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TRADING TRENDS USING FIBONACCI CORRECTION LEVELS AND JAPANESE CANDLESTICK PATTERNS IN THE EXAMPLE OF STANDARD & POOR'S 500 INDEX

Bachelor Thesis

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I have written the Bachelor thesis independently. All works and major viewpoints of the other authors, data from other sources of literature and elsewhere used for writing this thesis have been referenced.

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INTRODUCTION

In the times of computer trading and abundant information, banks and investment funds use intricate computer algorithms to predict price movements on the markets. These institutions are in a great need to constantly improve their trading systems and strategies which can outperform the market not only marginally but produce a sizeable profit for their stakeholders. At the same time, non-institutional investors (namely investors trading self-accrued funds) who are far less researched are avid users of complex charting analysis to either generate or confirm their trading decisions (Roscoe *et al.,* 2009). The testing and evaluation of such a charting strategy is the aim of this research. Such algorithm, if proved profitable, can help traders around the world, both institutional and private, to develop their own custom trading systems based on current market trends and psychology.

Mayall (2006) has divided charting-based trading (sample of non-professionals) into four rough categories which range from "scientific" system where traders try to eliminate as much human contact with trading decisions as possible to "trading as an art" where visual observations and trader intuition play a central role in decision making. This nomenclature was later formalized by Roscoe and Howorth (2009) along with conclusions that the interpretative activity by traders and investors plays an important role in the efficacy of technical analysis (charting). They also suggested that charting has power and importance to users as a heuristic device, regardless of its effectiveness in generating profits.

The trading method tested in this work explores the non-interpretative charting style (decisions based on a computer algorithm) and is based on two seemingly very different indicators. One of these indicators is Fibonacci correction levels, which are based on the works of Leonardo Fibonacci, namely his renowned work "The Book of Calculation"

(*Liber Abaci*) published in 1202. The efficacy of Fibonacci sequences in technical analysis is difficult to prove or disprove and it seems that only lately have researchers started to seriously consider testing such trading tools using scientific methods, even though the foundations of that tool go back over 800 years.

The second indicator that is used in this work is actually a set of indicators – candlestick patterns. Japanese candlestick charts originate, as the name says, from Japan, most likely such system was invented in the late 1800s by rice traders, according to some sources even around a hundred years earlier (Morris, 2006; Nison, 1994:14). Candlestick formation consists of four data points and contains therefore much more data than a line chart with only one data point (closing price). The patterns candlesticks make are usually observed on a visual basis. A myriad of candlestick patterns exist and are used by many traders. As this chart type was designed by and for the rice traders, it can therefore theoretically be best applied for commodities markets. Considering that candlesticks can show well the market sentiment and psychology, it is reasonable to think that these chart formations would also provide similar results on the equities markets.

According to Wagner (2010) and Nison (1994), Fibonacci retracements and candlestick patterns together can provide a more thorough understanding of the market and better trading results than either of them separately. These claims have not been empirically tested. It can be assumed, based on the similar nature of the signals provided by those indicators that a Fibonacci retracement line should fall in the same price area where a candlestick reversal signal appears. Candlestick patterns in this research serve as primary trading signals (showing declining or rising momentum) and Fibonacci retracements will be used as a confirming condition for the signal (projecting the price levels most likely to provide support or resistance). This is done to reduce the number of false signals generated by the primary candlestick pattern indicator.

The objective of the thesis is to assess the efficacy of using Fibonacci correction levels and candlestick patterns as an investment strategy in the example of S&P500 stock index. A sample trading algorithm will be provided as a secondary result of the research. The results of this research provide guidelines for further trading system design, namely whether or not the combination of those tools can provide greater insight into the markets

and be applicable as a profitable strategy. In order to reach that objective, it is necessary to fulfill the following tasks:

- Analyze the nature and underlying principles of candlestick patterns for understanding their ways of describing and interpreting data from the markets;
- Analyze and describe Fibonacci correction levels, the different theories of applying them in technical analysis;
- Review other works and scientific papers published on the topics;
- Test the predictive power of candlestick patterns without other technical indicators;
- Test whether applying Fibonacci retracement levels to candlestick analysis provides greater predictive value and creating a sample portfolio.

This work is divided into two main chapters: the first chapter describes the theoretical background and previous research on the topic, the second chapter contains empirical research conducted on the historical price data of the S&P500 index.

Keywords*:* *Fibonacci retracements, candlestick patterns, investment strategy, Elliott waves, technical analysis, charting.*

1. CANDLESTICK PATTERNS AND FIBONACCI CORRECTION LEVELS IN INVESTMENT STRATEGIES

1.1 Candlestick Pattern Formations in Technical Analysis

To understand why candlestick patterns provide important predictive information it is first necessary to understand how they are formed in the first place. They are very similar to bar charts, a chart type used long before candlestick charts were introduced to the western world (Nison, 1994)[1]. A candle consists of four data points: open, high, low, close. Open and close determine the color of the candle and form also the "body" of the candle. If the candle closes below the opening price then it has a red body and if the closing price is above open then the candle is red[2]. This makes reading candlestick charts and determining trends easier on visual observation. The formation of a candlestick is shown below on Fig. 1.

The shadows of the candles, often also referred to as wicks, show the amplitude of price fluctuation within the candle (one time period). It has been observed since the invention of such charts that certain rare candlesticks or combinations of them appear at significant times on the market, indicating a trend reversal. Such formations are called candlestick patterns and they are the first important indicator used in this research to create a trading system.

[1] Many of the further explanations refer to the works of Steve Nison since his research is the original source of candlestick analysis theory in all other pertinent literature published in the Western world.
[2] Some practitioners use black color for red and white for green candlesticks to facilitate reading black and white printing.

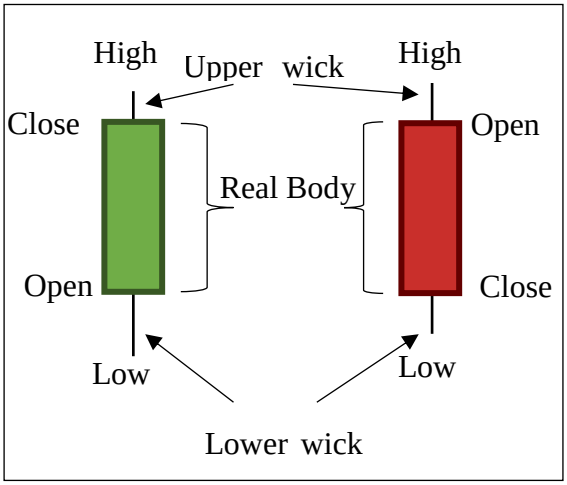


Figure 1. Anatomy of candlesticks. Made by the author

The major advantage of candlestick charts is that they show the momentum of price moves and are visually easier to understand than bar charts or line charts (Fischer and Fischer, 2003:83; Schlossberg, 2006). For the purposes of an automated trading program it is only necessary to have the four data points (open, high, low, and close) but since the pattern theory was developed in Japan using candlestick charts then for the purposes of all related research and visualizations, candlestick charts should be used.

Data on the efficacy of candlestick pattern formations varies greatly and should be taken with a grain of salt. As candlesticks are seldom used alone in making trade decisions then all findings regarding the efficacy of those patterns are inconclusive for trading purposes but are indicative for the selection of patterns which are theoretically more likely to yield profitable results when used in conjunction with other indicators. Although Robert and Jens Fischer (2003:84-88) found in their work that candlesticks can be profitable on their own, they also pointed out a research by Andre Rogalski who researched Dax 30 Futures Index and Euro-Bund Futures and found profit potential only in bullish engulfing pattern, hammer and hanging man (Rogalski 2001, referenced through Fischer and Fischer, 2003:85).

Maiani (2002) who researched US stocks and bonds over a period of 15 to 20 years found that the more rarely a candlestick formation appears the more likely it is to be accurate. For example a formation known as “Three Black Crows” resulted in the market rising the following day in 67.65% of the cases but such a formation was only found on 102

occasions out of the total of over 6 million candlestick patterns observed. The limitation of Maiani's work is that he evaluated the profitability of candlesticks based on the day immediately following the formation. This produces some misleading results, such as the case of the Three Black Crows which is a bearish signal (Nison, 2003:94) but according to Maiani it resulted in a bullish move in the market the following day. Considering that the patterns consist of three long bearish candlesticks (each candle closing at or near the session lows) then it is perfectly natural that the price will find support and bounce back after such an intensive period of sellers dominating the market.

Examples of different research methods include Marshall *et al* (2006) who used the bootstrapping methodology to simulate market data and research ten years of Dow Jones Industrial Average price data. He concluded that candlestick patterns produce no value (even before including transaction costs) for the investor. A year later he conducted a similar research on Japanese stock market data and arrived at the same conclusions (Marshall *et al*, 2007). In both studies, a ten-day moving average was used to determine trends and all positions opened based on those signals were closed ten days after opening. The way of determining profitable trades in those studies leaves one to wonder how close to the real world are these models. It is probably safe to assume that traders would take profits or cut losses depending on the price scale, not time.

However, the use of ten days in candlestick analysis is justified. The signals given by candlestick formations are effective in the short term, on average indeed about ten days (Nison, 1991:236-238). These results were also supported by an empirical study by Chen, *et al.* (2016). Reality is however more complex and the time period while positions are kept open depend from various biased factors, such as investor's mood, volatility of the markets, momentum (or duration of the trend for trend traders), position size and of course price movements. The "ten-day rule" is taken into consideration in this paper to assess the potential profitability of candlestick analysis. The average closing price for the ten-day period following a signal is calculated and stop-loss rules set. If that average is then higher (or lower, depending on the direction of the trade) than the opening price of the day following a candlestick signal then a trade is considered potentially profitable.

It should also be taken into consideration that algorithms used to identify chart patterns according to chosen rules are rigid which eliminates any bias a trader might have when

observing chart patterns visually. It means that a case of an otherwise valid and equally reliable pattern when it is even slightly off the input parameters will be overlooked by the search program but not by traders searching for these patterns manually. In case of trading, a certain degree of trader bias can be beneficial for the result and may be the reason why we often see practitioners achieving better results than academics.

Practitioners like Boris Schlossberg (2006:43) point out that candlestick analysis proponents often attribute almost "mystical powers" to candlestick analysis when describing their predictive power but in reality, they only have value when used together with other indicators. This may well hold true considering empirical evidence that renders candlestick analysis as stand-alone indicator unprofitable. The reason why it is considered profitable by its proponents can be thanks to tacit knowledge a trader possesses, some intuition developed over years of experience and practice. This opinion is further supported by Roscoe et al. (2009) who speculated it could be the reason why technical analysis has considerable effectiveness among practitioners in the first place.

The following paragraphs describe the visual properties of various candlesticks that were chosen to be tested with and without the addition of Fibonacci lines. The choice of candlesticks for this particular work is largely subjective by the author but does try to give a representative sample of single- and multiple line formations that have in previous works been deemed potentially profitable (see Maiani, 2002; Chen *et al*, 2016; Fischer 2003). The choice is also based on the rarity of the patterns and very rare patterns have been mostly excluded (based on the number of occurrences determined by Maiani, 2002). The majority of the patterns is formed by no more than two candlesticks.

Doji is a candle formation where the period opening price and closing price are the same or very close whereas the wicks of the Doji candle can vary in length. A typical Doji candle (where open and close prices do not exactly match) is shown on Figure 2.

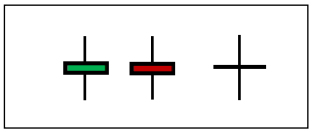


Figure 2. Bullish (green) and bearish (red) Doji candlesticks. Perfect Doji on the right. Made by the author.

Instead of classic “ideal” Doji candles where open and close match perfectly, a more liberal version of the Doji is used in this research. It means that the required distance between open and close price does not have to be zero but the Doji body to length ratio has to be less or equal to 0.1. Such concession can be made since the predictive power of Doji candles is derived from the underlying market psychology. Extreme proximity of open- and close prices indicates indecisiveness in the markets, it shows that the traders and market makers have not yet “decided” which way the market will go or should be going. As any simple observation can show, all financial markets will sooner or later experience significant fluctuations in prices.

According to Maiani (2002) who researched over 20 years of US stock and bond data, Doji candle formations did not have any predictive power in terms of market direction. He concluded that 42.28% of the times the market was up the following day and in 42.48% of the cases down. This information has no value in terms of price prediction since Doji in itself is not a trend predictive pattern. It is simply an indicator that both forces are present and equally strong in the market since the open and close prices are extremely close to each other. However, Doji can be a useful tool in determining when a trend or correction is exhausted. According to Nison (2003:52), Doji in a downtrend has less value than Doji in an uptrend. This theory is further examined in Chapter 2.

There are two special cases of Doji patterns which are trend predictive. They occur when one wick of the candle is significantly long while the other is very tiny or nonexistent (see Fig. 3). When the long wick is located on top it is called Gravestone Doji, when on the bottom then Dragonfly Doji.

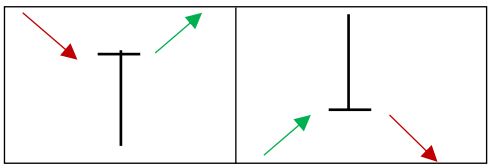


Figure 3. Dragonfly Doji candle (left) and Gravestone Doji (right). Made by the author.

The predictive power of these special Doji candles stems from their appearance in a trend. Dragonfly Doji at the end of a downtrend is extremely bullish and Gravestone Doji at the end of an uptrend is bearish (Nison, 1991:159). The length of the longer wick can be

however long (the longer the better) but shorter wick has to be nonexistent (maximum allowed wick length used here is again 1/10 of the candle length).

Hammer and Hanging Man are both candlesticks with small real bodies but long lower wick (see Fig. 4). As described by Nison (1994) the term "Hammer" comes from the market seemingly "hammering out a base" and "Hanging Man" from its resemblance to a man hanging down from a top. These names make it easy to remember: Hammer is a bullish signal, Hanging Man bearish. The color of the real body has no importance for the validity of the pattern. The restrictions used in the identification of Hammer and Hanging man are identical: the minimum lower wick length has to be 2/3 of the whole candle length (high – low), maximum allowed upper wick length is 10% of the candle length and minimum candle body length 10% of the total as well.

