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„Interdependencies of major stock market exchange
trading hours and their effect on trading signal
generation“

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Table of content

List of Figures and Tables	5
Preface	8
1 Introduction	9
1.1 Structure of the paper	9
2 Basics of Trading	11
2.2 Stages of Trading	11
2.3 Day Trading	12
2.3.1 Time of day patterns	14
2.3.2 Trading in another time zone	14
3 Technical Analysis of Financial Markets	15
3.1 Chart Construction	15
3.1.1 Volume	16
3.1.2 Open Interest	16
3.1.3 From daily charts to intraday price charts	18
3.2 Trend	19
3.2.1 Definition	19
3.2.2 Directions	19
3.2.3 Classifications	21
3.2.4 Support and Resistance Level	23
4. Trading Strategies	24
4.1 Trendline	24
4.1.1 The Fan Principle	27
4.1.2 The Channel Line	28
4.2 Candlestick Charts	28
4.2.1 Components of a candlestick	29
4.2.2 Candle Formations	31

4.2.2.1 The Doji.....	31
4.2.2.2 Hammer.....	33
4.2.2.3 Shooting Star.....	33
4.3 MACD.....	34
4.3.1 Definition.....	34
4.3.2 Crossovers.....	36
4.3.2.1 Signal Line Crossover.....	36
4.3.2.2 Centerline Crossover.....	37
4.3.2.3 Divergence.....	38
4.3.3 MACD Histogram.....	39
4.3.4 False Signals.....	40
4.4 Pivot Points.....	41
4.4.1 Definition.....	41
4.4.2 Calculation.....	42
4.4.3 Using Pivot Points.....	44
4.4.3.1 Bearish Pivot Point Filter.....	44
4.4.3.2 Bullish Pivot Point Filter.....	45
4.4.3.3 Pivot Point Bounce.....	46
4.4.3.4 The Trading Channel.....	48
4.4.3.5 Pivot Point Breakout.....	49
5 Introduction II.....	50
6 Hypotheses.....	51
6.1 Hypothesis I and II.....	51
6.2 Hypothesis III and IV.....	51
7 Data.....	53
7.1 EURO STOXX 50® (Ticker: FESX).....	53
7.2 S&P 500 (Ticker: SE).....	54

7.3 Hang Seng Index (Ticker: HSI).....	56
7.4 Overlapping trading hours	57
8 Methodology	59
8.1 Data Formatting.....	59
8.2 Correlation Test	59
8.3 Pivot Point Strategy Test	61
8.3.1 Trading with Pivot Points	61
8.3.2 Signal Trading with Pivot Points	63
9 Results	65
9.1 Correlation Results	65
9.1.1 FESX_HSI_SE_03.30 pm – 05.00 pm	65
9.1.2 HSI_FESX_08.00 am – 03.30 pm	70
9.2 Trading with Pivot Points	72
9.2.1 FESX_SE_03.36 pm - 03.45 pm.....	72
9.2.2 FESX_HSI_04.51 pm - 05.00 pm.....	73
9.2.3 FESX_HSI_08.06 am - 08.15 am	74
9.3 Signal Trading with Pivot Points.....	74
9.3.1 Granger Causality	74
9.3.2 FESX_SE_03.36 pm - 03.45 pm.....	75
9.3.3 FESX_HSI_04.51 pm - 05.00 pm.....	76
9.3.4 FESX_HSI_08.06 am - 08.15 am	77
10 Conclusion.....	79
11 Sources	82
12 Appendix	85

List of Figures and Tables

Figure 1 Stage Analysis.....	12
Figure 2 Daily Bar Chart of Intel	15
Figure 3 Line Chart of Intel.....	16
Figure 4 Spiking a bond bull	18
Figure 5 5-min bar chart of S&P 500 future	18
Figure 6 Three directions of a market trend	20
Figure 7 Major, secondary and near term trend	22
Figure 8 Major, secondary and near term trend of the Dow Industrials in 1997	22
Figure 9 Support and resistance levels in an upward trend.....	23
Figure 10 Support and resistance levels in a downward trend	23
Figure 11 Long term up trendline	25
Figure 12 Example of an up trendline.....	26
Figure 13 Basic buy and sell signals using trendlines.....	27
Figure 14 Example of the fan principle.....	27
Figure 15 A trend channel in a downtrend	28
Figure 16 Selling/Short	29
Figure 17 Buying/Long	29
Figure 18 The Doji	31
Figure 19 The Doji - Livechart	31
Figure 20 Gravestone	32
Figure 21 Gravestone - Livechart.....	32
Figure 22 Dragonfly	32
Figure 23 Dragonfly - Livechart	32
Figure 24 Hammer	33
Figure 25 Shooting Star.....	33
Figure 26 Shooting Star and Hanging Man - Livechart	34

Figure 27 Seven Month MACD line of Home Depot Inc.	35
Figure 28 Signal Line Crossover of IBM.....	37
Figure 29 A bullish divergence of Google Inc.	38
Figure 30 MACD Histogram.....	40
Figure 31 Bearish Pivot Point Filter.....	45
Figure 32 Bullish Pivot Point Filter	45
Figure 33 Bearish Indication	46
Figure 34 Bullish Indication.....	46
Figure 35 Pivot Point Bounce Trading.....	47
Figure 36 Trading the Channel Line	48
Figure 37 Pivot Point Breakout.....	49
Figure 38 Country Weighting of EURO STOXX 50 Index.....	54
Figure 39 Sector Breakdown of S&P 500 Index.....	55
Figure 40 Industry Weightings in HSI	56
Figure 41 Trading hours of FESX Future, HSI Future and SE Future.....	57
Figure 42 Trading hours of FESX and HSI.....	58
Figure 43 Trading strategy based on PP and 4 corresponding levels.....	63
Figure 44 Scatterplot of HSI and FESX (05/2014)	66
Figure 45 Scatterplot of HSI and SE (05/2014)	66
Figure 46 Scatterplot of SE and FESX (05/2014).....	67
Figure 47 Scatterplot of FESX and SE (03/2014).....	68
Figure 48 Scatterplot of FESX and SE (05/2014).....	70
Figure 49 Implementation of the trading strategy based on PP	73
Figure 50 Granger Causality of different data pairs at different trading windows	75
Figure 51 Signals from SE	75
Figure 52 Applying signals of SE for FESX.....	75
Figure 53 One-tailed t-test of the outperformance of signal trading.....	76

