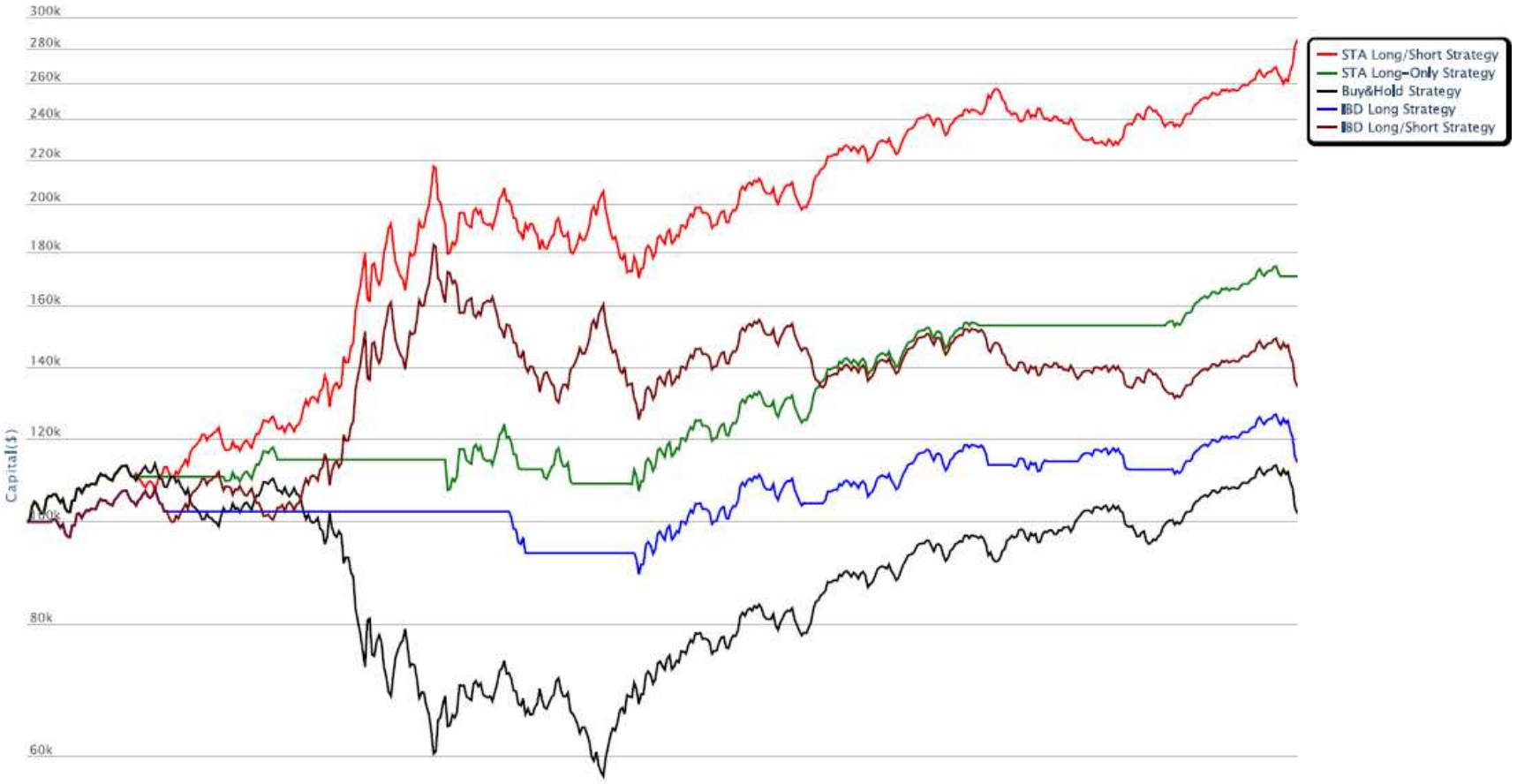

FIGURE 5.23. Growth of Capital for Keman-Mixed Long, Long/Short Strategies Compared with VectorVest Long, Long/Short Strategies and Buy&Hold from March 2008 to May 2010.

5.4 Comparison with AAII Stock Screens

As a more challenging contest, we take a look at different trading strategies introduced in AAII website named stock screens. They divided their investing strategies into the following categories:

- Value Screens,
- Value with Price Momentum Screens,
- Growth Screens,
- Growth with Price Momentum Screens (GVPM),
- Growth & Value Screens
- Growth & Value with Price Momentum Screens,
- Earnings Estimates Screens,
- Specialty/Sector Screens

Each stock screen strategy, selects a bunch of stocks that meet their trading criteria to construct a portfolio, and then they evaluate their performances monthly. Based on trading benchmark, they may sell some of them and/or buy other new stocks. Therefore, you should keep these two points in your mind that:

- These stock screens are not all applicable due to the low liquidity for some of the selected stocks,
- Each stock screen includes a diversified portfolio of stocks (See Appendix) and therefore, number of trades and transaction fees per month are considerable. But our Keman-Mixed approach is based on trading only one ETF and the average time between two consecutive trades is approximately two

months. So, transaction fees for Keman-Mixed timing algorithm are negligible.

We found the graphical comparison for the growth of capital more expressive than displaying the numbers in tables. Figures 5.24 to 5.28 compare the growth of capital for $1 as initial between the Keman Mixed Strategy and top 20 performers (in terms of total return) from August 1999 to March 2014. However, you may find the monthly performance of each strategy in Appendix in details along with some long-term statistics for each of them.

5.5 An Introduction to Fuzzy Trading System

So far for every buy, sell or short-sell signal the assumption was all-in strategy. In other words, we assumed that we put all of our money in our account in stock market after a buy signal and take all the money out of the market after every sell-cash signal.

Now, we want to create a trading algorithm by which we go partially long or short for buy and sell signals with different magnitudes. Therefore, the decision making system would be softer than the previous hard-decision version. A question may arise here is how to increase or decrease the amount of investment in stock market according to a given buy or sell signal. To create such an algorithm, we may split our money into two parts: *Saving* and *Investment*. Let's use $S(k)$ and $I(k)$ to show the amount of money in saving and investment accounts, respectively. Moreover, let's $C(k)$ be the total amount of our capital at k-th day. We have $C(k) = I(k) + S(k)$ as it is shown in Figure 5.29. As a general rule, the amount money in saving account does not change by change of the stock price. However, the balance in investment will change according to the type of current position and change in the price of the underlying stock. To raise or reduce the amount of investment, we have to take the money out of one account and add it to the other

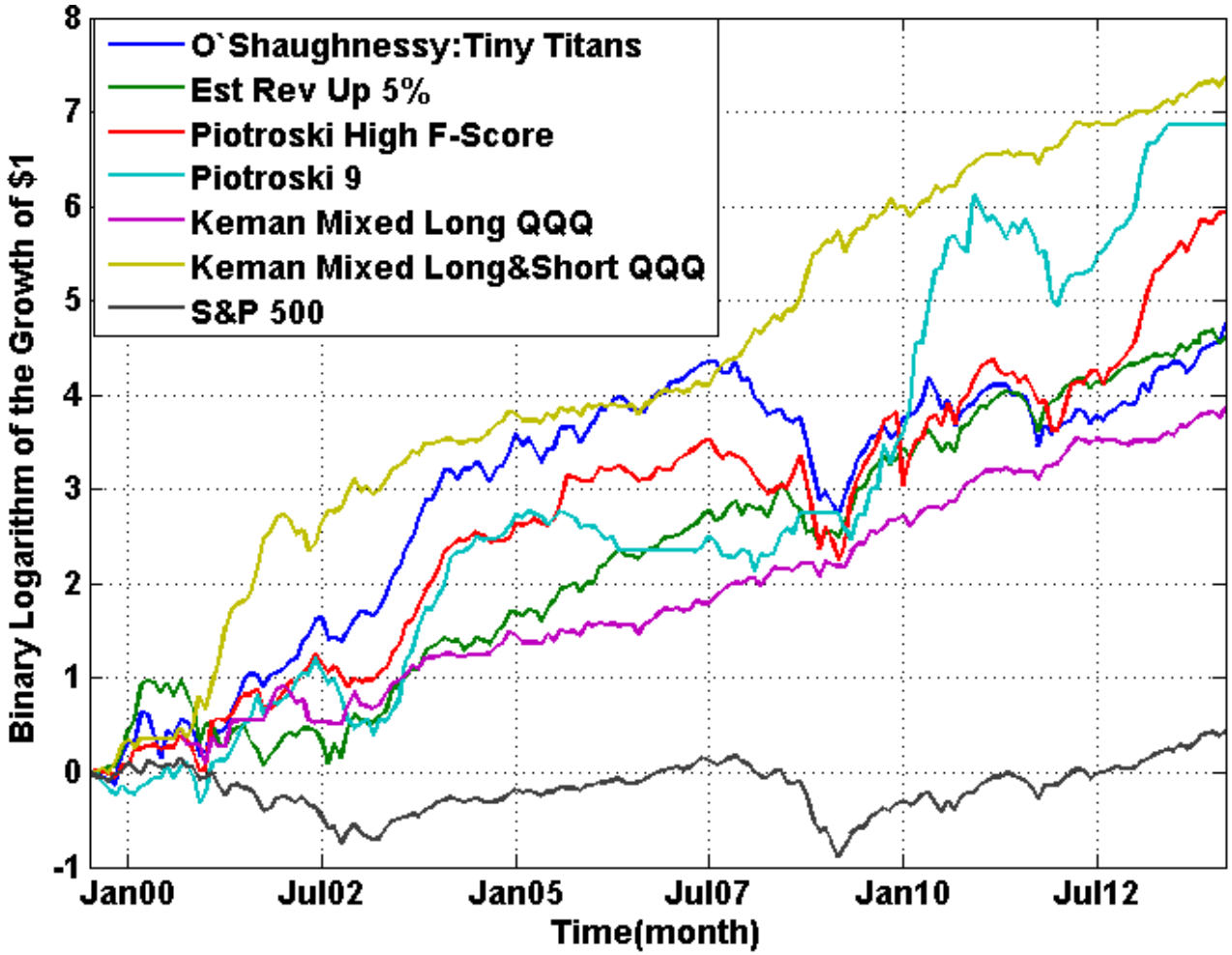

FIGURE 5.24. Comparison of the Growth of Capital Between Keman-Mixed Trader and Top 20 Performers From August 1999 to March 2014 (1 to 4).

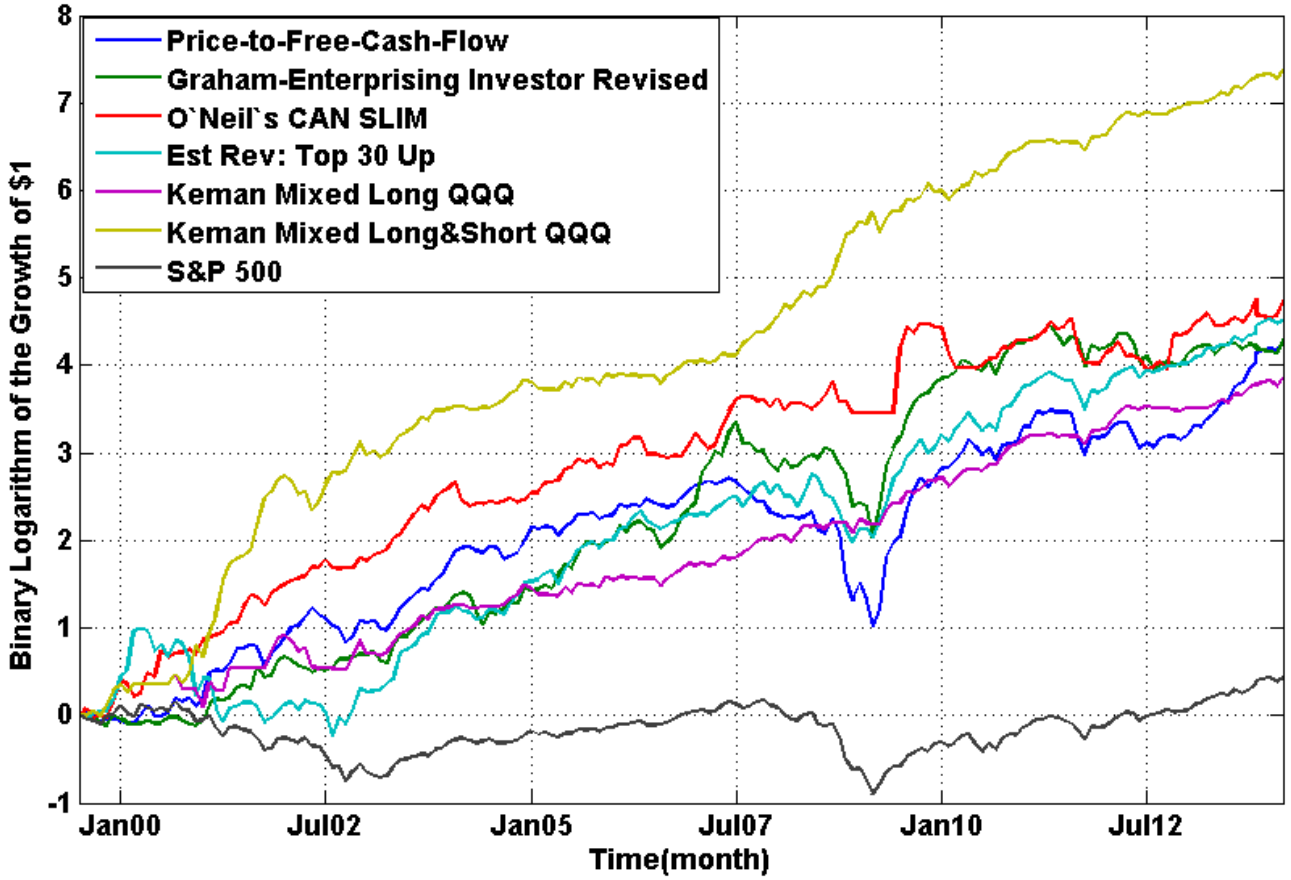

FIGURE 5.25. Comparison of the Growth of Capital Between Keman-Mixed Trader and Top 20 Performers From August 1999 to March 2014 (5 to 8).