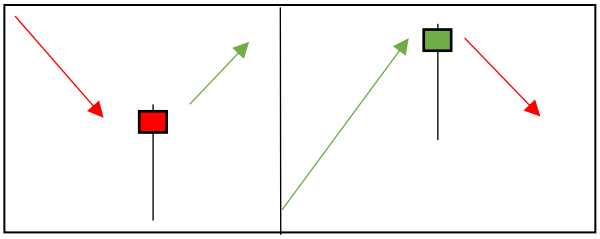


Figure 4. Hammer (left) and Hanging Man (right). Made by the author.

These patterns both need a trend to be valid indicators. It is also noted by Nison (1994:54) that the first price bounce from the Hammer may fail due to selling pressure still present in the market but the price usually comes back down to test the Hammer's support.

Inverted Hammer and Shooting Star are once again the same formation differentiated only by the trend in which they occur. They are like mirrored images of Hammer and Hanging Man (Fig. 4). Inverted Hammer in a downtrend predicts a soon-starting uptrend, just like Hammer itself. Shooting Star appearing in an uptrend shows exhaustion of the trend and imminent reversal. The parameters for identifying those patterns are the same as for Hammer and Hanging Man.

Marubozu, sometimes referred to as belt hold line, is a candlestick with a full candle body and either no wicks at all or they are minuscule compared to the full length of the candle. Since the more liberal interpretation of these formations by Nison would identify

an excess of signals in the daily time frame then a stricter version is used here. Period high must equal to its close in case of a white Marubozu (bullish) and low must be equal to close in case of a black Marubozu (bearish). In other cases, maximum allowed wick length is 1/10 of total length.

Harami (see Fig. 5) forms when a large candlestick totally engulfs a small following candle. Bearish and bullish versions of this formations exist and they are both relevant only when found in a trend.

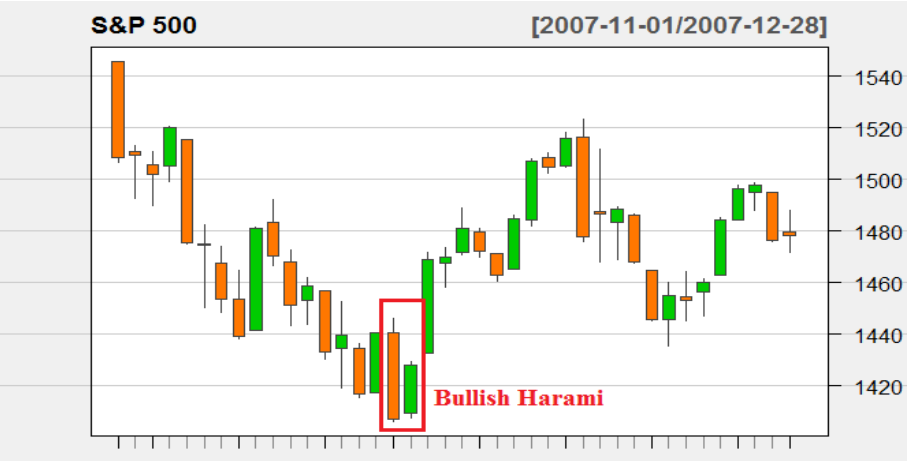


Figure 5. Bullish Harami in a downtrend (S&P500, D). Made by the author.

In 48.43% of the cases, a Bullish Harami predicts a positive trading day and Bearish Harami predicts a negative trading day with 50.8% accuracy (Maiani, 2006).

Harami's "cousin" is the **Engulfing Pattern** which is composed of the same elements as Harami but in a different order. In the Engulfing Pattern, the long candle appears after the short candle, making it a mirror image of the Harami. The Bullish Engulfing pattern was one of the few profitable patterns in a research concerning European and German bonds (Rogalski 2001, referenced via Fischer and Fischer, 2003:85).

Piercing Pattern and Dark Cloud Cover form when the second of the two candles penetrates more than half of the preceding candle's real body while opening at or above(below) the previous candle's closing price. The candles are of altering color – in Piercing Pattern a green candle follows previous red candle and in Dark Cloud formation a red candle "covers" most of the previous green candle. For both versions, a preceding trend is necessary for the validity of the pattern.

Since all of the above mentioned candlesticks need prior trend to verify the signal then a trend detection tool will be used for that. Previous researches have used the simple moving average of various periods, this work uses Donchian Channel (see Fig. 6) for trend determination. This indicator is chosen because it allows to determine also areas with no trend and exclude them. As such, it provides equally valid information about sideways markets (i.e. market with no current trend). The channel is composed of three lines, upper band indicating the highest price of the past *n* periods and lower band the lowest price. Middle line is simply an average of those two. If price is closing in the lower (higher) third of the channel then a downtrend (uptrend) is assumed and in the middle third, no trend is detected (see Fig. 6).

Figure 6. 20 period Donchian Channel and moving average (green). Made by the author.

As the chart on Fig. 6 shows, the 20 period moving average follows closely the basis line (dark red line) of the Donchian Channel. Dividing the rest of the channel into thirds will act as an efficient trend detection method since the up- and downtrends will correspond closely to the signals given by the moving average of the same period while excluding sideways movements with greater accuracy.

1.2. Fibonacci Correction Levels in Technical Analysis

Correction levels are a simple and quick way of predicting market support- and resistance areas. Fibonacci levels are not the only tool used for that purpose, for example, the Tirone levels (based on the works of Fibonacci levels are used in trading to determine potential trend reverse spots and trend support- and resistance levels. Numerous tools based on Fibonacci ratios exist and are used in trading, such as Fibonacci retracements, extensions, arcs, fan, time zones, channel (Gaucan, 2010). The most popular of these are the retracements and extensions, latter being simply extended retracement levels (over 100% retracement). The Fibonacci ratios used in trading are 23.6%, 38.2% and 64.8% which are the main guiding ratios. Naturally in every such a set exists also retracements 0.0% which means no price retracement whatsoever and 100.0% which means full retracement. Another retracement line used is the 50% line which has nothing to do with Fibonacci ratios but is added simply on the basis that price often finds support or resistance at that level (Gaucan, 2010).

The Fibonacci numbers themselves can be found by using a simple formula:

$$\begin{aligned} & f_n = f_{n-1} + f_{n-2} \quad \text{for } n > 2 \\ & \text{and } f_1 = f_2 = 1 \end{aligned} \tag{1}$$

Formula 1 gives a countably infinite sequence where the first numbers are 1,1,2,3,5,8,13,21 etc. The Fibonacci ratio is simply the ratio of two consecutive numbers in that sequence which approach the Golden Ratio marked with the symbol Φ and can be expressed as

$$\lim_{n\to\infty} \frac{f_n + 1}{f_n} = \frac{1+\sqrt{5}}{2} = \Phi \approx 1.618 \ldots \tag{2}$$

The Golden Ratio itself is thus considered a Fibonacci retracement value (Φ-1=61.8%). The k-th Fibonacci ratio is expressed as the limit of the ratio of a Fibonacci number with its k-th successor:

$$F_k = \lim_{n\to\infty} \frac{f_n}{f_{n+k}} = \Phi^{-k} = \left(\frac{1+\sqrt{5}}{2}\right)^{-k}$$

This formula (3) is used for the calculation of all the Fibonacci retracement values, for example (3)

$$F_1 = \left(\frac{1+\sqrt{5}}{2}\right)^{-1} \approx 0.618034 \ldots \approx 61.8\%$$

$$F_2 = \left(\frac{1+\sqrt{5}}{2}\right)^{-2} \approx 0.381966 \ldots \approx 38.2\%$$

$$F_3 = \left(\frac{1+\sqrt{5}}{2}\right)^{-3} \approx 0.236067 \ldots \approx 23.6\%$$

According to the retracement logic, the absolute maximum retracement can be 100% of the previous price move, meaning price can retrace the previous move until it reaches the starting point of the impulse wave[3] (see Fig. 6). Fibonacci retracement of 78.6% is found from formula 3 at k=0.5. It is interesting to observe that the Golden Ratio is not an exclusive property of the Fibonacci series but can be achieved applying the same formulas to any given series of random numbers where $f_n = f_{n-1} + f_{n-2}$.

For the sake of accuracy and better visual understanding, Fibonacci retracement lines are usually drawn manually on charts. This is observed by the author on the example of various non-professional as well as professional traders [4] and should be considered an unsubstantiated fact. Means of application for the Fibonacci tools vary depending on various factors such as the level of institutionalization of the trading venture (professional institutions rely more on computerized algorithms for signal search) and amount of capital traded. For more information on trading styles, see Roscoe *et al.*, 2009. The visual representation of the retracement lines is shown in the following figure (Fig. 7).

[3] After passing the 100% retracement Fibonacci levels can still be applied by adding an integer to it, usually the number 1, but such extensions are outside the scope of this work.

[4] Word „professional" refers to traders who do not have any other day job and income than securities trading.

Figure 7. Fibonacci retracement lines on the weekly chart of Halliburton (HAL). Made by the author.

After a clear uptrend that lasted for about two years, HAL peaked at $74 and started a downward trend in July 2014. The retracement lines on the graph are applied from the highest high of July 2014 at $74 to the lowest low in January 2016 when Halliburton's stock was worth less than $28. Following price action shows some price consolidation around the 38.2% retracement line and a continuation of the downtrend near 61.8% retracement level while not fully respecting it and closing above the line. However, in mid-August 2017 the long price drop found some support at the 23.6% retracement without closing below the line.

Although the example above uses a weekly chart, Fibonacci retracement tool can be used successfully on any time frame and asset (Boroden, 2008:6; Greenblatt, 2007; Kempen, 2016). The key to successful trade setups is in identifying the right swing highs and lows for drawing the retracement lines. There is no consensus on what constitutes as the "correct" wave. Practitioners apply different methods and timeframes and recommend applying the correction levels "differently than the majority" without specifications (Williams, 2012:28). Hartle (1993) and Krausz (1998) concluded that although Fibonacci indicators (including retracements) are widely used in practice, they are still almost always used together with other technical analysis tools and indicators as a component of some multi-indicator algorithm.

These time frames pose some difficulties for accurate computer algorithms since multiple time frames should be used at once – for example weekly to determine the general trend

the market follows at any moment, daily charts to determine short-term trends and significant price moves and also intraday charts (for example hourly chart) to find the best entry point for the trade. Time frames should be chosen based on the desired duration of holding a position open. To simplify that process of identifying highs and lows for the purposes of this research, the stock index will be simplified to straight lines based on high-low price data. In this paper, only daily data is used for trend determination since it was recently brought out by Kempen (2016) that Fibonacci retracements are scale-invariant.

It is important to bear in mind that trades should follow the current price trend of an asset. It is, of course, possible to execute successful trades countering the trend since the prices always go through a certain number of corrections before continuing in the general direction but such trades are riskier (Michalowski, 2012:36). The general principles of how any market behaves in terms of price and time come from Ralph Nelson Elliott who published his theory in the book "The Wave Principle" (1938). Elliott claimed that price movements on the stock market follow a certain wave pattern which is repetitive in form but not always in time and amplitude (Frost and Prechter, 2005:19). These patterns are now commonly referred to as Elliott waves. The idealistic form of the wave patterns is shown in Figure 8.

A market cycle consists of numerous waves of various degree which contain similar waves of lower degrees. This models the seemingly complex stock market into a self-repeating fractal which can be used to make predictions about future movements. Fig. 8 shows four types of Elliott waves where wave I is the motive or impulse wave and II the following corrective wave. Following subdivision consists of five motive waves marked [1] through [5] followed by same degree corrective waves marked [A] through [C].

Analysts like Frost and Prechter ("Elliott Wave Principle") who are sometimes referred to as "Elliott wave purists" do not discuss the Fibonacci connection to Elliott waves at all and consider only the wave count and counting rules as their primary indicator. Others such as Bulkowski (2005) and Fischer (2003) have added Fibonacci indicators to the mix based on observations that the Elliott correction waves tend to retrace the length of the previous impulse wave that is close to retracement values calculated from Fibonacci numbers.

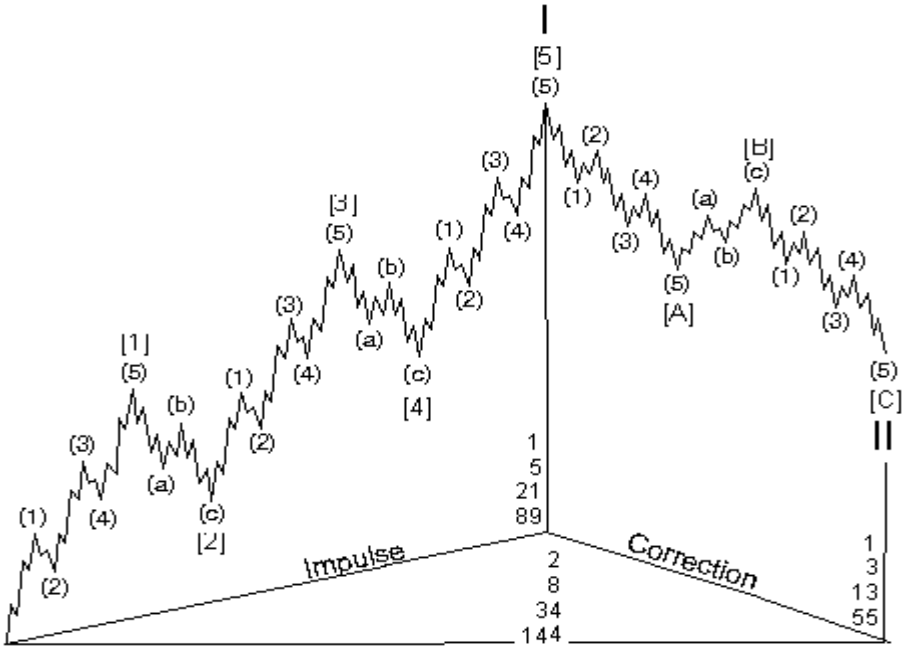


Figure 8. Complete market cycle in Elliott waves. Source: Frost and Prechter, 2005:25

Inside the 8 largest subdivision waves are 34 even smaller motive and corrective waves that are combined of 144 even smaller subdivisions which all follow the same 5+3 pattern. Frost and Prechter (2005) speculate that such combination of five waves to progress together with three waves to regress exist in that ratio because it is the minimum requirement to achieve both fluctuation and progress, making it the most efficient form of punctuated progress.