Figure 54 One-tailed t-test of the outperformance of signal trading.....	77
Figure 55 One-tailed t-test of the outperformance of signal trading.....	77
Table 1 Top 10 Companies by Weight of EURO STOXX 50®	53
Table 2 Top 10 Companies by Weight of S&P 500®	55
Table 3 Top 10 Companies by Weight of Hang Seng Index	57
Table 4 Pearson (P), Spearman-Rho (S) and Kendall-Tau (K) Correlation.....	65
Table 5 Pearson (P), Spearman-Rho (S) and Kendall-Tau (K) Correlation.....	67
Table 6 Pearson (P), Spearman-Rho (S) and Kendall-Tau (K) Correlation.....	68
Table 7 Pearson (P), Spearman-Rho (S) and Kendall-Tau (K) Correlation.....	70
Table 8 Pearson (P), Spearman-Rho (S) and Kendall-Tau (K) Correlation.....	71

Preface

The motivation for writing my master thesis was to find a way of combining theoretical know-how as well as extending my empirical knowledge. My interest in the world of trading has been awakened by taking part on a two – years trading program whereby I could and still can gain my first practical experience. Consequently, I wanted to find a topic that is dedicated to the great field of trading and furthermore which is suited for a theoretical as well as empirical analysis. Having these two requirements in mind, I decided to focus on various trading strategies for the theoretical research and as the second step choose one of the different techniques and put it into practice. After taking this decision, it was crucial to limit the potential extend as much as possible. As a result, I put my focus on four different trading strategies for the theoretical study. For the empirical evaluation I concentrated on one particular technique implemented for three different indices at different trading hours.

I would like to thank o.Univ.-Prof. Dipl.–Math. Dr. Jörg Finsinger for agreeing to supervise my research on this topic. I was also always welcomed to discuss the subject with Mag. Dr. Stephan Unger during the past months.

Furthermore, I want to thankfully dedicate this thesis to my parents, my au-pair family as well as my closest friends, who were always supportive and tried to encourage me throughout my entire studies as much as possible. They have always provided me with opportunities to grow, learn and develop.

Thank you very much.

1 Introduction

Trading seems to be quite easy in theory: your aim is to buy cheap and sell the underlying product more expensively afterwards (or the other way round when you enter a short position as the first step). But in reality trading works differently – there are many challenges and risk factors which have to be managed in order to benefit from a trading strategy. Consequently the analysis of the various risk factors, including market movements and possible trend reversals, is essential for every trader and that might be the reason why Technical Analysis is one of the oldest and still very common approaches for detecting and observing the underlying market conditions (Rossiwall and Schröder 2011, p. 9). For this purpose, the first priority of this thesis is examining various trading strategies based on technical analysis, which will be elaborated in the beginning of the thesis. Afterwards, in the empirical part one of the explained trading strategies, namely the Pivot Point analysis, will be tested with real data of three different indices. The main emphasis is applying theoretical knowledge to real data and drawing a conclusion of the founded results to figure out if the beforehand elaborated methods are applicable and useful in the real trading world.

1.1 Structure of the paper

The objective of the thesis is to examine in particular one trading strategy, called the Pivot Point analysis, on the one hand theoretical and on the other hand with empirical results. Because of that, the thesis is roughly divided into two main parts. Sections 1 to 4 are based on various theoretical literature, whereas sections 5 to 9 is dedicated to the empirical analysis.

After the first section, a short introduction into the world of trading (Section 2) follows and subsequently the basic knowledge of technical analysis, which includes the fundamentals and importance of trend movements in the market (Section 3) are explained. Section 4, one of the main chapter of the theoretical part, is dedicated to the analysis of various trading strategies, such as Trendlines, Candlestick Charts, MACD and Pivot Points.

Subsequently, after explaining the required theoretical knowledge, the empirical part follows. First, a detailed explanation of the main hypotheses will be given (Section 6). The first one, is based on checking the dataset for correlation, whereas the second one refers to examining one specific trading technique based on pivot points. Afterwards the used dataset (Section 7) as well as the applied methods (Section 8) will be described in more detail. The most important information will be contained in Section 9, which focuses on the representation of the detected

results. Finally, in Section 10 the explained theoretical fundamental are brought in line with the empirical findings and a final conclusion will be drawn.

2 Basics of Trading

“Risk comes from not knowing what you’re doing”

(Warren Buffet)

(Buffet in Buffet and Clark 2006, p.110)

This statement was quoted by Warren Buffet, one of the most famous and influential people in the finance world. He highlights the importance of being able to fully understand the intricacies of investing, no matter in which certain financial asset. Those who properly analyze and consequently figure out when to enter and when to exit any transactions, will probably benefit from their knowledge. It is important for each trader to be aware when to get out and where to put his stops. With knowing when you have to bail out at a peak or bottom you possibly might be able to increase your profit opportunities due to taking full advantage of certain market movements. In order to extract all the energy available in the up and downs of the prices, you have to set up a theoretical framework consisting of certain trading methods and understand various trading triggers that helps you acting consistently over time, however the market fluctuates. The key is to determine a trading strategy based on the various methods for technical analysis of financial markets (Sweeney 1996, p. 2-3). Technical analysis which is defined as “the study of market action, primarily through the use of charts, for the purpose of forecasting future price trends” (Murphy 1999, p. 1) helps defining indicators, establishing trading methods and selecting trading instruments and is consequently essential for every successful trader.

2.2 Stages of Trading

One way of determining certain stages for trading is to follow the concept of Stan Weinstein. He defines four various stages in order to determine the right time for buying, selling or holding any trade. The price movements need to be compared to a Moving Average (analyzing weekly stock charts and compare it with the 30-week moving average, see Section 4.3 MACD) in order to figure out in which certain stage the price is at the moment. In the following Figure 1, the four different stages a trade can be in, are shown (Weinstein 1988, p.1).

