

Computer Science and Systems Analysis
Computer Science and Systems Analysis
Technical Reports

Miami University

Year 2003

Evaluating Market Conditions: A
simplified Approach for Analyzing Stock
Price Activity

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MIAMI UNIVERSITY

DEPARTMENT OF COMPUTER SCIENCE & SYSTEMS ANALYSIS

TECHNICAL REPORT: MU-SEAS-CSA-2003-000

**Evaluation Market Conditions: A Simplified Approach for
Analyzing Stock Price Activity
Kevin Shuller and Jon Puz**



School of Engineering & Applied Science | Oxford, Ohio 45056 | 513-529-5928

Evaluating Market Conditions: A Simplified Approach for Analyzing Stock Price
Activity

A thesis submitted to the Miami University Department
of Computer Science and Systems Analysis in partial
fulfillment of the requirements for Departmental Honors

by

Kevin Shuller and Jon Puz

May, 2003
Oxford, Ohio

Abstract

To simplify the process of determining which actions an investor should take, an application that provides a list of trades to be placed each morning was designed. Because the application gives signals on the long and the short side, users can make money in both rising and falling markets and can minimize market risk by keeping money in both sides of the market.

This application works by prompting the user for the stocks to be traded. Users can also tailor settings based on their personal investment style. Given these inputs, and using publicly available stock data, a comparison of current price levels relative to recent performance is made and the strength and the direction of market trends are measured. Based on these results, and using a methodology that the researchers developed, concrete buy, sell, and short commands are given to the user.

While most trading theories fail in their inability to perform in different market conditions, the methodology that drives this application has been shown to outperform market indices. Additionally, this theory provides evidence against the popularly accepted Random Walk theory, which states that it is impossible to accurately predict the direction in which the market will move.

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Kevin Shuller and Jon Puz

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Acknowledgements

We would like to thank our advisors, Dr. John Benamati and Dr. Douglas Troy, and our two readers, Dr. David Marshall and Patrick Servé.

We are grateful for the support the Miami University Honors Program, the Student Initiative Fund, and the Computer Science and Systems Analysis Department provided in allowing us to present our research at the 2003 National Conference on Undergraduate Research.

Kevin would like to thank Burton Malkiel for providing the motivation for this whole project and Bryan Bueltel for his help and his encouragement during the initial stages of research and model development.

Kevin and Jon would like to thank their respective fathers for their feedback, encouragement, and general counsel.

Finally, we would like to thank Daewoo Motors for their high quality automobiles. Daewoo!

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Part I. The Theory

Introduction

Many academicians believe that there is no way to consistently “beat the market.” Throughout the bull market of the late 1990’s, the mutual fund industry expanded to include over 8,000 open-end mutual funds (Motley Fool). Among those mutual funds, approximately 80% of them underperformed the market. Therefore, most people theorize that if professional money managers cannot outperform broad market indices, then amateur investors do not stand a chance.

We propose that there are ways for investors to outperform the market because the amateur investor is not restricted in many ways that mutual fund managers are. By making an advisory service that is customizable and user-friendly, we can take a big step forward in helping investors take control of their own finances. Additionally, we think that if users are happy with the results, they will be interested in learning more about technical analysis and the methods that make the system work.

Overview of Technical Analysis

Most academics assume technical analysts are chart-watchers “because they study records or charts of past stock prices, hoping to find patterns they can exploit to make a profit” (Bodie 343). This is a slanted assessment of technical analysis (TA) as it pigeonholes all of TA in one aspect. John Murphy provides a more accurate assessment of TA when he calls it “the study of market action, primarily through the use of charts, for the purpose of forecasting future price trends” (Murphy 1).

Perhaps the most biting criticism of technical analysis is from Random Walk theorists, who think that price changes “should be random and unpredictable” (Bodie 341). However, if one were to accept that price changes are random, one cannot explain the presence of trends in individual stock prices and in markets as a whole. Without trends, then one cannot explain the presence of bull and bear markets where directional price movement is weighted in one direction. One look at a chart shows that this is not true. In the last 10 years, we have seen both a bull market and a bear market, both of which were the result of major trends. If the motion of the market were truly random, the odds of the market moving predominately in the same direction for so long is statistically unlikely (Figure 1).

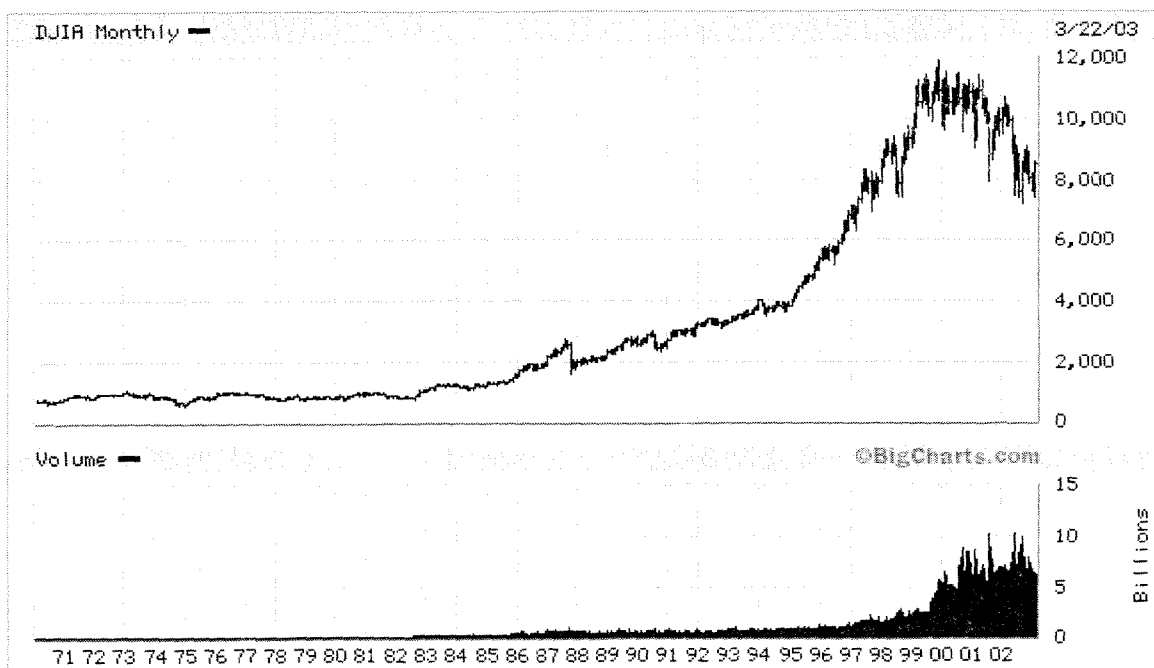


Figure 1. DJIA Monthly 1970 - 2003

TA is not, however, limited to charting trendlines and support and resistance levels. Technical analysis also contains technical indicators, which are objective, quantifiable methods of measuring a market’s action. Each type of indicator works by measuring market action in a different way. While some indicators show the market in

terms of trends and momentum, others use recent price movement to calculate temporary overbought and oversold conditions. None of them serve as a “magic bullet” (Elder 120) that solve everyone’s investing problems.

When all aspects of TA are combined, they do not form an easily readable picture of the future. TA is an art. Nothing is ever cut and dry, and nothing is ever certain. In fact, TA indicators and other methods often contradict each other. For example, a stock in a downtrend will show sell signals in trend-following indicators, but buy signals in oscillators. Thus, it is left to the indicator users to evaluate the proper action to take on the stock.

Mechanical Trading Systems

Many traders use completely mechanical trading systems to make their investing decisions for them. Put simply, mechanical trading systems are set up as a set of criteria that will advise the user to make a specific transaction at a specified time. Many successful traders, including Robbins World Cup champion Larry Williams, use mechanical trading systems to find trades with high success probability.

Most traders that use mechanical systems for their stock trading generally design their own systems. Some trading software packages combine mechanical trading abilities with automated order execution to create hands-off trading environments, while others give signals and leave the execution up to users. There are three main types of trading systems:

- **Black Boxes** give the user buy and sell signals with no reasons why
- **Grey Boxes** gives the user buy and sell signals while also giving the user some idea as to why the signals were given. Most are customizable.

- **Toolboxes** give the user the values of indicators used to make decisions, allowing a user to come to his or her own conclusion.

Since most professionals design their own systems, then trade based on the signals given by them, most professional systems are a grey box/toolbox hybrid.

Advantages

Mechanical trading systems have several advantages over subjective investment methods. First of all, they take the variable of human emotion out of investment decisions. Traders often speak of indecision as one of the most destructive traits of failed traders. Trading psychologist Ari Kiev thinks “the most critical thing is to be able to make minute-to-minute decisions without hesitating” (Kiev 100). By making the evaluation automated, it allows users to take their emotions out of the decision-making process which should force them to be more decisive.

Many users also have problems making sense of their own analysis. Although a person’s own objective opinion is likely to have a high “buy-in” by its user, “most people have trouble applying their objective analysis to actual trading situations” (Murphy 494). A computer’s analysis must be objective and, as such, would make decisions based solely on data.

Another advantage of mechanical trading systems is its ability for back-testing. Once a system is developed, a user can use widely available historical data to see how the system performs in market conditions. By doing this, system developers don’t have to go through the time-consuming action of “paper-trading” a system to see how it would perform. TA expert John Murphy explains: “Helping us see how a system would have

performed in the past, it allows us to make better decisions when it really counts”

(Murphy 494).

Murphy also points out that using a computer for your decision-making requires significantly less time than subjective analysis because all analysis is made automatically and, as such, decisions can be made instantaneously. For professional traders, this means that they can devote more time to developing other models, researching new ideas, or analyzing other markets. For amateur traders, it means that they can take a more active role in their investments without having to devote a lot of time to portfolio management.

In the same vein, Murphy points out that following a mechanical system will force an investor to be more consistent (387). This is done through letting profits grow, while minimizing losses. Since any good mechanical system has trade exit rules that are just as important as trade entry rules, it will turn around and take an investor out of a trade if it does not move his or her direction. Thus, the system functions as a stop loss.

Disadvantages

If mechanical trading systems were the perfect way to trade, people would have no need to pay attention to the movement of the market and would base trades solely on the output of his or her system. The main problem of mechanical trading systems is the same as one of the main disadvantages: it takes personal interpretation out of the decision making process. A person's experience and intuition play no part in trading with a mechanical trading system, and while this may be a benefit for traders who do not have enough experience to read markets accurately, it often impedes knowledgeable traders with the ability to forecast trends by serving as a crutch, making subjective analysis that could otherwise be profitable seemingly unnecessary.

Another impediment in using mechanical trading systems is that they are based solely on stock price movement. As a result, macroeconomic effects are only accounted for to the extent that it impacts the stock price. For example, an old adage states that once the Federal Reserve lowers the Fed Funds rate three times, investors should move out of stocks and into bonds, forecasting lower, or even negative, returns for equities. Upon the third rate drop, the entire effect is not immediately factored into the price of a stock. As a result, the system would continue to give trades in the direction opposite the overall outlook for the market if the individual stock's movement deems it so.

Though the previous two disadvantages have been focusing on the application of mechanical trading systems, Murphy makes the following argument against their design:

- Most mechanical systems are trend-following
- Trend-following systems rely on major trends in order to be profitable
- Trend-following systems are generally non-profitable when markets are not trending.
- There are long periods of time when markets are not trending and, therefore, not suitable for a trending approach (Murphy 388).

Trend vs. Ranging Markets

A key assumption of TA is that the markets move in trends. Many may argue the presence of trends, but when one looks at a chart of the Dow Jones Industrial Average (DJIA), one will notice that over the last 33 years, there has been a significant uptrend in the market (Fig 1). There have been periods of downtrends (2000-2003), but over the long term, stock prices have risen. If there was no such thing as a trend and all movement were truly random, we would expect to see all up-moves negated by down-

moves, and the value of the DJIA to stay roughly stable. The fact that the DJIA gained roughly 700% from 1970 to 2003 suggests that there is an up trend in the market.

We know, however, that prices are not always moving up. There are bear markets in which broader averages of stock prices decrease. These often last over a year and can result in great losses. Most of these price declines have been a gradual erosion of value and not single-day, catastrophic events. As Fig. 1 shows, the DJIA has been in a downtrend since the beginning of 2000. Though that period contains massive drops (for example, the days following September 11, 2001, when the market sustained heavy losses) the drop has been consistent over the time period.

Murphy recognized that there are uptrends and downtrends, but specifies that there are periods, usually in shorter periods, where there is no apparent trend. These periods are typically referred to either as sideways trends or as “trendless” (Murphy 51).

However, it is common to find a stock trading within a certain set of boundaries when it is trendless. The upper and lower bounds are known as resistance and support levels, respectively; the stock price will meet resistance when it tries to break above the upper bound and will find support when it reaches the lower bound. This is shown clearly in the price action of Hovnanian Industries between September 2002 and February 2003 (fig. 2). The stock was not in a directional trend, but was trading in two different ranges. One range spanned from 30 to 40 and another from 30 to 34.50. Each time the price tried to break outside of this range, it could not because it would either be propped up by support or impeded by resistance.



Figure 2. Hovnanian Enterprises Aug. 2002 – Feb. 2003

With these three options -- uptrend, downtrend, and trading range -- we can encompass almost all price movement as one of these three. We must also realize that these are not mutually exclusive states; a stock can be in two different states depending on the time frame being examined. For example, in Figure 3, Amazon.com was in an uptrend during late 2001 and 2002. However, there was a short-term downtrend during June and July of 2002 that did not disturb the longer-term uptrend that the stock was in. As such, we can see two different trends in the stock at the same time.



Figure 3. Amazon.com October 2001 – March 2003

Of the three market states, the ranging market is by far the most common. J. Welles Wilder, famous trader and technical indicator inventor, estimates that strong-trends occur only 30% of the time (Murphy 384). This leaves 70% of markets that are either in trends too weak in which to trade or in a trading range.