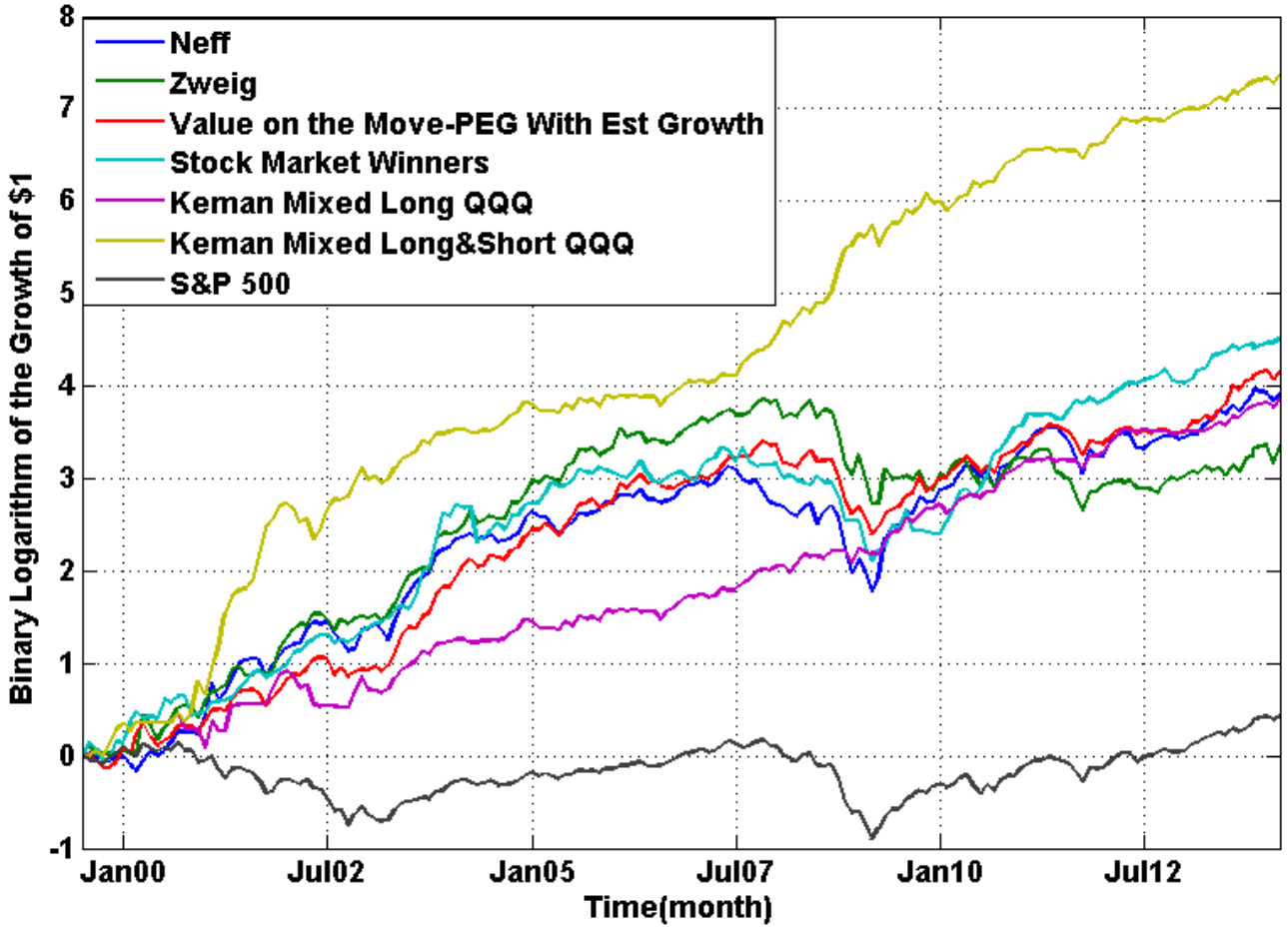

FIGURE 5.26. Comparison of the Growth of Capital Between Keman-Mixed Trader and Top 20 Performers From August 1999 to March 2014 (9 to 12).

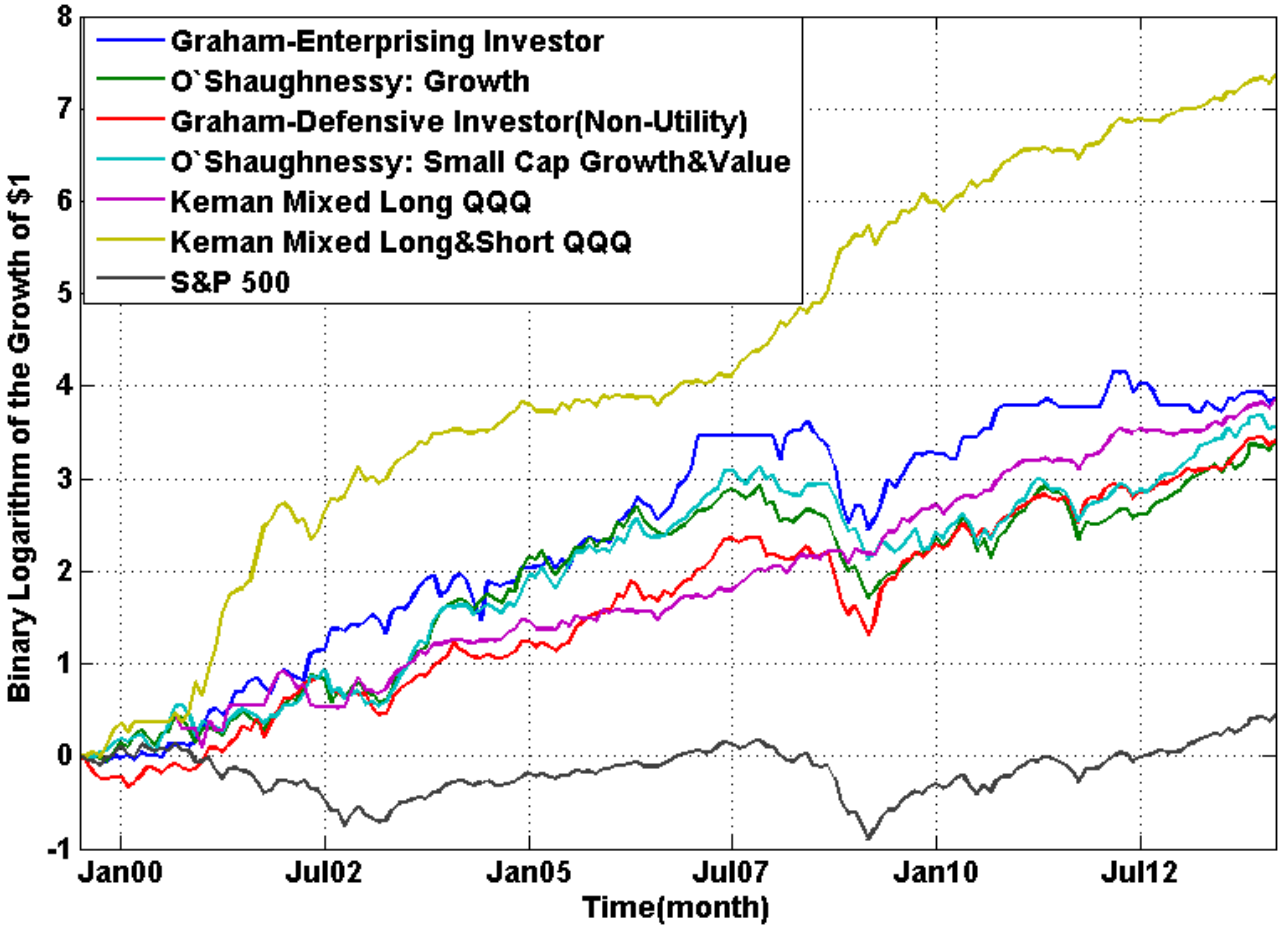

FIGURE 5.27. Comparison of the Growth of Capital Between Keman-Mixed Trader and Top 20 Performers From August 1999 to March 2014 (13 to 16).

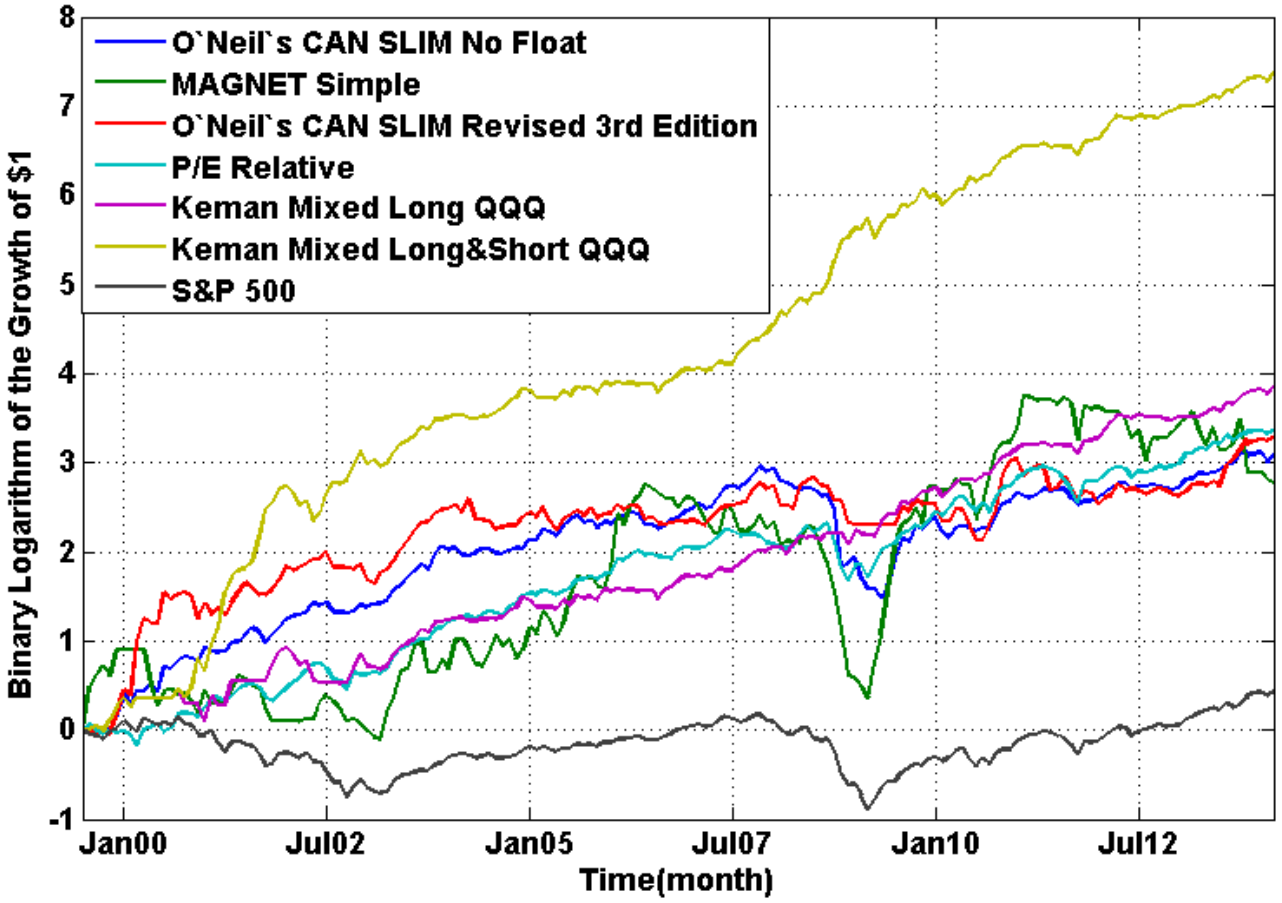

FIGURE 5.28. Comparison of the Growth of Capital Between Keman-Mixed Trader and Top 20 Performers From August 1999 to March 2014 (17 to 20).