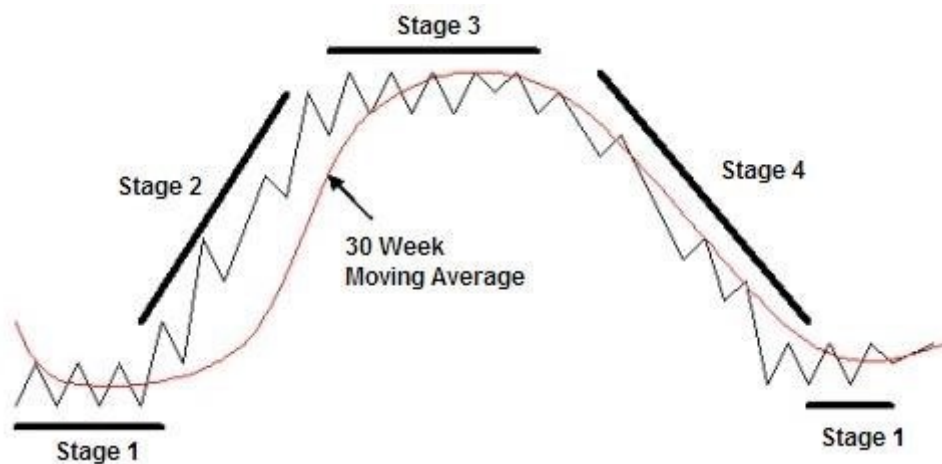


Figure 1 Stage Analysis
Source: Next Big Trade 2014

When a stock performs sideways, meaning horizontal instead of up or down, it is in the first stage known as the 'Basing stage'. It always follows a strong decline of prices and in general, the longer this horizontal base remains for a certain period of time, the more likely will be a subsequent rise of the price. Compared to the moving average line it mostly fluctuates above and below the line. If the stock starts rising above the average and breaks out of the horizontal base, it has come to stage 2 called the 'Advancing stage'. In the flow from stage 1 to stage 2, a key component is the huge increase of volume. Without raising volume on the breakout, it is more likely that the market will fall back again in stage 1. Now the trader has to become active – the stock should be bought until the price reaches stage 3. Stage 3, the 'Consolidation or Topping stage', is characterized by a stagnation of the price. It seems that the price has lost momentum and in addition also the moving average line starts trading sideways. If the price starts to decline it will end at stage 4, or it falls back into stage 2 and gains momentum again. Momentum refers to the bias that rising prices will further increase, or declining prices will drop even further. In the case of entering stage 4, the 'Declining stage' the trader should sell the stock, otherwise he could have to face a big loss during this phase. The price movements will be below stage 3 trading range, as well as below the moving average line. Consequently, you should interfere with buying any new stocks (Weinstein 1988, p. 2-3).

2.3 Day Trading

Day trading is characterized by entering and closing trading positions at the same trading day. The idea behind day-trading is that movements from one day to the next cannot be manageable. It is very common that the closing price of the previous day is not the same as the opening price

on the next day and to overcome this risk, day traders want to finalize their trades within one single day, which is defined as the overcoming of negative price gaps (Thomsett 2010). By contrast, swing traders hold their assets for a longer period like days or months, whereas investors keep their securities in the portfolio for sometimes years. So on the one hand, this short-term nature of day trading aims to reduce the risk, on the other hand this reduced risk can limit profit. Over a longer period it might be more likely that a trading idea will work out, in contrast to earn huge profits from trading one single day. There might be bad days where traders do not trade anything. In general, there are only a limited number of traders who are able to constantly generate profits with day trading (For Dummies® 2014). Furthermore the rules which might have been helpful for stock-picking or investing in other financial assets will not serve anymore, since it is a completely different game. Day traders have to be extremely disciplined, concentrated and need to follow a professional established trading structure. Day trading requires fast responses to changing situations. Due to the short response time, the possibility for mistakes is more likely. Consequently as mentioned before, a well-elaborated trading plan for each day has to be set up in advance. Based on the current movement of the prices, the trader should figure out which situations might be most likely during a day and what his actions are going to be depending on the arising situation. In addition, he should also have a plan in mind in the case of upcoming extreme unexpected moves in either positive or negative directions. Without establishing this plan, the more likely are mistakes due to spot decisions. As described before, day trading refers to short-term price movements, the traders work with very short-term daily price charts, like a 20-minute or even a 5-minute or 1-minute chart in order to enter or exit a position at the best point (Kaufman 2005, p. 590).

The greatest problem of day-trading profits are transaction costs, called 'slippage'. Slippage refers to “the difference between your execution and your intended price plus the commission costs” (Kaufman 2005, p. 592). These costs added together can reduce the potential profitability substantially and change expected profits into unexpected losses. Consequently, careful selected opportunities and reducing commission costs as much as possibly, is crucial for each day trader (Kaufman 2005, p. 592).

Furthermore, it is important to mention that the cost of trading in the direction of the price move, called 'trend trading' is different from the cost of trading against the direction, known as, 'mean reverting'. The majority of day traders follow the market movements and buy new assets as prices start rising and selling short if prices are showing downward movements. As the next step for identifying the appropriate day-trading candidates, a trader has to look at the volume of the underlying trade. It is important to choose markets with high volume, otherwise slippage

of thinly traded markets can limit profit potential considerably. Consequently, taking the combination of highest volume and highest volatility is very much recommended for any day-trader (Kaufman 2005, p. 592-593).

2.3.1 Time of day patterns

Day traders finish their trades within one day. Generally there are specific times which are more important than others. An important term in this context is the 'opening gap' which refers to the change of price levels from the previous closing price to the opening price. "The opening gap and the continuation of that direction usually take the first 15 to 20 minutes of the trading day, as does the reaction to the U.S. economic reports which are released at 8.30 A.M in New York" (Kaufman 2005, p. 597). Afterwards, it is common that a kind of trading range is established that continues until the mid of the day. It is also very likely that price reversal takes place (Kaufman 2005, p. 597).

2.3.2 Trading in another time zone

The outcome of holding a position which is traded at one stock market but reflects the development of another stock exchange, might be considerably influenced by this fact. Holding an asset overnight has positive, like the possibility for a greater return, as well as negative side effects, such as greater risk. Consequently, as mentioned above, every trader has to be aware of the opening gap. In general, it can be observed that "markets that are traded in one time zone, but reflect the business of a completely different geographic region, have larger systematic gap openings" (Kaufman 2005, p. 598). For example, the Nikkei 225 is traded at the Chicago's stock exchange. It is clear that the Nikkei includes all changes and developments of Japan's economy and environment, but since Japan is 14 hours ahead of Chicago, this information will be already absorbed by the market when the Chicago's stock exchange opens at 7.00 AM at local time (which means local time in Japan is 9.00 PM and a trading day in Japan is already over when the day just starts in Chicago) (Kaufman 2005, p. 598).