There are three main principles of such movement, described by R. N. Elliott as follows:

- Wave 2 never moves beyond the starting point of wave 1;
- Wave 3 is never the shortest wave;
- Wave 4 does not enter (close) in the price range of wave 1.

It has been highlighted by Robert R. Prechter, Jr. in his article "Elliott Waves, Fibonacci and Statistics" (2005) that R. N. Elliott himself never used the Fibonacci ratios for forecasting and never made generalizations about retracements. Nevertheless, practitioners and theorists like Tom Joseph (1999), Robert and Jens Fischer (2003), Kathy Lien (2004) and many others have recommended using Fibonacci retracement values in one way or another to predict the wave pattern formations. The most common way of integrating Fibonacci retracements into Elliott wave theory seems to be using certain

retracement values to determine a resistance area where the trend is expected to either break or continue after a pullback (i.e. correction wave). Bulkowski (2005) went a step further with Fibonacci Elliott wave connection and discussed Fibonacci price targets which he calculates based on Fibonacci multiples (extensions as well as retracements). This gives reason to assume that Fibonacci retracements can help other technical analysis tools (such as candlestick patterns) to be more efficient since for every significant price move it gives a finite number of potentially significant support- or resistance levels.

Based on a recent research (Kempen, 2016), active trends will continue with almost 59% probability (retracement ends before retracing 100% of the previous move). The concept of trend continuation being more likely than trend break is also the basic tenet of all trend following strategies in general. It makes sense looking at the basic Elliott 5-wave motive pattern – there are more and stronger moves that go with the trend (3 waves) than there are movements against it (2 correction waves). If Elliott wave theory holds true and we assume equal length for all the 5 waves then it is clear that 60% of all the movement is in the direction of the underlying trend, a result which interestingly is very similar to the trend continuation probability determined by Kempen.

Combining the knowledge that trends are more likely to continue than break and that every market impulse is followed by a correction gives a rather good idea where to enter the market for a trend following trade. To make a profitable trade, one should open a position at or near the end of a correction wave and hold it until trend continues its movement in the original direction. This holds true for both uptrends and downtrends. In such way investor or trader can put his or her faith in the greater probability that trend continues. If a trader is good at determining which moves are correctional then such approach is poised to generate profits over time.

Unfortunately, predicting the points where market finds support or resistance as well as determining the current Elliott wave in which the market moves can prove to be a very difficult challenge. This is where many traders seek help from technical analysis. Wagner (2010) combined Elliott wave theory with Fibonacci retracement lines and candlestick patterns to predict gold prices. His way of analysis did not include any computerized algorithms, he counted the waves and patterns visually from the chart (a method known as "chart-seeing" (Roscoe *et al.,* 2009)). Other researchers (e.g. Kempen, 2016;

Bhattacharya *et al.,* 2006) have used purely statistical methods without visual observations of the price charts to analyze the efficacy of Fibonacci lines. Not surprisingly, practitioners who use visual observations for short-term analysis of a price chart always present positive examples while statistical analysis is rarely yielding any evidence that Fibonacci retracements have value for price predictions. Their success can be attributed to two factors – careful selection of sample data with selective presentation of results and possession of tacit knowledge gained from years of experience in securities trading (Roscoe *et al.,* 2009). However, it is possible (and nothing in science rules it out) that the success of practitioners is achieved purely on technical analysis.

Michalowski (2012:37) reported that in trending markets, 38.2% and 50% retracements are the most relevant Fibonacci retracement levels and called the area between those levels "Correction Zone". He explained that if that zone holds the price then the trend is very likely to continue since trend makers are committed. For trend determination, Michalowski used the simple moving average (100 period). Williams (2012) on the other hand deemed the 38.2% and 61.8% retracements most useful and profitable. He provided the following guidelines for both values:

For 38.2% retracement:

- If price holds at the retracement, then the prior move is strong and the counter move will be also strong;
- Retracement after a strong move is usually followed by a move to a new high;
- After a strong decline, if retracement holds, a new low is typically created.

For 61.8% retracement:

- If price reaches this retracement, prior move has been weak and as a result, counter move will be weak;
- The chance of exceeding the prior high when price hits the retracement after a strong move is 1/3;
- The first retracement after a strong move is considered a trade signal in the main trend direction but exiting the position should be considered when price nears its previous high or low.

The frequent change of direction (i.e. continuation of the previous trend) on the 61.8% retracement line was also noted on the US and Lithuanian stock markets (Baranauskas, 2011). From those observations the following conclusion can be made about the retracement lines: signals forming at lower value retracements (such as 23.6% and 38.2%) have greater potential for successful trend trades than higher value retracements. It seems that when it comes to deciding which retracements perform best, no consensus has yet been reached by practitioners.

Kempen (2016) who tested Fibonacci retracement levels on different scale trends did not find any evidence that some retracement levels performed better than others, but noted that price reversal is more likely around the 50% retracement. His analysis was strictly statistical and did not involve the tacit knowledge a lifelong trader might have, meaning the degree of bias has been kept to minimum. He further concluded that Fibonacci retracements are scale-invariant, meaning that their predictive power does not change when switching from major trends to short-term trends. This discovery is taken into consideration for the empirical analysis conducted in this research. Author proposes that Fibonacci retracement lines are used by traders in similar way as technical analysis in general (according to Roscoe and Howorth (2009)) – as a heuristic device to facilitate decision making and provide support to previous analysis. This does not imply that they would not have any objective value, but it appears that the subjective value is greater. That deduction is based on the lack of uniformity in applying the tool and interpreting it.

Fibonacci retracement lines are calculated in the empirical part of this researcg by using significant highs and lows in the S&P 500 price series which are obtained by applying the ZigZag tool. The tool smoothes out price movements to straight lines with specified sensitivity resulting in a series of angled lines. The sensitivity used is 2.5% of the previous price move. This means that every price movement smaller than 2.5% will be eliminated from the series and the lines between remaining extreme points are interpolated. The result is a series that contains only straight lines which are located between local maxima and minima points. Those points are then located in the series and they equal to the S&P500 High-Low prices.

2. EMPIRICAL TESTING OF FIBONACCI RETRACEMENTS AND CANDLESTICK PATTERNS WITH A STRATEGY EXAMPLE

2.1. Data and Methodology

The most important part of creating an efficient trading system is the process of back-testing which means running a retrospective simulation with historical market data to ascertain whether a combination of indicators and their settings would have generated a sufficient amount of profitable trades. The results of that simulation are what determines the efficacy of a technical analysis indicator. The data used for the analysis is obtained from Yahoo databases (*www.finance.yahoo.com*) by importing the dataset directly into RStudio[5] using the analysis package "quantmod". The data matrix contains six columns of information: open price, daily high, daily low and close price, trading volume and adjusted price which in the sample is equal to the daily closing price. The index is composed of the 500 largest U.S. companies and is regarded by Investopedia as one of the best representations of the U.S. stock market and economy.

The data spans from January 3rd 2007 to November 17th 2017 containing 10 years and 10 months of historic price data on the index. Weekends and US national holidays (such as Independence Day, Labor Day and Christmas) are excluded since the stock markets were closed and no trading took place. Since candlestick patterns were introduced to the western world in the early 1990s and OHLC stock data also made available around that time then traders have had the chance to implement candlestick trading patterns only from

[5] R is an open source software and programming language for statistical computing, RStudio is a software application for R.

the start of 1992 (Marshall, 2006). Therefore it can be assumed that data prior to that decade would perform worse in back testing since it is missing the "self-fulfilling prophecy" [6] factor since candlestick patterns were largely unknown to traders in the US. Daily index data is used in this particular research since an investment strategy is tested and not day trading strategy then such a time frame contains less random noise and whiplash which is widely present in smaller time frames. For day traders, intraday charts should be used to test the efficacy of Fibonacci and candlestick pattern strategy.

Both short and long positions will be considered to analyze the efficacy of the investment strategy in up- and downtrends. Long position means buying the security, anticipating further price increase so the assets can be sold at a later time for higher price than at the time of the purchase. Short position (selling short) involves borrowing, selling and buying back shares in the hope that price will decrease and the assets sold could be bought back cheaper at a later date.

Using the two chosen indicators it is necessary to have three conditions fulfilled in order for a buy or sell signal to be generated. These are:

1. Market must be in either a down- or an uptrend defined by the section of the Donchian Channel. Location determined by the closing price of the last candle in the formation ;
2. Candlestick pattern formation is required (see Chapter 1.1), either bullish (in a downtrend) or bearish (in an uptrend);
3. Candlestick formation (body of the last candle in the formation) must exist on any of the five Fibonacci correction line described in Chapter 1.2.

It is important to bear in mind that candlestick patterns are highly visual tools and even though it is perfectly possible to create a computerized algorithm for finding formations similar to these patterns, the final decision for entering a position should be assessed individually by the investor based on his risk tolerance, trading style and of course by other external factors the investor deems relevant in a particular asset at a given moment.

Since the profit-taking from trades would vary from person to person then no strict targets or rules have been used at first. This is to add objectivity to this research and not tie it to

[6] Idea that the predictive power of an indicator is derived from traders acting upon signals of that indiator.

strict trading rules which are very different among investors and traders. Only potential profitability is assessed based on the short-term nature of candlestick patterns. It means that a signal is considered profitable if and when the average closing price of a ten-day period following the signal is higher or lower (depending on the direction of the trade) than the opening price of the day immediately following the signal. Opening prices are used since it is assumed that the position would be opened as soon as possible following a relevant signal. Closing prices are used for the calculation of the price average since it is assumed (based on Marshall *et al*, 2007 and Chen *et al*, 2016) that ten days would be the optimal period when to close the trade.

For the second part of the assessment, trades are executed based on simple trading rules at the liberty of the author. This exercise serves as one example of how profitable this strategy can be under only one set of conditions. It will be demonstrated only with the combination strategy on the following conditions:

1. Positions are entered when the market opens for trading the day following a signal;
2. A stop-loss order is triggered when the market makes a move against the trade by at least 3% counting from the highest/lowest price of the signal candle formation
    - Long side stop-loss $SL = L_{min} - (L_{min} \cdot 0.03)$
    - Short side stop-loss $SL = H_{max} - (H_{max} \cdot 0.03)$;
3. Position is closed when price has reached a price target of 10% increase counting from the closing price of the signal candle formation;
4. Multiple positions can be open at the same time, including simultaneous holdings of short- and long positions;
5. Absent to signal, no funds on the dummy account will be held invested in securities nor will they earn interests outside the S&P500 index futures.

This method is simple yet powerful – by setting the stop-loss and profit targets the same time as position is opened the trade can only have two outcomes: either a small loss is suffered or a sizeable profit generated. This analysis does not go into detail about where the stop-loss and profit-taking orders should be placed since this is highly dependent on the risk tolerance of the investor as well as the volatility of the asset (Teweles *et al.*, 1987:275). A stop-loss rule of 7 or 8% loss of invested capital was proposed by O'Neil (1988:87) for equities markets but since S&P 500 is considerably less volatile than any

single stock then this rule would likely be inefficient. If we operate under the assumption that a fraction of the starting capital is traded then the cumulative losses can be as exponentially growing as potential cumulative gains. It means that according to simple math, it takes more than a +10% gain to make up for a -10% loss since after said loss, the account traded is smaller, hence the future gains on that +10% would be smaller. Because of that, any outcome of any portfolio depends heavily on whether or not the first trade was a successful one. Since it is virtually impossible to foresee this (especially when testing an algorithm) then risk must be managed in such a way that potential gains more than cover potential losses. On the example of O'Neil's 7-8% stop-loss the profit target should be significantly larger.

A "rule of thumb" was described by Linton (2010) claiming that the ideal trade is where profit outweighs loss by a ratio of 3 to 1. This ratio is known as risk-reward ratio and expresses how many units of money a trader is willing to risk to achieve the desired gain. On the example of 3:1 ratio, trader risks one dollar to gain 3 (assuming operations in dollars). Applying this math to O'Neil's stop-loss of maximum 8% capital loss we get that in this case, price target should be at slightly above 19% move in the predicted direction. Considering numerous experts who have, either empirically or through experience, claimed that candlestick signals are short-term then expecting such a substantial move in short-term is not justified.

The knowledge that major indexes do not move as rapidly as equity shares is well known to everyone and deductible from logic, therefore using this knowledge for setting targets and stop-losses in back-testing is allowed. Any further calculations however (based on the sample data) would distort the results and credibility of research since it would have been impossible to access such data before entering the market. Considering all that, the stop-loss rule for the purposes of the back-testing algorithm will be 3% movement against the trade (less than half of that proposed by O'Neil) and profit target at 10%, giving a risk-reward ratio of 3.29, slightly more favorable than Linton's 3. This means that even if only one trade out of three is profitable then investor will at least break even (neither lose nor gain significant money).

In chapter 2.2 a strategy based solely on candlestick patterns is tested for potential profitability. In chapter 2.3 candlestick patterns are used in conjunction with Fibonacci

correction levels and tested for potential profitability as well as real profitability on the example of simple position entry- and exit rules. A comprehensive list of risk-adjusted ratios (such as Sharpe ratio, Sortino ratio) and other portfolio evaluation metrics such as standard deviation, portfolio alpha and beta will be provided in the end. All of the calculations and analysis was conducted in R language

2.2. Testing the Candlestick Pattern Based Strategy

Researches that concentrate solely on the efficacy of candlestick patterns often return lackluster results as observed earlier. This work will not aim to test the whole pantheon of patterns (which there are over 40) but rather takes example from earlier works where better performing and often occurring candlestick patterns were recognized. Patterns are divided into two categories: single candle lines and patterns composed of two or more candlesticks.