one as an internal *Cash Flow*. So, we have the following equations for long position in stock:

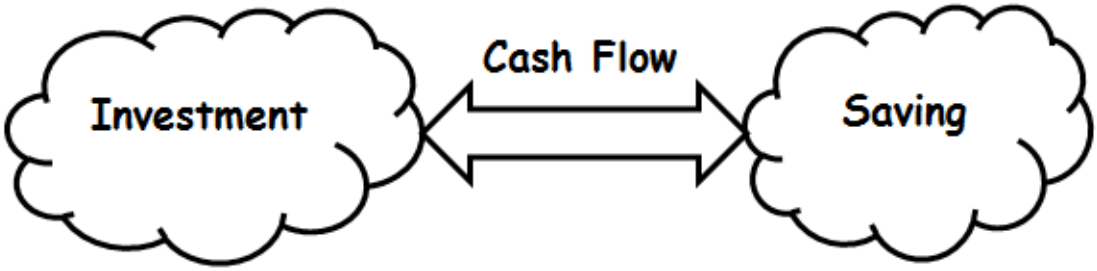

FIGURE 5.29. Saving and Investment Account with Internal Cash-Flows Used for Fuzzy Trading.

$$I(k) = I(k-1).\frac{P(k)}{P(k-1)} + CF(k) \qquad Long$$

$$I(k) = I(k-1).\frac{P(k-1)}{P(k)} + CF(k) \qquad Short$$

$$S(k) = S(k-1) - CF(k) \qquad Saving$$

where, $P(k)$ represents the price of the underlying stock at day k and $CF(k)$ is the amount cash flow from saving account to investment account. Now, we have these two equations for the total capital:

$$C(k) = I(k) + S(k) = I(k-1).\frac{P(k)}{P(k-1)} + S(k-1) \qquad Long$$

$$C(k) = I(k) + S(k) = I(k-1).\frac{P(k-1)}{P(k)} + S(k-1) \qquad Short$$

It obviously shows that the total capital in day k does not depend on the amount internal cash flows. Now, the problem is to determine the amount of $CF(k)$ at each day according to the magnitude of buy and sell signals. To do this, we consider four threshold levels for each of buy and sell signals:

$$0 < THB_1 < THB_2 < THB_3 < THB_4$$

$$THS_4 < THS_3 < THS_2 < THS_1 < 0$$

Corresponding to these eight threshold levels, we define nine different states for our fuzzy trading system as follows:

- $State(k) = 4$ or 100% in long position.
- $State(k) = 3$ or 75% in long position.
- $State(k) = 2$ or 50% in long position.
- $State(k) = 1$ or 25% in long position.
- $State(k) = 0$ or 100% in cash.
- $State(k) = -1$ or 25% in short position.
- $State(k) = -2$ or 50% in short position.
- $State(k) = -3$ or 75% in short position.
- $State(k) = -4$ or 100% in short position.

Basic idea to implement an appropriate algorithm for fuzzy trading can be described by using a state transition table as Table **??**. Once we want to raise our investment in either long or short positions, we look at our current state and the amount of money in the saving account.

On the other hand, whenever we want to reduce the money in the market, we look at our investment account and take out a portion of money according to our current and next state. Suppose that we are in cash position and we get a buy signal above the highest threshold level i.e., $Buy(k) > THB_4$, we need to insert all of the saving account into the investment account i.e. $CF(k) = S(k)$.

Now, if we had $THB_3 < Buy(k) < THB_4$, we would have $CF(k) = 0.75S(k)$. Remember we reduce the level of investment if and only if we get a sell signal beyond the threshold levels. Therefore, lower buy signals after a high level signal do not cause to reduce the investment level.

Although transition from cash to any investment level is easy to understand, transitions between mid-levels of investment may need more caution. Suppose that we are in state 2 or 50% in the market and we are allowed to go short. If we get $THS_3 < Sell(k) < THS_2$, then we jump from state 2 to state -2 without any change in the amount of investment. We only need to change our position from long to short in the same level, i.e. convert 50% long to 50% short. So, the amount cash flow would be zero in this case.

TABLE 5.10. Performance Summary of Fuzzy Trading Algorithm from 1998 to 2014

Total Net Profit	$2,544,800.00
Annual Rate of Return	23.03%
Total Number of Trades	158
Number of 100% Long Positions	63
Number of 75% Long Positions	14
Number of 50% Long Positions	14
Number of 25% Long Positions	19
Number of 100% Cash Positions	23
Number of 25% Short Positions	5
Number of 50% Short Positions	3
Number of 75% Short Positions	1
Number of 100% Short Positions	16
Wining Trades	89
Losing Trades	68

What if we had $THS_4 < S(k) < THS_3$? In this case, not only we need to change the position, but also we need to change the level of investment. We need to go from state 2 to state -3. So, we should increase the amount investment from 50% to 75% but in short position instead of long position. Since we have already 50% in the market, there exists 50% of initial capital in the saving account. We need to

add 25% of initial capital that is 50% of current saving balance to our investment account, i.e $CF(k) = 0.5S(k)$. Since our trading system also uses economic signals and they are only zero-one by nature, we consider any buy and sell signal from the economic analyzer as 100%-in, or 100%-cash.

Growth of capital for fuzzy trading algorithm has been shown in Figure 5.30. Results of trading based on such an algorithm have been given in Table 5.10. Annual rate of return is less than what we had got from hard-decision system. It was predictable, because we are following a more conservative strategy than previous one.

Another obvious difference is in the total number of trades that is much more than previous version due to the sensitivity of the trading system to the lower levels of buy and sell signals.

FIGURE 5.30. Growth of $\$100,000$ as Initial Capital for Fuzzy Trading Algorithm From 1998 to 2014.

Chapter 6
Conclusion

Assuming financial markets and specifically stock markets are predictable, we started this work and created a mechanical trading system, named Keman-Mixed Trader, to track the major trends of the US major indexes. Such a trading system is useful for small investors who wants to trade ETFs tracking major indexes. More than eighteen months of real-time results along with 14 years of back-testing show significant improvements with respect to buy and hold strategy and many other trading systems.

Keman-Mixed Trader includes two kind of trading systems: a technical trader working with daily data from the stock market including NASI, price and volume and a economic analyzer that uses monthly data for Industrial Production Index, Unemployment Rate, Commodity Price Index and the level of Margin Debt. These two traders sends the corresponding buy and sell signals to a decision making unit in which Keman Trader collect the data and generate buy, sell, hold, cash or short selling commands.

We evaluated the performance of our trading system absolutely in terms of the annualized return, risk and risk adjusted return and also relatively by comparing monthly returns with other trading strategies.

Our goal is to stay in the market in spite of short term declines but step out of the market whenever a major depreciation is coming. So, unlike other stochastic systems, we do not intend to predict the future prices. Instead, we try to predict the major trends by considering some monetary and economic data as well as the daily price and volume.

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Appendix:
Total Performance of Top 20 AAII Stock Screens

Total performance of the top 20 stock screens are given in the next 14 pages. We divide them into two groups of ten strategies, 1-10 and 11-20, respectively. These data are available for free on the AAII website and can be downloaded in spreadsheets. First rows of the table show the total performance in terms of risk and return criteria that are explained in chapter 1. Portfolio average is the monthly average of the number of stocks in the portfolio for each strategy from 1998 to 2014. More information about the terms and values are available at http://www.aaii.com.

As we mentioned before, some of the stock screen strategies are not applicable due to the lack of liquidity in some of their portfolio stocks.

Many stock screens show poor performance during the stock market crashes while the Keman Mixed trader displays either cash or short selling signals during those specific eras. The real time performance of the Keman Trader acknowledges its excellent tracking performance during the bull market of 2013 whereas many stock screens had a degraded performance due to the short-term volatility.

In total, Keman-Mixed system is more robust to stock market crashes to the detriment of missing some short-term uptrends. Again, risk and return go hand in hand.

	Piotroski 9 price chg	Piotroski: High F-Score price chg	Est Rev: Up 5% price chg	O'Shaughnessy: Tiny Titans price chg	Est Rev: Top 30 Up price chg	O'Neil's CAN SLIM price chg	Graham--Enterprising Investor Revised price chg	Price-to-Free-Cash-Flow price chg	Stock Market Winners price chg	Value on the Move--PEG With Est Growth price chg
Sharpe Ratio	28.3%	27.2%	27.2%	24.7%	25.3%	23.0%	22.0%	21.5%	24.5%	25.0%
Standard Deviation	11.0%	9.4%	8.0%	8.8%	8.4%	8.7%	8.0%	8.1%	6.7%	6.1%
Average Mthly Return	3.3%	2.8%	2.4%	2.4%	2.3%	2.2%	1.9%	1.9%	1.8%	1.7%
Highest Return	61.8%	43.1%	30.8%	37.4%	36.4%	69.6%	36.4%	51.2%	22.0%	15.7%
Lowest Return	-29.7%	-42.0%	-21.7%	-21.0%	-26.7%	-23.1%	-22.4%	-31.7%	-23.4%	-23.1%
Total Return	20010.9%	8350.5%	5171.5%	4508.9%	4264.8%	3451.9%	2234.0%	2190.8%	2128.3%	1804.6%
Portfolio Average	4	21	42	25	30	6	0	30	12	40
Max Passing	18	65	160	27	32	32	0	33	60	138
Min Passing	0	2	3	24	27	0	0	20	0	6
Average Turnover	37%	24%	93%	42%	93%	57%	100%	22%	59%	44%
1999 Performance	-13.8%	5.6%	36.8%	24.6%	34.9%	32.1%	-2.4%	-4.6%	9.4%	6.0%
Greatest Monthly Gain	6.8%	8.6%	17.6%	22.9%	19.7%	18.9%	7.5%	2.8%	14.2%	10.9%
Largest Monthly Loss	-7.3%	-2.8%	-8.0%	-5.5%	-7.8%		-6.0%	-6.3%	-7.8%	-7.2%
						0.0%				
2000 Performance	-0.9%	-2.8%	3.6%	-6.6%	-0.7%	38.0%	-1.4%	17.8%	27.6%	22.9%
Greatest Monthly Gain	8.8%	12.4%	30.8%	23.7%	36.4%	23.6%	4.8%	11.8%	17.5%	15.7%
Largest Monthly Loss	-17.2%	-13.0%	-21.7%	-15.6%	-26.7%	-8.7%	-3.8%	-7.7%	-13.8%	-10.3%
2001 Performance	100.2%	76.3%	-8.1%	84.1%	-18.3%	54.4%	65.8%	63.8%	41.6%	34.8%
Greatest Monthly Gain	25.7%	42.6%	11.4%	16.8%	11.1%	12.7%	18.4%	25.1%	7.7%	8.2%
Largest Monthly Loss	-14.1%	-12.8%	-13.8%	-7.9%	-21.7%	-6.2%	-7.4%	-14.4%	-4.6%	-9.4%
2002 Performance	-15.9%	7.6%	12.9%	51.9%	9.8%	20.5%	2.2%	13.6%	32.1%	7.9%
Greatest Monthly Gain	12.9%	8.8%	23.4%	13.0%	16.1%	8.1%	7.3%	12.9%	9.5%	8.1%
Largest Monthly Loss	-14.9%	-7.4%	-15.7%	-14.2%	-16.7%	-5.5%	-3.8%	-10.5%	-5.7%	-11.7%
2003 Performance	154.6%	131.6%	75.0%	154.8%	88.6%	79.0%	50.1%	61.7%	131.5%	87.0%