3 Technical Analysis of Financial Markets

Technical analysis belongs to one of the oldest disciplines concerning observing market movements and subsequent trend reversals. Nevertheless, it is still one of the most common and highly-used technical approaches to determine the behavior of the market. Technical analysis should help traders to react faster to changing market conditions and consequently be able to benefit from higher trading profits, due to entering and exiting their positions at the right time. But beforehand understanding the methods and results of technical analysis correctly, is indispensable (Kahn 2010, p. 15). As a consequence, establishing a basic knowledge, including reading a chart, understanding terms like volume and open interest and realizing the importance of a market trend, is essential for understanding the various elaborated Trading Strategies in Section 3. In the following Chapter 2 this required basic knowledge should be established.

3.1 Chart Construction

To understand other types of charts such as trend lines or candlestick charts, it is crucial to know the simple but most widely used type of charts, namely daily bar charts. For each trading day a vertical bar is constructed illustrating its open, high, low and closing price. Additionally the opening price is characterized by a tic to the left, whereas the closing price is marked with a tic to the right (Murphy 1999, p. 36). Figure 2 illustrates the daily bar chart of Intel Corporation.

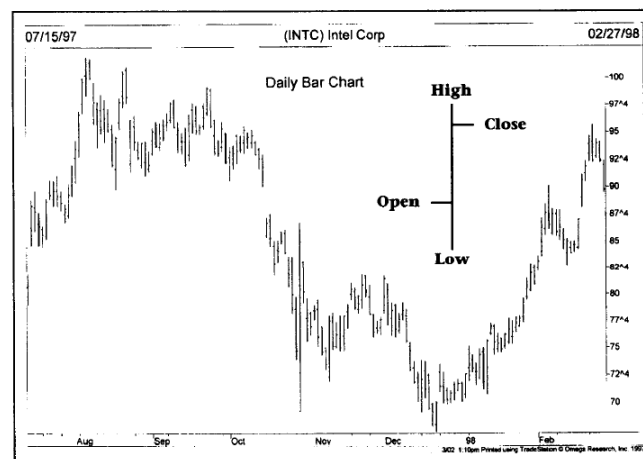


Figure 2 Daily Bar Chart of Intel
Source: Murphy 1999, p.3

In comparison, there is also a possibility to show only the closing prices represented by one solid line. Most traders argue that a line chart is more reasonable, since the closing price is the most critical price within one trading day. Considering Figure 3, the difference between a daily bar chart and a line chart is easily observable (Murphy 1999, p. 36).

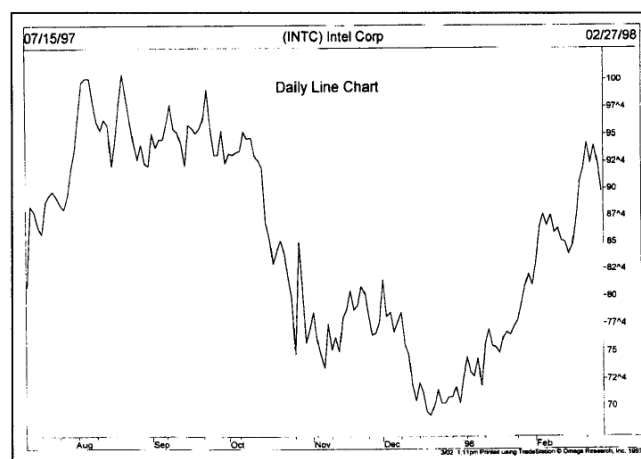


Figure 3 Line Chart of Intel
Source: Murphy 1999, p. 37

3.1.1 Volume

“Volume is simply the number of trades executed during a specified period – one trader buys and one trader sells and the volume is one”, according to Person (2004, p. 67). When the volume figure is given, it usually refers to the total of all trades for all the contract months. This figure is an essential aspect of analysis for many traders, since it reflects the behavior of the market, in particular the strength of a market trend. Examples for some methods such as pivot point analysis or moving average studies will be elaborated in chapters 4.3 and 4.4. In order to benefit from volume analysis, traders should stick to some general trading principles. If a market is declining in price and volume is rising, the market is seen as bearish. The same principle, but just the opposite, works for an increasing market. In particular, if the market shows a strong move (like a considerable increase of a daily market price) after a long steady uptrend or downtrend combined with high volume, it might be a signal that a market turning point has been reached. This movement is called a 'blow-off top or bottom' (Person 2004, p. 68)

3.1.2 Open Interest

Besides volume data, another key figure is open interest which refers to “the total number of positions that are still open and outstanding, that is, they have not been closed by an offsetting trade or delivered upon” (Person 2004, p. 68). In contrast to the volume figure, it does not determine the total of both positions a trader can enter, it represents the longs and shorts separately. It can be interpreted as a kind of money flow indicator. There are also some

guidelines which might be helpful. When prices decrease and open interest declines as well, this activity implicates that more new shorts have entered the market. Again the opposite movement occurs for a rising market (Person 2004, p. 68).

The condition of the market can be determined by the value of open interest data. But in order to evaluate the value of open interest, information of price movements and volume figures have to be combined and analyzed in the first step. According to Person (2004, p. 69), the conclusion of putting it all together is

“if there is a price increase on strong volume and open interest increases, then this is a signal that there is more buying interest that could mean a continued trend advance. If prices increase but volume stays relatively flat or declines and open interest declines, then this reflects a weakening market condition. This is considered to be a bearish situation because the combination of rising prices and declining open interest indicates that shorts are covering by buying back their positions rather than new longs entering the market. That activity would give a trader a clue that there is a potential trend reversal coming”.

Understanding the concept of volume and open interest can be very helpful for any trader to detect the current market condition and trend situation. One very strong signal for an upcoming trend reversal are extremely volatile movements or in other words stronger than normal price fluctuations combined with a decrease in open interest and unusually strong volume. The following Figure 4 illustrates an example when a bull market started to show a trend reversal ending in a strong declining market. It seems that traders who were holding a long position started selling their holdings, whereas bond traders who were short tried to cover their position by buying. These activities might be the reason behind the unusually high volume. The strong price increase can be explained by the panic behavior of the holders of short positions and longs who did not want to exit their position at a too low price. These steps are typical major signals that a trend reversal is coming (Person 2004, p. 69-70).