Single lines are patterns composed of only one candlestick. They are the most common patterns due to their simplicity, confirmed by Maiani (2002). Such patterns always have either abnormally long wicks on top or bottom or no wicks at all. An exception here is a simple Doji candle where the key distinction is open and close price being extremely close. Doji candles are also tested here using preceding trend to differentiate bullish and bearish formations. If a Doji appears in an uptrend then it generates a sell signal and when in downtrend then buy signal.

To assess whether or not a pattern is profitable, an average of the following 10 days is calculated. If that average is higher (lower) than price at the time when buy (sell) signal was generated then trade is considered potentially profitable. Closing prices were used to calculate that average. This method is similar to the one used by Marshall (2006 and 2007) but instead of closing the trade on the 10^{th} day, only the possible profitability of the trade is observed.

Table 1 illustrates the frequency (number of occurrences) and percentage of profitable signals for single line candlestick formations tested.

Table 1. Single line candlestick formation profitability results. Made by the author.

Candlestick	No. of occurrences	Accurate signals*	% of total trades
Hammer (long)	18	12	67%
Inverted Hammer (long)	13	7	54%
Shooting Star (short)	20	8	40%
Hanging Man (short)	84	34	41%
White Marubozu (long)	23	14	61%
Black Marubozu (short)	21	11	52%
Gravestone Doji (short)	5	1	20%
Dragonfly Doji (long)	3	3	100%
Doji in uptrend (short)	173	62	34%
Doji in downtrend (long)	56	33	59%

*Signal is considered accurate when its 10-day price average was above (below) the open price

These percentages are definitely not final since some formations occur very few times, such as the Dragonfly Doji which appeared in the necessary downtrend only three times in ten years of observations and is therefore too small a sample to make definite conclusions. However, none of the bearish candlestick patterns (with the exception of the Black Marubozu) succeeded in predicting 10-day periods where the price would on average stay in the desired direction. That is due to the major uptrend (after 2009) in the S&P 500 index which renders the majority of short positions worthless. Long positions performed significantly better with the Hammer and White Marubozu exhibiting potential to predict the price average right in over 60% of the cases.

The poor performance of the Gravestone Doji is also apparent in Maiani's (2006) research where in near quarter of the cases it failed to predict any market movement and only 31% of the cases a down movement. Doji in downtrend performed better than in uptrend and this is contradicting Nison's statement stating the opposite probability.

For multiple candle formations, same evaluation metrics were used. Due to the rarity of most 3-candle patterns (also observed by Maiani (2006)) only the Morning- and Evening Star are included. Results summarized in table 2.

Table 2. Multiple candle formation profitability results. Made by the author.

Pattern	No. of occurrences	Accurate Signals*	% of total trades
Bullish Engulfing	14	11	78%
Bearish Engulfing	40	19	47%
Bullish Harami	54	31	57%
Bearish Harami	86	32	37%
Piercing Pattern	5	3	60%
Dark Cloud Cover	11	7	64%
Evening Star	4	2	50%
Morning Star	2	1	50%

*Signal is considered accurate when its 10-day price average was above (below) the open price

The best performing patterns out of the chosen two-candle patterns are Dark Cloud Cover which is the bearish version of the Piercing Pattern and the Bullish Engulfing which is supposed to predict that previous downtrend has been exhausted and an uptrend will shortly follow. If in case of the single-line patterns bullish formations performed better than their bearish counterparts then in multiple candlestick formations this trend is reversed. In almost all of the cases patterns predicting downward movements are more reliable than their bullish versions which leads to the proposition that single lines are better at predicting uptrends and multiple candle formations are more reliable in predicting downtrends. There are no previous researches confirming or refuting this observation. Table 3 shows the cumulative returns achieved by only using candlestick pattern based signals.

Table 3. Cumulative returns of candlestick pattern signals. Made by the author.

Bearish Candlestick Patterns	Cumulative Returns	Bullish Candlestick Patterns	Cumulative Returns
Bearish Engulfing Pattern	-2.25%	Bullish Engulfing Pattern	28.35%
Black Marubozu	29.16%	Bullish Harami	13.08%
Dark Cloud Cover	11.90%	Dragonfly Doji	25.18%
Bearish Harami	-12.30%	Hammer	15.03%
Evening Star	0.82%	Inverted Hammer	1.59%
Gravestone Doji	-15.72%	Morning Star	8.12%
Hanging Man	2.54%	Piercing Pattern	10.03%
Shooting Star	-5.93%	Doji in Downtrend	7.24%
Doji in Uptrend	-19.35%	White Marubozu	3.81%

The total cumulative return is 101.3% where short side positions generated a loss of over -11%. This is very similar to strategy buy-hold where cumulative return for the whole period equals 82.3%. This is in line with results conducted by Marshall (2006 and 2008)

and show little to no profit potential in candlestick analysis alone (long side trades in table 3 should be viewed bearing in mind the long uptrend in S&P500 dataset).

2.3. Testing the Candlestick Pattern Strategy in Conjunction with Fibonacci Correction Levels

Tests conducted in the previous chapter show that candlestick patterns alone are not particularly effective in predicting price movements. These results confirm statistical analyses conducted by Marshall (2006 and 2008) and Maiani (2006). This in itself does not state that candlestick analysis would not offer opportunities for turning a profit since it is still possible that profits from successful trades would cover the losses caused by inaccurate signals but if every position opened is of the same size then to make consistent profits using only candlestick analysis is indeed impossible. To make this strategy profitable, the number of false signals needs to be reduced by other analytical tools.

The mean of the lengths (distances between extremal points) of the waves created with the ZigZag tool described in the end of chapter 1.2 is $75 and it is less than 5% from the average closing prices of the period while maximum length of any wave is $328 and shortest wave is only $9 “long” on the price scale (extremely short waves appear during periods of very high volatility, such as the 2008 crisis). Those extremal points are used to calculate the Fibonacci retracements for every ZigZag line (wave).

A candlestick signal is considered valid if it’s located on any of the five Fibonacci lines. For candlestick patterns, the same conditions are applied as used in the previous test. Counting every candlestick formation tested both single- and multiple line patterns, the total number of all patterns is 632. Out of those, a total of 135 or 21.4% were located in the Fibonacci lines. It should be considered that candlesticks with longer bodies have higher chance of being represented on any one Fibonacci line than tiny candlesticks (such as Dojis).

The criteria for potentially profitable trades was once again the average closing price of the ten day period following a. Results are brought in Table 4 for every candlestick pattern.

Table 4. Results of combining Fibonacci correction lines with candlestick patterns. Made by the author.

	Number of Occurrences	Accurate Signals*	As Percentage
Hanging Man (short)	6	3	50%
Hammer (long)	10	7	70%
Shooting Star (short)	0	0	0%
Inverted Hammer (long)	3	2	67%
Doji in Uptrend (short)	14	10	71%
Doji in Downtrend (long)	17	10	59%
Gravestone Doji (short)	1	1	100%
Dragonfly Doji (long)	3	3	100%
Black Marubozu (short)	9	6	67%
White Marubozu (long)	9	7	78%
Bearish Engulfing (short)	9	7	78%
Bullish Engulfing (long)	10	9	90%
Bearish Harami (short)	15	10	67%
Bullish Harami (long)	22	13	59%
Dark Cloud Cover (short)	0	0	0%
Piercing Pattern (long)	4	2	50%
Evening Star (short)	1	0	0%
Morning Star (long)	2	1	50%

*Signal is considered accurate when its 10-day price average was above (below) the open price

After applying the Fibonacci correction levels as a filter for candlestick patterns, all but one patterns which produced a signal were correct at least 50% of the times. These results do not in any way indicate that using this strategy such percentage gains could be produced from the stock market. The summary percentages allow to compare the efficacy of candlestick patterns before and after applying the Fibonacci retracement tool. The results indicate that Fibonacci lines are a filter which improves the accuracy of candlestick signals and therefore offer a better alternative to simple candlestick analysis to be used in designing trading algorithms. The real profitability of this strategy will be tested with one set of parameters but there is a multitude of techniques and parameters one may want to test, depending on various factors and needs.

Before applying Fibonacci retracements, the total number of trading signals produced is 632 (both single- and multiple line patterns) and only 291 signals (46%) were considered

potentially profitable. It is clear that such a percentage does not indicate an efficient investment strategy. After reducing the number of signals using Fibonacci filtering system described above, the amount of signals dropped to 135 (slightly less than a quarter of the unfiltered signals) and out of those 91 (67%) predicted the average price of the following 10 days to be in the desired area. Considering all the candlestick patterns, both single and multiple lines, the results have improved remarkably.

These findings confirm earlier research results from European markets that the Hanging Man, Hammer and Engulfing pattern are all potentially profitable candlestick formations but to achieve this profitability, Fibonacci retracement lines should be added to the mix. At the same time the usefulness of candlestick patterns alone is refuted, confirming the statistical findings from the US and Japanese equity markets by Marshall *et al* (2006 and 2008).

These results pave the way to construct any number of trading systems at the investor's desire, knowing that the combination of these two instruments yields better results than candlestick patterns alone. However, this leaves the curious mind wanting, since no examples have been provided on the possible applications of this knowledge. To find out if this theory can be applied to the S&P 500 index to actually generate a profit. The conditions of entering and exiting a position have already been described in previous sections of the work: position gets closed (stopped out) with a loss of -3% and closed with profit (reaches target) at +10%.

By applying a simple non-trailing stop-loss rule, a mere 34% of the trades were closed with profits (i.e. were not stopped out with small losses). In total figures it means that 45 out of 134 trades resulted in positive earnings. Even though the rules for entering and exiting the trade were same throughout the observed period, the individual amounts gained or lost in a particular trade are quite different because of slippage[7] (targets and stop-losses calculated based on signal price data, see chapter 2.1) and growth/decline of the index value itself. The greatest loss in absolute numbers occurred in January 2014 with a short-selling trade ($-91.48 or -5%) and greatest gain in June 2016 with a long order ($233.03 or +12%). For the complete list of trades (order book) see Appendix 1.

[7] The difference between expected price and actual price at which the trade is executed, here means the gaps in price between signal candle closing price and next day opening price.

For further calculations and quantitative analysis the cumulative return of each candlestick pattern is found by multiplying the S&P500 Index daily returns with either 1 or -1 (for short side trades) for every day that a position was held. This means creating a vector in RStudio where the index return exists for every day that a position was open and 0% return for every day that no positions existed. This allows equal treatment of the S&P500 buy-hold strategy and use of that index as a benchmark index with which to compare the Fibonacci candlesticks strategy. Cumulative returns are found using arithmetic chaining to aggregate the returns which assumes equal position size for every trade. The cumulative returns for the tested strategy are summarized in Table 5.

Table 5. Cumulative returns of the strategy (by pattern). Made by author

Bearish Candlestick Patterns	**Cumulative Returns**	**Bullish Candlestick Patterns**	**Cumulative Returns**
Bearish Engulfing Pattern	27.78%	Bullish Engulfing Pattern	46.59%
Black Marubozu	41.16%	Bullish Harami	86.04%
Dark Cloud Cover	0.00%	Dragonfly Doji	22.18%
Bearish Harami	27.78%	Hammer	50.19%
Evening Star	0.00%	Inverted Hammer	11.59%
Gravestone Doji	0.00%	Morning Star	13.06%
Hanging Man	12.54%	Piercing Pattern	11.4%
Shooting Star	0.00%	Doji in Downtrend	74.17%
Doji in Uptrend	19.35%	White Marubozu	57.11%

It appears that the most productive pattern in the strategy was Bullish Harami formation which produced a return of 86% over the period under observation (roughly 8.6% a year). The smallest returns were generated by the Piercing Pattern and Inverted Hammer, both bringing in a rather modest 11% return for ten years. For the same period, the S&P 500 Index cumulative return was 82.3%, making the Bullish Harami also the only candlestick pattern in the strategy which on its own could outperform the index. The cumulative returns of bullish signals (buy signals) only was 372.33% and bearish (sell) signals 128.61% showing once again that buy signals were far more profitable in the context of the data selection. For illustrative charts on the cumulative returns, drawdowns and daily returns see Appendix 2 (for tested Fibonacci Candlestick strategy) and Appendix 3 (benchmark buy-hold strategy on S&P500 Index).

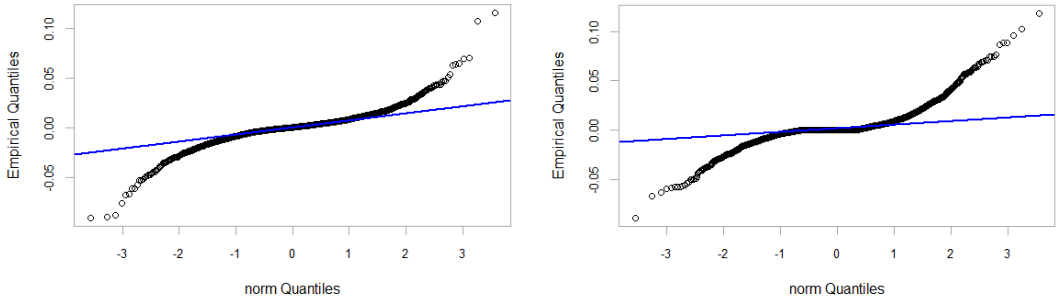


Figure 9. Q-Q plots of S&P500 returns (left) and strategy returns (right). Made by author

The Q-Q plots[8] on figure 9 (index and strategy return quantiles plotted against normal theoretical quantiles) show that the data is not following normal distribution and has rather large values at either end of the quantile range. The presence of a high degree of kurtosis ("fat tails") is considered when calculating the risk-adjusted returns (VaR Sharpe ratio is provided). The distributions of the returns are similar for both strategies, although Index returns follow normal distribution closer.