Greatest Monthly Gain	34.3%	14.9%	16.9%	15.3%	24.2%	10.0%	16.5%	10.6%	22.0%	14.5%
Largest Monthly Loss	-10.9%	0.1%	-1.9%	-1.8%	0.0%	-3.8%	-6.5%	-6.4%	-2.3%	-3.2%
2004 Performance	82.2%	37.7%	25.8%	45.8%	27.3%	-3.8%	10.2%	30.9%	9.6%	54.1%
Greatest Monthly Gain	21.6%	12.6%	11.6%	13.2%	11.9%	6.0%	12.6%	10.6%	10.7%	8.7%
Largest Monthly Loss	-1.7%	-4.1%	-6.4%	-8.2%	-5.8%	-14.0%	-11.9%	-8.3%	-23.4%	-5.1%
2005 Performance	-8.5%	37.8%	24.5%	7.5%	38.7%	24.1%	48.2%	10.6%	25.9%	23.1%
Greatest Monthly Gain	5.4%	20.6%	9.2%	17.0%	13.3%	9.4%	15.1%	6.9%	9.0%	9.4%
Largest Monthly Loss	-7.6%	-3.2%	-7.0%	-10.5%	-10.1%	-7.2%	-3.7%	-6.3%	-3.0%	-6.3%
2006 Performance	-15.8%	8.1%	40.3%	35.2%	22.4%	29.5%	34.5%	26.6%	-5.5%	18.3%
Greatest Monthly Gain	1.9%	9.2%	12.9%	10.8%	9.2%	16.6%	15.4%	9.3%	7.5%	14.2%
Largest Monthly Loss	-9.1%	-4.9%	-4.7%	-7.0%	-7.7%	-11.8%	-12.4%	-2.6%	-8.3%	-6.3%
2007 Performance	-1.3%	1.8%	25.7%	2.2%	26.2%	30.4%	29.4%	-21.2%	13.0%	29.5%
Greatest Monthly Gain	6.1%	6.0%	8.4%	8.0%	9.3%	14.8%	28.1%	3.3%	11.7%	6.9%
Largest Monthly Loss	-8.8%	-8.0%	-9.5%	-12.6%	-8.9%	-7.1%	-16.1%	-8.8%	-10.4%	-3.2%
2008 Performance	32.6%	-35.3%	-18.4%	-56.4%	-31.1%	-10.5%	-22.6%	-41.5%	-34.7%	-37.2%
Greatest Monthly Gain	16.0%	17.1%	15.2%	5.8%	17.7%	12.1%	10.1%	15.6%	6.9%	7.3%
Largest Monthly Loss	-13.1%	-21.1%	-15.6%	-19.8%	-13.2%	-14.7%	-22.4%	-31.7%	-17.2%	-15.7%
2009 Performance	78.3%	34.6%	86.3%	71.1%	110.0%	97.3%	168.4%	147.2%	-9.0%	24.2%
Greatest Monthly Gain	38.2%	43.1%	14.3%	15.3%	21.6%	69.6%	36.4%	51.2%	16.8%	12.7%
Largest Monthly Loss	-13.3%	-42.0%	-6.0%	-8.6%	-9.9%	-4.4%	-22.2%	-18.9%	-17.3%	-11.9%
2010 Performance	431.3%	138.8%	35.9%	21.1%	47.6%	-9.6%	32.9%	39.2%	124.6%	29.7%
Greatest Monthly Gain	61.8%	24.8%	17.0%	19.7%	19.1%	8.9%	13.7%	13.4%	17.1%	12.0%
Largest Monthly Loss	-8.5%	-13.5%	-7.5%	-16.5%	-8.2%	-18.7%	-9.3%	-8.9%	-6.1%	-6.4%
2011 Performance	-51.7%	-36.4%	6.1%	-22.9%	-2.3%	-10.2%	-4.1%	-7.0%	21.2%	-0.3%
Greatest Monthly Gain	13.4%	5.1%	18.8%	16.1%	15.9%	9.2%	17.4%	15.1%	8.6%	11.3%

Largest Monthly Loss	-29.7%	-18.8%	-12.7%	-17.5%	-12.6%	-21.0%	-18.6%	-18.2%	-3.7%	-9.4%
2012 Performance	105.6%	91.7%	28.8%	20.0%	21.9%	18.0%	-4.9%	1.1%	13.6%	9.0%
Greatest Monthly Gain	17.3%	18.7%	8.2%	7.3%	9.8%	31.6%	9.3%	7.3%	4.7%	5.7%
Largest Monthly Loss	-0.1%	-9.8%	-7.0%	-8.3%	-8.3%	-10.8%	-14.9%	-11.5%	-7.3%	-5.2%
2013 Performance	82.6%	137.6%	27.7%	54.4%	42.1%	13.1%	2.1%	97.8%	34.8%	59.5%
Greatest Monthly Gain	34.6%	21.3%	9.4%	15.3%	6.7%	13.0%	5.2%	12.9%	9.6%	14.8%
Largest Monthly Loss	0.0%	-6.6%	-4.1%	-7.4%	-3.5%	-11.7%	-6.8%	-0.3%	-3.8%	-3.5%
2014 Performance	0.0%	7.8%	-5.2%	16.5%	-0.4%	14.5%	9.7%	5.9%	3.1%	-1.5%
Greatest Monthly Gain	0.0%	7.5%	4.0%	13.0%	2.9%	13.3%	11.1%	8.5%	2.8%	5.9%
Largest Monthly Loss	0.0%	0.3%	-8.8%	3.1%	-3.2%	1.0%	-1.3%	-2.4%	0.3%	-7.0%
Jul 1999	0.0%	1.8%	-1.6%	-1.1%	-3.2%	5.3%	0.1%	1.2%	10.2%	1.9%
Aug 1999	-7.3%	-1.3%	1.7%	-1.9%	4.2%	-7.1%	-1.4%	-0.7%	-4.7%	-5.9%
Sep 1999	-5.1%	-0.9%	4.5%	-2.2%	2.6%	2.1%	-4.9%	-6.3%	-7.8%	-4.6%
Oct 1999	-3.5%	-2.8%	0.6%	-3.5%	0.1%	-1.3%	-1.2%	2.8%	0.3%	0.2%
Nov 1999	6.8%	8.6%	10.7%	22.9%	8.7%	12.6%	7.5%	-0.1%	14.2%	4.3%
Dec 1999	-5.0%	0.6%	17.6%	10.7%	19.7%	18.9%	-2.3%	-1.4%	-1.3%	10.9%
Jan 2000	-0.5%	12.4%	6.7%	0.6%	6.4%	-3.4%	-3.8%	-2.0%	17.5%	-3.2%
Feb 2000	5.5%	0.6%	30.8%	23.7%	36.4%	-8.7%	-0.8%	0.9%	7.5%	15.7%
Mar 2000	1.9%	1.6%	2.6%	-0.7%	2.2%	2.4%	1.0%	5.8%	-4.1%	7.4%
Apr 2000	4.4%	0.8%	-1.2%	-15.5%	-2.0%	17.3%	1.4%	7.9%	1.2%	-10.3%
May 2000	-0.1%	-3.3%	-7.4%	-14.2%	-15.0%	-2.9%	-1.7%	-7.7%	-1.3%	-5.6%
Jun 2000	7.6%	2.4%	7.5%	21.8%	5.3%	23.6%	0.3%	0.0%	15.5%	3.6%
Jul 2000	-6.9%	-0.5%	-9.4%	-4.1%	-9.4%	-5.8%	4.8%	3.1%	-2.7%	3.0%
Aug 2000	8.8%	7.8%	13.3%	13.7%	14.5%	3.6%	0.2%	11.8%	5.0%	8.3%
Sep 2000	2.7%	-2.7%	-9.3%	-1.8%	-3.7%	0.3%	-3.1%	-2.0%	0.3%	0.5%
Oct 2000	-9.6%	-7.7%	-11.3%	-7.7%	-8.9%	2.8%	-2.4%	2.6%	-13.8%	-0.6%
Nov 2000	-17.2%	-13.0%	-21.7%	-15.6%	-26.7%	-4.1%	-1.5%	-6.4%	1.6%	-4.1%
Dec 2000	6.1%	1.3%	13.7%	2.7%	14.3%	12.5%	4.6%	4.2%	1.8%	8.9%
Jan 2001	25.7%	42.6%	1.0%	16.8%	0.1%	1.0%	13.8%	25.1%	7.0%	8.2%

Feb 2001	1.8%	1.6%	-13.8%	-0.7%	-21.7%	3.2%	3.9%	2.0%	1.0%	0.6%
Mar 2001	0.1%	-1.9%	-2.0%	2.7%	-9.2%	2.1%	-0.4%	-1.0%	0.4%	-0.8%
Apr 2001	7.0%	5.4%	11.4%	12.4%	11.1%	6.6%	1.7%	6.1%	1.7%	8.2%
May 2001	13.1%	10.7%	3.7%	14.2%	2.2%	0.9%	8.1%	13.2%	7.7%	6.5%
Jun 2001	7.6%	4.0%	0.6%	12.1%	2.1%	12.7%	1.8%	-0.1%	4.7%	1.1%
Jul 2001	3.9%	0.4%	-11.8%	3.4%	0.4%	9.9%	-2.9%	2.5%	7.5%	0.5%
Aug 2001	20.3%	3.7%	-4.7%	-0.6%	-2.9%	-1.5%	18.4%	-1.1%	0.9%	-2.5%
Sep 2001	-14.1%	-12.8%	-11.0%	-7.9%	-12.4%	-6.2%	-7.4%	-14.4%	-4.6%	-9.4%
Oct 2001	10.9%	-0.7%	8.7%	8.5%	3.5%	10.5%	1.5%	10.0%	3.3%	5.8%
Nov 2001	-3.3%	5.2%	4.8%	1.1%	5.9%	3.3%	12.6%	5.7%	2.2%	6.5%
Dec 2001	4.2%	7.9%	8.9%	3.5%	5.8%	3.4%	3.5%	7.1%	4.3%	7.2%
Jan 2002	3.6%	7.6%	2.3%	6.1%	1.2%	3.3%	-3.5%	9.2%	9.5%	4.8%
Feb 2002	10.1%	-0.4%	-2.7%	1.8%	-5.8%	2.0%	-3.8%	1.0%	1.5%	-0.7%
Mar 2002	6.3%	6.9%	6.6%	13.0%	7.4%	1.4%	-1.4%	7.2%	5.2%	4.7%
Apr 2002	-1.1%	5.3%	0.4%	4.7%	-1.6%	8.1%	-3.0%	7.1%	3.6%	8.1%
May 2002	12.9%	8.8%	-2.1%	12.0%	-1.7%	-0.9%	1.9%	-4.2%	3.3%	1.0%
Jun 2002	-8.5%	-7.2%	-7.2%	1.4%	-5.8%	6.1%	-0.8%	-4.3%	-0.1%	-0.9%
Jul 2002	-9.2%	-5.3%	-15.7%	-14.2%	-16.7%	-5.5%	1.6%	-5.1%	-5.7%	-11.7%
Aug 2002	3.3%	4.3%	17.2%	1.0%	15.4%	-0.9%	7.3%	-1.9%	2.8%	5.8%
Sep 2002	-12.9%	-7.3%	-10.8%	-3.1%	-4.9%	0.8%	0.2%	-10.5%	-2.2%	-6.8%
Oct 2002	-14.9%	-7.4%	23.4%	8.2%	14.3%	-0.4%	1.5%	5.9%	3.0%	4.4%
Nov 2002	-6.0%	6.9%	12.7%	9.6%	16.1%	8.1%	2.5%	12.9%	4.8%	1.8%
Dec 2002	3.9%	-2.5%	-4.9%	5.2%	-3.0%	-2.4%	0.1%	-1.9%	3.3%	-1.0%
Jan 2003	2.7%	1.4%	-1.9%	-0.7%	1.2%	5.0%	1.1%	1.2%	3.5%	2.6%
Feb 2003	-10.9%	0.1%	0.0%	-1.8%	0.0%	1.8%	-6.5%	-6.4%	1.0%	-3.2%
Mar 2003	11.9%	5.0%	4.3%	5.1%	5.3%	2.9%	-1.3%	-0.8%	2.7%	4.6%
Apr 2003	-0.7%	3.8%	5.0%	11.9%	4.3%	9.4%	16.5%	8.9%	6.0%	11.9%
May 2003	7.6%	11.7%	16.9%	12.1%	24.2%	3.1%	6.1%	10.1%	3.9%	13.1%
Jun 2003	7.0%	6.7%	2.8%	7.2%	1.0%	8.1%	-0.4%	4.9%	-2.3%	5.1%
Jul 2003	34.3%	14.9%	5.5%	14.9%	3.9%	8.7%	7.4%	4.9%	9.7%	-0.5%
Aug 2003	7.8%	4.1%	7.2%	9.3%	8.9%	6.6%	5.5%	4.9%	19.4%	8.8%
Sep 2003	18.6%	11.1%	0.2%	14.1%	1.5%	-3.8%	4.2%	-0.8%	5.1%	3.3%
Oct 2003	15.0%	12.0%	14.0%	15.3%	14.6%	10.0%	5.2%	6.9%	22.0%	14.5%