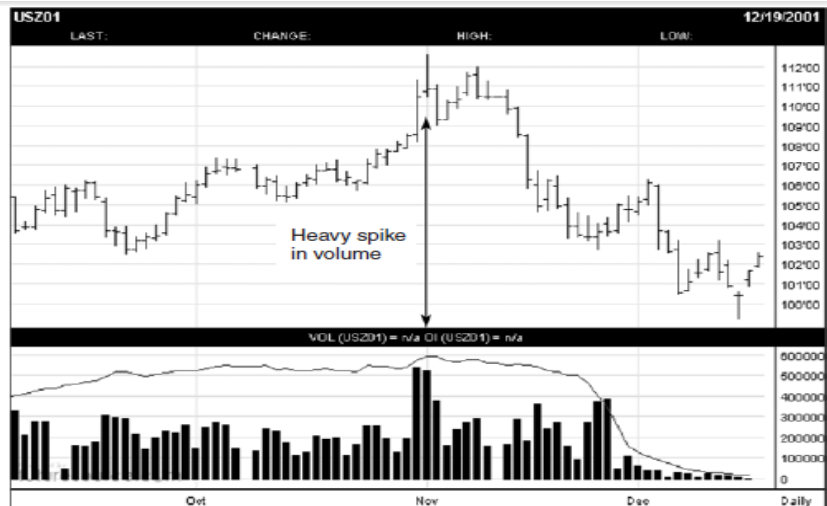


Figure 4 Spiking a bond bull
Source: Person 2004, p. 70

3.1.3 From daily charts to intraday price charts

Because the focus of the thesis is to examine trading strategies at specified timing points within one trading day, intraday price charts need to be examined as well. In general, it has to be pointed out, that the trading process always has to start with a long range view and step by step narrowed towards a shorter term. The guidelines which have been explained before, selling at a peak and buying at the bottom, should be applied in the same way. In the figure below, a five minute bar chart of the S&P500 future contract of nearly two trading days is shown (11.03.1998 and half a day of 12.03.1998). The arrows represent stochastic warnings, for example at March the 11th at 11.45 am was a signal for selling the position whereas nearly half an hour later the arrow indicates to buy again (Murphy 1999, p. 405-406).

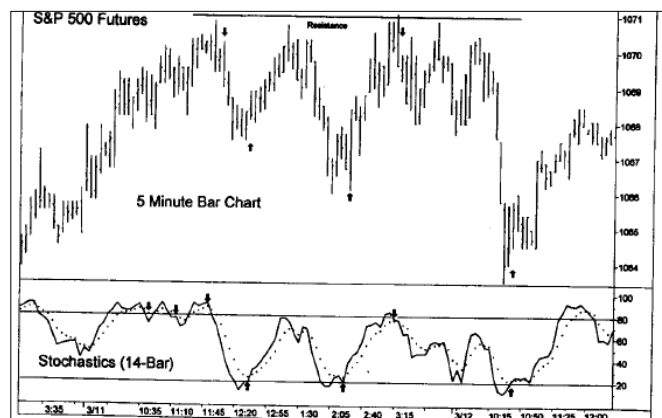


Figure 5 5-min bar chart of S&P 500 future
(11.03.1998-12.03.1998)
Source: Murphy 1999, p. 406

3.2 Trend

For many analysts, who are used to technical indicators like support and resistance levels, moving averages, trendlines and pivot points etc., the concept of trend is indispensable. The reason for its great importance is to identify the direction of the market and finally participating and benefiting from that movement. Expressions like 'always trade in the direction of the trend', 'never buck the trend' or 'the trend is your friend' are very common in the wide field of technical analysis of financial markets (Murphy 1999, p. 49).

3.2.1 Definition

Generally and easily explained 'trend' refers to the direction and movements of the market in a specified time period. But to be more precise, the concept of trend can be defined as

“the general direction of a market or of the price of an asset. Trends can vary in length from short, to intermediate, to long term. If you can identify a trend, it can be highly profitable, because you will be able to trade with the trend. As a general strategy, it is best to trade with trends, meaning that if the general trend of the market is headed up, you should be very cautious about taking any positions that rely on the trend going in the opposite direction” (Investopedia 2014).

3.2.2 Directions

Normally the market movements include many ups and downs. These movements consist of peaks and troughs. They are known in literature as a series of 'zigzags', which form the current market trend. It is important to mention that the market has got more than two directions of a trend - it can move upwards, downwards and sideways. If there are successively declining peaks and dips, the market shows a downward trend or in other words the market is in a bearish state. The opposite, meaning an uptrend or a bullish market occurs if there is a series of increasing peaks and troughs observable. If the peaks and troughs form a horizontal line, analysts define this situation as a neutral state or the market trades sideways (Murphy 1999, p. 49-50). Figure 6 below shows the three different major directions that a market can show.

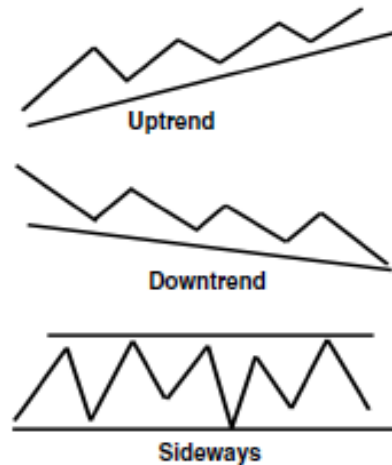


Figure 6 Three directions of a market trend
Source: Person 2007, p. 79

Knowing that a market cannot only move upwards or downwards is very important, since for at least a third of time, the market is in the neutral state. When prices are flat and consequently market moves sideways, it is said that the market is in equilibrium, since supply and demand are well balanced. In theory, it is more common to describe this direction as being 'trendless'. It has to be mentioned that trading in this trendless phase is the most difficult and also most frustrating state for traders, because most technical tools are primarily working best if the market is in a bearish or bullish mood (Murphy 1999, p. 52).

In general, as it has been explained in the previous chapter, there are some certain guidelines, traders should follow in each certain state. It is recommendable to go long (buy) if the market is bullish and to sell assets (go short) if the market shows a declining direction. In the case of a neutral market state, it is preferable to stay out of the market and because of that it is the most discouraging period a trader can face, since he can only wait until an upward or downward trend is coming (Murphy 1999, p. 52).