The data about returns on investment, calculated daily for both S&P500 Index (also the benchmark index for comparing strategies) and the Fibonacci Candlestick strategy allows the calculation of various ratios which are used to evaluate the "goodness" of a given portfolio. Those metrics are brought in table 6. Some of those ratios are representing the same categories of assessment ratios (such as Sharpe and Sortino ratios) but are still brought separate for the convenience of the reader, should one take more interest in a slightly different ratio than used for the strategy assessment by the author.

The evaluation metrics in table 6 show that the composed strategy outperforms simple buy and hold strategy in multiple categories. On average it takes the portfolio 5 days to recover (achieve previous peak) after a drawdown whereas the buy-hold strategy requires 15 days for recovery. The size of the drawdowns is also more favorable for author's strategy as maximum portfolio drawdown was limited to less than 6% (thanks to stop-loss rules) and for S&P500 the maximum drawdown was 66% (that due to the financial crisis of 2008) although average drawdown is smaller for the Index returns.

Table 6. Portfolio evaluation metrics for Fibonacci Candlestick strategy (benchmark S&P500 Index). Made by author.

METRIC	STRATEGY VALUE	BUY-HOLD VALUE
Average Recovery Period	**4.7**	14.9

[8] Normal distribution quantiles are projected on the horizontal axis and return distribution on vertical axis.

Average Drawdown	0.02091155	**0.01856261**
Maximum Drawdown	**-0.05575329**	-0.6645504
Standard Deviation	0.01457347	**0.01269449**
Sharpe Ratio	**0.1390553**	0.02366265
VaR Sharpe Ratio	**0.1529297**	0.01659016
Sortino Ratio (MAR=0%)	**0.2501105**	0.03304825
Alpha	0.001969126	
Annualized Alpha	0.6417	
Beta	0.202791	
Bernardo Ledoit Ratio	**1.744213**	1.077546
Calmar Ratio	**3.221823**	0.100257
Ulcer Index	**0.03175565**	0.1661444
Sterling Ratio	**2.122735**	0.08524297
Burke Ratio	**1.165123**	0.08559346

*Values in bold are outperforming in comparison, *MAR=Minimum Acceptable Return

The Sharpe ratio which shows the average return earned in excess of the risk-free rate (considered 0% here) per unit of volatility or total risk (standard deviation) is higher for the tested strategy, indicating higher returns since standard deviation is smaller for the Index. Therefore we can say that the Index is less risky investment but considering also the returns then Fibonacci Candlestick strategy performs better. The modified Sharpe ratio is a version of the original Sharpe ratio amended to include skewed/abnormal data such as the dataset tested. It is calculated by dividing the excess returns by the modified value at risk (VaR). Another modified Sharpe ratio, the Sortino ratio, considers only volatility of periods of negative returns (thus not considering upside deviation). This ratio is also much higher and therefore better than for Index returns where the ratio of excess returns to downside risk is virtually zero.

The Bernardo Ledoit ratio is a ratio of positive returns to negative returns and should obviously exceed 1 to show profitability. This ratio was derived from the Omega ratio by Bernardo and Ledoit (2000) by equating the target return threshold with zero. The Calmar ratio, similar to Sterling Ratio, divides the average annual rate of return by the maximum drawdown of the period. Both values are more favorable for the tested strategy, leading to the conclusion that the Fibonacci Candlestick strategy's risk-adjusted returns are greater than those of the benchmark – S&P500 Index (the buy-hold strategy).

Portfolio alpha shows that this strategy managed to outperform the benchmark by a modest 0.2%. Portfolio beta (which uses a baseline of 1 instead of 0 as in alpha) is 0.2 meaning that the portfolio experienced less volatility than the benchmark index. This

however is less reliable indicator in this context than for example standard deviation since the portfolio's R-squared value in relation to the benchmark is relatively low: 0.0332. It means that only about 3% of the movements of the Fibonacci Candlestick strategy could be explained by movements in the S&P500 index although the asset traded in both cases is the same.

An interesting and intuitive way to assess the "goodness" of a strategy is also to consider the probability an investor investing at any point in time will outperform the benchmark over a given horizon. This method is more used in marketing and is rather a robust estimate but nevertheless gives investor an idea at a glance how likely they are to outperform the benchmark index. For the probabilities, see table 7.

It is evident that the longer the observed period is, the more likely is the strategy to outperform its benchmark index. If the two strategies are compared during a period of two months (or roughly 36 days considering possible holidays and other days when markets are closed) then the Fibonacci Candlestick strategy will with over 70% likelihood outperform the buy-hold strategy based on the S&P500 daily returns.

Table 7. Probabilities that the Fibonacci Candlestick strategy will outperform benchmark. Periods in days. Made by author.

Periods	Strategy outperforming benchmark (S&P500)
1	0.5215356
3	0.5467958
6	0.5807327
9	0.6037317
12	0.6209007
18	0.6432225
36	0.7183442

To summarize the results, adding Fibonacci retracement lines to candlestick patterns helps to improve the accuracy of those signals. Testing the Fibonacci and candlestick pattern combination strategy gave better results in both risk and return categories than buy and hold strategy of the same asset. These results can be generalized for equity markets in the U.S. considering the proposed descriptiveness of the S&P500 Index for the American stock market in general. However, the profitability of the strategy with -3% stop-loss and +10% profit target proves weak, considering the systemic risk involved in

the trading algorithm. The total cumulative return of the strategy adds to 517.16% over ten years, meaning on average about 51.7% a year. Averaging this return to the number of candlestick patterns (18) gives a return per pattern of 2.9% a year or 3.7% when calculated over signal producing candlesticks (14). Many investors may consider this return too low, especially considering that the risk-adjusted return for the portfolio (Sharpe ratio) was 0.14, far smaller value than 1 which is usually the minimum value recommended for investing (Maverick, 2018). The profitability of the strategy as a whole can be improved by excluding less profitable candlestick formations from the mix and relying only on few most profitable ones. It is also possible to improve results by adjusting the price target and stop-loss rules. This research has proved that Fibonacci retracements offer added value to candlestick analysis and shows by example how profitable one such strategy could be. Author urges all readers to understand that past performance does not guarantee future results but it seems that at very least past performance can offer better insight and increase chances of success.

CONCLUSIONS

This research studied ten years of S&P 500 index price data to find whether candlestick analysis in conjunction with Fibonacci retracement levels can predict price movements and be therefore applied as a trading strategy. The theoretical part of this research covers the formation of candlestick patterns and their use in price predictions as well as the use of Fibonacci retracement lines and its connection to general market patterns, specifically the Elliott wave theory. Empirical analysis used both theoretical and practical testing of the trading methodology.

It was noted that the literature concerning technical trading rules (such as the indicators tested in this work) was mainly written by practitioners and analysts who execute trades on their clients' accounts as a day job. Academic literature about technical analysis is readily available in some categories (like for candlestick analysis) but lacks in other categories (Fibonacci trading tools). Researchers have pointed out that the reason why literature and trading results by active traders and investors is more favoring technical analysis may be the presence of tacit knowledge accumulated over years of practice that can improve the overall performance of the trader. This means that it is possible that technical analysis is profitable thanks to other factors that are tacit and are not transferrable knowledge. It is supported also by the fact that most articles on technical analysis return the conclusion that the indicator under observation did not yield any significant gains.

It is evident that there is no consensus on how strong predictive power Fibonacci retracements have and which of them are more "respected" by the market. Academics have obtained somewhat conflicting results with different research methods, latest papers reveal that none of the retracement values have significant advantage over another. Practitioners seem to have opinions on which lines are more predictive, their opinions are

often conflicting and there is no clarity in how exactly are those opinions formed or on what research are they based.

Candlestick analysis is more clearly formulated than Fibonacci analysis and has less room for interpretation. The main problem with candlestick analysis is the subjectivity of the trader and his or her tacit knowledge. Candlestick signals are visual prediction tools and therefore have a higher degree of freedom in interpretation than for example Fibonacci retracements which are defined as fixed percentages. Scientific research has been extensively carried out for candlestick signals, results depend on the financial markets and research methods.

The empirical part of this research first determined the potential profitability of candlestick analysis as an individual strategy and then in combination with Fibonacci retracement lines. In the end, a computational example is provided about the efficacy of the strategy using stop-loss rule and price targets.

The key findings are the following:

- Out of 18 candlestick patterns examined, only 10 showed profit potential when used alone;
- When Fibonacci retracement lines were added, 12 out of 16 patterns turned out to be potentially profitable (two patterns yielded no signals);
- Bullish patterns perform better than their bearish counterparts;
- Doji candles at Fibonacci levels are profitable signals but they perform better in downtrend than uptrend;
- Total cumulative returns for the strategy are 517.16%, making an average yearly return for a candlestick pattern 3.7% (excluding patterns with no signals);
- Sharpe ratio for risk-adjusted returns is greater for the integrated strategy than for buy-hold strategy but both of those values are smaller than 1;
- Buy-hold strategy did not outperform the tested strategy in any risk-return evaluation category apart the size of average drawdown and standard deviation of the returns.

All of the Fibonacci retracement levels, including the 50% level were treated equally and no testing was conducted regarding the reliability of any retracement in particular. The

retracements were located using a ZigZag tool to smooth the price data (with 2.5% sensitivity) for finding relevant peaks and valleys in the data. Trend was determined by using 20 period Donchian channel with 1/3 division – upper third meaning uptrend, lower third downtrend and middle third indicates the absence of a trend. The profitability of trading signals was assessed using 10 day average closing price following a signal.

According to the conducted research, there is positive potential in using Fibonacci retracements and candlestick patterns simultaneously for predicting equity market price movements. Since the sample dataset is descriptive of the U.S. equity market then further research is needed to confirm or refute the efficacy of this strategy in other markets, including FOREX and commodities markets.

In addition, this research is limited to proving that Fibonacci retracements as a filter increase the accuracy of candlestick pattern signals. The results obtained assist investors in choosing the most profitable candlestick formations for predicting future price movements and prove the efficacy of adding Fibonacci analysis to candlestick analysis. An example of the efficacy of the system is shown using certain stop-loss and price target rules but since different investors have different trading styles, rules and guidelines then it serves as just one of many possible ways of applying the strategy. Further research is needed to check whether these results are consistent in other markets and offer similar efficacy when applied to separate stocks and commodities. Testing with different levels of risk (stop-loss rules) would also provide greater understanding about the profitability of the system.

REFERENCES

1. **Baranauskas, S.** (2011). Elliott wave and Fibonacci level mutual relationship and applying in a stock market. Business: theory and practice. Vol. 12 (4), pp 390-397
2. **Bhattacharya, S., Kumar, K.** (2006). A computational exploration of the efficacy of Fibonacci Sequences in Technical analysis and trading. Bond Business School Publications.
3. **Bernardo, A., Ledoit, O.** (2000). "Gain, Loss, and Asset Pricing". Journal of Political Economy. 108 (1): 144–172.
4. **Boroden, C.** (2008). Fibonacci Trading: How to Master the Time and Price Advantage. McGraw-Hill. 303pp
5. **Bulkowski, T.** (2005). Encyclopedia of Chart Patterns, 2nd edition, Wiley Trading, 1035 pp.
6. **Chen, S.**, **Bao, S., Zhou, Y.** (2016). The predictive power of Japanese candlestick charting in Chinese stock market. Physica A. Statistical Mechanics and its Applications. Vol. 457, pp 148-165
7. **Erman, W.** (1999). Log Spirals on the Markets and In Nature. Technical Analysis of Common Stocks & Commodities, vol. 17 (2) pp 16:34
8. **Fischer, R.**, **Fischer, J.** (2003). Candlesticks, Fibonacci, and Chart Pattern Trading Tools: A Synergistic Strategy to Enhance Profits and Reduce Risk. John Wiley and Sons, pp 256.
9. **Gaucan, V**. (2010). How to Use Fibonacci Retracement to Predict Forex Market. Titu Maiorescu University, Bucharest, Romania. Journal of Knowledge Management, Economics and Information Technology. Vol. 1 Issue 2.
10. **Greenblatt, J**. (2007). Trading Stocks with Fibonacci and Lucas. [http://www.futuresmag.com/2007/04/18/trading-stocks-fibonacci-and-lucas]
11. **Hartle, T.** (1997). Fibonacci Trader Product Review – Stock & Commodities Magazine, pp 1-15.

12. **Joseph, T.** (1999). Applying Technical Analysis. Trading Techniques, Inc. pp182
13. **Krausz, R**. (1998). New Gann Swing Charist Dynamic Fibonacci Channels. – Fibonacci Trader Journal, Vol. 1, No. 1: 1-8.
14. **Lien, K.** (2004). Basic Guide to Understanding Elliott Wave. Daily FX Research. pp6
15. **Linton, D.** (2010). Cloud Charts: Trading success with the Ichimoku technique. Updata Plc, London. Pp 240
16. **Kempen, R.** (2016). Fibonaccis Are Human (Made). IFTA Journal. 2016 Edition. The International Federation of Technical Analysts. Pp 77
17. **Maiani, G**. (2002). How Reliable Are Candlesticks? Technical Analysis of Stocks & Commodities, pp. 60–65.
18. **Michalowski, G.** (2012). Trading Forex with the Trend. [http://www.futuresmag.com/2012/08/31/trading-forex-trend]
19. **Marshall, B.R., Young, M.R. & Cahan, R**. Rev Quant Finan Acc (2008) 31: 191. https://doi.org/10.1007/s11156-007-0068-1
20. **Marshall, B. R., Young, M. R., Rose, L. C.** (2006). Candlestick technical trading strategies: Can they create value for investors? Journal of Banking & Finance 30, pp 2303–2323.
21. **Mayall, M**. (2006). Seeing the market: Technical analysis in trading styles. Journal for the Theory of Social Behaviour, 36 (2), pp 119–140.
22. **Maverick, J.B.** What is a good Sharpe ratio? Investopedia. [https://www.investopedia.com/ask/answers/010815/what-good-sharpe-ratio.asp] 11.01.2018
23. **Morris, G. L.** (2006). Candlestick Charting Explained: Timeless Techniques for Trading Stocks and Futures. McGraw-Hill. Pp 560
24. **Nison, S.** (1994). Beyond Candlesticks: New Japanese Charting Techniques Revealed. Wiley Finance
25. **Nison, S.** (1991). Japanese Candlestick Charting Techniques: A Contemporary Guide to the Ancient Investment. New York Institute of Finance Simon & Schuster. Pp 315
26. **Nison, S.** (2003). The Candlestick Course. John Wiley and Sons, pp 219

27. **O'Neil, W.J.** (1988). How to Make Money in Stocks. New York, McGraw-Hill, pp 464.
28. **Prechter, R. R. Jr., Frost, A. J.** (2005). Elliott wave principle: Key to Market Behavior. 10th edition. New Classics Library. Pp 255.
29. **Prechter, R. R. Jr.** (2005). Elliott Waves, Fibonacci and Statistics. [http://www.socionomics.org/pdf/EW_Fibo_Statistics.pdf]
30. **Roscoe, P., Howorth, C.** (2009). Identification through technical analysis: A study of charting and UK non-professional investors. Accounting, Organizations and Society, vol. 34 pp. 206-221
31. **Schlossberg, B.** (2006). Technical analysis of the currency market: classic techniques for profiting from market swings and trader sentiment. John Wiley & Sons. Pp 225
32. **Teweles, R.J., F.J. Jones, and B. Warwick.** (1987). The Futures Game: Who Wins? Who Loses? Why? New York, McGraw-Hill, pp 279.
33. **Wagner, G. S.** (2010). Gold and the New Technical Triad. Stocks & Commodities V. 28:8 (12-17)
34. **Williams, B.** (2012). It's Not Witchcraft, it's Fibonacci. Futures Magazine. [http://www.futuresmag.com/2012/05/29/it%E2%80%99s-not-witchcraft-it%E2%80%99s-fibonacci]

APPENDIXES

Appendix 1. Order book. Made by author, based on Yahoo Finance data.