Technical Indicators

Most technicians and traders use technical indicators as a way to identify and evaluate potential trades. An indicator can be described as “a series of data points that are derived by applying a formula to the price data of a security” (Hill Pt. 1). Indicators break down price movement as a way of analyzing it and they vary widely in terms of what they measure and how they measure it. On their own, indicators are of little use, but when coupled with other indicators and with the data of the actual stock price, we are left with powerful tools for analyzing stock price movement.

Perhaps the easiest indicator to understand is a simple moving average. The value of this indicator is simply the average closing price of a stock for a given period, and is

often used to determine if a trend is present and where a current price is in relation to previous price levels. Figure 4 displays a 50-day moving average for Oracle Corp. The simple moving average is increasing from late November 2002 through early February 2003, implying that the stock is in an uptrend. Many people also believe that moving averages can serve as support as it appears to for Oracle on occasions in November, late December, and mid-January through mid-February.

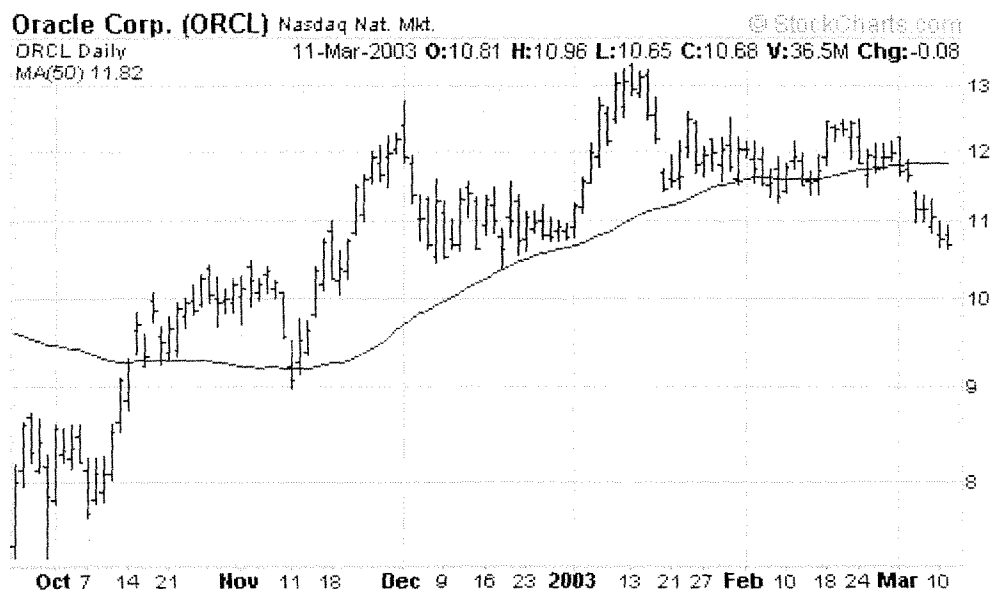


Figure 4. Oracle Sept. 2002 – March 2003

Types of Indicators

There are two main categories of indicators, trend-following (or lagging) and oscillators (or leading). A person's investment style will tend to dictate category choice. Lagging indicators focus on analyzing what has happened in the past to give the user a perspective on current conditions. These often do not have predictive powers. TA expert and author Arthur Hill explains, "Rarely, if ever, will these indicators lead the price of a security" (Hill Pt. 1). As such, these indicators are typically used for measurement purposes, such as measuring the strength of a trend.

The main advantage of using these indicators to make trading decisions is that they will tell you when a strong trend is present. By trading with a strong trend, you will be able to trade with the trend and stay with the trend. As a trend lengthens, large gains have a tendency to follow along with decreased trading. Strong trends tend to account for most of a gain in a stock. Traders tend to have their most profitable positions when they have a position during a trend. Since they expect trends to continue, they will not jump in and out of positions as quickly as they would during a trading range. Hill specifies that trend-following indicators “can be enormously profitable and easy to use” (Hill Pt. 2).

There are drawbacks to using lagging indicators, though. The main disadvantage is that the markets are only in a trend approximately 30% of the time. Thus, we are left with indicators that are not useful the remaining 70% of the time. If an investor were to try to use these indicators during periods where there was either a weak or no trend, then the investor will find himself making many trades in non-ideal conditions. In spite of dramatically decreased trading cost in recent years due to the proliferation of discount brokers, the trader would accumulate substantial commission fees while making miniscule, if any, profit on a trade.

Leading Indicators work by trying to “lead” price movements. There are two types of leading indicators: momentum-based oscillators and contrarian oscillators. Momentum-based leading indicators, such as Lambert’s Commodity Channel Index (CCI), work by trying to measure when a security’s price has enough momentum to sustain a continuation in that direction. These differ from lagging indicators in their use. Momentum-based leading indicators are used as signals for what will happen next as opposed to lagging indicators, which focus on present conditions.

The other type of leading indicator is a contrarian oscillator. These measure the current price in relation to the recent range of the security's values, the idea being to identify when a stock is oversold or overbought relative to its most recent activities. If a trader can identify these extremes, he or she is more likely to identify potentially profitable trades. Two of the most popular contrarian indicators, Stochastic Oscillator and Relative Strength Index (RSI), are also known as banded oscillators. They have levels at which one can easily identify oversold and overbought status. Figure 5 shows the 14-day RSI being used to identify periods where the stock is oversold and overbought. With RSI, the threshold values for overbought is 70 and oversold is 30. Thus, many people expect a stock to rebound if its RSI drops below 30 and, conversely, expect a sell-off if the RSI goes above 70.

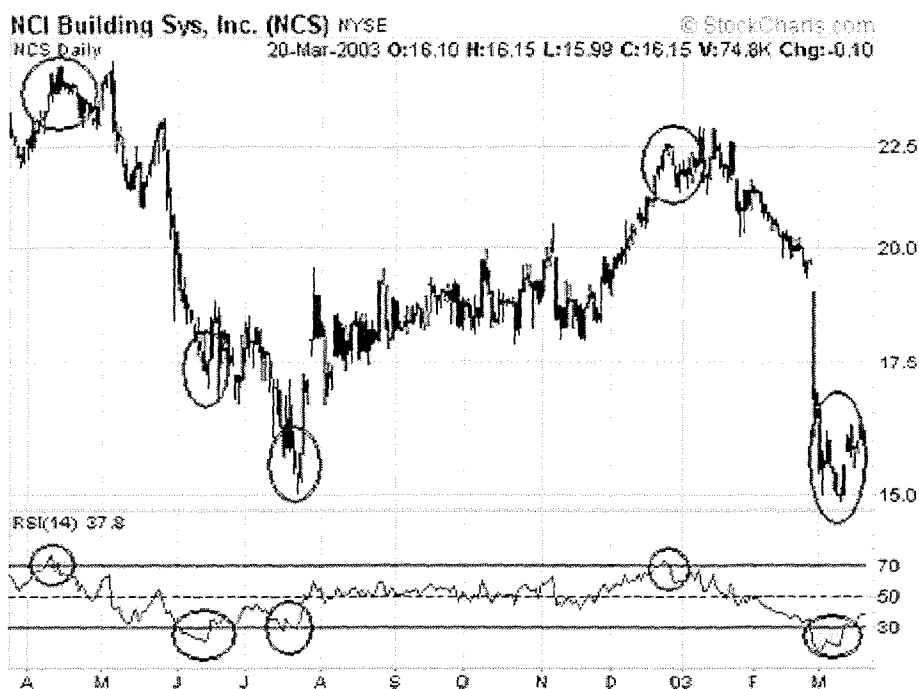


Figure 5. NCI Building Sys March 2002 – March 2003

While these indicators do not function this well all the time, they tend to do quite well during periods where the stock is within a set trading range. They will identify

when the stock is close to support and resistance, thus specifying good times to enter and exit positions in the stock. For example, in Figure 5, the RSI dropped below 30 each time NCS dropped to its support level of 15. We can see that during this 1 year period, we would have been signaled to buy at 17.50 and twice around 15 and prompted to sell at 22 and 24.

No indicator will function as a golden ticket working perfectly at all times. However, if a trader knows the current market conditions, he can then pick the proper leading indicator that would give the most accurate signals.

Selection of Indicators

One of the critical attributes of a trading system is that it must be “readily understood by the decision maker” (Colby 10). Eventually mechanical trading systems boil down to concrete “buy” and “sell” signals, which are easily understood by even the most novice investor. However, when designing a system one must be comfortable with each indicator used in order to understand how it functions and how it interacts with other indicators. In this section, we will discuss the indicators that are used in this trading system, why they have been chosen, and how they function together.

Directional Movement Indicator (DMI)

Invented by J. Welles Wilder in the 1970's, the DMI is a lagging indicator that is used to measure the strength and direction of a trend. The DMI outputs three data points that can help a user make decisions, DI+, DI-, and ADX.

The first two data points, DI+ and DI- are measurements of the typical direction of stock price movement outside of the previous day's range over a given period of time. For example, if one day's high were higher than the previous day's high, then the stock

would have positive directional movement. However, if one day's low were lower than the previous day's low, then the stock would have negative directional movement for the day. DI+ and DI- are averages of daily directional movement in up and down directions respectively. This reflects the idea that if a stock is moving in a trend, the directional movement, on average, will be greater in the direction of the trend. Instead of leaving the direction of the trend to the subjective interpretation of an observer, these data points give a quantifiable measurement of the direction of a trend.

The Average Directional Movement (ADX) uses the DI+ and DI- datapoints to measure the strength of any trend. The ADX line does this by averaging the daily difference between the DI+ and DI- datapoints relative to their numerical values over a given time period. As the difference between the DI+ and DI- grows, it means that the directional movement in one direction is overpowering the other direction. The ADX line is actually a simple moving average of the differential over a given number of days. This provides a smoothing effect to the line, which makes it easier to measure, interpret, and use in mechanical systems.

The ADX, while complicated to calculate, provides the key to many trend-following systems. There are two common ways of interpreting the movement of the ADX line to determine whether a stock is in a trend or not. One method states that a trend is significant when the value of ADX is greater than 20 and is weakening when it drops from above 40 to below 40. Thus, according to this method, the only time a market is considered to be trending is during the period where ADX goes from below 20 to above 40. Once the ADX drops below 40, the trend is over and a trading range starts. In that sense, this method uses ADX like an oscillator.

The second interpretation is simpler. The more common way of using the ADX states that the stock is trending when ADX is rising and is ranging when ADX is weakening. Figure 6 shows Intel Corp in 2000. This chart shows trends in both directions with a ranging period in between. Through March, the ADX line was rising and so was the stock price. Since DI+ was greater than DI-, it signified that we were in an uptrend. The opposite occurred from early September through the end of the year. ADX rose while DI- was greater than DI+ signifying a downtrend. The period between these two trends found the ADX line decreasing. The trend was over and there were no prolonged moves in either direction.

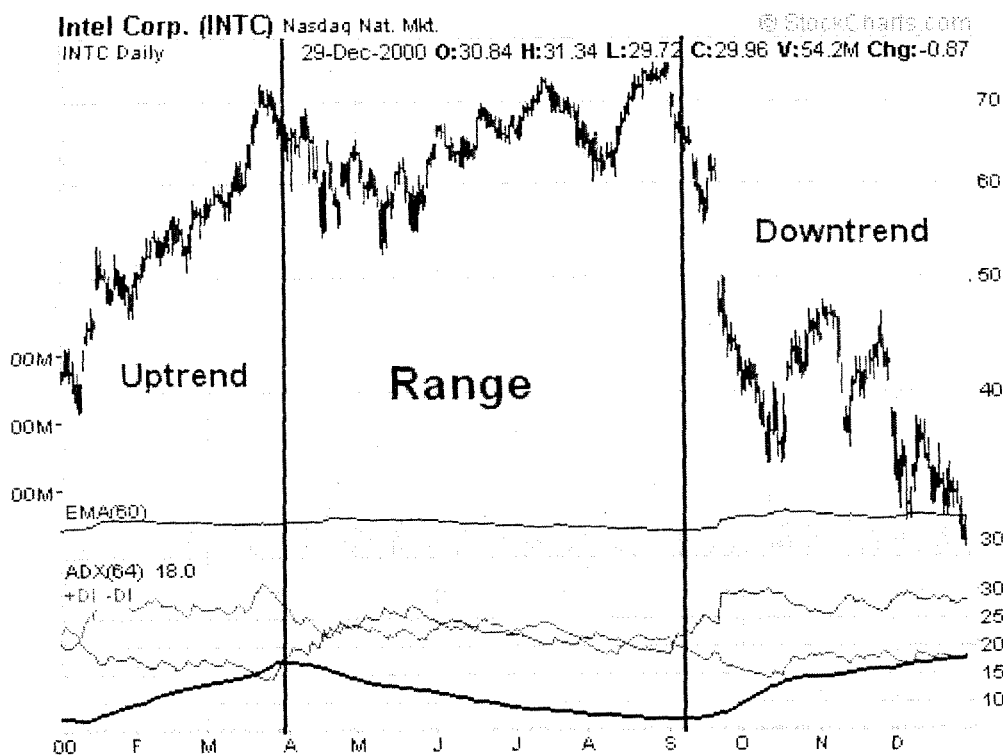


Figure 6. Intel Corp. 2000

The main problem with the first application of ADX is that the use of 20 and 40 as the threshold levels becomes hard to follow as one changes the time period for ADX. A 14 day ADX will regularly reach the 40 level whereas a 64 day ADX will rarely, if

ever, reach 40. As such, if a trader looks to measure the trend for a longer time period, this method becomes virtually useless. Additionally, this method doesn't allow for occurrences where ADX is greater than 20, but doesn't reach 40 before it starts to fall. Users are left to draw their own conclusions as to when to classify the stock as a non-trending stock. Thus, this method of analysis is not useful in mechanical trading systems.