Nov 2003	0.0%	6.2%	2.8%	0.5%	2.1%	6.2%	-0.2%	5.9%	21.9%	5.8%
Dec 2003	10.1%	11.3%	2.2%	11.4%	0.8%	2.5%	5.7%	10.6%	-2.2%	0.1%
Jan 2004	8.4%	12.6%	4.4%	11.3%	4.4%	4.9%	5.8%	8.3%	8.7%	7.9%
Feb 2004	21.6%	4.3%	-2.4%	-0.5%	-3.7%	-14.0%	1.8%	3.1%	-2.2%	8.7%
Mar 2004	4.5%	4.2%	0.4%	-6.1%	-0.6%	-4.4%	-1.7%	0.7%	0.9%	4.9%
Apr 2004	0.3%	-0.6%	-6.4%	8.2%	-5.8%	1.9%	-11.9%	-2.8%	-23.4%	-5.1%
May 2004	3.5%	2.4%	3.7%	-0.3%	2.1%	0.0%	-10.6%	-1.6%	3.5%	0.5%
Jun 2004	7.7%	4.0%	5.4%	5.0%	6.2%	1.9%	10.4%	4.8%	4.9%	7.6%
Jul 2004	-1.7%	-2.5%	-1.8%	-5.9%	-0.9%	-1.5%	-0.4%	-0.8%	5.7%	-1.2%
Aug 2004	0.3%	-4.1%	-3.0%	-8.2%	-3.0%	1.9%	4.7%	-8.3%	-4.2%	-1.7%
Sep 2004	0.5%	0.6%	8.8%	10.8%	8.6%	2.3%	4.2%	1.4%	10.7%	7.2%
Oct 2004	2.7%	0.1%	4.9%	1.6%	6.3%	-3.1%	-0.6%	3.2%	0.5%	2.3%
Nov 2004	6.5%	1.7%	11.6%	12.4%	11.9%	1.8%	12.6%	10.3%	7.4%	8.4%
Dec 2004	9.3%	11.1%	-1.0%	13.2%	0.3%	6.0%	-1.7%	10.6%	1.5%	5.8%
Jan 2005	-2.1%	-0.9%	-2.0%	-8.8%	1.6%	-0.3%	0.5%	-1.0%	0.5%	-0.3%
Feb 2005	4.1%	0.9%	4.7%	5.9%	5.3%	8.1%	3.6%	1.9%	7.0%	4.5%
Mar 2005	-1.3%	3.5%	-1.6%	-8.7%	2.1%	0.9%	-2.2%	-0.5%	9.0%	-3.7%
Apr 2005	-2.3%	-3.2%	-7.0%	-8.6%	-10.1%	0.9%	10.6%	-6.3%	-3.0%	-4.5%
May 2005	-5.8%	-0.8%	9.2%	10.3%	13.3%	9.4%	9.2%	6.7%	0.3%	7.3%
Jun 2005	5.4%	4.8%	6.8%	0.4%	6.4%	2.2%	-3.7%	3.5%	4.1%	7.7%
Jul 2005	4.6%	12.4%	9.2%	17.0%	8.8%	6.1%	15.1%	6.9%	9.0%	9.4%
Aug 2005	-2.3%	20.6%	0.8%	-0.4%	3.8%	-2.3%	6.5%	0.3%	-2.2%	0.4%
Sep 2005	-1.9%	-0.1%	3.2%	0.0%	2.3%	3.0%	0.6%	1.0%	-0.6%	3.4%
Oct 2005	-7.6%	-3.0%	-6.4%	-10.5%	-4.8%	-7.2%	-3.1%	-5.0%	4.5%	-6.3%
Nov 2005	1.9%	0.1%	7.2%	8.1%	6.9%	4.8%	3.7%	2.5%	-2.7%	2.8%
Dec 2005	-0.7%	0.5%	-0.2%	7.0%	-0.2%	-2.6%	1.0%	1.0%	-1.6%	1.7%
Jan 2006	-4.4%	9.2%	12.9%	10.8%	9.2%	16.6%	13.0%	9.3%	-1.9%	14.2%
Feb 2006	-4.9%	-1.1%	1.5%	0.4%	1.9%	0.7%	-5.3%	-2.5%	-2.0%	-3.3%
Mar 2006	1.9%	0.2%	6.7%	5.6%	7.7%	6.1%	7.2%	1.4%	5.5%	6.0%
Apr 2006	-9.1%	2.6%	5.0%	3.3%	5.2%	-0.4%	1.6%	-0.7%	7.5%	4.5%
May 2006	0.0%	-3.5%	-4.7%	-2.5%	-7.7%	-11.8%	-5.4%	5.7%	-8.3%	-6.3%
Jun 2006	0.0%	-2.3%	-0.2%	-7.0%	-3.2%	-0.1%	-1.9%	-2.4%	-6.5%	1.4%
Jul 2006	0.0%	-4.9%	-2.3%	-0.4%	-3.3%	-1.7%	-12.4%	-2.6%	-0.9%	-2.7%

Aug 2006	0.0%	1.1%	4.8%	0.1%	3.3%	-1.4%	4.7%	-1.2%	4.6%	-1.8%
Sep 2006	0.0%	1.0%	3.0%	8.3%	3.2%	1.7%	6.3%	1.1%	2.7%	-0.3%
Oct 2006	0.0%	8.4%	2.3%	5.7%	2.2%	-0.1%	15.4%	6.5%	0.9%	4.2%
Nov 2006	0.0%	-1.7%	5.5%	-0.8%	3.6%	7.9%	4.6%	4.8%	-4.1%	1.8%
Dec 2006	0.0%	-0.2%	1.0%	8.5%	-0.6%	11.5%	5.9%	5.3%	-2.0%	0.9%
Jan 2007	0.0%	6.0%	1.5%	1.2%	0.8%	-7.1%	28.1%	1.4%	11.7%	2.1%
Feb 2007	0.0%	4.6%	1.7%	1.2%	-1.2%	-5.4%	6.9%	2.0%	4.2%	-1.7%
Mar 2007	-0.2%	2.7%	3.7%	4.5%	5.5%	3.5%	9.6%	-2.0%	1.8%	4.4%
Apr 2007	-1.0%	2.8%	2.6%	3.0%	3.4%	14.8%	-2.8%	1.0%	8.3%	5.3%
May 2007	4.4%	4.6%	6.6%	4.5%	5.1%	14.0%	20.2%	3.3%	-2.8%	6.9%
Jun 2007	6.1%	2.1%	3.5%	1.4%	1.4%	9.5%	8.8%	-3.4%	-8.0%	-0.8%
Jul 2007	-3.9%	-8.0%	-6.9%	0.1%	-7.5%	2.5%	-16.1%	-4.7%	11.7%	1.8%
Aug 2007	-8.8%	-5.6%	2.3%	-8.3%	6.6%	0.0%	0.0%	-5.2%	-10.4%	-0.2%
Sep 2007	-0.8%	4.2%	8.4%	0.3%	9.3%	-3.4%	-5.8%	-4.8%	-3.0%	6.4%
Oct 2007	-1.2%	-2.4%	4.1%	8.0%	4.1%	0.7%	0.5%	0.1%	1.0%	5.1%
Nov 2007	6.1%	-1.8%	-9.5%	-12.6%	-8.9%	-5.7%	-9.6%	-8.8%	-0.1%	-3.2%
Dec 2007	-1.1%	-6.1%	6.8%	0.7%	6.7%	6.5%	-5.6%	-1.7%	0.5%	0.7%
Jan 2008	-13.1%	-6.3%	-2.6%	-12.9%	-7.7%	-8.2%	10.1%	-1.6%	-9.2%	-13.0%
Feb 2008	12.6%	-6.6%	0.9%	-3.8%	-0.2%	5.9%	-6.5%	1.9%	1.3%	-0.9%
Mar 2008	-1.1%	-5.2%	-5.8%	-7.9%	-8.1%	-0.4%	0.8%	-2.5%	-3.9%	-1.8%
Apr 2008	1.5%	1.2%	10.4%	1.7%	9.9%	-1.0%	5.8%	0.9%	-1.4%	7.3%
May 2008	15.5%	4.3%	15.2%	2.6%	17.7%	-4.2%	3.5%	4.0%	-2.1%	5.4%
Jun 2008	4.4%	-1.3%	-4.9%	-7.8%	-3.5%	5.0%	-3.1%	-13.6%	6.9%	-7.4%
Jul 2008	-3.4%	12.0%	-10.2%	-1.6%	-12.0%	6.3%	8.6%	-2.1%	-4.4%	0.3%
Aug 2008	16.0%	12.1%	-3.2%	3.5%	-2.6%	12.1%	-2.3%	11.9%	0.1%	0.6%
Sep 2008	0.0%	-18.2%	-15.6%	-16.7%	-10.6%	-14.7%	-10.2%	-9.4%	-9.6%	-12.4%
Oct 2008	0.0%	-21.1%	2.0%	-19.8%	-13.0%	0.0%	-7.2%	-31.7%	-17.2%	-15.7%
Nov 2008	0.0%	-21.1%	-11.7%	-18.4%	-9.2%	-8.7%	-22.4%	-15.7%	0.0%	-10.3%
Dec 2008	0.0%	17.1%	10.2%	5.8%	10.9%	0.0%	2.7%	15.6%	0.0%	6.0%
Jan 2009	0.0%	-8.9%	1.0%	-8.3%	-0.3%	0.0%	-2.6%	-12.8%	-17.3%	-7.6%
Feb 2009	0.0%	-14.6%	-3.9%	-7.2%	-6.9%	0.0%	-22.2%	-18.9%	-10.3%	-11.9%
Mar 2009	-11.2%	12.4%	12.0%	13.5%	15.3%	0.0%	29.4%	14.8%	8.1%	6.0%
Apr 2009	-7.0%	43.1%	10.9%	15.3%	14.0%	0.0%	36.4%	51.2%	3.5%	10.9%

May 2009	19.2%	14.2%	14.3%	14.1%	21.6%	0.0%	14.9%	12.0%	16.8%	2.8%
Jun 2009	0.0%	9.5%	2.3%	6.6%	6.3%	69.6%	9.5%	4.9%	-2.0%	1.9%
Jul 2009	22.0%	8.4%	11.7%	10.5%	13.1%	16.5%	17.4%	24.4%	14.4%	8.6%
Aug 2009	0.0%	9.3%	4.2%	0.6%	5.1%	-4.4%	11.5%	16.2%	-14.1%	2.5%
Sep 2009	38.2%	16.8%	6.7%	8.1%	7.7%	7.3%	6.2%	9.3%	0.0%	12.7%
Oct 2009	-13.3%	3.3%	-6.0%	-8.6%	-9.9%	-0.1%	1.3%	-6.0%	-1.0%	-11.3%
Nov 2009	16.6%	3.7%	5.1%	3.6%	4.9%	-2.6%	8.6%	7.2%	-1.4%	5.0%
Dec 2009	6.3%	-42.0%	7.8%	10.9%	10.1%	0.0%	4.1%	7.7%	0.0%	6.1%
Jan 2010	21.4%	24.8%	-6.0%	2.8%	-4.7%	-18.7%	0.6%	0.9%	8.8%	0.3%
Feb 2010	61.8%	11.1%	8.0%	2.9%	9.0%	-11.0%	4.0%	4.8%	10.8%	6.6%
Mar 2010	0.0%	2.7%	7.3%	7.5%	7.4%	0.0%	10.6%	7.8%	13.5%	4.8%
Apr 2010	31.5%	15.4%	4.6%	19.7%	7.0%	0.0%	-1.9%	10.5%	2.3%	4.9%
May 2010	29.8%	1.8%	-7.2%	-9.3%	-8.2%	0.0%	-5.3%	-5.2%	-6.1%	-6.4%
Jun 2010	1.7%	-6.8%	-7.5%	-12.3%	-6.1%	2.6%	-1.2%	-7.1%	6.5%	-5.4%
Jul 2010	23.6%	17.3%	6.2%	5.5%	5.9%	4.8%	7.3%	5.9%	11.0%	4.5%
Aug 2010	1.9%	-13.5%	-5.2%	-16.5%	-4.6%	0.7%	-9.3%	-8.9%	17.1%	-4.9%
Sep 2010	-8.5%	17.0%	17.0%	9.1%	19.1%	8.9%	13.7%	12.6%	3.5%	12.0%
Oct 2010	-2.5%	4.7%	3.1%	4.8%	1.5%	-0.9%	11.1%	0.4%	8.5%	3.9%
Nov 2010	50.8%	12.2%	6.2%	2.9%	7.6%	6.8%	1.7%	1.5%	8.1%	1.8%
Dec 2010	-8.0%	9.8%	7.8%	7.9%	9.2%	0.0%	0.1%	13.4%	1.8%	5.9%
Jan 2011	-9.5%	3.4%	-0.6%	2.4%	0.8%	0.0%	3.2%	0.5%	8.6%	-1.3%
Feb 2011	2.7%	2.2%	5.2%	3.8%	3.4%	2.0%	2.0%	12.1%	-0.1%	7.1%
Mar 2011	-6.2%	-8.1%	3.7%	0.3%	4.1%	4.3%	3.1%	-1.3%	0.1%	2.9%
Apr 2011	-9.8%	-2.6%	3.8%	0.0%	2.7%	9.2%	4.8%	2.4%	0.4%	5.4%
May 2011	13.4%	2.4%	-2.3%	-7.5%	-3.4%	-6.0%	-7.1%	-1.2%	-3.1%	-1.0%
Jun 2011	-7.4%	-7.7%	-0.4%	0.9%	-3.0%	2.0%	-7.0%	0.2%	-0.5%	-2.0%
Jul 2011	10.6%	5.1%	-5.4%	-1.8%	-0.3%	6.8%	6.6%	-1.1%	7.5%	-2.5%
Aug 2011	-9.7%	-8.6%	-8.2%	-15.9%	-8.9%	-21.0%	-2.4%	-18.2%	7.1%	-6.9%
Sep 2011	-13.9%	-9.9%	-12.7%	-17.5%	-12.6%	-11.2%	-18.6%	-12.2%	-2.8%	-9.4%
Oct 2011	1.6%	0.8%	18.8%	16.1%	15.9%	0.0%	17.4%	15.1%	4.5%	11.3%
Nov 2011	-29.7%	-18.8%	4.5%	-6.2%	-1.4%	-0.4%	-3.7%	-0.8%	-3.7%	-1.3%
Dec 2011	-4.9%	0.4%	2.9%	4.5%	3.1%	8.2%	2.0%	1.5%	2.4%	-0.8%
Jan 2012	17.3%	15.5%	8.2%	4.5%	9.8%	3.9%	3.8%	7.3%	2.6%	4.3%