Comparing literature, it has to be mentioned that Person (2007) elaborates and extends the neutral state in more detail. If the market is, as he calls it in the 'congestion phase' or trading at a horizontal line, traders need to know which technical tools are appropriate and helpful to understand the signals stemming from the market behavior correctly. They need to figure out if the trend will continue (resume) or if there will be a trend reversal. For example, if the market trades sideways after a considerable upward trend, traders need to forecast if a resumption, meaning the previous upward trend will continue, or a trend reversal is more likely (Person 2007, p. 80).

3.2.3 Classifications

The concept of trend includes not only three directions, but also three classifications, namely the major, intermediate or secondary and near term trends. In reality, there are even a lot more trends like 5-minutes trends to very long term trends around 50 to 100 years. Commonly analysts use the three major categories, nevertheless there is a kind of inconsistency among technicians as to how they classify each trend. A major trend for future traders might refer to a time period for more than a year, whereas Murphy recommends limiting it down to around six months. The intermediate or secondary category relates to three weeks or several months and examining a period less than two weeks would be allocated to a near term trend (Murphy 1999, p. 52). Due to this ambiguity of understanding what is meant by a trend, it is always important to ascertain which trading window a trader is focused on. For a day trader, a substantial movement within a couple of days might be essential, whereas for a long term trader, this movement might not have any considerable impact and effects. Consequently it is crucial “to understand the different degrees of trend and to make sure that all involved in a transaction are talking about the same ones” (Murphy 1999, p. 54)

An important characteristic of these three classifications is, that “each trend is part of the next larger trend and is itself comprised of smaller trends” (Murphy 1999, p. 53). For example, a major upward trend can include a slight decline and this move belongs to the intermediate trend. This process is known as correction. The market needs to intermit and after it has corrected itself, it can continue its upward path. In addition, the secondary trend includes further waves, called as near term dips (downs) and rallies (ups). Looking at Figure 7 this process is illustrated. The major upward trend is represented by points 1 to 4. Wave 2-3 shows a correction in the secondary state and is still within the major upward trend. In addition, each secondary wave includes two or three minor waves, illustrated by waves A-B-C (Murphy 1999, p. 53).

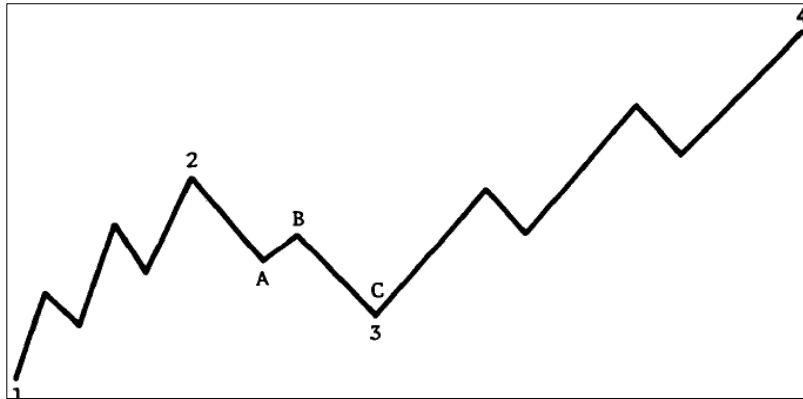


Figure 7 Major, secondary and near term trend
Source: Murphy 1999, p. 53

The same process occurs in Figure 8, where a major upward trend of the Dow Industrial in 1997 is represented. During March there is a correction since the market declines for a short period. But a stronger secondary correction happened from August to November, which is in addition broken down into three short-term near trend corrections (Murphy 1999, p. 54).

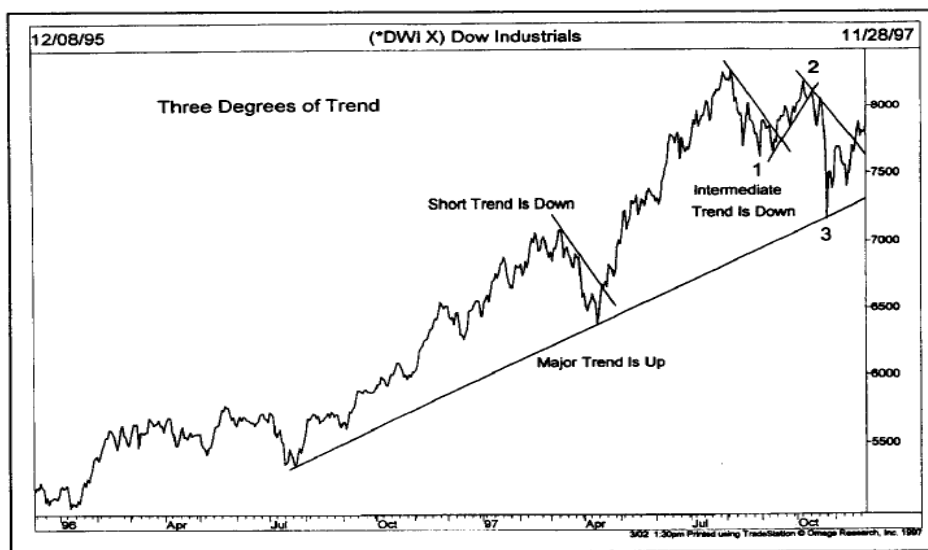


Figure 8 Major, secondary and near term trend of the Dow Industrials in 1997
Source: Murphy 1999, p. 53

3.2.4 Support and Resistance Level

So far, the direction of the market as determined by its peaks and troughs, has been explained. As the next step, the appropriate names of these important points have to be introduced and elaborated. Using the definition of Murphy, the lows are known as 'support levels' and defined as "...a level or area on the chart under the market where buying interest is sufficiently strong to overcome selling pressure" (Murphy 1999, p. 55). Consequently, the downward trend has come to an end and prices rise again. On the contrary, there is the 'resistance level', which refers to "a price level or area over the market where selling pressure overcomes buying pressure and a price advance is turned back" (Murphy 1999, p. 55). Figure 9 and Figure 10 show these two important levels, either in an upward as well as if the market is moving down.