Open date (D.MM.YYYY)	Order Side	Open price	Price Target	Stop-loss order	Close date (D.MM.YYYY)	Close price	Profit or Loss	Profit or Loss (%)	Duration (days)
7.03.2007	LONG	$1 395,02	$ 1 534,95	$ 1 353,55	31.05.2007	$1 534,95	$ 139,93	10,03%	85
9.03.2007	LONG	$1 401,89	$ 1 542,08	$ 1 359,83	13.07.2007	$1 542,08	$ 140,19	10,00%	126
2.08.2007	LONG	$1 465,46	$ 1 612,39	$ 1 421,84	15.08.2007	$1 421,84	$ -43,62	-2,98%	13
7.08.2007	LONG	$1 467,62	$ 1 614,44	$ 1 423,64	15.08.2007	$1 423,64	$ -43,98	-3,00%	8
10.08.2007	SHORT	$1 453,09	$ 1 307,78	$ 1 542,13	1.10.2007	$1 542,13	$ -89,04	-6,13%	52
13.08.2007	LONG	$1 453,42	$ 1 599,00	$ 1 410,03	15.08.2007	$1 410,03	$ -43,39	-2,99%	2
17.08.2007	LONG	$1 411,26	$ 1 552,40	$ 1 368,93	5.10.2007	$1 552,40	$ 141,14	10,00%	49
28.08.2007	SHORT	$1 466,72	$ 1 320,11	$ 1 523,74	19.09.2007	$1 523,74	$ -57,02	-3,89%	22
30.08.2007	LONG	$1 463,67	$ 1 610,14	$ 1 419,85	21.11.2007	$1 419,85	$ -43,82	-2,99%	83
16.10.2007	SHORT	$1 547,81	$ 1 393,84	$ 1 611,68	8.01.2008	$1 393,84	$ 153,97	9,95%	84
25.10.2007	LONG	$1 516,15	$ 1 667,47	$ 1 470,40	8.11.2007	$1 470,40	$ -45,75	-3,02%	14
25.10.2007	LONG	$1 516,15	$ 1 667,47	$ 1 470,40	8.11.2007	$1 470,40	$ -45,75	-3,02%	14
26.10.2007	LONG	$1 522,17	$ 1 665,84	$ 1 468,97	8.11.2007	$1 468,97	$ -53,20	-3,50%	13
28.11.2007	LONG	$1 432,95	$ 1 571,05	$ 1 385,38	9.01.2008	$1 385,38	$ -47,57	-3,32%	42
13.12.2007	SHORT	$1 483,27	$ 1 337,93	$ 1 557,32	17.01.2008	$1 337,93	$ 145,34	9,80%	35
10.01.2008	LONG	$1 406,78	$ 1 550,04	$ 1 366,86	16.01.2008	$1 366,86	$ -39,92	-2,84%	6

Open date (D.MM.YYYY)	Order Side	Open price	Price Target	Stop-loss order	Close date (D.MM.YYYY)	Close price	Profit or Loss	Profit or Loss (%)	Duration (days)
24.01.2008	LONG	$1 340,13	$ 1 472,46	$ 1 298,44	7.03.2008	$1 298,44	$ -41,69	-3,11%	43
6.02.2008	SHORT	$1 339,48	$ 1 202,98	$ 1 421,69	2.05.2008	$1 421,69	$ -82,21	-6,14%	86
5.03.2008	LONG	$1 327,69	$ 1 459,43	$ 1 286,95	7.03.2008	$1 286,95	$ -40,74	-3,07%	2
12.03.2008	LONG	$1 321,13	$ 1 452,72	$ 1 281,03	14.03.2008	$1 281,03	$ -40,10	-3,04%	2
6.05.2008	SHORT	$1 377,48	$ 1 266,74	$ 1 457,80	1.07.2008	$1 266,74	$ 110,74	8,04%	56
8.07.2008	LONG	$1 249,50	$ 1 401,07	$ 1 235,49	11.07.2008	$1 235,49	$ -14,01	-1,12%	3
17.07.2008	LONG	$1 246,31	$ 1 369,90	$ 1 208,00	15.09.2008	$1 208,00	$ -38,31	-3,07%	60
30.07.2008	LONG	$1 264,52	$ 1 389,52	$ 1 225,30	5.09.2008	$1 225,30	$ -39,22	-3,10%	37
6.08.2008	LONG	$1 283,99	$ 1 413,37	$ 1 246,33	4.09.2008	$1 246,33	$ -37,66	-2,93%	29
10.09.2008	SHORT	$1 227,50	$ 1 102,06	$ 1 306,72	6.10.2008	$1 102,06	$ 125,44	10,22%	26
16.09.2008	SHORT	$1 188,31	$ 1 073,43	$ 1 288,45	6.10.2008	$1 073,43	$ 114,88	9,67%	20
30.09.2008	SHORT	$1 113,78	$ 995,78	$ 1 245,34	8.10.2008	$ 995,78	$ 118,00	10,59%	8
1.10.2008	LONG	$1 164,17	$ 1 283,00	$ 1 131,37	2.10.2008	$1 131,37	$ -32,80	-2,82%	1
11.10.2008	LONG	$ 936,75	$ 989,14	$ 872,24	16.10.2008	$ 872,24	$ -64,51	-6,89%	5
17.10.2008	LONG	$ 942,29	$ 1 041,07	$ 918,04	22.10.2008	$ 918,04	$ -24,25	-2,57%	5
29.10.2008	LONG	$ 939,51	$ 1 034,56	$ 912,29	6.11.2008	$ 912,29	$ -27,22	-2,90%	8
29.10.2008	LONG	$ 939,51	$ 1 034,56	$ 912,29	6.11.2008	$ 912,29	$ -27,22	-2,90%	8
24.11.2008	LONG	$ 801,20	$ 880,03	$ 776,03	26.11.2008	$ 880,03	$ 78,83	9,84%	2
16.12.2008	SHORT	$ 871,53	$ 781,71	$ 911,17	19.12.2008	$ 911,17	$ -39,64	-4,55%	3
22.12.2008	SHORT	$ 887,20	$ 799,09	$ 932,63	2.01.2009	$ 932,63	$ -45,43	-5,12%	11
16.01.2009	LONG	$ 844,45	$ 928,11	$ 818,43	20.01.2009	$ 818,43	$ -26,02	-3,08%	4
4.02.2009	LONG	$ 837,77	$ 922,36	$ 813,35	12.02.2009	$ 813,35	$ -24,42	-2,91%	8
25.02.2009	LONG	$ 770,64	$ 850,45	$ 749,95	27.02.2009	$ 749,95	$ -20,69	-2,69%	2

Open date (D.MM.YYYY)	Order Side	Open price	Price Target	Stop-loss order	Close date (D.MM.YYYY)	Close price	Profit or Loss	Profit or Loss (%)	Duration (days)
11.03.2009	LONG	$ 719,59	$ 791,56	$ 698,01	18.03.2009	$ 791,56	$ 71,97	10,00%	7
30.03.2009	SHORT	$ 809,07	$ 734,35	$ 853,54	9.04.2009	$ 853,54	$ -44,47	-5,50%	10
7.04.2009	SHORT	$ 834,12	$ 751,93	$ 864,94	16.04.2009	$ 864,94	$ -30,82	-3,70%	9
21.04.2009	SHORT	$ 831,25	$ 749,15	$ 894,32	4.05.2009	$ 894,32	$ -63,07	-7,59%	13
29.04.2009	SHORT	$ 856,85	$ 769,64	$ 890,41	4.05.2009	$ 890,41	$ -33,56	-3,92%	5
12.05.2009	SHORT	$ 910,52	$ 818,32	$ 950,68	5.06.2009	$ 950,68	$ -40,16	-4,41%	24
9.06.2009	SHORT	$ 940,35	$ 845,23	$ 974,72	23.07.2009	$ 974,72	$ -34,37	-3,66%	44
11.06.2009	SHORT	$ 939,04	$ 845,24	$ 978,26	23.07.2009	$ 978,26	$ -39,22	-4,18%	42
15.06.2009	SHORT	$ 942,45	$ 861,59	$ 974,69	8.07.2009	$ 861,59	$ 80,86	8,58%	23
24.06.2009	LONG	$ 896,31	$ 984,61	$ 868,25	30.07.2009	$ 984,61	$ 88,30	9,85%	36
25.06.2009	LONG	$ 899,45	$ 991,03	$ 873,91	8.07.2009	$ 873,91	$ -25,54	-2,84%	13
6.07.2009	SHORT	$ 894,27	$ 806,78	$ 948,88	20.07.2009	$ 948,88	$ -54,61	-6,11%	14
13.07.2009	LONG	$ 879,57	$ 967,04	$ 852,76	23.07.2009	$ 967,04	$ 87,47	9,94%	10
11.08.2009	SHORT	$1 005,77	$ 906,39	$ 1 040,42	10.09.2009	$1 040,42	$ -34,65	-3,45%	30
11.08.2009	SHORT	$1 005,77	$ 906,39	$ 1 040,42	10.09.2009	$1 040,42	$ -34,65	-3,45%	30
26.10.2009	SHORT	$1 080,36	$ 971,64	$ 1 128,70	28.12.2009	$1 128,70	$ -48,34	-4,47%	63
18.11.2009	SHORT	$1 109,44	$ 999,29	$ 1 143,84	8.01.2010	$1 143,84	$ -34,40	-3,10%	51
19.11.2009	SHORT	$1 106,44	$ 998,82	$ 1 144,43	8.01.2010	$1 144,43	$ -37,99	-3,43%	50
25.11.2009	SHORT	$1 106,49	$ 995,09	$ 1 140,79	7.01.2010	$1 140,79	$ -34,30	-3,10%	43
25.11.2009	SHORT	$1 106,49	$ 995,09	$ 1 140,79	7.01.2010	$1 140,79	$ -34,30	-3,10%	43
21.01.2010	SHORT	$1 138,68	$ 1 024,24	$ 1 182,39	5.04.2010	$1 182,39	$ -43,71	-3,84%	74
8.02.2010	LONG	$1 065,51	$ 1 172,81	$ 1 034,20	23.03.2010	$1 172,81	$ 107,30	10,07%	43
8.02.2010	LONG	$1 065,51	$ 1 172,81	$ 1 034,20	23.03.2010	$1 172,81	$ 107,30	10,07%	43