	Zweig price chg	Neff price chg	O'Shaughnessy: Small Cap Growth & Value price chg	Graham--Defensive Investor (Non-Utility) price chg	O'Shaughnessy: Growth price chg	Graham--Enterprising Investor price chg	P/E Relative price chg	O'Neil's CAN SLIM Revised 3rd Edition price chg	MAGNET Simple price chg	O'Neil's CAN SLIM No Float price chg
Sharpe Ratio	19.7%	21.7%	21.8%	21.9%	20.4%	18.1%	24.0%	17.0%	14.5%	20.4%
Standard Deviation	8.3%	7.5%	6.9%	6.3%	6.9%	8.0%	5.2%	8.5%	13.7%	6.4%
Average Mthly Return	1.8%	1.8%	1.7%	1.6%	1.6%	1.6%	1.4%	1.6%	2.2%	1.5%
Highest Return	32.7%	32.6%	18.5%	25.8%	18.6%	33.1%	18.4%	52.7%	52.1%	23.5%
Lowest Return	-24.2%	-21.7%	-18.2%	-17.3%	-17.9%	-23.4%	-18.3%	-26.7%	-34.0%	-35.5%
Total Return	1689.2%	1662.5%	1579.2%	1320.4%	1283.4%	1198.4%	1132.2%	1120.0%	1108.3%	1087.9%
Portfolio Average	11	22	25	21	50	4	32	8	3	0
Max Passing	32	64	27	62	61	15	110	34	16	0
Min Passing	1	4	10	1	43	0	0	0	0	0
Average Turnover	42%	33%	50%	20%	38%	44%	77%	35%	68%	0%
	3.9%	-0.5%	14.2%	-14.5%	10.1%	-1.0%	-1.0%	36.4%	86.5%	31.6%
1999 Performance	8.7%	1.8%	5.2%	1.0%	7.0%	4.9%	4.2%	18.6%	40.4%	17.0%
Greatest Monthly Gain	-9.2%	-5.2%	-8.1%	-7.9%	-7.0%	-7.2%	-5.0%	-5.8%	-17.1%	-4.7%
Largest Monthly Loss										
	46.2%	37.3%	13.2%	12.0%	11.5%	24.2%	20.3%	96.3%	-26.7%	43.9%
2000 Performance	32.7%	15.3%	17.8%	7.2%	13.9%	10.7%	13.3%	52.7%	21.0%	21.4%
Greatest Monthly Gain	-9.2%	-6.3%	-15.1%	-7.0%	-10.6%	-3.8%	-6.4%	-14.5%	-23.4%	-6.2%
Largest Monthly Loss										
	57.9%	65.2%	13.4%	61.5%	19.2%	55.3%	16.1%	33.4%	-21.7%	25.3%
2001 Performance	18.0%	26.8%	9.7%	11.7%	10.5%	13.7%	7.0%	11.1%	12.9%	7.0%
Greatest Monthly Gain	-6.7%	-12.0%	-6.0%	-14.6%	-7.3%	-6.1%	-8.2%	-8.2%	-13.1%	-7.3%
Largest Monthly Loss										
	16.9%	15.0%	0.8%	3.1%	10.1%	43.5%	11.1%	-10.3%	-6.7%	9.7%
2002 Performance	9.0%	15.3%	14.4%	7.4%	10.6%	22.1%	14.9%	6.5%	14.7%	7.4%
Greatest Monthly Gain	-7.0%	-8.3%	-15.4%	-13.5%	-16.7%	-3.5%	-8.4%	-11.7%	-8.6%	-7.0%
Largest Monthly Loss								0.0%		0.0%
	88.8%	85.1%	107.5%	32.7%	90.3%	25.9%	51.1%	74.7%	62.1%	55.8%
2003 Performance	26.2%	17.1%	18.5%	12.3%	18.6%	18.2%	9.5%	9.5%	23.4%	13.9%
Greatest Monthly Gain	-5.0%	-7.2%	-3.9%	-10.4%	-6.3%	-14.6%	-1.0%	-2.8%	-20.7%	-4.1%
Largest Monthly Loss										
	49.5%	29.5%	26.8%	11.7%	45.1%	18.9%	24.7%	-2.6%	38.1%	8.2%
2004 Performance	12.8%	12.2%	12.3%	10.6%	18.4%	33.1%	7.0%	11.2%	25.8%	7.2%

Greatest Monthly Gain	-8.1%	-5.7%	-7.2%	-4.8%	-4.6%	-13.5%	-2.0%	-15.7%	-14.0%	-5.2%
Largest Monthly Loss										
	27.8%	7.7%	19.1%	26.2%	14.4%	21.3%	17.2%	-1.0%	58.1%	13.3%
2005 Performance	11.6%	7.0%	10.4%	11.6%	8.7%	14.5%	6.2%	9.1%	24.8%	8.7%
Greatest Monthly Gain	-5.5%	-7.7%	-7.8%	-4.4%	-9.9%	-8.6%	-2.5%	-10.5%	-12.7%	-6.5%
Largest Monthly Loss										
	18.6%	13.9%	36.2%	26.6%	17.2%	72.3%	21.2%	-5.4%	72.1%	12.8%
2006 Performance	15.4%	7.3%	13.1%	12.4%	13.2%	16.9%	12.3%	7.1%	52.1%	5.0%
Greatest Monthly Gain	-8.1%	-6.8%	-10.5%	-9.8%	-9.8%	-9.7%	-3.5%	-10.0%	-8.8%	-7.6%
Largest Monthly Loss										
	20.7%	-13.9%	29.6%	20.6%	12.6%	28.1%	3.9%	31.4%	-17.0%	35.4%
2007 Performance	5.9%	7.3%	14.3%	8.8%	7.2%	28.1%	5.7%	8.7%	25.3%	8.5%
Greatest Monthly Gain	-3.9%	-8.1%	-9.4%	-12.2%	-14.0%	0.0%	-5.3%	-4.7%	-14.6%	-5.0%
Largest Monthly Loss										
	-33.9%	-33.6%	-32.4%	-32.0%	-38.2%	-40.7%	-15.8%	-26.3%	-70.2%	-49.7%
2008 Performance	16.6%	11.2%	8.5%	6.7%	4.8%	20.0%	12.6%	18.9%	12.9%	5.6%
Greatest Monthly Gain	-21.0%	-21.7%	-14.7%	-17.3%	-14.4%	-23.4%	-18.3%	-16.0%	-30.0%	-35.5%
Largest Monthly Loss										
	-13.3%	52.5%	-3.3%	57.9%	22.4%	48.5%	51.8%	16.8%	339.5%	36.9%
2009 Performance	29.2%	32.6%	12.8%	25.8%	8.7%	17.8%	11.6%	14.8%	41.1%	23.5%
Greatest Monthly Gain	-16.9%	-15.0%	-14.2%	-11.6%	-11.9%	-16.2%	-8.8%	-3.5%	-11.4%	-15.6%
Largest Monthly Loss										
	12.8%	35.0%	26.1%	31.4%	21.3%	43.5%	29.6%	42.7%	56.1%	20.6%
2010 Performance	10.2%	15.9%	12.0%	9.6%	15.4%	17.1%	13.1%	33.3%	23.5%	12.4%
Greatest Monthly Gain	-9.7%	-12.1%	-13.2%	-7.2%	-15.1%	-3.4%	-7.2%	-12.5%	-23.0%	-11.3%
Largest Monthly Loss										
	-18.3%	-4.2%	-0.3%	7.0%	-7.5%	-1.1%	-1.9%	-30.1%	19.5%	-3.9%
2011 Performance	15.5%	18.9%	11.3%	17.5%	14.2%	4.3%	18.4%	8.7%	31.0%	4.2%
Greatest Monthly Gain	-15.1%	-11.3%	-11.9%	-10.8%	-15.9%	-4.2%	-10.0%	-15.8%	-24.3%	-7.4%
Largest Monthly Loss										
	6.4%	15.0%	30.3%	18.9%	28.8%	1.1%	14.3%	7.3%	-12.4%	8.9%
2012 Performance	6.9%	11.2%	6.9%	8.4%	6.4%	14.8%	5.3%	8.9%	19.8%	4.3%
Greatest Monthly Gain	-5.8%	-9.2%	-6.7%	-8.3%	-6.7%	-14.9%	-7.1%	-4.1%	-20.6%	-4.9%
Largest Monthly Loss										
	26.2%	39.5%	46.8%	33.9%	38.7%	9.6%	29.5%	55.2%	-31.1%	30.8%
2013 Performance	10.9%	7.5%	9.4%	7.9%	10.5%	10.8%	8.4%	17.6%	21.3%	7.8%
Greatest Monthly Gain	-5.9%	-5.2%	-7.4%	-2.2%	-7.7%	-4.6%	-4.0%	-3.4%	-34.0%	-2.9%
Largest Monthly Loss										
	0.2%	-1.1%	-7.8%	-2.2%	4.8%	-4.1%	-0.2%	1.2%	-9.5%	-1.6%
2014 Performance	14.8%	5.3%	1.7%	4.1%	7.6%	3.1%	3.2%	2.8%	-4.0%	6.4%