The second method is much more usable, but has faults of its own. The main problem is that over time, the ADX line will split its time evenly between increasing and decreasing. This means that the ADX will show a market as trending approximately 50% of the time. Since Wilder states that markets are only trending 30% of the time, we are left with roughly 1/5 of all trading periods where we believe the market is trending, but it is not. Additionally, when a stock has been in a prolonged range, the value of DI+ and DI- will be roughly equal. In cases like this, the ADX value will be very low.

Low ADX values pose several problems. With the difference between the positive and negative values so small, the tiniest movement in either direction could cause the ADX value to increase, albeit minutely, and cause a system to believe a market is trending when it is not. Additionally, since the ADX is a typically a simple moving average, an occasion where a high differential value gets bumped out of the calculation could cause a one-day aberration in the ADX value that could cause an increasing ADX line to decrease for one day thus initiating any end-of-trend exit strategies that are built into the system. Both of these instances do the investor a great disservice by creating a statistical inaccuracy in measuring trends. As such, people may take trending positions in non-trending markets or may close a trending position on a false end-of-trend signal.

One possible way of fixing this problem is to maintain a short term moving average, for example, 4 days of the ADX, which we will call the average directional movement average (ADXA). Whenever the ADX is greater than ADXA, then the stock is in a trending state. While this method solves the one-day moving average aberration problem, it still doesn't address the 20% false trend signal problem.

Commodity Channel Index (CCI)

The CCI is a leading indicator that typically functions as a momentum indicator. However, Murphy says that recently "most chartists use CCI simply as an overbought/oversold oscillator" which makes it one of the more versatile indicators in a trader's repertoire (238). This indicator measures the typical deviation from a stock or commodity's mean value over a given time period. The deviation of the stock's current price to the mean price is normalized using the mean deviation and a constant divisor to create a datapoint whose value is between +100 and -100 approximately 70% of the time. Thus, when the CCI is outside of this range, we can say that the stock is greater than one standard deviation from its average price.

When Dennis Lambert developed this indicator, he used it as a momentum indicator. He felt that once a stock was greater than one standard deviation away from its mean, then the movement was obviously not random and was being driven by a trend. Thus, he recommended going long on a stock once the CCI was greater than +100 and selling once it dropped below +100. Additionally, one should go short when the CCI drops below -100 and should cover the short when CCI increases above -100.

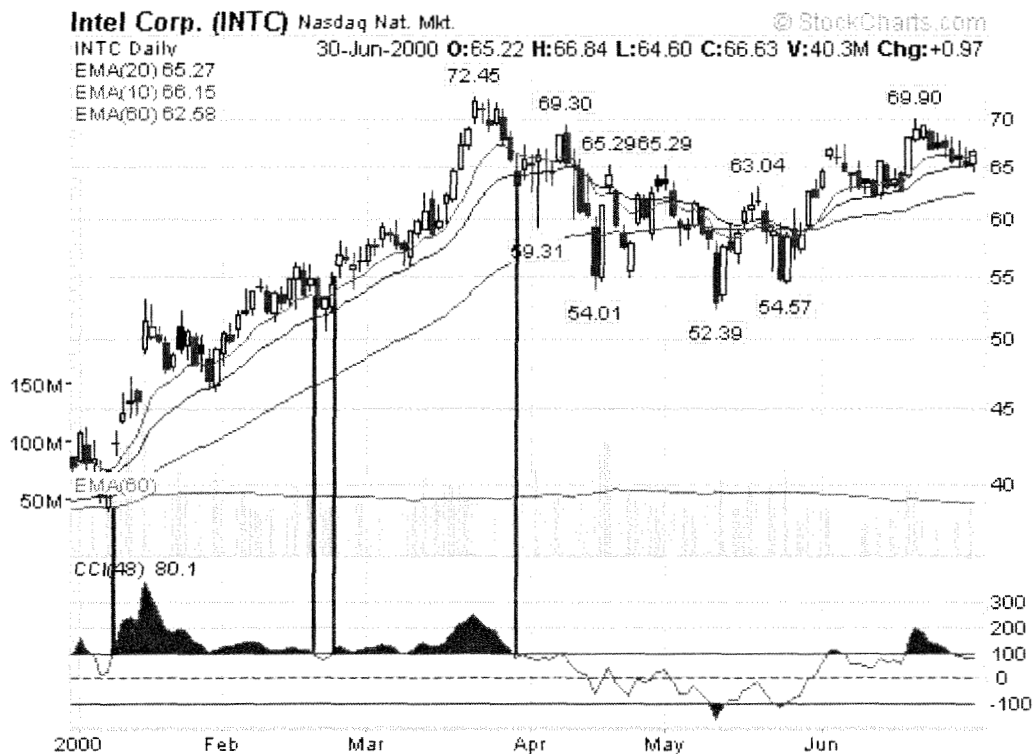


Figure 7. Intel Corp. Jan. 2000 – June 2000

Figure 7 shows the CCI graphed with the stock price of Intel over the first half of 2000. Recalled from Figure 6, Intel was in an uptrend for the first three months of 2000. In this uptrend, we notice that the CCI is above +100 for much of this time period and the stock is making significant price gains during these periods. However, when the stock moves from a trend into a trading range as it does in April, any moves outside of the +/- 100 boundaries are rare and don't last long.

The indicator can be used as a contrarian oscillator as well. Many people will buy a security when its CCI has just moved from less than -100 to greater than +100 under the premise that the stock will eventually move back to its mean value. Since the stock would then be within one standard deviation of its typical value and below the mean value, they feel the security is primed for a price increase.

Stochastic Oscillator

The stochastic oscillator is a leading contrarian indicator that functions solely as a measure of a stock's current location within a trading range. This oscillator measures where a stock is relative to the maximum and minimum values reached in a set number of trading days. This indicator usually involves smoothing values using simple moving averages so as to reduce the wild volatility of the indicator. The main line is called the %K line and the smoothed line is known as the %D or signal line. A chart of this indicator (see Fig 8) is usually labeled with 2 numbers such as (14,3) which means that the %K is based on the extremes of the previous 14 days while the signal line is a simple moving average of the %K over the last 3 days.

With this particular indicator, the 20 and 80 are the values typically associated with overbought and oversold status. George Lane, who developed this indicator in the 1950's, thought "some of the best signals occurred when the oscillator moved from overbought territory back below 80 and from oversold territory back above 20" (Hill Stochastic).



Figure 8. Chicos FAS Jan -March 2003

This indicator is most useful during ranging markets as it does its best work by identifying when a stock is moving back from an extreme value. Since ranging markets are, by definition, trading between certain stock prices, this indicator points out when a stock is at the low end of the range so the stock can be purchased with minimal risk. Additionally, it indicates when stocks are at the high point of their range so that a stock may be sold at a price close to the top of a stock's range. In Figure 8, we see that Chico's FAS is in a trading range and has hit the 20 and 80 thresholds several times between January and March 2003. Each signal given, indicated by the arrows, was close to the extremes of its move.

Designing the System

In using the stochastic oscillator as a contrarian indicator and the CCI as a momentum indicator, a trading system designer has two sources of trading signals. The only problem is that often the indicators contradict each other. Usually, when a security's CCI is above +100, its momentum has caused the stochastic to rise above 80. In Fig. 9 We see that when the CCI for Amazon.com rose above +100 in early March, the stochastic oscillator was already above 80 and considered the stock overbought. However, in retrospect, we can see that the stock was not overbought, but starting its run-up by breaking out of its trading range.



Figure 9. Amazon.com Dec 2002 - March 2003

Since we have two different sets of signals that work in two different market conditions, we must somehow filter the output of these signals so that we are only acting upon the signals generated by the indicator that works best with current market conditions. Since we have one indicator that works best in trending markets and one that works best in ranging markets, what we need is an objective and concrete way of deciding whether or not a stock is in a trend or a range. Since DMI can serve this purpose, we have a filtering device to tell us which signals to act upon.

Entry Points

Simply put, when ADX is signaling that the stock is in a trend, we will follow the signals generated by CCI. Conversely, we will follow the signals generated by the stochastic when the DMI is telling us that a stock is trading in a range. This makes entering trades easy because you know that you are making the proper move given current market conditions.

Exit Points

This system also provides exit points in a fashion similar to the entry points, however there is a complicating factor to closing a position. Often, when a trader has an open position, the market conditions will change, for example, a stock riding a trend will find its trend come to an end. Thus, the reason the trader was in the position -- the momentum -- is no longer valid. Additionally, a stock in a trading range could break out of it into a trend in either direction. A system must be designed to handle changes in market conditions if it is going to be successful over the long run. As such, we propose the following guidelines for dealing with changes in market conditions:

The second interpretation is simpler. The more common way of using the ADX states that the stock is trending when ADX is rising and is ranging when ADX is weakening. Figure 6 shows Intel Corp in 2000. This chart shows trends in both directions with a ranging period in between. Through March, the ADX line was rising and so was the stock price. Since DI+ was greater than DI-, it signified that we were in an uptrend. The opposite occurred from early September through the end of the year. ADX rose while DI- was greater than DI+ signifying a downtrend. The period between these two trends found the ADX line decreasing. The trend was over and there were no prolonged moves in either direction.

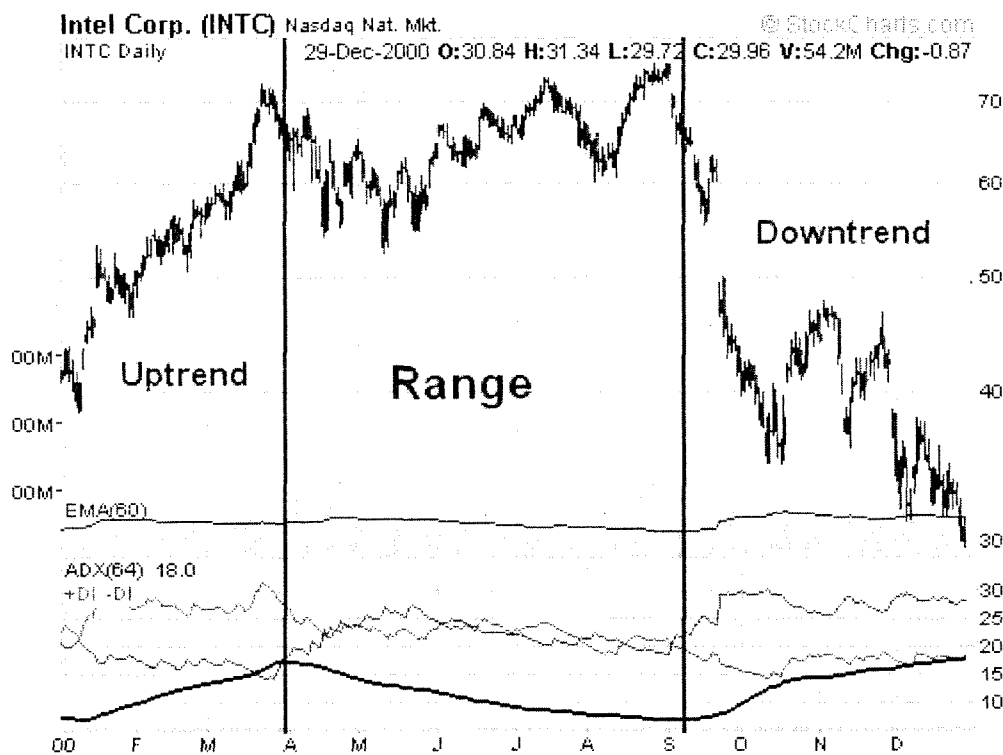


Figure 6. Intel Corp. 2000

The main problem with the first application of ADX is that the use of 20 and 40 as the threshold levels becomes hard to follow as one changes the time period for ADX. A 14 day ADX will regularly reach the 40 level whereas a 64 day ADX will rarely, if

ever, reach 40. As such, if a trader looks to measure the trend for a longer time period, this method becomes virtually useless. Additionally, this method doesn't allow for occurrences where ADX is greater than 20, but doesn't reach 40 before it starts to fall. Users are left to draw their own conclusions as to when to classify the stock as a non-trending stock. Thus, this method of analysis is not useful in mechanical trading systems.

The second method is much more usable, but has faults of its own. The main problem is that over time, the ADX line will split its time evenly between increasing and decreasing. This means that the ADX will show a market as trending approximately 50% of the time. Since Wilder states that markets are only trending 30% of the time, we are left with roughly 1/5 of all trading periods where we believe the market is trending, but it is not. Additionally, when a stock has been in a prolonged range, the value of DI+ and DI- will be roughly equal. In cases like this, the ADX value will be very low.

Low ADX values pose several problems. With the difference between the positive and negative values so small, the tiniest movement in either direction could cause the ADX value to increase, albeit minutely, and cause a system to believe a market is trending when it is not. Additionally, since the ADX is a typically a simple moving average, an occasion where a high differential value gets bumped out of the calculation could cause a one-day aberration in the ADX value that could cause an increasing ADX line to decrease for one day thus initiating any end-of-trend exit strategies that are built into the system. Both of these instances do the investor a great disservice by creating a statistical inaccuracy in measuring trends. As such, people may take trending positions in non-trending markets or may close a trending position on a false end-of-trend signal.

One possible way of fixing this problem is to maintain a short term moving average, for example, 4 days of the ADX, which we will call the average directional movement average (ADXA). Whenever the ADX is greater than ADXA, then the stock is in a trending state. While this method solves the one-day moving average aberration problem, it still doesn't address the 20% false trend signal problem.