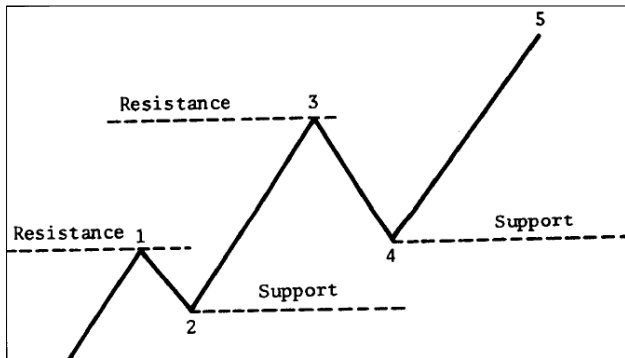


Figure 9 Support and resistance levels in an upward trend
Source: Murphy 1999, p.55

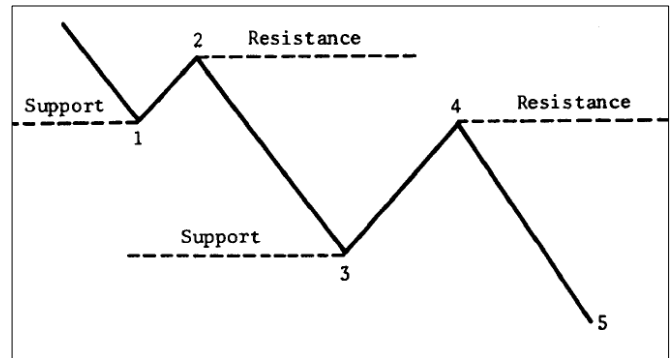


Figure 10 Support and resistance levels in a downward trend
Source: Murphy 1999, p.55

Considering Figure 9 and looking closer at an uptrend, it has to be pointed out that after each resistance level normally follows a higher one. On the contrary, facing Figure 10 the downward trend, the support levels are not strong enough "to stop the decline permanently, but are able to check it at least temporarily", according to Murphy (1999, p. 56). Furthermore there are certain guidelines, which have to be fulfilled. In the case of a continuing upward trend, each support level (low) has to be higher than the previous one. For a high (resistance level) counts the same, each resistance level needs to be greater than the one before. In addition there are two other important rules in order to detect a potential trend reversal. Murphy formulates it as followed

"if the corrective dip in an uptrend comes all the way down to the previous low, it may be an early warning that the uptrend is ending or at least moving from an uptrend to a sideways trend. If the support level is violated, then a trend reversal from up to down is likely" (Murphy 1999, p. 56).

4. Trading Strategies

After explaining the main purpose of technical analysis and basic terms like trend, chart construction, open interest or volume, the next step is the analysis of four specific trading strategies. They have in common that by reaching specific trading triggers, traders should know when to enter and exit their positions. So the aim of all of these four methods is to understand and respond as fast as possible to underlying buying and selling signals. First of all, to directly adjoin on to the previous chapter, the concept of using trendlines will be elaborated. In this subsection the different directions of trendlines and two variations will be represented. The second trading method is looking at candlestick charts, including its components and various formations. The Moving Average Convergence Divergence (MACD) approach will be analyzed subsequently. In this subsection, a definition as well as two most important signals, but also false signals will be explained. As the last point, a technique based on pivot points will be explained in great detail. This chapter is very fundamental for the subsequent empirical part of the thesis, since understanding the specific methods and trading triggers will be of high significance for the implementation of one specific trading technique.

4.1 Trendline

Trendlines are one of the most essential and beneficial technical tools to examine market trends. They are used in order to detect the current price direction, or in particular the steepness of this movement and moreover to determine when this trend will come to an end and a trend reversal might take place. An up trendline and a down trendline are the most common trendlines but it is also possible to observe a flat and horizontal trendline (Murphy 2009, p. 51). An up trendline “is a straight line drawn upward to the right along successive reaction lows...A down trendline is drawn downward to the right along successive rally peaks” (Murphy 1999, p. 65). It is very common that if a trendline has already been drawn, that prices are coming back to this line again and again. In the case of a bullish market, it is very likely that prices fall back to the trendline and afterwards increase again. This situation represents a favorable buying position (see Figure 11). For a bearish market exactly the same is observable - prices are bouncing back to the trendline and are falling afterwards. Traders with a short position should use this situation and sell their assets (Murphy 1999, p. 66).

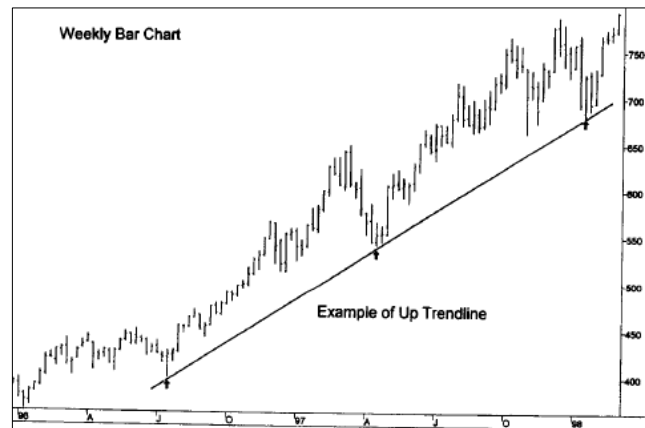


Figure 11 Long term up trendline
Source: Murphy 1999, p. 66

For drawing a trendline, it is important that all price movements are covered. An up trendline should touch all price troughs, whereas a down trendline is drawn with touching all peaks during a certain trading session. It seems to be quite easy to draw a correct trendline but it might be necessary to redraw it. There are some helpful guidelines that analysts should follow in order to set up the correct trend line: First of all, it is crucial that a trend is observable and affirmed. In the case of an up trendline, this can be done as soon as there are at least two lows and the second low is higher than the previous one. Sometimes, analysts require that there has to be a third low in order to prove the validity of the trendline (see Figure 12). Nevertheless, the market does not always satisfy this desire and the underlying trendline is only tentative (Murphy 2009, p. 53). According to Murphy (1999) it is easy to summarize: “two points are needed to draw the trendline, and a third point to make it a valid trendline” (Murphy 1999, p. 67). Concerning the significance of a trendline, it can be said that the significance increases with the duration and number of time it has been confirmed. It is obvious that a trendline which has shown evidence nine times in succession, is more significant than if it demonstrates its validity only two times. In addition, the duration is also substantial for measuring the relevance of a trendline – the longer, the higher its importance will be. It is important, since the greater the significance of a trendline, the more confidence traders can have in the underlying market movement and the more meaningful will be its penetration (Murphy 1999, p. 97). Looking at the steepness of a line, in general a 45 degree line is used. If a line is too steep, in the case of an uptrend, this would suggest that prices rise too quickly and that this price advance will not sustain for a long time. A too flat line might result from a too light and too weak trend with less confidence coming from the traders (Murphy 1999, p. 105).