Greatest Monthly Gain	-12.7%	-6.0%	-9.3%	-6.0%	-2.6%	-7.0%	-3.2%	-1.6%	-5.8%	-7.5%
Largest Monthly Loss										
Jul 1999	8.7%	1.8%	-0.1%	-4.2%	0.3%	-0.8%	4.2%	0.3%	40.4%	1.5%
Aug 1999	-7.2%	-3.0%	-1.0%	-7.9%	-0.8%	1.7%	-4.4%	-3.1%	9.6%	-4.7%
Sep 1999	1.2%	-1.7%	4.5%	-4.2%	-0.6%	-2.4%	-2.7%	1.2%	6.9%	3.6%
Oct 1999	-0.1%	-0.2%	0.8%	-0.3%	-2.5%	-3.1%	2.2%	-1.3%	-7.1%	-0.3%
Nov 1999	-0.3%	1.6%	5.2%	1.0%	6.6%	4.9%	-1.1%	18.6%	21.9%	12.4%
Dec 1999	2.2%	1.0%	4.2%	0.3%	7.0%	-1.1%	1.2%	18.5%	0.0%	17.0%
Jan 2000	-1.9%	-6.3%	-2.7%	-7.0%	-2.0%	2.2%	-4.2%	-3.7%	0.0%	-6.2%
Feb 2000	0.4%	-4.5%	3.7%	3.2%	8.8%	-3.8%	-6.4%	52.7%	0.0%	9.9%
Mar 2000	32.7%	8.1%	1.7%	5.4%	3.6%	5.3%	13.3%	19.4%	0.0%	0.1%
Apr 2000	-8.0%	6.9%	-6.8%	7.2%	-5.8%	-1.5%	2.0%	-4.5%	-23.4%	5.5%
May 2000	-9.2%	-3.1%	-5.5%	-2.0%	-5.4%	-0.5%	1.7%	0.2%	-15.0%	-6.1%
Jun 2000	7.8%	3.5%	13.1%	-3.4%	9.3%	-1.1%	-5.4%	28.0%	11.2%	21.4%
Jul 2000	7.1%	7.0%	5.9%	5.2%	1.1%	10.5%	3.1%	-5.9%	1.9%	-0.8%
Aug 2000	9.2%	8.4%	17.8%	3.0%	13.9%	-0.3%	10.9%	4.0%	-3.6%	5.8%
Sep 2000	2.1%	0.4%	1.0%	-3.9%	-2.6%	0.3%	1.6%	2.6%	0.5%	3.6%
Oct 2000	-0.7%	0.1%	-6.3%	-1.5%	-7.2%	-1.9%	-0.7%	-5.0%	-6.4%	-1.4%
Nov 2000	-8.2%	-1.4%	-15.1%	1.1%	-10.6%	3.0%	-2.8%	-14.5%	-9.5%	-2.3%
Dec 2000	14.1%	15.3%	10.5%	5.3%	11.2%	10.7%	7.6%	12.1%	21.0%	10.9%
Jan 2001	6.6%	26.8%	-2.6%	11.5%	0.3%	13.0%	7.0%	-8.2%	-9.2%	-2.3%
Feb 2001	1.2%	-12.0%	-1.3%	-0.3%	-2.1%	3.4%	1.2%	4.8%	0.2%	-0.6%
Mar 2001	3.2%	6.1%	-3.5%	-2.9%	-3.0%	-4.7%	-2.8%	-5.2%	-0.8%	0.8%
Apr 2001	12.9%	11.3%	9.7%	5.9%	10.5%	4.6%	4.2%	10.8%	12.9%	6.9%
May 2001	3.0%	11.3%	4.3%	4.5%	3.3%	13.7%	4.7%	8.4%	9.8%	0.4%
Jun 2001	-6.7%	2.7%	3.8%	9.2%	5.0%	-0.1%	3.7%	7.5%	-2.1%	4.7%
Jul 2001	-0.1%	1.3%	-3.1%	-2.7%	-4.7%	8.0%	0.8%	-4.5%	-5.2%	6.5%
Aug 2001	4.3%	-1.5%	-1.7%	11.7%	-2.5%	2.3%	-1.8%	-4.8%	-3.0%	-4.0%
Sep 2001	-4.6%	-11.9%	-6.0%	-14.6%	-7.3%	-6.1%	-8.2%	0.0%	-13.1%	-7.3%
Oct 2001	4.5%	9.0%	5.9%	10.5%	8.8%	-5.5%	-2.6%	4.4%	-10.6%	6.1%
Nov 2001	18.0%	7.4%	0.0%	9.4%	4.6%	13.7%	5.0%	7.6%	0.0%	5.9%
Dec 2001	6.7%	6.6%	8.6%	10.3%	6.6%	5.3%	4.9%	11.1%	0.0%	7.0%
Jan 2002	7.4%	2.6%	-0.1%	-0.5%	5.3%	-3.5%	5.4%	-3.3%	0.0%	2.7%
Feb 2002	4.4%	0.6%	2.1%	4.5%	-1.2%	-2.8%	2.6%	2.4%	0.0%	0.3%
Mar 2002	-1.0%	10.6%	6.9%	7.4%	9.0%	-1.0%	6.3%	2.4%	1.9%	2.0%
Apr 2002	9.0%	5.6%	14.4%	1.8%	10.6%	22.1%	5.3%	4.2%	0.0%	7.4%
May 2002	0.3%	-0.8%	-2.0%	2.9%	-2.3%	1.7%	0.7%	0.0%	14.7%	-1.6%
Jun 2002	-5.1%	0.7%	6.5%	5.3%	0.2%	0.7%	-4.1%	6.5%	4.6%	2.0%
Jul 2002	-7.0%	-8.3%	-15.4%	-13.5%	-16.7%	17.1%	-8.4%	-11.7%	-4.9%	-7.0%

Aug 2002	8.7%	-5.4%	2.9%	-3.1%	7.5%	0.3%	-1.1%	0.1%	-5.3%	-0.2%
Sep 2002	-3.7%	-6.7%	-6.9%	-3.2%	-3.3%	-1.8%	-6.5%	-0.8%	-8.6%	-0.8%
Oct 2002	4.0%	1.2%	2.3%	2.8%	6.5%	4.6%	14.9%	-1.5%	1.6%	1.5%
Nov 2002	1.7%	15.3%	3.2%	0.0%	4.3%	-0.6%	-2.3%	4.4%	-4.3%	5.2%
Dec 2002	-1.4%	1.1%	-9.6%	0.3%	-6.8%	3.0%	0.1%	-11.6%	-4.7%	-1.6%
Jan 2003	2.9%	4.1%	1.9%	-10.4%	-1.2%	5.0%	1.8%	-2.8%	-5.3%	1.8%
Feb 2003	-5.0%	-5.4%	-3.9%	-4.1%	-6.3%	-3.3%	-1.0%	8.9%	-1.6%	0.9%
Mar 2003	5.6%	-7.2%	3.6%	0.4%	2.1%	-10.0%	4.0%	2.5%	23.4%	3.1%
Apr 2003	8.1%	17.1%	9.2%	12.3%	11.5%	18.2%	9.5%	7.2%	12.4%	7.9%
May 2003	13.2%	13.3%	11.1%	5.9%	11.8%	2.8%	6.9%	9.5%	21.3%	3.8%
Jun 2003	9.1%	8.4%	6.6%	4.5%	2.0%	-0.6%	2.8%	6.4%	3.2%	6.0%
Jul 2003	3.1%	7.3%	13.3%	3.0%	11.2%	8.3%	1.6%	8.8%	19.0%	5.8%
Aug 2003	3.0%	5.0%	7.9%	4.4%	2.6%	9.3%	2.8%	6.5%	2.7%	4.9%
Sep 2003	-2.0%	2.8%	-1.4%	-0.4%	2.4%	5.6%	0.3%	0.3%	-20.7%	-4.1%
Oct 2003	26.2%	14.5%	18.5%	6.8%	18.6%	3.0%	7.4%	7.2%	0.0%	13.9%
Nov 2003	4.8%	4.0%	6.6%	3.6%	8.3%	-14.6%	1.5%	2.8%	10.5%	5.6%
Dec 2003	-0.6%	2.3%	4.0%	4.4%	5.6%	3.9%	4.9%	0.7%	-6.5%	-3.0%
Jan 2004	1.0%	5.9%	-0.3%	10.6%	3.3%	9.8%	1.5%	2.3%	25.8%	1.4%
Feb 2004	5.2%	2.1%	1.3%	-4.8%	2.1%	3.1%	2.6%	-4.7%	0.0%	-5.2%
Mar 2004	10.9%	2.2%	0.2%	-3.3%	-2.5%	-4.9%	0.8%	11.2%	-7.5%	-0.2%
Apr 2004	-8.1%	-3.8%	-7.2%	-2.4%	-4.6%	-13.5%	-2.0%	-15.7%	-11.4%	1.9%
May 2004	2.4%	0.5%	4.2%	-0.5%	6.0%	-13.2%	2.2%	0.0%	-1.3%	3.3%
Jun 2004	3.2%	2.4%	4.2%	2.6%	5.6%	33.1%	3.7%	-0.8%	10.3%	0.0%
Jul 2004	-2.1%	-5.7%	-3.6%	-2.9%	-3.7%	-2.4%	-1.9%	-6.2%	15.2%	-3.3%
Aug 2004	-0.1%	1.4%	-3.3%	0.0%	-2.6%	-1.3%	-1.1%	1.6%	-8.4%	-0.6%
Sep 2004	12.8%	2.1%	7.4%	1.6%	9.7%	2.6%	6.5%	1.7%	5.6%	2.7%
Oct 2004	0.1%	3.2%	-1.3%	3.5%	-0.3%	1.0%	1.6%	-0.1%	-14.0%	2.5%
Nov 2004	6.5%	12.2%	12.3%	7.7%	18.4%	10.8%	7.0%	6.5%	7.1%	-0.9%
Dec 2004	11.1%	4.8%	12.0%	0.2%	8.8%	-0.1%	1.8%	4.3%	19.9%	7.2%
Jan 2005	-2.3%	-3.5%	-1.6%	-4.1%	-2.0%	0.6%	-1.0%	-4.2%	-6.1%	-0.2%
Feb 2005	5.2%	0.1%	7.2%	3.2%	6.6%	0.0%	3.4%	8.5%	19.6%	8.7%
Mar 2005	-1.5%	-6.2%	-7.8%	-2.1%	-9.9%	8.2%	-1.8%	-10.5%	-5.3%	-2.0%
Apr 2005	-3.6%	-7.7%	-7.0%	-4.4%	-6.5%	-8.6%	-2.5%	-6.9%	-12.7%	-3.1%
May 2005	11.6%	6.4%	9.2%	5.0%	6.2%	7.8%	3.8%	9.1%	10.0%	8.1%
Jun 2005	3.8%	3.5%	9.2%	1.8%	5.4%	-7.3%	2.6%	2.6%	24.8%	4.8%
Jul 2005	10.9%	7.0%	10.4%	11.6%	8.7%	14.5%	6.2%	4.9%	16.2%	3.2%
Aug 2005	-0.7%	-0.6%	-0.3%	4.6%	-0.5%	6.5%	0.6%	-4.8%	-1.8%	-5.1%
Sep 2005	2.1%	1.4%	4.3%	4.8%	7.7%	4.0%	2.0%	6.0%	1.1%	2.3%
Oct 2005	-5.5%	2.9%	-4.4%	1.5%	-6.0%	-3.1%	-1.9%	-7.8%	-6.6%	-6.5%
Nov 2005	3.5%	5.5%	2.0%	1.4%	5.3%	0.2%	4.0%	3.8%	-2.4%	5.0%