Commodity Channel Index (CCI)

The CCI is a leading indicator that typically functions as a momentum indicator. However, Murphy says that recently “most chartists use CCI simply as an overbought/oversold oscillator” which makes it one of the more versatile indicators in a trader's repertoire (238). This indicator measures the typical deviation from a stock or commodity's mean value over a given time period. The deviation of the stocks current price to the mean price is normalized using the mean deviation and a constant divisor to create a datapoint whose value is between +100 and -100 approximately 70% of the time. Thus, when the CCI is outside of this range, we can say that the stock is greater than one standard deviation from its average price.

When Dennis Lambert developed this indicator, he used it as a momentum indicator. He felt that once a stock was greater than one standard deviation away from its mean, then the movement was obviously not random and was being driven by a trend. Thus, he recommended going long on a stock once the CCI was greater than +100 and selling once it dropped below +100. Additionally, one should go short when the CCI drops below -100 and should cover the short when CCI increases above -100.

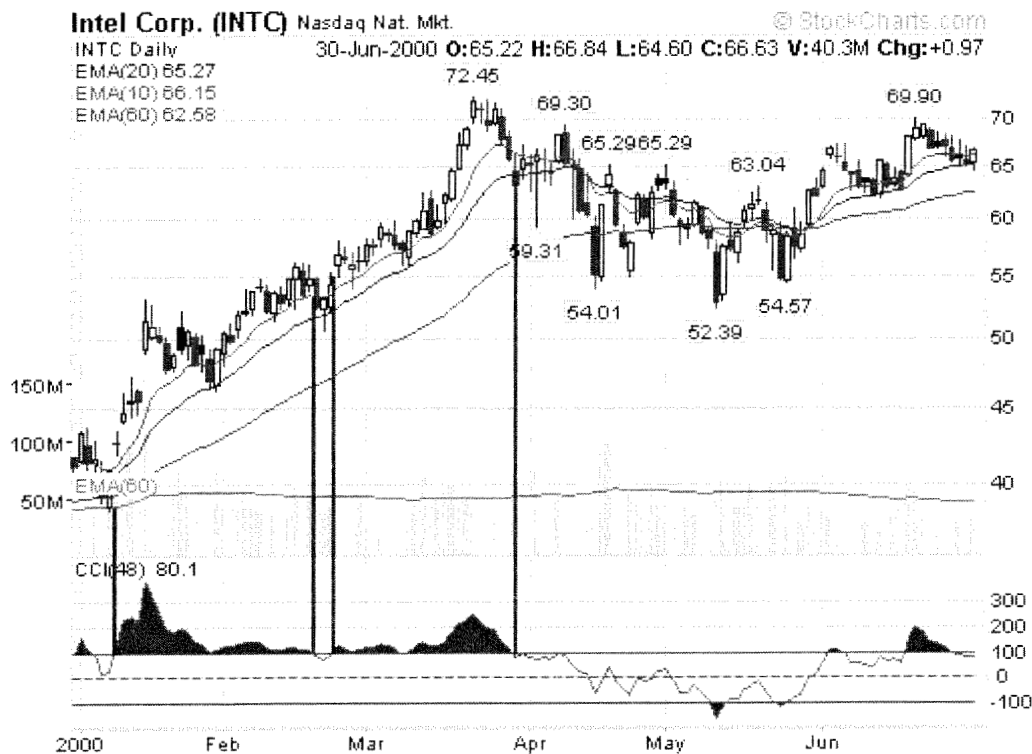


Figure 7. Intel Corp. Jan. 2000 – June 2000

Figure 7 shows the CCI graphed with the stock price of Intel over the first half of 2000. Recalled from Figure 6, Intel was in an uptrend for the first three months of 2000. In this uptrend, we notice that the CCI is above +100 for much of this time period and the stock is making significant price gains during these periods. However, when the stock moves from a trend into a trading range as it does in April, any moves outside of the +/- 100 boundaries are rare and don't last long.

The indicator can be used as a contrarian oscillator as well. Many people will buy a security when its CCI has just moved from less than -100 to greater than +100 under the premise that the stock will eventually move back to its mean value. Since the stock would then be within one standard deviation of its typical value and below the mean value, they feel the security is primed for a price increase.

Stochastic Oscillator

The stochastic oscillator is a leading contrarian indicator that functions solely as a measure of a stock's current location within a trading range. This oscillator measures where a stock is relative to the maximum and minimum values reached in a set number of trading days. This indicator usually involves smoothing values using simple moving averages so as to reduce the wild volatility of the indicator. The main line is called the %K line and the smoothed line is known as the %D or signal line. A chart of this indicator (see Fig 8) is usually labeled with 2 numbers such as (14,3) which means that the %K is based on the extremes of the previous 14 days while the signal line is a simple moving average of the %K over the last 3 days.

With this particular indicator, the 20 and 80 are the values typically associated with overbought and oversold status. George Lane, who developed this indicator in the 1950's, thought "some of the best signals occurred when the oscillator moved from overbought territory back below 80 and from oversold territory back above 20" (Hill Stochastic).

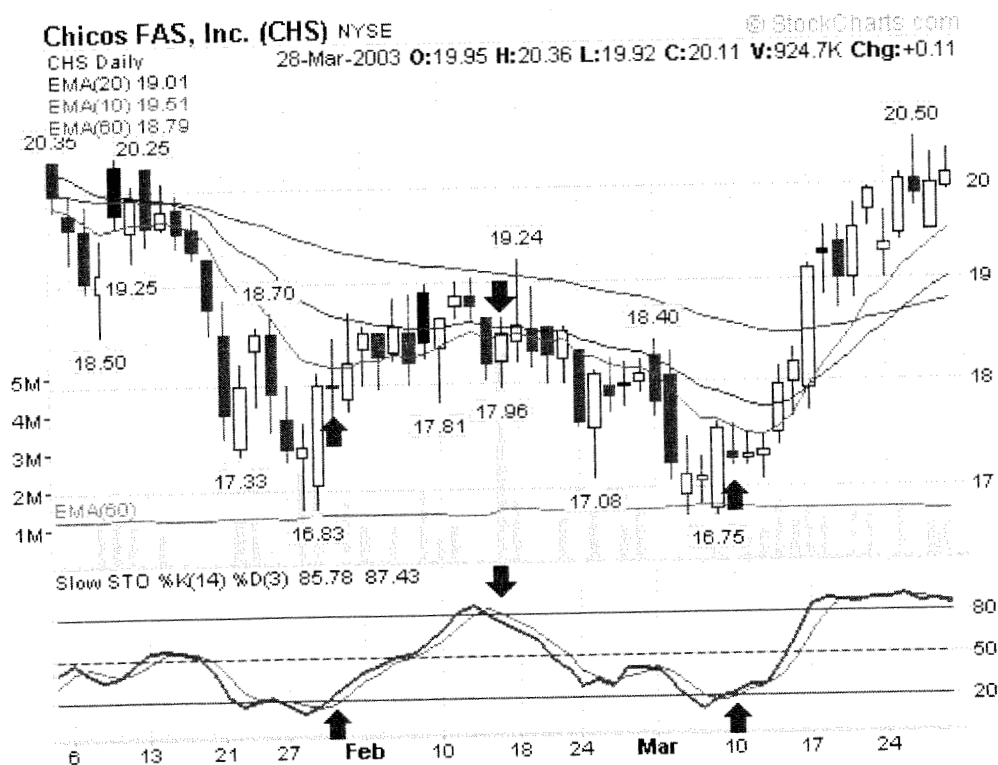


Figure 8. Chicos FAS Jan -March 2003

This indicator is most useful during ranging markets as it does its best work by identifying when a stock is moving back from an extreme value. Since ranging markets are, by definition, trading between certain stock prices, this indicator points out when a stock is at the low end of the range so the stock can be purchased with minimal risk. Additionally, it indicates when stocks are at the high point of their range so that a stock may be sold at a price close to the top of a stock's range. In Figure 8, we see that Chico's FAS is in a trading range and has hit the 20 and 80 thresholds several times between January and March 2003. Each signal given, indicated by the arrows, was close to the extremes of its move.

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	To:	Uptrend	Downtrend	Range
From:				
Uptrend		-----	Close long positions	Close Long Positions
Downtrend		Close short positions	-----	Close Short Positions
Range		Keep long positions	Close long positions	-----

These guidelines make two critical assumptions that almost all traders hold true:

1. In an uptrend, one should be either long or on the sidelines (Rhodes)
2. In a downtrend, one should only be short or out of the market.

We recommend closing all positions after a trend because of an old street adage: "The trend is your friend, except at the end where it bends". If you either entered into or kept a position because it was in a trend, a trader's reason for being in the position is no longer valid and thus, it should be liquidated.

Although an extremely rare situation, if a trend moves from an uptrend to a downtrend, or vice versa, without going through a ranging period, its open positions should be closed. If the stock was in a downtrend, then the only position one should be in is short. However, since one should never be short in an uptrend, the positions should be liquidated immediately.

The remaining two situations come when stocks move from a range into a trend. In this case, we will be assuming that in a range a trader will only be taking long positions. If a trader is in a long position and the stock breaks down out of the range and into a downtrend, the stock should be liquidated. However, if a long position has been established in a trading range and the stock breaks out into an uptrend, then there is no reason why the position should be sold. The entire purpose of being long is to achieve

capital appreciation, and an uptrend typically provides that. As such, the position should be held and should be subjected to the exit rules of a trend. Thus, the position should not be sold until a trending sell signal is given or the uptrend comes to an end.

Filtering Return Enhancing Device (FRED)

The trading system that was born out of this thought process is known as FRED. Its name is derived from the fact that in the data processing arm of the system, the DMI acts as a filter, getting rid of all trade entries that are not optimized for current market conditions.

The main problem encountered in this system's development was the noticeably streaky tendencies of the indicators. The majority of the undesirable trades came from CCI signals. We noticed that many of the most profitable trades came from these trending signals. However, the trending signals (buy and short) comprised roughly 70% of the total entries while accounting for less than 50% of profitable trades.

As a result of this inadequacy, a second filter was added to further screen the trades. A longer-term filter, twice the time-period of the first DMI filter, was added as another screen to make sure the trend was moving in the same direction as the trade. We found that this second filter eliminated many of the "whipsaws" and losing trades because these often came at times where the long and intermediate term trends were not the same. Thus, any trades based on CCI, our momentum indicator, must coincide with both the long and intermediate term trends. Similarly, if the two DMI trends do not match up or if either of the DMIs shows a range, then the stock is considered a range and the entry signals for stochastic are followed.

FRED gives users three settings for trading that a user can specify for each stock entered. Each setting allows a user to tailor the system's trading to their own degree of risk tolerance.

Aggressive

The aggressive setting is for people who do not mind trading frequently; the actual frequency of which depends on the volatility of the stock. The aggressive strategy makes recommendations on both the long and short side of a stock.

There are several advantages to allowing one to short the market. First, it allows an investor to profit during a down market. Secondly, it allows an investor the means to hedge market risk. By keeping equal amounts of money on both the long and short side of the markets, an investor can negate any stock price movement that is based solely on the market's direction. Thus, the strength and weakness of individual stocks are the basis for the change in value of the entire portfolio. Buy buying the strongest performers and shorting the weakest, investors can profit on the spread in relative performance. For example, If A is showing strength in the market and B is showing weakness, it is not uncommon to see a return structure set up like this:

Stock Return	Market Direction	
	Up	Down
A	+3 %	-2%
B	+2%	-3%

In this situation, when long A and short B, regardless of what the market does, we would expect the portfolio to return 1%. This is what the aggressive portfolio setting attempts to do.

The aggressive setting has its settings built-in. The DMI filters are based on modified 32 and 64-day time periods. Typically, the ADX is calculated using the same number of days as DI+ and DI-, but we made ADX a separate setting. We set the ADX number lower than the DI+/- to make the ADX line more responsive and more heavily reliant on the most recent data. We selected these time periods because they are based on the 16-day “cycle” that J.M. Hurst proved in his book *The Profit Magic of Stock Transaction Timing* (Downs 35). We figured it would be best to base trends on at least two cycles so that we could be sure to calculate the trend based on two sets of small rallies and corrections.

The 16-day cycle provided the basis for the 48-day CCI that is used for trending signals. It is important to recognize that CCI is not used as a trend-determining indicator. Instead, in functioning as a measurement of a stock’s divergence from its typical price, it measures breakouts from typical ranges. We want to find the opportunities that compliment the 32 and 64-day trends, not compete with them. That is why the CCI setting is between the two DMI settings.

The trading range settings are based on Slow Stochastics with a (14,3) setting. We chose this setting because it allows the system to take advantage of shorter-term opportunities. The problem with using longer-term indicators is their lack of responsiveness. In using a 14-day stochastic, we are able to jump on momentary oversold positions that the trending indicators would have missed.

Conservative

FRED allows users who do not feel comfortable with the large volume of trading usually associated with the aggressive strategy and the idea of shorting stock. The

conservative strategy is long only. The basis of the conservative strategy is a 39-day slow stochastic. This is a very simple strategy where one should buy the stock when the stochastic goes above 50 and should sell the stock when the stochastic falls below 50. This strategy was outlined by Colby and Myers in *The Encyclopedia of Stock Market Indicators*.

Custom

The custom setting on FRED allows users to change the settings on each indicator so that it will coincide with the investor's time horizons. This setting was included for advanced users who understand each of the indicators and how they work together. This setting is not recommended for novice users.

Signals Generated by FRED

FRED generates seven concrete signals requiring no interpretation by the reader to tell the user what action to take. The signals are divided into three separate categories: no signal, trending, and ranging.

When FRED gives a no signal, the user is to take no action. If the user currently has an open position in the stock, it means that the user should keep that position open. If the user currently does not have a position in the stock, he or she should not open a position.

The trending signals only occur when the two DMIs with different time-periods are trending in the same direction. A user can get four trending signals:

- Buy Trending – The user should open a new long position in the stock.

- Sell Trending – The user should close long positions regardless of whether they were opened in trending or ranging markets.
- Short Trending – The user should open a new short position in the stock.
- Cover Trending – The user should cover any short positions.