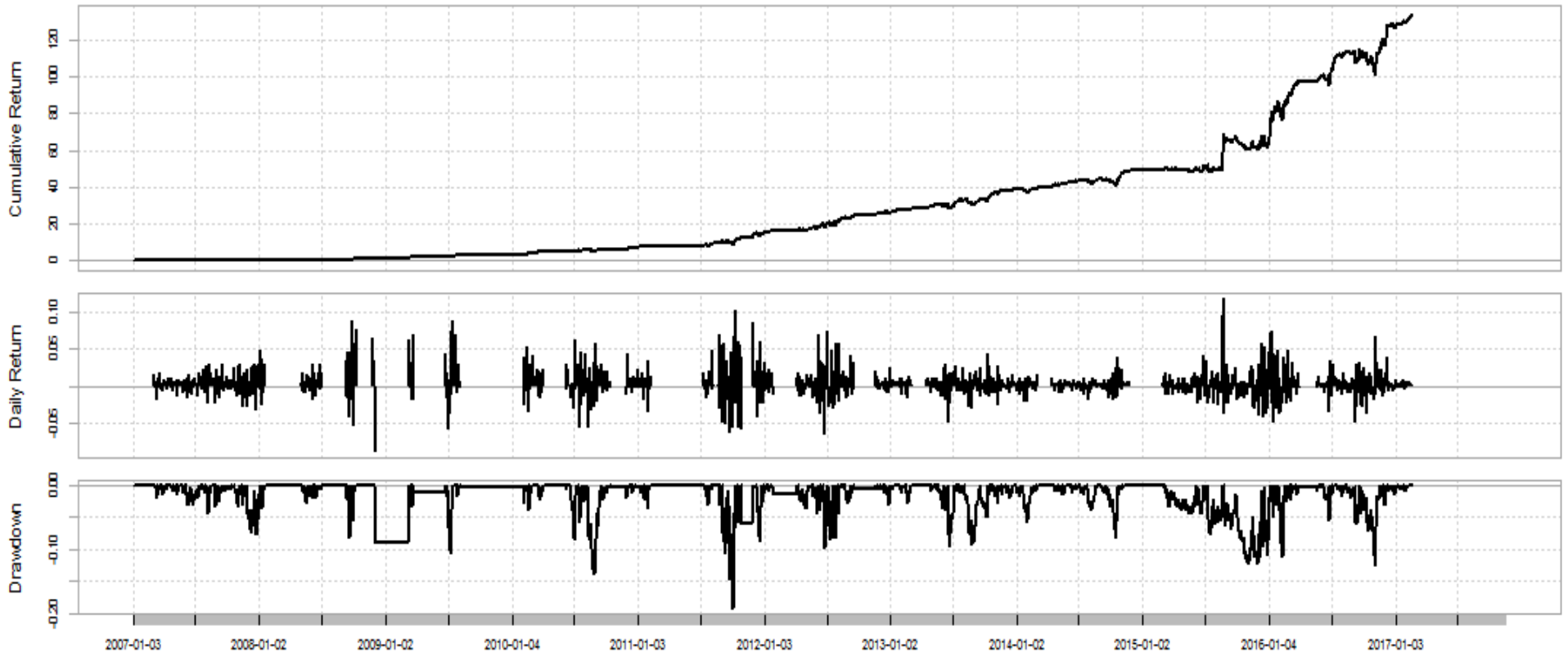
Open date (D.MM.YYYY)	Order Side	Open price	Price Target	Stop-loss order	Close date (D.MM.YYYY)	Close price	Profit or Loss	Profit or Loss (%)	Duration (days)
8.02.2010	LONG	$1 065,51	$ 1 172,81	$ 1 034,20	23.03.2010	$1 172,81	$ 107,30	10,07%	43
26.05.2010	LONG	$1 075,51	$ 1 181,43	$ 1 041,81	30.06.2010	$1 041,81	$ -33,70	-3,13%	35
9.06.2010	LONG	$1 062,75	$ 1 168,20	$ 1 030,14	30.06.2010	$1 030,14	$ -32,61	-3,07%	21
7.07.2010	LONG	$1 028,54	$ 1 130,87	$ 997,22	17.09.2010	$1 130,87	$ 102,33	9,95%	72
15.07.2010	SHORT	$1 094,46	$ 985,65	$ 1 132,05	20.09.2010	$1 132,05	$ -37,59	-3,43%	67
16.07.2010	SHORT	$1 093,85	$ 986,83	$ 1 131,62	20.09.2010	$1 131,62	$ -37,77	-3,45%	66
10.11.2010	SHORT	$1 213,14	$ 1 092,06	$ 1 263,65	3.01.2011	$1 263,65	$ -50,51	-4,16%	54
30.11.2010	LONG	$1 182,96	$ 1 306,54	$ 1 152,13	1.02.2011	$1 306,54	$ 123,58	10,45%	63
30.11.2010	LONG	$1 182,96	$ 1 306,54	$ 1 152,13	1.02.2011	$1 306,54	$ 123,58	10,45%	63
18.03.2011	LONG	$1 276,71	$ 1 401,09	$ 1 235,51	3.08.2011	$1 235,51	$ -41,20	-3,23%	138
20.06.2011	LONG	$1 271,50	$ 1 398,65	$ 1 233,36	4.08.2011	$1 233,36	$ -38,15	-3,00%	45
24.06.2011	LONG	$1 283,04	$ 1 411,85	$ 1 245,00	3.08.2011	$1 245,00	$ -38,05	-2,97%	40
28.06.2011	LONG	$1 280,21	$ 1 408,11	$ 1 241,70	3.08.2011	$1 241,70	$ -38,51	-3,01%	36
11.07.2011	SHORT	$1 343,31	$ 1 209,42	$ 1 392,96	4.08.2011	$1 209,42	$ 133,89	9,97%	24
10.08.2011	LONG	$1 171,77	$ 1 289,78	$ 1 137,35	11.08.2011	$1 137,35	$ -34,42	-2,94%	1
23.08.2011	LONG	$1 124,36	$ 1 236,20	$ 1 090,11	4.10.2011	$1 090,11	$ -34,25	-3,05%	42
23.08.2011	LONG	$1 124,36	$ 1 236,20	$ 1 090,11	4.10.2011	$1 090,11	$ -34,25	-3,05%	42
5.10.2011	LONG	$1 124,03	$ 1 236,34	$ 1 090,23	21.10.2011	$1 236,34	$ 112,31	9,99%	16
26.10.2011	SHORT	$1 229,17	$ 1 106,15	$ 1 291,82	27.10.2011	$1 291,82	$ -62,65	-5,10%	1
29.11.2011	LONG	$1 192,56	$ 1 311,81	$ 1 156,77	19.01.2012	$1 311,81	$ 119,24	10,00%	51
29.11.2011	LONG	$1 192,56	$ 1 311,81	$ 1 156,77	19.01.2012	$1 311,81	$ 119,24	10,00%	51
13.12.2011	SHORT	$1 236,83	$ 1 112,82	$ 1 292,70	10.01.2012	$1 292,70	$ -55,87	-4,52%	28
4.04.2012	SHORT	$1 413,09	$ 1 274,16	$ 1 461,57	5.06.2012	$1 274,16	$ 138,93	9,83%	62

Open date (D.MM.YYYY)	Order Side	Open price	Price Target	Stop-loss order	Close date (D.MM.YYYY)	Close price	Profit or Loss	Profit or Loss (%)	Duration (days)
12.04.2012	LONG	$1 368,77	$ 1 505,58	$ 1 327,65	16.05.2012	$1 327,65	$ -41,12	-3,00%	34
17.04.2012	LONG	$1 369,57	$ 1 506,53	$ 1 328,48	15.05.2012	$1 328,48	$ -41,09	-3,00%	28
25.04.2012	LONG	$1 372,11	$ 1 509,17	$ 1 330,81	15.05.2012	$1 330,81	$ -41,30	-3,01%	20
23.05.2012	LONG	$1 316,02	$ 1 448,29	$ 1 277,13	4.06.2012	$1 277,13	$ -38,89	-2,96%	12
24.05.2012	LONG	$1 318,72	$ 1 450,75	$ 1 279,29	1.06.2012	$1 279,29	$ -39,43	-2,99%	8
5.06.2012	LONG	$1 277,82	$ 1 406,00	$ 1 239,83	7.08.2012	$1 406,00	$ 128,18	10,03%	63
6.06.2012	LONG	$1 285,61	$ 1 414,05	$ 1 246,94	16.08.2012	$1 414,05	$ 128,44	9,99%	71
23.07.2012	SHORT	$1 362,34	$ 1 226,39	$ 1 417,81	17.08.2012	$1 417,81	$ -55,47	-4,07%	25
23.07.2012	SHORT	$1 362,34	$ 1 226,39	$ 1 417,81	17.08.2012	$1 417,81	$ -55,47	-4,07%	25
18.09.2012	SHORT	$1 461,19	$ 1 345,07	$ 1 509,60	16.11.2012	$1 345,07	$ 116,12	7,95%	59
24.09.2012	SHORT	$1 459,76	$ 1 314,14	$ 1 511,08	1.02.2013	$1 511,08	$ -51,32	-3,52%	130
24.09.2012	SHORT	$1 459,76	$ 1 314,14	$ 1 511,08	1.02.2013	$1 511,08	$ -51,32	-3,52%	130
20.11.2012	LONG	$1 386,82	$ 1 525,58	$ 1 345,28	13.02.2013	$1 525,58	$ 138,76	10,01%	85
22.04.2013	LONG	$1 555,25	$ 1 710,78	$ 1 508,59	18.09.2013	$1 710,78	$ 155,53	10,00%	149
7.06.2013	LONG	$1 625,27	$ 1 784,82	$ 1 573,88	24.06.2013	$1 573,88	$ -51,39	-3,16%	17
26.06.2013	LONG	$1 592,27	$ 1 746,83	$ 1 540,39	21.10.2013	$1 746,83	$ 154,56	9,71%	117
11.10.2013	LONG	$1 691,09	$ 1 861,82	$ 1 641,78	28.02.2014	$1 861,82	$ 170,73	10,10%	140
27.01.2014	SHORT	$1 791,03	$ 1 611,26	$ 1 881,77	6.03.2014	$1 881,77	$ -90,74	-5,07%	38
15.04.2014	LONG	$1 831,45	$ 2 013,67	$ 1 775,69	19.09.2014	$2 013,67	$ 182,22	9,95%	157
29.07.2014	SHORT	$1 980,03	$ 1 781,02	$ 2 040,97	11.11.2014	$2 040,97	$ -60,94	-3,08%	105
3.10.2014	LONG	$1 905,65	$ 2 140,79	$ 1 887,78	13.10.2014	$1 887,78	$ -17,87	-0,94%	10
16.10.2014	LONG	$1 855,95	$ 2 048,74	$ 1 806,62	18.11.2014	$2 048,74	$ 192,79	10,39%	33
17.12.2014	LONG	$1 973,77	$ 2 170,01	$ 1 913,56	24.08.2015	$1 913,56	$ -60,21	-3,05%	250

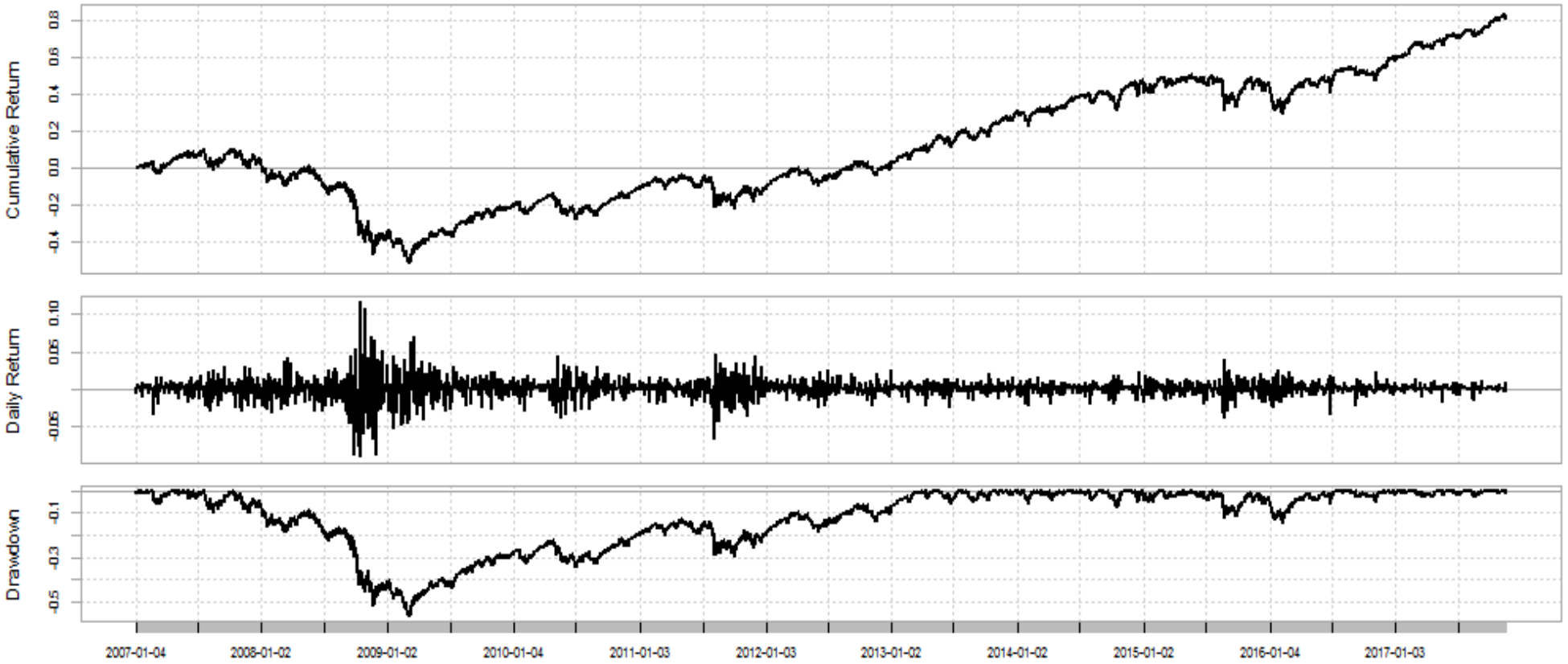
Open date (D.MM.YYYY)	Order Side	Open price	Price Target	Stop-loss order	Close date (D.MM.YYYY)	Close price	Profit or Loss	Profit or Loss (%)	Duration (days)
5.01.2015	SHORT	$2 054,44	$ 1 852,38	$ 2 134,53	20.05.2015	$2 134,53	$ -80,09	-3,90%	135
4.03.2015	SHORT	$2 107,72	$ 1 897,00	$ 2 179,23	24.08.2015	$1 897,00	$ 210,72	10,00%	173
30.03.2015	LONG	$2 064,11	$ 2 267,12	$ 1 999,19	21.08.2015	$1 999,19	$ -64,92	-3,15%	144
29.05.2015	SHORT	$2 120,66	$ 1 908,71	$ 2 185,94	24.08.2015	$1 908,71	$ 211,95	9,99%	87
29.05.2015	SHORT	$2 120,66	$ 1 908,71	$ 2 185,94	24.08.2015	$1 908,71	$ 211,95	9,99%	87
10.06.2015	LONG	$2 081,12	$ 2 288,16	$ 2 017,75	21.08.2015	$2 017,75	$ -63,37	-3,05%	72
10.07.2015	LONG	$2 052,74	$ 2 256,44	$ 1 989,77	21.08.2015	$1 989,77	$ -62,97	-3,07%	42
10.07.2015	LONG	$2 052,74	$ 2 256,44	$ 1 989,77	21.08.2015	$1 989,77	$ -62,97	-3,07%	42
13.08.2015	LONG	$2 086,19	$ 2 294,66	$ 2 023,47	21.08.2015	$2 023,47	$ -62,72	-3,01%	8
21.08.2015	SHORT	$2 034,08	$ 1 832,16	$ 2 138,91	20.01.2016	$1 832,16	$ 201,92	9,93%	152
3.09.2015	LONG	$1 950,79	$ 2 143,75	$ 1 890,39	28.09.2015	$1 890,39	$ -60,40	-3,10%	25
6.11.2015	SHORT	$2 098,60	$ 1 889,94	$ 2 172,04	15.01.2016	$1 889,94	$ 208,66	9,94%	70
9.11.2015	SHORT	$2 096,56	$ 1 889,28	$ 2 164,97	15.01.2016	$1 889,28	$ 207,28	9,89%	67
8.12.2015	SHORT	$2 073,39	$ 1 869,36	$ 2 153,13	15.01.2016	$1 869,36	$ 204,03	9,84%	38
15.12.2015	LONG	$2 025,55	$ 2 224,13	$ 1 961,28	7.01.2016	$1 961,28	$ -64,27	-3,17%	23
15.12.2015	LONG	$2 025,55	$ 2 224,13	$ 1 961,28	7.01.2016	$1 961,28	$ -64,27	-3,17%	23
22.12.2015	LONG	$2 069,28	$ 2 223,27	$ 1 960,52	7.01.2016	$1 960,52	$ -108,76	-5,26%	16
21.01.2016	LONG	$1 861,46	$ 2 045,26	$ 1 803,55	17.03.2016	$2 045,26	$ 183,80	9,87%	56
22.01.2016	LONG	$1 877,40	$ 2 055,89	$ 1 812,92	11.02.2016	$1 812,92	$ -64,48	-3,43%	20
25.04.2016	SHORT	$2 089,37	$ 1 882,42	$ 2 157,15	14.07.2016	$2 157,15	$ -67,78	-3,24%	80
20.05.2016	LONG	$2 041,88	$ 2 244,04	$ 1 978,84	8.12.2016	$2 244,04	$ 202,16	9,90%	202
29.06.2016	LONG	$2 042,69	$ 2 239,70	$ 1 975,01	7.12.2016	$2 239,70	$ 197,01	9,64%	161
22.08.2016	SHORT	$2 181,58	$ 1 965,48	$ 2 250,55	8.12.2016	$2 250,55	$ -68,97	-3,16%	108