Dec 2005	2.6%	-0.2%	-1.6%	1.2%	0.7%	-0.8%	0.9%	0.8%	17.9%	-1.2%
Jan 2006	15.4%	5.2%	11.4%	12.4%	13.2%	16.9%	12.3%	7.1%	52.1%	4.9%
Feb 2006	-6.5%	0.2%	-4.2%	-1.5%	-3.6%	1.8%	-1.6%	-4.7%	-8.8%	1.2%
Mar 2006	2.3%	-1.2%	13.1%	12.4%	10.1%	7.1%	3.6%	3.9%	17.8%	3.0%
Apr 2006	2.0%	5.6%	5.8%	-3.3%	6.0%	9.6%	4.1%	0.0%	6.7%	-1.4%
May 2006	-8.1%	-6.8%	-10.5%	-9.8%	-9.8%	-4.6%	-3.5%	-10.0%	10.0%	-7.6%
Jun 2006	3.0%	-0.3%	-3.1%	2.8%	-4.5%	-1.9%	1.1%	2.2%	-3.3%	0.0%
Jul 2006	-2.1%	-2.3%	0.8%	-4.2%	-4.5%	-9.7%	-2.3%	-5.4%	-4.1%	-3.4%
Aug 2006	-1.5%	1.4%	0.6%	8.1%	-1.2%	5.8%	-0.7%	-0.6%	-3.9%	1.9%
Sep 2006	2.7%	1.5%	7.5%	-4.1%	0.4%	5.6%	-0.8%	1.1%	0.0%	5.0%
Oct 2006	5.6%	7.3%	2.8%	6.7%	3.4%	15.4%	6.9%	2.0%	-6.6%	1.8%
Nov 2006	3.7%	3.7%	2.4%	5.1%	3.3%	4.4%	2.6%	-0.8%	7.9%	4.9%
Dec 2006	2.6%	-0.2%	7.0%	1.9%	5.5%	8.6%	-1.3%	1.0%	-0.2%	2.5%
Jan 2007	5.5%	2.5%	3.9%	7.1%	5.6%	28.1%	0.5%	-1.4%	-7.6%	3.4%
Feb 2007	-3.9%	-3.0%	6.3%	2.1%	0.8%	0.0%	0.4%	-2.1%	-9.7%	-3.9%
Mar 2007	3.6%	2.5%	3.4%	5.5%	2.5%	0.0%	4.2%	6.0%	-7.2%	2.0%
Apr 2007	3.7%	7.3%	3.4%	8.8%	5.2%	0.0%	4.0%	5.5%	-3.7%	7.0%
May 2007	2.7%	4.7%	14.3%	7.4%	6.4%	0.0%	5.7%	3.7%	25.3%	8.5%
Jun 2007	-3.7%	-2.1%	-0.4%	0.3%	1.8%	0.0%	-1.3%	0.4%	-2.5%	0.5%
Jul 2007	-0.1%	-7.0%	-5.9%	-2.3%	-3.8%	0.0%	-3.0%	1.6%	-14.6%	-1.5%
Aug 2007	2.2%	-2.2%	-3.9%	2.5%	-3.3%	0.0%	0.1%	2.2%	-1.5%	4.3%
Sep 2007	5.9%	1.1%	7.6%	0.4%	3.8%	0.0%	0.9%	8.7%	4.1%	6.5%
Oct 2007	4.4%	-8.1%	6.7%	0.3%	7.2%	0.0%	-1.3%	5.9%	9.7%	7.2%
Nov 2007	-3.5%	-7.6%	-9.4%	-12.2%	-14.0%	0.0%	-5.3%	-4.7%	-10.4%	-5.0%
Dec 2007	2.9%	-1.7%	2.5%	0.6%	1.8%	0.0%	-0.5%	2.8%	5.7%	2.8%
Jan 2008	-13.0%	-1.8%	-10.3%	-2.2%	-13.3%	-15.7%	-4.0%	-14.8%	-15.9%	-8.9%
Feb 2008	2.7%	-4.6%	-1.3%	-1.7%	1.7%	20.0%	0.8%	0.0%	2.5%	-1.2%
Mar 2008	-1.9%	-2.0%	-2.2%	0.5%	-2.0%	3.5%	1.4%	-2.5%	-0.9%	-3.3%
Apr 2008	8.0%	5.9%	-0.5%	4.4%	4.3%	0.1%	9.5%	18.9%	-0.3%	-1.9%
May 2008	5.1%	4.0%	8.5%	4.9%	4.8%	7.0%	6.2%	4.3%	12.9%	2.1%
Jun 2008	-12.3%	-14.7%	0.2%	-8.0%	-1.3%	-8.2%	-4.7%	2.9%	-1.5%	-2.2%
Jul 2008	5.7%	8.9%	0.5%	2.2%	-2.5%	-5.0%	4.2%	-5.9%	-13.2%	-4.6%
Aug 2008	-1.0%	5.3%	0.1%	1.0%	-3.0%	-5.2%	3.5%	-0.5%	-12.6%	0.9%
Sep 2008	-15.3%	-7.7%	-8.4%	-15.4%	-13.6%	-13.8%	-14.4%	-10.2%	-19.0%	-11.7%
Oct 2008	-21.0%	-21.7%	-14.7%	-17.3%	-14.4%	-23.4%	-18.3%	0.0%	-25.8%	-35.5%
Nov 2008	-7.3%	-16.7%	-10.4%	-9.4%	-8.3%	-14.8%	-8.7%	-16.0%	-30.0%	1.9%
Dec 2008	16.6%	11.2%	2.4%	6.7%	3.4%	13.7%	12.6%	-1.6%	-1.6%	5.6%
Jan 2009	-16.6%	-8.1%	-11.8%	-9.8%	-11.9%	0.0%	0.0%	0.0%	-7.5%	-15.6%
Feb 2009	-16.9%	-15.0%	-10.8%	-11.6%	-10.3%	-16.2%	-8.8%	0.0%	-7.7%	-7.4%
Mar 2009	0.0%	13.2%	5.8%	12.9%	5.9%	8.5%	11.6%	0.0%	31.8%	0.0%

Apr 2009	29.2%	32.6%	9.5%	25.8%	7.4%	14.1%	10.9%	0.0%	24.3%	-6.9%
May 2009	-7.1%	10.1%	-4.5%	7.4%	4.5%	17.8%	2.6%	0.0%	41.1%	11.0%
Jun 2009	0.9%	0.2%	-4.0%	0.6%	1.8%	-5.8%	2.1%	0.0%	39.9%	23.5%
Jul 2009	1.8%	9.6%	5.0%	13.1%	3.4%	9.5%	8.2%	14.8%	18.5%	16.0%
Aug 2009	-3.5%	-0.5%	6.4%	1.7%	5.1%	8.9%	1.7%	-3.5%	4.1%	-2.6%
Sep 2009	7.5%	12.9%	6.9%	5.9%	5.9%	7.7%	5.0%	9.2%	10.1%	13.7%
Oct 2009	-11.7%	-4.0%	-14.2%	-3.4%	-1.0%	-0.1%	-2.2%	-3.4%	-11.4%	-3.4%
Nov 2009	-2.5%	0.0%	0.2%	4.5%	3.4%	1.4%	5.7%	0.0%	32.2%	5.7%
Dec 2009	13.4%	9.8%	12.8%	5.0%	8.7%	-0.8%	7.6%	0.0%	0.0%	4.6%
Jan 2010	-1.9%	1.2%	-4.4%	-3.7%	-6.3%	-0.5%	-3.0%	-12.5%	-2.5%	-11.3%
Feb 2010	9.3%	3.3%	8.4%	4.6%	5.5%	-3.4%	5.8%	0.0%	0.0%	-3.7%
Mar 2010	3.1%	8.5%	3.9%	8.4%	7.1%	0.0%	7.7%	10.3%	10.2%	7.2%
Apr 2010	-1.6%	7.0%	7.2%	7.0%	12.5%	17.1%	2.4%	-0.4%	-5.4%	2.3%
May 2010	-9.7%	-3.7%	-8.9%	-7.2%	-10.1%	0.0%	-7.2%	-12.1%	0.0%	-2.0%
Jun 2010	-6.7%	-6.0%	-13.2%	-2.5%	-15.1%	0.0%	-4.6%	-10.3%	-23.0%	-2.7%
Jul 2010	7.8%	5.9%	12.0%	5.9%	10.4%	6.1%	6.1%	0.0%	12.6%	2.8%
Aug 2010	-9.3%	-12.1%	-7.5%	-5.2%	-13.7%	0.0%	-6.7%	11.9%	23.5%	-1.2%
Sep 2010	10.2%	15.9%	11.6%	9.6%	15.4%	16.3%	13.1%	13.0%	21.9%	12.4%
Oct 2010	5.4%	1.9%	3.4%	5.5%	4.9%	3.3%	7.7%	33.3%	6.3%	9.3%
Nov 2010	7.4%	5.0%	5.9%	0.7%	8.4%	0.0%	0.6%	8.9%	1.0%	1.5%
Dec 2010	0.8%	6.5%	9.1%	6.2%	6.7%	0.0%	6.5%	2.6%	9.6%	6.6%
Jan 2011	-1.8%	7.3%	1.3%	2.1%	2.7%	0.0%	3.5%	-12.5%	31.0%	-3.0%
Feb 2011	6.3%	5.6%	11.3%	3.2%	7.9%	0.0%	3.6%	4.8%	-0.9%	-0.2%
Mar 2011	1.6%	3.2%	5.5%	3.6%	6.6%	0.2%	0.7%	3.3%	-2.9%	2.3%
Apr 2011	-0.1%	1.1%	-3.1%	1.2%	3.7%	4.3%	1.5%	-1.2%	0.5%	4.2%
May 2011	-15.1%	0.5%	-5.2%	-2.7%	-3.9%	-1.3%	-1.9%	-15.8%	0.0%	-1.4%
Jun 2011	-3.1%	-5.2%	0.7%	-1.3%	-0.4%	-4.2%	-2.0%	1.1%	-3.9%	0.6%
Jul 2011	-2.4%	-5.9%	-1.9%	2.1%	-5.0%	-0.2%	-6.3%	8.7%	5.6%	0.9%
Aug 2011	-11.7%	-11.3%	-8.7%	-6.9%	-11.7%	0.0%	-6.9%	-8.8%	-4.1%	-7.4%
Sep 2011	-11.0%	-10.7%	-11.9%	-10.8%	-15.9%	0.0%	-10.0%	-7.6%	-24.3%	-5.0%
Oct 2011	15.5%	18.9%	10.2%	17.5%	14.2%	0.0%	18.4%	6.2%	29.4%	3.4%
Nov 2011	0.2%	-4.5%	3.0%	2.7%	-2.0%	0.0%	0.0%	-1.1%	-2.1%	-0.2%
Dec 2011	5.4%	0.5%	1.1%	-1.4%	0.1%	0.3%	0.2%	-8.8%	1.1%	2.4%
Jan 2012	1.1%	11.2%	2.1%	8.4%	2.7%	12.5%	4.8%	5.8%	-3.1%	4.0%
Feb 2012	1.7%	4.1%	5.4%	3.6%	3.7%	14.8%	4.4%	1.4%	0.0%	4.3%
Mar 2012	-0.9%	2.4%	6.9%	-2.1%	4.4%	0.0%	1.7%	8.9%	0.0%	3.1%
Apr 2012	1.0%	-1.1%	-2.1%	-0.4%	0.7%	0.9%	-1.1%	-4.1%	-5.0%	1.0%
May 2012	-5.8%	-9.2%	-6.7%	-8.3%	-6.7%	-14.9%	-7.1%	1.0%	-14.4%	-4.9%
Jun 2012	0.0%	-1.1%	3.9%	5.0%	3.1%	7.4%	5.3%	-1.2%	5.3%	2.6%
Jul 2012	-0.2%	4.8%	-1.2%	0.5%	0.2%	0.2%	-1.0%	-3.5%	-20.6%	-0.3%

Aug 2012	-2.8%	2.7%	4.2%	2.7%	6.4%	-6.2%	1.3%	2.6%	19.8%	1.2%
Sep 2012	6.9%	2.1%	6.3%	3.5%	3.8%	-9.7%	3.6%	3.3%	-0.8%	-1.2%
Oct 2012	5.1%	0.1%	3.2%	0.1%	0.9%	0.0%	-1.1%	-2.2%	0.0%	-1.2%
Nov 2012	-2.0%	-2.6%	-0.3%	2.9%	3.8%	0.0%	1.2%	-3.7%	6.2%	-1.7%
Dec 2012	2.6%	1.9%	5.8%	2.5%	3.2%	0.0%	2.1%	-0.5%	5.6%	2.1%
Jan 2013	4.1%	2.8%	5.3%	5.8%	7.4%	0.0%	8.4%	3.3%	4.8%	6.5%
Feb 2013	-1.3%	-0.1%	2.0%	-2.0%	3.1%	-4.6%	0.0%	6.0%	4.9%	0.3%
Mar 2013	4.4%	7.3%	9.4%	0.9%	1.8%	0.0%	4.3%	0.2%	-15.0%	4.6%
Apr 2013	-3.3%	3.0%	0.8%	1.1%	2.8%	7.5%	-1.6%	-1.1%	-8.5%	-0.9%
May 2013	2.7%	7.3%	3.3%	1.1%	4.6%	-4.4%	5.6%	2.9%	14.1%	1.2%
Jun 2013	-5.9%	-2.7%	0.6%	-2.2%	-5.4%	-2.5%	-0.8%	-3.4%	-15.9%	1.7%
Jul 2013	8.5%	7.5%	9.0%	4.8%	10.5%	10.8%	7.1%	17.6%	0.0%	4.6%
Aug 2013	-4.9%	-5.2%	-7.4%	7.9%	-7.7%	-1.9%	-4.0%	4.6%	4.9%	1.5%
Sep 2013	10.9%	7.1%	9.4%	5.4%	3.7%	4.8%	4.3%	8.1%	21.3%	7.8%
Oct 2013	2.2%	6.8%	2.4%	6.9%	8.5%	2.2%	1.5%	8.0%	-34.0%	0.8%
Nov 2013	5.9%	3.2%	4.0%	-1.0%	6.9%	-0.7%	1.0%	-3.2%	0.0%	-2.9%
Dec 2013	1.7%	-2.3%	1.5%	1.6%	-1.3%	-0.8%	1.0%	3.4%	0.0%	2.4%
Jan 2014	-12.7%	-6.0%	-9.3%	-6.0%	-2.6%	-7.0%	-3.2%	-1.6%	-5.8%	-7.5%
Feb 2014	14.8%	5.3%	1.7%	4.1%	7.6%	3.1%	3.2%	2.8%	-4.0%	6.4%

Vita

Iman Khademi was born in Esfahan, Iran, in 1984. He graduated summa cum laude from Ferdowsi University of Mashhad, Iran with B.Sc in Electrical Engineering in 2006. He received his M.Sc degree from Amirkabir University of Technology in Tehran in 2009. He is currently working toward the Ph.D. degree in Electrical Engineering with the School of Electrical Engineering and Computer Sciences at the Louisiana State University (LSU), Baton Rouge. He is expected to graduate by August 2014. He is also a member of the National Organization of Iranian Elites (Bonyad-e Melli-e Nokhbegan) from May 2008.

Mr. Khademi worked as a graduate assistant at LSU from 2010 to present. He has been working under the supervision of Prof. Kemin Zhou. His research interests are optimal control, adaptive control and adaptive filtering, and signal processing applications in financial markets.