The ranging signals occur when the DMIs are not signaling a trend. Since these are based on the stochastic and there are no short signals given in ranging markets, there are only two signals given:

- Buy Ranging – The user should open a new long position.
- Sell Ranging – The user should close all long positions opened by “Buy Ranging” signals.

Backtesting and Results

Since the Aggressive and Custom settings are the only original products, those methodologies are the only ones tested. The testing that led to the conservative strategy can be found in Colby and Myers’s *The Encyclopedia of Stock Market Indicators*.

There were two goals set for FRED’s development: we wanted to increase return over the buy and hold strategy while reducing risk. Given current market environment and the bear market that American investors have endured in the last few years, an inflow of cash into bond mutual funds shows a risk aversion in the investing public.

Stocks were selected at random from the S&P 500 so that we could have better odds that the stocks would have 10 years worth of data and would be liquid enough for frequent trading. For testing purposes, we used 10 years worth of data, but ignored any trades in the first 6 months because the long-term filter works on 120 days worth of data

and we wanted to make sure that we had completely accurate indicator data points when we finally started trading.

The results of FRED's backtesting were disappointing. While FRED did succeed in reducing overall volatility of the stock, that could have been reasonably predicted by the fact the user does not always have an open position, long or short, in the stock. In fact, the backtesting showed that the user is only in a position 31% of the time. Thus, once we account for the rare occasions where the user will have two long positions, we can reasonably state that the total volatility of FRED's positions in a single stock will be approximately 1/3 of the security itself.

Since the volatility was 1/3 of the stocks, we made 1/3 of the stock's return over the backtesting period as the threshold for what we considered acceptable performance for our aggressive strategy. This seemed reasonable because FRED's performance could then theoretically be triple-leveraged to create a return greater than that of the individual stock.

In each case, we found that the individual security dramatically outperformed FRED over the backtesting period. Often, FRED showed total losses while the stock showed dramatic gains. For example:

Stock	Security Return	FRED return
Cintas (CTAS)	270%	-14%
Dell (DELL)	560%	43%
Ford Motor Co. (F)	20%	-27%
Pfizer (PFE)	535%	10%

These results are a sample of the overall pattern. Of the 12 stocks we tested, none of them beat the risk-adjusted benchmark of 1/3 of the security's return. FRED did have

some short periods where it did dramatically outperform the stock (For example: FRED returned 40% on INTC in 2000 vs. -24% on INTC stock.). However, over the long run, FRED just did not perform.

Analysis

A contingency that we failed to plan for was that of stop losses. Most traders advocate the use of stop loss orders as a way of limiting risk, as they work by automatically closing a position once it has accrued a set loss. There are many different methods of finding a price to set a stop loss order. One of the most vocal advocates of stop losses, William O'Neil advocates setting stop-losses at 8% for every position a person takes. O'Neil considers it so important that he prints it daily in his newspaper, *Investors' Business Daily*. The impact of building this in is unknown, as there are several positions in each stock's testing that incurred losses of greater than 8%. However, it is unknown how many positions reached the 8% loss level intraday before turning around and turning into either a profitable position or was closed at a loss smaller than 8%.

In a troubleshooting effort, FRED's return-by-signal was analyzed. We expected the trending signals to provide a bulk of the total return. However, just the opposite occurred. We found that in all instances, the ranging entry signals provided a higher return than the trending signals.

Stock	Ranging Return	Trending Return
CTAS	-5.4%	-9.2%
DELL	33.9%	6.7%
F	-17.3%	-20.2%
PFE	119%	-48.5%

As such, we are pleased with the general performance with the ranging signals. The stochastic appears to be performing well. Since the stochastic functions in non-

trending markets, one would expect the return to, over time, zero each other out.

However, the fact that the average return is greater than zero makes us confident that we are on the right track to profiting from stagnant markets.

Recommended Improvements

We are very troubled, however, by the failure of FRED's ability to profit in trends, which are typically the most profitable trading condition. The simplest explanation for this finding is that we were too discriminating when it came to opening positions in a trending market. Richard Rhodes's #1 trading rule is that "in bull markets, one is supposed to be long," (Rhodes) so perhaps we should just automatically open a position in the direction of the trend as soon as both DMIs are in agreement that there is an up- or downtrend. Using the CCI as a concrete signal provider might have prevented us from getting into positions merely because it gave a signal a day or two before an important trend started; since the signal was given while the system considered the market to be in a range, the signal was ignored.

The trade log shows that the poor results are due to being out of the market during major price moves, not from being in the wrong side of the market. Perhaps being sure to be in the market when there is a trend in progress will allow FRED to leverage the power of the trend to increase returns. Therefore, we propose that a position be initiated whenever both DMIs coincide and conclude that the market is trending. The trending position would then be liquidated as soon as the trend ends.

Additionally, this change will not have an effect on the returns of the ranging signals. Since we are not changing the way trends and ranges are being decided, the

stocks will be in ranges the same times they were before. The only difference is on the trend side.

Another positive repercussion this improvement would offer is decreased trading. Since the CCI is not calling the trades, we do not have to worry about the CCI gyrating around the +/- 100 levels and whipsawing during an otherwise profitable trend. This saves time for the user and, more importantly, commissions to the brokerage.

Conclusion

We hope we have provided a general comprehension of an oft-misunderstood aspect of finance and personal investment. We hope that this system will provide a jumping off point for each individual to develop his or her own system. As the results show, although this is a conceptually solid system, it simply did not work in historical market conditions. This does not necessarily mean that the idea is flawed. Further research and testing could show that small changes such as the one we proposed could turn this into a winning system. The name of the stock market game is change. Market conditions are always changing and so must traders' approaches.

Part II. Technical Documentation for FRED

Introduction to FRED

FRED is the implementation of the theory detailed in the thesis, *Evaluating Market Conditions: A Simplified Approach for Analyzing Stock Price Activity*. In general terms, FRED is a website that allows users to, in a very simple way, systematically determine which trades to place each day. Currently, FRED can be found at:
< <http://134.53.113.84/fred/> >

The Origin the Name FRED

FRED is an acronym for Filtering Return Enhancing Device.

Technologies Used in Creating FRED

Several different technologies were used in the creation of FRED. These include:

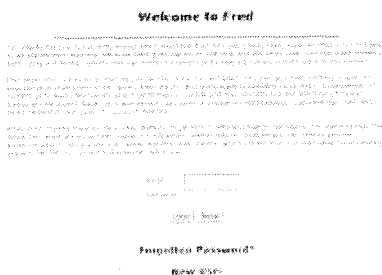
- Apache 1.3.27 (the web server)
- PHP 4.2.3 (the primary development language)
- MySQL 3.23.54 (the database)
- HTML and Dynamic HTML
- JavaScript
- CSS (Cascading Style Sheets)
- Sessions

Additionally, although FRED was developed on a system running Windows 2000, Service Pack 3, FRED is compatible with systems running Unix and Linux.

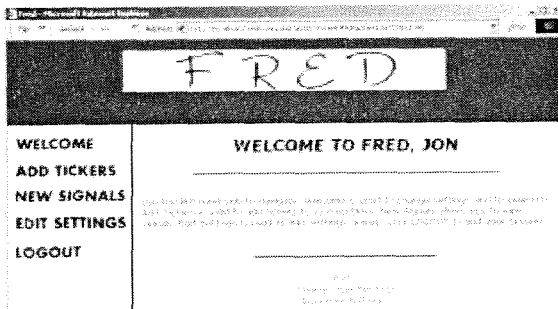
How FRED Works

As can be gathered from the high level view of FRED shown in Figure 1, FRED can be broken down into a series of four steps.

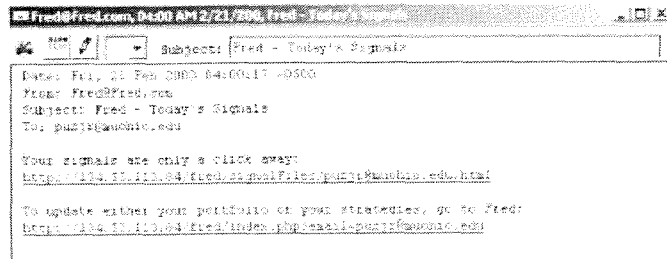
1. Log in



2. Add tickers, define strategies



4. Send signals via email



3. Get data and process it



Date	Open	High	Low	Close	Volume
8-Jan-08	33.3	33.4	32.66	32.87	165100
7-Jan-08	33.76	33.8	33.14	33.37	215500

Figure 10. A high level view of FRED

Step 1. Log In

After registering as a new user, the user can log in to FRED.

Step 2. Add Tickers and Define Strategies

Once the user is inside of FRED, they can, as shown in Figure 2, add ticker-strategy combinations to their portfolio, edit the tickers in their portfolio, and view the

signals FRED generated. Additionally, the user can access Frequently Asked Questions (FAQs), change their settings, and view the disclaimer and privacy statement.

F R E D

Please add to your portfolio by defining an investment strategy for each ticker.

Enter Ticker:

Investment Strategy: Aggressive Conservative Custom

DI+/DI- Days	<input type="text" value="32"/>	<input type="text" value="N/A"/>	<input type="text"/>
ADX Days	<input type="text" value="28"/>	<input type="text" value="N/A"/>	<input type="text"/>
Stoch %K	<input type="text" value="14"/>	<input type="text" value="50"/>	<input type="text"/>
Stoch %D	<input type="text" value="3"/>	<input type="text" value="1"/>	<input type="text"/>
OCI	<input type="text" value="48"/>	<input type="text" value="N/A"/>	<input type="text"/>
Stoch Oversold	<input type="text" value="20"/>	<input type="text" value="40"/>	<input type="text"/>
Stoch Overbought	<input type="text" value="30"/>	<input type="text" value="50"/>	<input type="text"/>

[Help](#)

Figure 11. The Add Tickers page

Step 3. Get the Data and Process It

During each weekday night, a data file is pulled from Yahoo! for each distinct ticker in the database. This data file, along with the strategy defined by the user for each ticker in their portfolio, is processed in order to generate one signal for each ticker. This signal will tell the user how to trade that ticker.

Step 4. Send Signals via Email

As seen in Figure 3, signal files that list the ticker, the current signal, the previous signal, the date of the previous signal, and the strategy are then generated for each user. These files are available via a link from the email that is sent to each user; an identical table may be viewed by logging into FRED. In order to allow users to customize their

experience with FRED, users are able to stop emails from being sent daily by changing their user settings.

Fred - Current Signals

Ticker	Today's Signal	Previous Signal	Previous Signal Date	Strategy
AEOS	No Signal	Buy Ranging	11-Mar-03	Aggressive
AMMD	Short Trending	Cover Trending	19-Mar-03	Aggressive
AMZN	No Signal	N/A	N/A	Aggressive
ATH	No Signal	Cover Trending	27-Feb-03	Aggressive
BBOX	No Signal	Short Trending	13-Mar-03	Aggressive
CLDN	No Signal	Buy Ranging	18-Mar-03	Aggressive
GE	No Signal	N/A	N/A	Aggressive
HMT	No Signal	Cover Trending	10-Mar-03	Aggressive
HTV	No Signal	Cover Trending	17-Mar-03	Aggressive
INTC	No Signal	Sell Ranging	27-Feb-03	Aggressive
JBLU	No Signal	Sell Ranging	17-Mar-03	Aggressive
MSFT	No Signal	N/A	N/A	Aggressive
NFLX	No Signal	Buy Trending	14-Mar-03	Aggressive
WPI	No Signal	Cover Trending	19-Mar-03	Aggressive

Figure 12. Example signal table for one of FRED's users.

The Heart of FRED: Steps 2, 3, and 4

A Detailed View of FRED's Heart

The heart of FRED is the algorithm that is used to process every ticker. This algorithm is a direct transformation of the aforementioned thesis into the code that gave FRED life.¹ More specifically, this algorithm is implemented in the process that occurs each weekday night (Step 3 in Figure 1); this process can be decomposed into a series of

¹ In this transformation, a key aspect of this project comes into play—the combination of a Finance and Accounting double major with a Computer Science and Systems Analysis double major. Independently, neither person had the skills necessary to make this project work. However, by combining a business background with technical knowledge, the project was able to succeed.

individual steps:

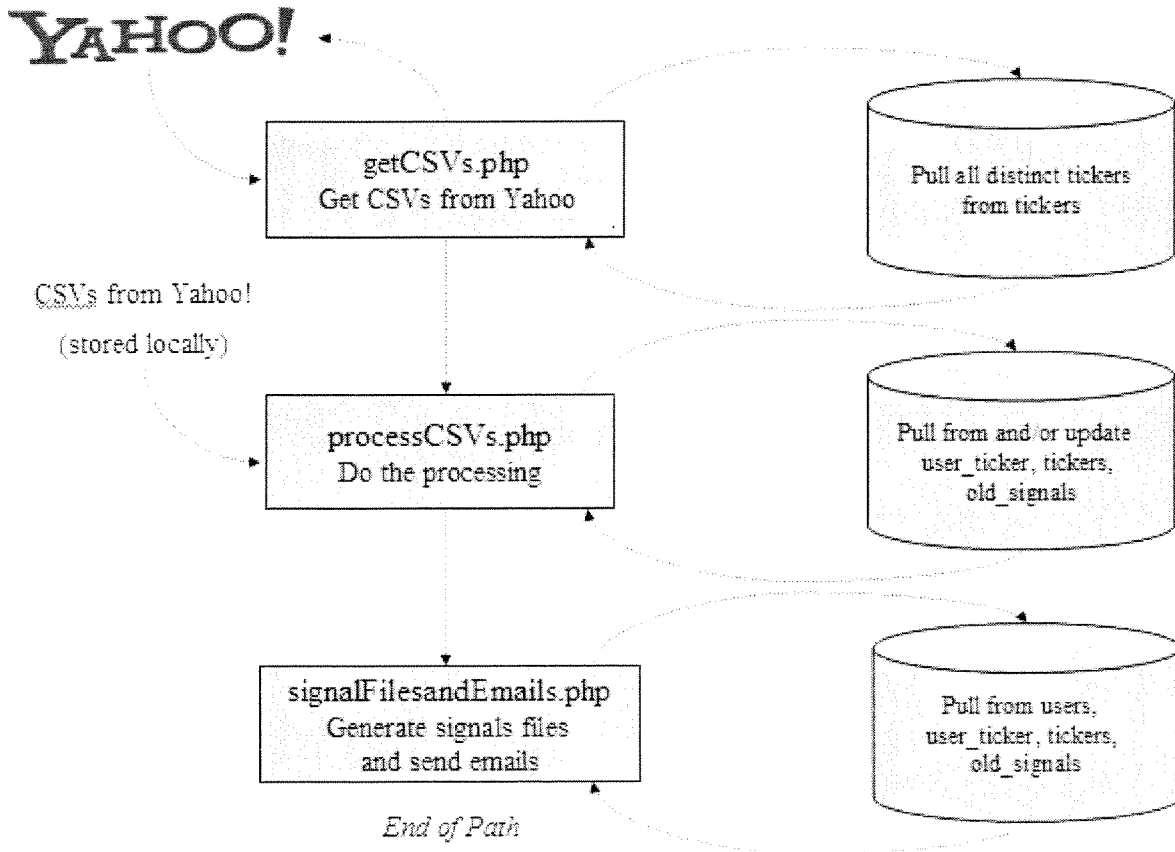


Figure 13. A diagram of the process in terms of the files, their roles, and their interactions with the database.²

As can be seen in Figure 4, the first step of this process involves retrieving data from Yahoo!. In this step, `getCSVs.php` queries the database for all distinct tickers and then retrieves a file from Yahoo! for each of the distinct tickers in the database. This file, which is in Comma Separated Value (CSV) format, contains one year's worth of data in the form: Date, Opening Price, High Price for the Day, Low Price for the Day, Closing Price, and Volume.

² More information on the database will be presented later in this document.

Once the data is received, processCSVs.php processes every ticker. The inputs to this file are:

- the CSVs from Yahoo!
- the strategy³ each user has defined for each ticker (generated from a database query)

Using the aforementioned algorithm, a signal is generated. Based on this output:

- the tickers table⁴ is updated with the current signal
- the old_signals table is updated only if the previous day's signal was something other than a "No Signal"

Finally, signalFilesandEmails.php generates signal files for each user that list the ticker, the current signal, the most recent signal, the date of the most recent signal, and the strategy (Figure 2). These files are available via a link from the email that is sent to each user; an identical table may be viewed by logging into FRED.

Ensuring that FRED's Heart Does Not Miss a Beat

In order to guarantee that this process occurs each night, either cron, the scheduler in Unix and Linux systems, or Scheduled Tasks, the scheduler in Windows systems, should be used to schedule these tasks to occur at the appropriate times. The amount of work to be done, which is determined by the number of users and the number of tickers, will determine the times at which these jobs should run.

³ The thesis contains a detailed explanation of the strategy and the signals.

⁴ More information on the database will be presented later in this document.

The Site from a Semi-Technical Standpoint

From a relatively high level view, Figure 5 represents the flow of FRED. In this figure, the solid lined arrows represent links between areas of the system and arrows are used to show the direction in which users may go.

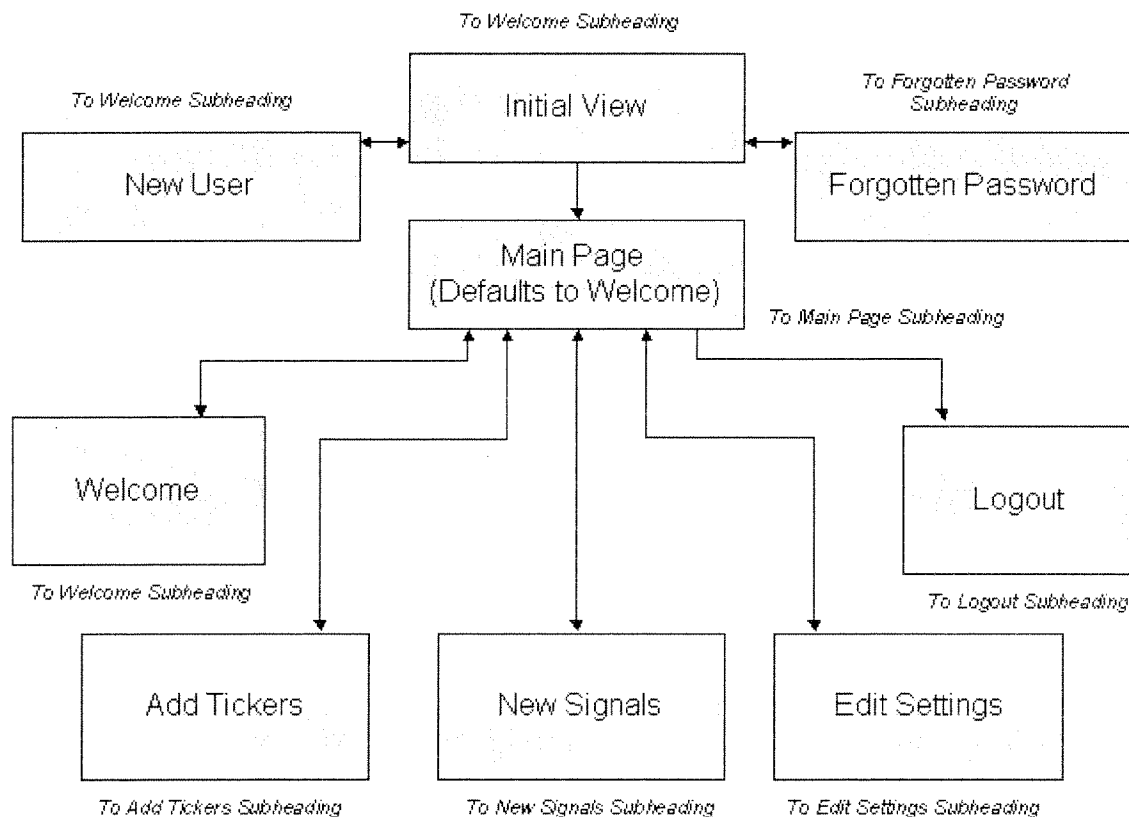


Figure 14. A high level diagram of FRED's data flow.

The Initial View

The opening page of FRED gives users three options (Figure 6). Most of the time, users will submit their email address and their password to log in; in doing so, login.php will be called automatically. If the email-password combination matches the values in the database, the user will be passed into the site; if not, the user will be returned to the index page.

In terms of the two index pages, index.php is the same as index.html except that index.php is capable of handing an email address and then putting it into the email address box so that the user only has to type their password.

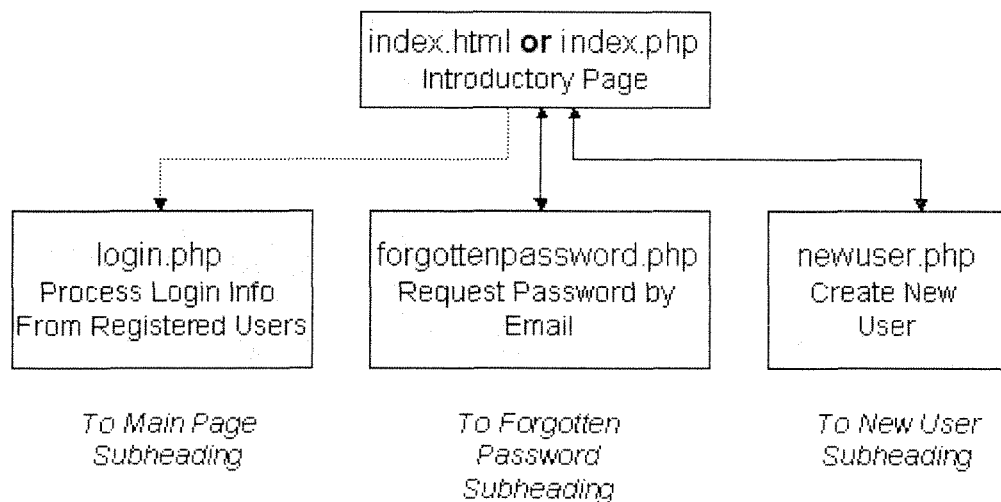


Figure 15. The Initial View

New User

Provided that a potential new user submits their registration information, that the potential new user agrees that they have read and that they understand the Disclaimer and Privacy Statement, and that the provided information passes a series of rudimentary checks, newuser.php will add the user to the database and then send the user their

randomly generated password⁵. A message stating that they successfully registered will then be displayed to the user with a link to index.php (one of the main login pages).

(Figure 7 models this part of FRED.)

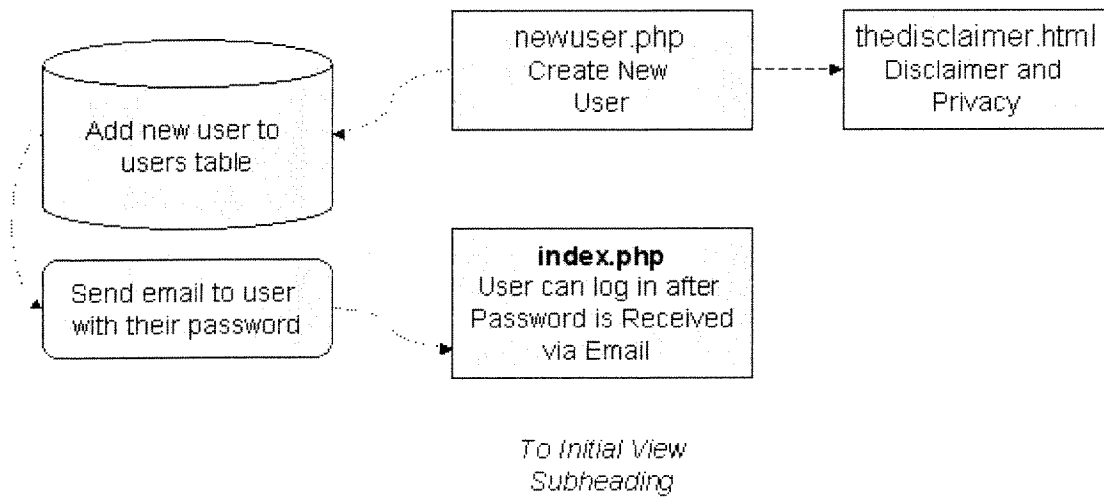


Figure 16. New User

⁵ This password is based on eight randomly generated numbers that fall between 1 and 62, inclusive. These numbers are mapped to the set of numbers, lower case, and upper case letters. Therefore, 62^8 , or 218,340,105,584,896 possible passwords exist.

Forgotten Password

As shown in Figure 8, `Forgottenpassword.php` simply takes a user's email address, queries the database to determine if an existing user has registered the email address that was submitted to `forgottenpassword.php`, and then mails a new password to that address. Since the old password is overwritten with the new password, the old password is immediately invalidated.

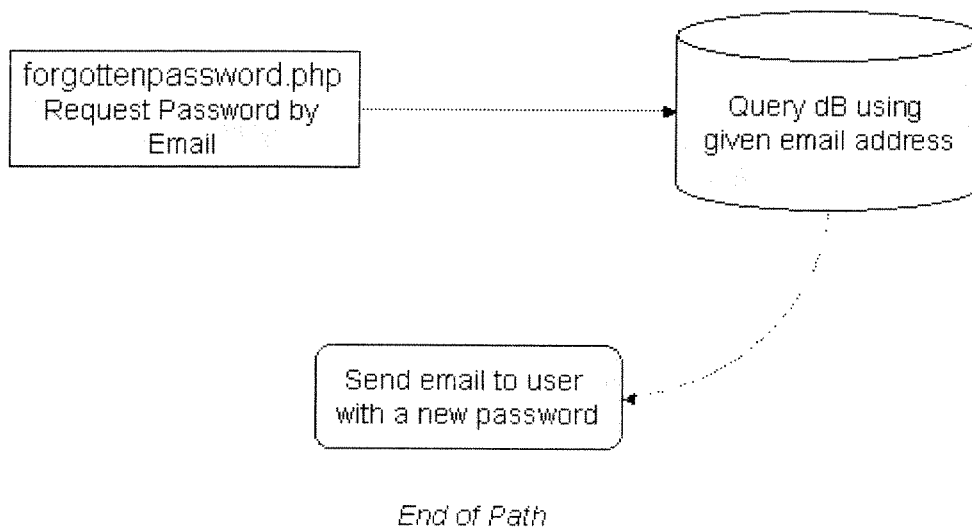


Figure 17. Forgotten Password

Main Page

Figure 9 depicts the main view of FRED. Once a user has successfully logged in to FRED, the user will be able to move between any of the five main functional units: Welcome, Add Tickers, New Signals, Edit Settings, and Logout. However, as shown by the one-way arrow to logout.php, the Logout process is a one way path. Additionally, because sessions (as maintained with the PHP code) are being used, no user can access any of these pages without having first logged into FRED.