Open date (D.MM.YYYY)	Order Side	Open price	Price Target	Stop-loss order	Close date (D.MM.YYYY)	Close price	Profit or Loss	Profit or Loss (%)	Duration (days)
22.08.2016	SHORT	$2 181,58	$ 1 965,48	$ 2 250,55	8.12.2016	$2 250,55	$ -68,97	-3,16%	108
15.09.2016	LONG	$2 125,36	$ 2 338,35	$ 2 062,00	15.02.2017	$2 338,35	$ 212,99	10,02%	153
3.03.2017	SHORT	$2 380,92	$ 2 143,73	$ 2 466,59	19.07.2017	$2 466,59	$ -85,67	-3,60%	138

Appendix 2. Strategy performance summary. Made by author.



Appendix 3. Benchmark performance summary. Made by author.



KOKKUVÕTE

TRENDIKAUPLEMINE JAAPANI KÜÜNALMUSTREID JA FIBONACCI KORREKTSIOONITASEMEID KOMBINEERIDES S&P500 INDEKSI NÄITEL

Martin Promen

Algoritmkauplemise ja küllusliku informatsiooni ajastul kasutavad pangad ja investeerimisfondid keerukaid programme ja võimsaid arvuteid ennustamaks hindade liikumisi finantsturgudel. Sellised institutsioonid peavad alaliselt parendama oma investeerimis- ja kauplemisstrateegiaid ning algoritme, et teenida suuremat kasumit kui turgu kirjeldavad baasindeksid. Ühe sellise süsteemi väljaarendamine ja testimine on ka käesoleva töö peamine eesmärk. Kasumlik strateegia, mida on ajaloolistel andmetel ulatuslikult testitud, võib aidata nii suuri institutsionaalseid investoreid ning kauplejaid kui ka väiksemate summadega toimetavat erainvestorit kes oma säästudest hobi koras kauplemist harrastab.

Käesolevas töös käsitletav strateegia keskendub trendide järgimisele ning turupsühholoogiale. Töö eesmärk on pakkuda investeerimis- või kauplemisotsuseid tegevale institutsioonile või eraisikule empiiriliselt testitud tulemusi Fibonacci korrektsioonitasemete ja küünalmustrite kombinatsioonile loodud trendikauplemisstrateegia võimalikkuse ja kasulikkuse kohta S&P500 indeksi näitel. Selleks on ühe töö osana koostatud ka lihtsatel kauplemisreeglitel põhinev näidisalgoritm näitamaks, kui kasumlik selline strateegia olla saab (võrreldes S&P500 indeksiga).

Uuritav kauplemisstrateegia põhineb kahele näiliselt üsna erinevale tehnilise analüüsi indikaatorile. Üks neist on tuntud Fibonacci korrektsioonitasemete nime all, mille juured ulatuvad aastasse 1202 mil Leonardo Fibonacci avaldas oma kuulsa “Arvutuste raamatu” (*Liber Abaci*). Fibonacci arvujadal põhinevate tööriistade efektiivsust ja kasumlikkust

finantsturgudel hindade ennustamiseks on keeruline tõestada või ümber lükata kuna vaatamata oma üle 800 aastasele ajaloole on Fibonacci tasemeid finantsturgude kontekstis tõsiselt uurima hakatud alles hiljuti.

Teiseks indikaatoriks mida peale Fibonacci tasemete on töös kasutatud on küünalmustrid. Jaapani küünalmustrid on vanim teadaolev tehnilise analüüsi meetod ennustamaks hindade liikumisi. Nagu nimigi ütleb pärineb see meetod Jaapanist, kõige tõenäolisemalt võeti need mustrid kasutusele hilisel 19. Sajandil Osaka riisikauplejate seas, mõnedel andmetel ka juba sada aastat varem (Morris, 2006; Nison, 1994:14). Üks küünal mis kirjeldab ühte kauplemisperioodi koosneb neljast andmepunktist ning sisaldab seega oluliselt rohkem informatsiooni kui lihtne joongraafik mis sisaldab ainult ühte hinda (sulgemishinda). Küünalmustreid analüüsitakse tavaliselt visuaalselt. Eksisteerib väga mitmesuguseid mustreid mida paljud kauplejad kasutavad tehinguotsuste langetamiseks. Kuna selline hinna kommunikeerimise viis leiutati algselt riisikauplejate tarbeks siis võib eeldada, et kõige paremini võiks selline analüüs sobida toorainete turule. Süvenedes aga küünalde ja küünalmustrite olemusse siis on selge, et need peegeldavad hästi turupsühholoogiat ja turuosaliste hulgas valitsevat meeleolu ning võiksid seega sobida edukalt ka kapitaliturgude hinnaliikumiste ennustamiseks.

Wagner (2010) ja Nison (1994) on väitnud, et Fibonacci tasemed ja küünalmustrid töötavad sünergiliselt ning koos kasutades pakuvad nad paremat arusaamist turu hetkeolukorrast ning paremaid tulemusi kui kumbki neist eraldi. Neid väiteid ei ole empiiriliselt testitud. Võib arvata, et tänu mõlema indikaatori sarnasele väljundile (trendide jätku ja pöördumiste ennustamine) on tõenäoline, et küünalmustrid langevad samasse piirkonda, kuhu Fibonacci tasemedki.

Töö teoreetiline pool uurib küünalmustrite ajalugu, "anatoomiat", kasumlikkust ja põhjuseid, miks küünalmustreid kauplemises kasutatakse. Samuti selgitatakse Fibonacci korrektsioniastmete leidmise tagamaid ning seotust teiste finansturgude käitumist selgitavate teooriatega tehnilise analüüsi kontekstis (Elliotti lained. Empiirline käsitlus hõlmab nii teoreetilise kui ka praktilise kasumlikkuse testimist Fibonacci tasemete ja küünalmustrite kombinatsioonstrateegias.

Kirjanduse ülevaatest selgus, et enamik asjakohast lektüüri pärineb analüütikutelt ja praktikutelt kes on teemaga ise igapäevaselt kokku puutunud ning oma propageeritavaid

võtteid ka reaalselt kasutavad. Akadeemiline kirjandus on aga kohati puudulik – näiteks Fibonacci korrektsioonitasemeid on teaduslikult uuritud alles hiljuti ning seega on keeruline tulemusi võrrelda. Samas on küünalmustrite kohta leida laialdaselt teadusartikleid erinevatelt kontinentidelt ja kultuuridest. Uurijad on välja toonud, et investeerimisega tihedalt kokku puutuvad praktikud võivad näidata tehnilist analüüsi tegelikust paremas valguses, kuna neil endil on kogunenud aastatepikkuse praktika ja investeerimistegevuse käigus hulgaliselt niinimetatud vaikivat teadmist (*tacit knowledge*), mis neid otsuste langetamisel oluliselt aitab. Seda toetab ka võrdlus akadeemilise ja praktilise kirjanduse vahel – akadeemikute saavutatud investeerimistulemused on tunduvalt kehvemad ning tehnilise analüüsi kasumlikkus oponeerivamad kui praktikute tulemused.

Selgus ka, et Fibonacci korrektsioonitasemete kohta puudub uurijate hulgas konsensus nende kasumlikkuse kohta. Samuti puudub üksmeel selle osas, millised Fibonacci väärtused on kõige kasumlikumad. Akadeemikud on siinkohal leidnud, et tegelikkuses ei oma Fibonacci korrektsioonastmed mingit eelist mõne teise korrektsioonastme ees, st. nende ennustamisvõimed on samaväärsed. Praktikute poolt avaldatud artiklites ja raamatutes leidub erinevaid arvamusi nende joonte indivduaalse tootlikkuse kohta. Tihti puudub selgus kuidas need arvamused on tekkinud või millistel andmetel need põhinevad, rõhutades enamgi vaikiva teadmise olulisust tehnilises analüüsis.

Küünalmustrid on Fibonacci indikaatoritest rohkem analüüsitud ning selgemini formuleeritud. Suurim probleem siingi on küünalmustrite formuleerimine – mustrid, mis mõnele vähem riskikartlikule investorile võivad kvalifitseeruda signaalina võivad mõne teise arvestuse kohaselt tähendada mitte midagi. Küünalmustrid on väga visuaalsed indikaatorid ning seega saab neid ka mitmeti tõlgendada. Küünalmustrite kui eraldiseisva analüüsimeetodi kohta on teaduskirjandust piisavalt ning see on mitmekesine. Enamik uuringuid, mis küünalmustrite kohta on läbi viidud, näitavad vähest või negatiivset tootlust.

Empiirilise analüüsi põhilised tulemused ja tähelepanekud on järgmised:

- 18st analüüsi kaasatud küünalmustrist ainult 10 näitasid kasumipotentsiaali (uuritud iseseisva indikaatorina);

- Kombinatsioonis Fibonacci korrektsioonitasemetega osutus 12 mustrit 16st kasumlikuks (kaks mustrit ei tootnud ühtegi signaali);
- Ostusignaalid olid tootlikumad kui müügi (*short-selling*) signaalid;
- Doji küünlad Fibonacci tasemetel on kasumlikud, kuid on tootlikumad langevas trendis (vastupidiselt kirjanduses väidetule);
- Koondkasum analüüsitud perioodil oli 517,16% ehk keskmiselt 3,7% aastast kasumit küünalmustri kohta. Baasstrateegia puhul oli koondkasum 82.27%;
- Sharpe suhtarv riskiga kaalutud tulususe kohta näitas, et kombinatsioonstrateegia Fibonacci ja küünalmustritega on tootlikum kui baasstrateegia (osta-hoia) kuid mõlemal juhul jääb suhtarv alla 1;
- Osta-hoia (buy-hold) strateegia jäi riski ja tootluse suhtarvude võrdluses kehvemaks valikuks kui kombineeritud strateegia.

Kombinatsioonstrateegia tingimuseks oli, et küünalmustri keha peab asuma Fibonacci joonel. Kõiki Fibonacci korrektsiooniastmed, kaasa arvatud 50% taset käsitleti samaväärsena ning eraldi testimist erinevate tasemete usaldusväärsuse kohta läbi ei viidud. Korrektsioonitasemete asukohad määrati ZigZag tööriistaga (2,5% tundlikkusega), mis ühtlustas hinnagraafiku ja tuvastas sobivad tipud. Tehingusignaalide kasumlikkust hinnati signaalile järgneva 10 päeva keskmise sulgemishinna abil.

Uuring kinnitab, et korrektsioonitasemed omavad arvestatavat potentsiaali kui neid kasutada küünalmustrite filtreerimisel ehk mustrite signaalide kinnitusena. Süsteemi tootlikkuse hindamine on suhteline, kuid suhteliselt madal Sharpe' suhtarv annab alust arvata, et selline strateegia ei pakuks enamikule investoritest sellisel kujul huvi. Indikaatoreid üheaegselt kasutades on võimalik oluliselt suurendada küünalmustrite usaldusväärsust, kuid analüüs ei andnud väga "säravaid" tulemusi. Kuna uuringus kasutatud andmestik kirjeldab USA kapitaliturgu, siis küünalmustrite ja Fibonacci strateegia testimise tulemusi ei saa üldistada teiste riikide kapitaliturgudele ega FOREXi või toorainete turgudele.

Lisaks tõestab käesolev uuring ainult valitud indikaatorite koosmõju potentsiaalset kasumlikkust ja õigustab Fibonacci korrektsioonitasemeid kui kasulikku filtrit küünalmustrite strateegiale. Saadud tulemused võivad olla investoritele ja kauplejatele abiks suurima kasumipotentsiaaliga küünalmustrite valikul ning sobiva strateegia

väljatöötamisel, kuid ei luba mingit kindlat alalist tootlikkust. Uuring ei käsitle transaktsioonikulusid ja positsiooni varieeruvat suurust sest need sõltuvad konkreetselt tehingu sooritaja riskitaluvusest ja kauplemisstiilist.

Lihtlitsents lõputöö reprodutseerimiseks ja lõputöö üldsusele kättesaadavaks tegemiseks

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Tartus, 16.01.2018

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(*allkiri*)