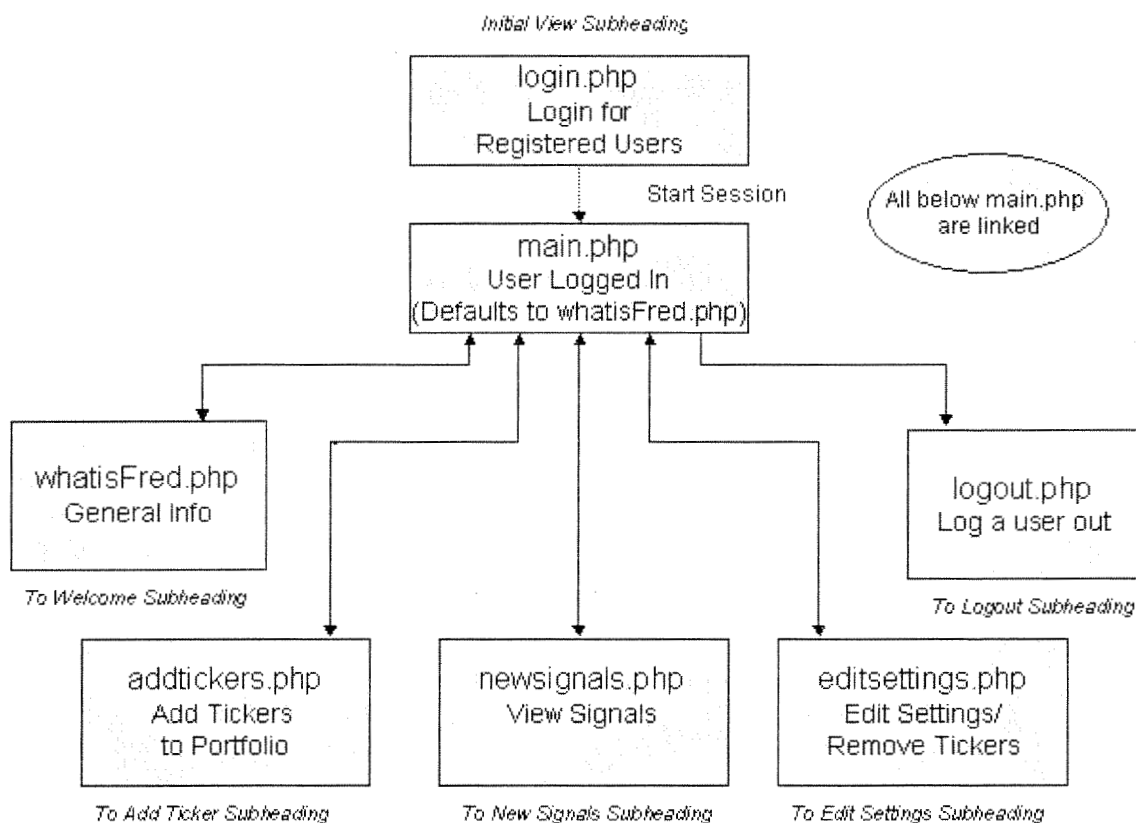


Figure 18. Main Page

Welcome

The Welcome page (Figure 10) provides the general information a user might want (faqs.html), the ability to change user settings (change.php), and the ability to view the disclaimer and privacy statement. As a way to personalize the site, whatisFRED.php pulls the user's first name from the database and plugs it into a statement that says, "Welcome to FRED, X" (where X is the first name of the user).

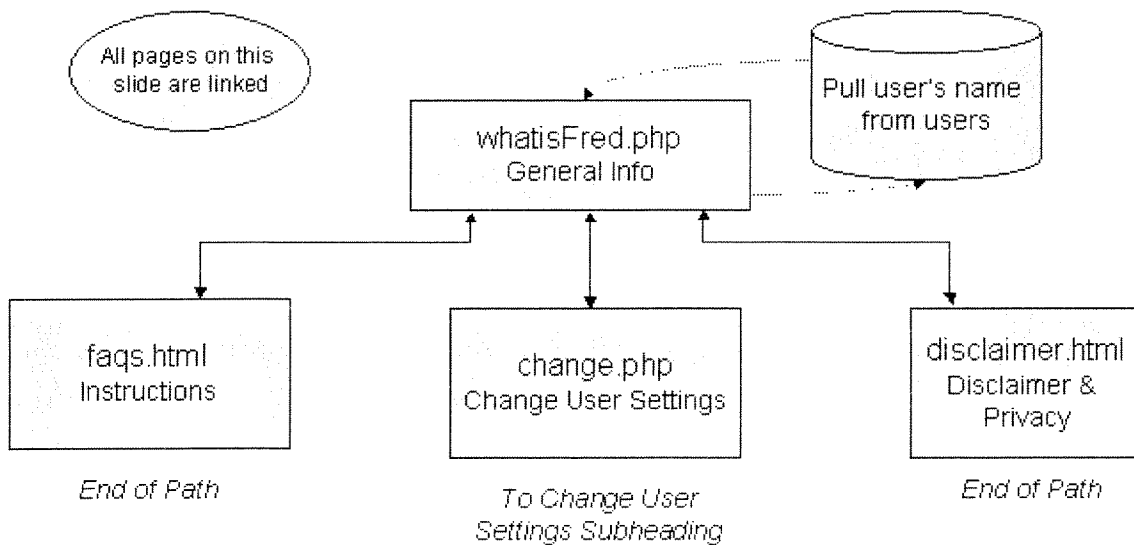


Figure 19. Welcome

Change User Settings

As shown in Figure 11, inside of FRED, users have four changes they can make:

- Update their email address
- Change their password
- Stop FRED from sending daily signal emails
- Close their account, which means that their user information and their portfolio are removed from the database

Of these four types of changes, the first three are simple as they involve an update to a field or two in the users table. However, closing an account is more complex (this process is detailed in the Close Account subheading).

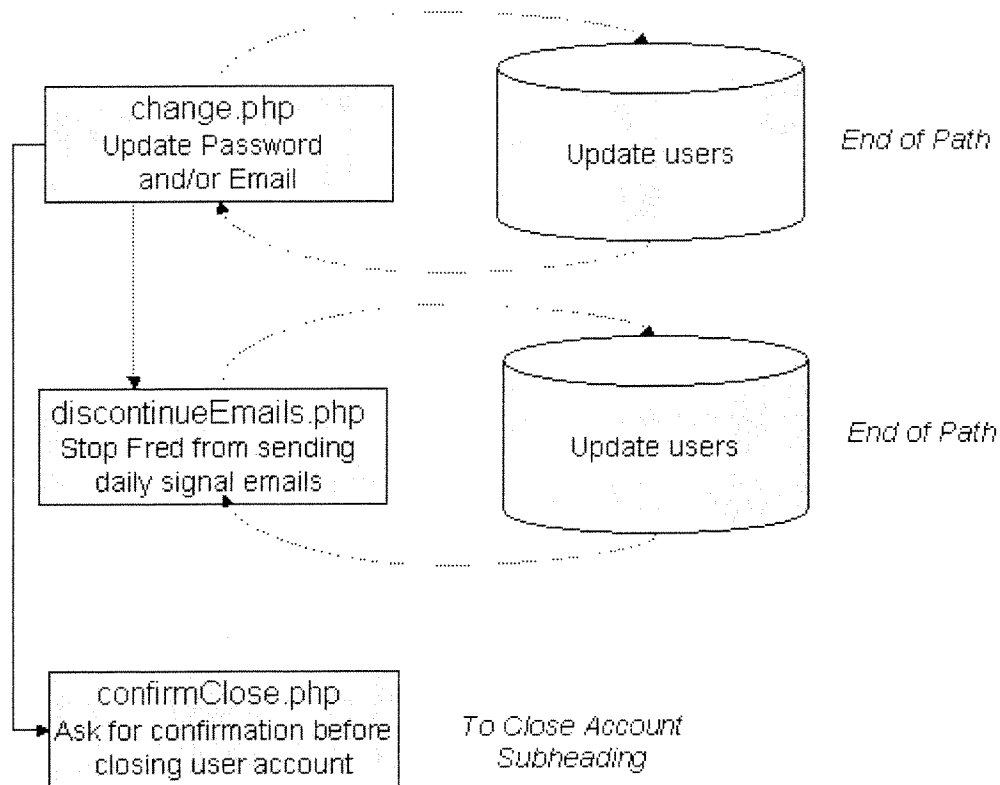


Figure 20. Change User Settings

Close Account

Before closing their account, the user is told that closing their account will delete their entire portfolio as well as their user information. If they choose not to proceed, they are taken back to the Welcome page (whatIsFRED.php). Otherwise, closeAccount.php is called; this file removes the user's entries from the database, ends the user's session, and then redirects to a page (accountClosed.html) that states that the user's account was successfully closed. Although the account was closed, the user is still free to create a new account at any time. (This part of FRED is modeled in Figure 12.)

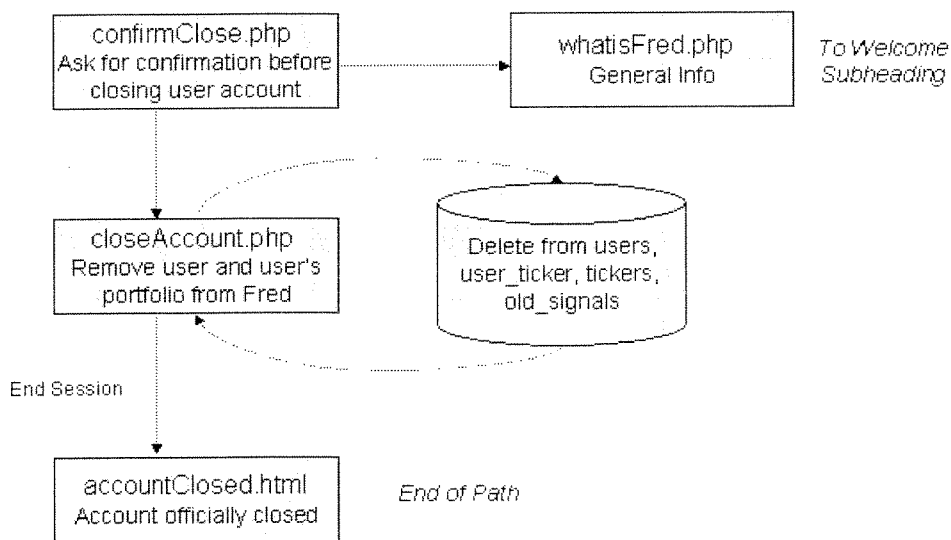


Figure 21. Close Account

Add Tickers

Adding tickers to a user's portfolio is a relatively simple process (Figures 2, 13). The ticker is typed into a text box and the strategy can be either the predefined Aggressive⁶ or Conservative or the self-defined Custom; error checking provides a check to be sure that the values in the Custom fields are not invalid. Upon clicking submit, the error checking occurs and, if the input passes, the appropriate additions are made in the database; otherwise, addtickers.php is redisplayed.

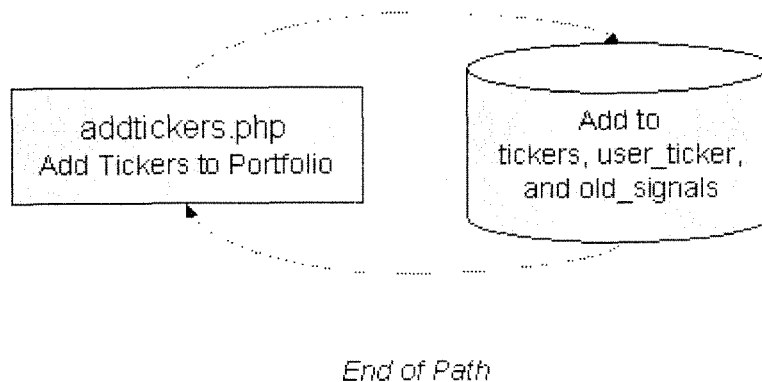


Figure 22. Add Tickers

⁶ The thesis details these strategies.

New Signals

The new signals table (Figure 3) is simply the formatted result of query (as shown in Figure 14) that pulls together the tickers, the current signal, the most recent signal that was not a, "No Signal," the date of that most recent signal, and the strategy associated with each ticker for each user. This table would provide the basis for any trades that are made using FRED.

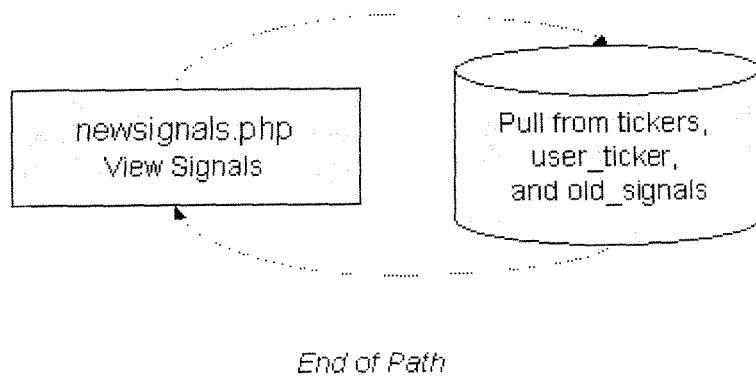


Figure 23. New Signals

Edit Settings

The edit settings unit (Figure 15) of FRED provides users the ability to remove tickers from their portfolios as well as to update the strategy they have defined for their tickers. After first presenting a table containing one ticker and strategy per row, a user can select a ticker to modify. Upon clicking on the ticker, the user is taken to a page that is nearly identical to the Add Tickers page (addtickers.php). The user can either click a checkbox to have the strategy removed or change the strategy for the ticker. If both options are selected, the remove will take precedence. (At the same time, the user can click the back button of the browser to escape the feature.) Upon submitting the data, the database is updated to reflect the changes the user requested.

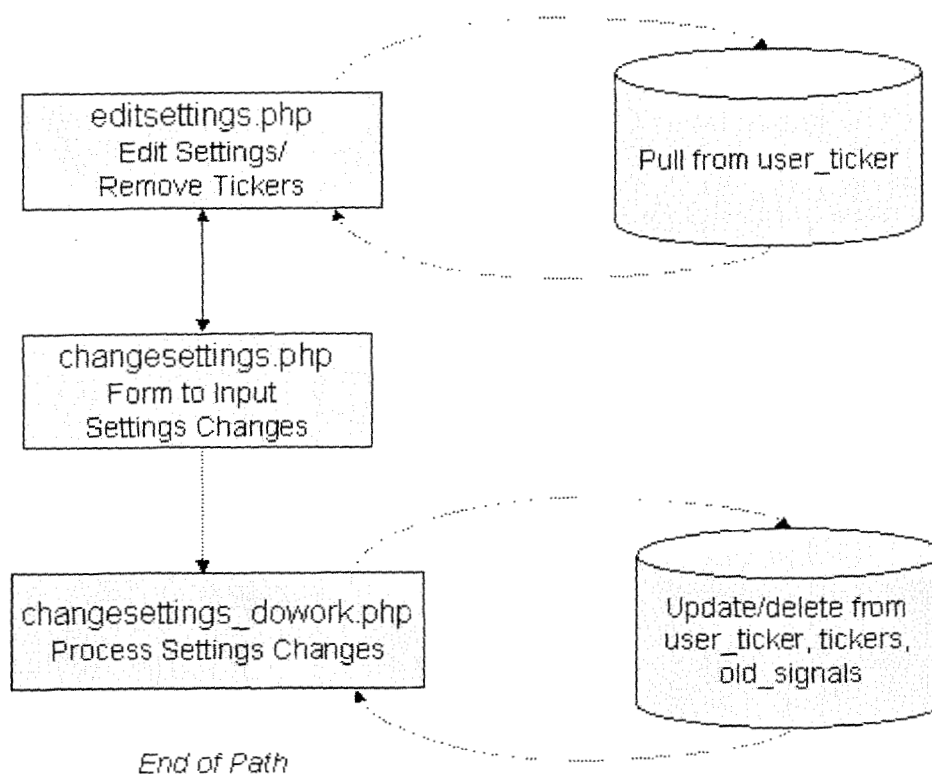


Figure 24. Edit Settings

Logout

As shown in Figure 16, when a user clicks Logout, `logout.php` is called; this file simply ends the user's session and then redirects to a page (`loggedout.html`) that states that the user's account was successfully closed. Once this process is started it cannot be stopped; however, because no data will be lost and because the user can easily log back in to FRED if they so desire, there is no need to confirm that the user indeed wants to log out before starting the process.

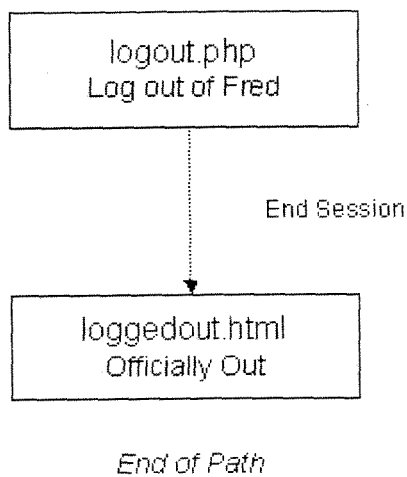


Figure 25. Logout

The Database

As expected, the database is critical to FRED's daily operations. The main components are:

- Four tables: `users`, `user_ticker`, `tickers`, `old_signals`;
- The tables' respective primary keys, which are simply a unique integer which is automatically incremented with each addition to the database, are: `usersID`, `user_tickerID`, `tickersID`, `old_signalsID`;

- Six relationships:

Involved Tables	Relationship
users to user_ticker	One to Many
user_ticker to users	Many to One
tickers to user_ticker	One to Many
user_ticker to tickers	Many to One
tickers to old_signals	One to One
old_signals to tickers	One to One

The users Table

The purpose of the users table (Figure 17) is to hold user information. In terms of the table itself, the interesting points are as follows:

- Both userID and email currently hold the email address; if a need to switch to user names is created, the user names should be stored in userID.
- The field lName is not currently being used because that piece of information is a considered to be nice to know as opposed to something that FRED needs to know. Quite simply, FRED has no need for the last name, which means that there is no reason for collecting it.
- The disabled field is used to determine whether a user wants to receive signal emails each day. If disabled holds a value of zero, then send emails.

Field	Type	Null	Key	Default	Extra
usersID	int(5)		PRI	NULL	auto_increment
userID	varchar(30)		UNI		
fName	varchar(30)	YES		NULL	
lName	varchar(30)	YES		NULL	
email	varchar(60)				
zip	int(5)	YES		NULL	
disabled	tinyint(1)			0	
pwd	varchar(32)				

Figure 26. The users table.

The user_ticker Table

The purpose of the user_ticker table (Figure 18) is to serve as the association between the users table and the tickers table as well as to hold information about the strategy each user defined for each ticker. This table is necessary to implement a many-to-many relationship between the users table and the tickers table.

Although having the ticker field present in this table is not necessary, doing so makes life much easier when working with the database both in terms of writing the code and in terms of the speed of database queries.

Finally, the strategy field represents the strategy that the user chooses to use for each entry in their portfolio. In this database, a value of 1 signifies aggressive, 2 signifies conservative, and 3 signifies custom. As for the seven fields that begin with numDays, Appendices A and B provide the necessary background information.

Field	Type	Null	Key	Default	Extra
user_tickerID	int(5)		PRI	NULL	auto_increment
usersID	int(5)	YES		NULL	
tickerID	int(5)	YES		NULL	
ticker	char(5)				
strategy	tinyint(4)	YES		NULL	
numDaysDI	tinyint(4)	YES		NULL	
numDaysADX	tinyint(4)	YES		NULL	
numDaysStochK	tinyint(4)	YES		NULL	
numDaysStochD	tinyint(4)	YES		NULL	
numDaysCCI	tinyint(4)	YES		NULL	
numDaysStochOversold	tinyint(4)	YES		NULL	
numDaysOverbought	tinyint(4)	YES		NULL	

Figure 27. The user_ticker table.

The tickers Table

In addition to serving as the holder of the tickers that are entered into FRED, the tickers table (Figure 19) also holds the current signal. The table itself has several fields of interest:

- The data_exists field serves three purposes:

- If there is enough data available to generate a valid signal enough data then data_exists has a value of 0;
 - If there is not enough data available to generate a valid signal then data_exists has a value of 1;
 - If the user entered the ticker and now signals have been generated yet then data_exists has a value of 2.
- Disabled is used to denote invalid tickers; if (valid) then disabled=0 else disabled=1
 - The significance of the remaining seven fields, with the exception tickerID and ticker, is detailed in Appendices A and B.

Field	Type	Null	Key	Default	Extra
tickerID	int(5)		PRI	NULL	auto_increment
ticker	char(5)				
buy_trending	tinyint(1)	YES		NULL	
sell_trending	tinyint(1)	YES		NULL	
nosignal	tinyint(1)	YES		NULL	
short_trending	tinyint(1)	YES		NULL	
cover_trending	tinyint(1)	YES		NULL	
buy_ranging	tinyint(1)	YES		NULL	
sell_ranging	tinyint(1)	YES		NULL	
data_exists	tinyint(1)	YES		NULL	
disabled	tinyint(1)	YES		NULL	

Figure 28. The tickers table.

The old_signals Table

The old_signals table (Figure 20) holds the past signals for each ticker. Because all but two fields (the primary key, old_signalsID, and signaldate, which holds the date of the signals in this table) come directly from the tickers table, this table is very similar to that table.

Field	Type	Null	Key	Default	Extra
old_signalsID	int(5)		PRI	NULL	auto_increment
tickerID	int(5)			0	
ticker	varchar(5)				
buy_trending	tinyint(1)	YES		NULL	
sell_trending	tinyint(1)	YES		NULL	
nosignal	tinyint(1)	YES		NULL	
short_trending	tinyint(1)	YES		NULL	
cover_trending	tinyint(1)	YES		NULL	
buy_ranging	tinyint(1)	YES		NULL	
sell_ranging	tinyint(1)	YES		NULL	
signaldate	varchar(10)	YES		NULL	

Figure 29. The old_signals table.

Database Backup and Restoration

In order to boost the reliability of the database, a fourth, lesser known overnight job backs up the database each night. This script is called databaseBackup.bat; it is located in the databaseBackups folder. This script should be set to run each night, at minimum, so that in the event of a database catastrophe, only a minimal amount of data will be lost. (In order to guarantee that this process occurs each night, either cron, the scheduler in Unix and Linux systems, or Scheduled Tasks, the scheduler in Windows systems, should be used to schedule this task to occur at the appropriate times.)

If a database catastrophe were to occur, by simply clicking on the script databaseRestore.bat, the database can be restored to its most recent version. In order for this to work, the file FRED.sql must not be deleted, such as by user error.

Migrating FRED to Other Systems

In terms of transferring FRED between systems, outside of a system that has a web server with PHP and MySQL running, the only major concerns are the jobs that must be run overnight and the database. Because the jobs that need to be run overnight can be scheduled with either Scheduled Tasks in Windows or cron in Unix/Linux, this issue is not much of a concern at all. However, the database could become more of an issue. Undoubtedly, the database will have to be recreated if FRED is transferred between boxes. In terms of recreating the database, the database section of this presentation contains the necessary code and an accompanying explanation. If the database contains information that needs to be carried between systems, the scripts in the databaseBackups folder can be run to backup and then restore the database. The other issue involved in transferring the database will be the function calls used to connect to the database. This issue is addressed immediately following the code for the database (Appendix A).

Next Steps

The purpose of this section is to formally address the steps that could be taken to increase the robustness of FRED. Additionally, one technical concern, as well as possible ways of addressing, that concern are detailed.

System Availability

Because FRED is hosted with the support of a low-end universal power supply, which is a device that supplies power to the system on which FRED runs in the event of a power outage, FRED could go down in the event of an extended power outage.

Additionally, FRED is hosted on a computer that is not a dedicated server. However, by

moving FRED to a dedicated server with a better power supply, FRED's availability over the long term would approach 100%.

Closing User Accounts

Currently, as soon as a user opts to remove their account from the system, the account is deleted. A more robust way of doing this would be to hold the account for forty-eight to seventy-two hours and then send the user an email to confirm that they want to close their account. In this case, the user would not lose their portfolio if they changed their mind within a few days.

The Database

Because the database was developed in a piecewise manner, improvements could be made to the database. Specifically, the tickers and old_signals table could be combined into a table with five fields:

- tickersID, the primary key (a unique, automatically incremented integer)
- ticker, which would contain the actual ticker symbol
- current_signal, which would hold the current signal as an integer. The numbers 1 through 7, inclusive, could represent each of the signal types.
- old_signal, which would hold the old signals
- old_signal_date, which would hold the date that the old signal was generated

Data Issues

One major concern that developed, and to some extent still exists, centers on the CSVs. From experience, Yahoo! seems to begin updating its CSVs with the information

from that day's trading after the closing bell. However, these updates can take until midnight Eastern Standard Time to complete. Therefore, if the jobs are started too early in the evening, the necessary data may not be available. At the same time though, the longer FRED waits to do the nightly work, the greater the risk of not having the signals files created and the emails sent becomes.

On top of this issue is the data availability concern. At any time, Yahoo! could block FRED's IP address. If this were to happen, FRED would literally be crippled. Furthermore, Yahoo! seems to be the only data source that provides files that are updated nightly, that are in a usable format, and that are available at no cost. For these reasons, the biggest technical concern about FRED is that a data problem could bring the system down on any given night.

However, in order to address these three concerns, the following possibilities exist:

- A faster connection than Miami's T-1 and/or multiple computers could be used to pull the files across more quickly;
- Other sources that require a fee for their data could be consulted; in this situation, the files that are pulled across may have to be parsed into a format that matches the format of the Yahoo! CSVs.

By implementing these features, any major data issues most likely can be avoided.

Appendix A. Database Implementation Details

In order to create the database, these steps should be used:

1. Create a mysql user and password:

```
user: fred  
password: fredsthesis
```

2. Create a mysql database:

```
database: fred
```

3. Create the following tables by copying them into the mysql window and then hitting enter:

```
create table users (usersID integer(5) NOT NULL auto_increment PRIMARY KEY,  
userID varchar(30) NOT NULL, fName varchar(30), lName varchar(30), email  
varchar(60) NOT NULL, zip integer(5), disabled BOOL NOT NULL, pwd varchar(32)  
NOT NULL, CONSTRAINT uniqueID UNIQUE(userID));
```

```
create table user_ticker (user_tickerID integer(5) NOT NULL auto_increment  
PRIMARY KEY, usersID integer(5), tickerID integer(5), ticker char(5) NOT NULL,  
strategy TINYINT, numDaysDI TINYINT, numDaysADX TINYINT, numDaysStochK  
TINYINT, numDaysStochD TINYINT, numDaysCCI TINYINT,  
numDaysStochOversold TINYINT, numDaysOverbought TINYINT, FOREIGN KEY  
(usersID) REFERENCES users(usersID), FOREIGN KEY (tickerID) REFERENCES  
tickers(tickerID));
```

```
create table tickers (tickerID integer(5) NOT NULL auto_increment PRIMARY KEY,  
ticker char(5) NOT NULL, buy_trending BOOL, sell_trending BOOL, nosignal BOOL,  
short_trending BOOL, cover_trending BOOL, buy_ranging BOOL, sell_ranging  
BOOL, data_exists BOOL, disabled BOOL);
```

```
create table old_signals (old_signalsID integer(5) NOT NULL auto_increment  
PRIMARY KEY, tickerID integer(5) NOT NULL, ticker char(5) NOT NULL,  
buy_trending BOOL, sell_trending BOOL, nosignal BOOL, short_trending BOOL,  
cover_trending BOOL, buy_ranging BOOL, sell_ranging BOOL, signaldate  
varchar(10));
```

4. If problems are encountered when connecting to the database, replace the statement:

```
mysqlconnect(); with mysqlconnect("localhost", "fred", "fredsthesis"); in all files.
```

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