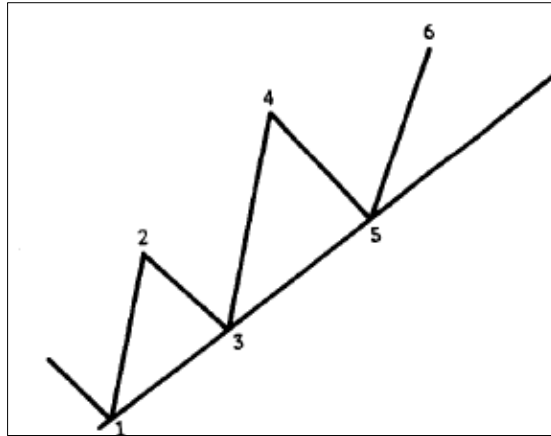


Figure 12 Example of an up trendline.
Point 5 confirms the validity of the trendline.
Source: Murphy 1999, p. 65

After the validity of a trendline has been proved and confirmed, this technical tool can become very helpful in a variety of ways. First of all, since it is very common that “a trend in motion will tend to remain in motion. As a corollary to that, once a trend assumes a certain slope or rate of speed, as identified by the trendline, it will usually maintain the same slope” (Murphy 1999, p. 68). Besides detecting the extremities of a certain trading phase, what is more, is that trendlines can help traders to evaluate when a change of the trend might occur. As long as a trendline is not violated, i.e., prices are bouncing back to trendline but not breaking through it, traders should use this phase as buying and selling periods. For example, in a bullish market, traders benefit if they are going long in the corrective dip, whereas in a down trend, traders should sell their positions if prices are bouncing back up to the trendline. Nevertheless, a breaking of the trendline should be taken seriously as it might signal an upcoming trend reversal and consequently “calling for liquidation of all positions in the direction of the previous trend” (Murphy 1999, p. 68).

According to Kaufman (2005), there are further guidelines for using this technical tool. As the market often behaves differently than described in theory, traders need to find ways in order to deal with this situation. With regard to trading and trendlines it is very likely that prices fluctuate a lot including breaking through the trendline and afterwards continuing their previous trend direction. Consequently these price movements might put traders into a kind of indecision where they might consider the following advice:

“Wait a set time period to confirm that prices remain on the new side of the trendline. Wait for a reversal after the penetration, then enter a trade in the new direction even if the reversal crosses the trendline again. Create a small safety zone around the trendline and enter the new trade if prices move through the trendline and through the safety zone” (Kaufman 2005, p. 85).

In Figure 13 certain recommendations for three different situations are given.



Figure 13 Basic buy and sell signals using trendlines
Source: Kaufman 2005, p. 85

4.1.1 The Fan Principle

As mentioned above and described by Kaufman, prices fluctuate a lot and consequently will penetrate a trendline, but not indicating a trend reversal. “Sometimes after the violation of an up trendline, prices will decline a bit before rallying back to the bottom of the old up trendline (now resistance line)” (Murphy 1999, p. 74). As the next step a second trendline can be drawn which is also going to be violated. After this break, trendline three is set up and if this line is violated, this is an early warning that prices are moving further downwards. At this stage it is important to mention that previous support levels change into resistance levels (if prices tend to fall after a strong uptrend, see Figure 14) and vice versa if prices start rising after a down trend. The crucial point is the penetration of trendline 3 which indicates an upcoming trend reversal. Murphy (1999) describes the appearance as “[T]he term 'fan principle' derives from the appearance of the lines that gradually flatten out, resembling a fan” (Murphy 1999, p.76).

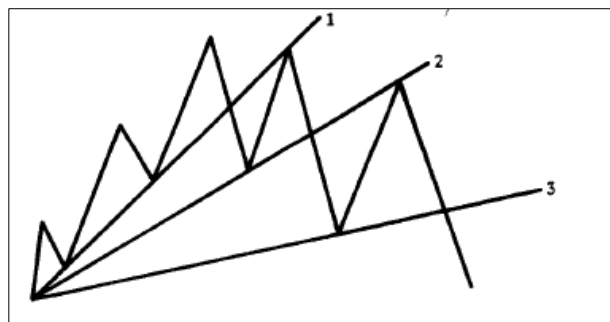


Figure 14 Example of the fan principle
Source: Murphy 1999, p. 74

4.1.2 The Channel Line

The channel line is a common variation of the basic trendline. Sometimes also called the return line, it is drawn in addition to the basic trendline and serves to identify support and resistance levels (see Figure 15). In the case of a downtrend, first the basic trendline, including all price peaks (points 1, 3, 5) has to be drawn. Afterwards from the first low (point 2) a second (often dotted) line which is parallel to the basic line is added. Prices will bounce back touching the basic trendline, as well as falling down to another low (point 4). Connecting these points (1, 3, 5 and 2, 4) creates a channel. Of course, the same works for an uptrend, just in the opposite direction. In this situation, the advantage of both lines is, that “the basic up trendline can be used for the initiation of new long positions. The channel line can be used for short term profit taking” (Murphy 1999, p. 82). Furthermore it is important to mention that the penetration of a channel line implies support of the underlying trend and not a warning for a trend reversal in the case of the violation of a basic trend line (Murphy 2009, p. 55).

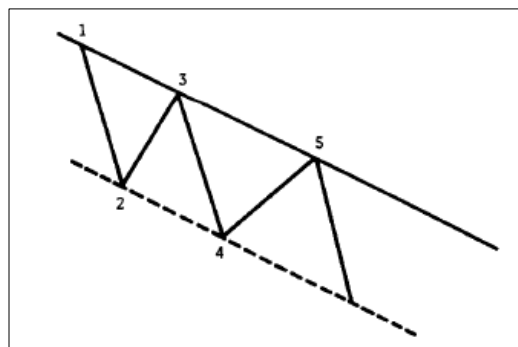


Figure 15 A trend channel in a downtrend
Source: Murphy 1999, p. 81

4.2 Candlestick Charts

Candlestick charting has gained great importance over the last few years. It has its origins in Japan and is a technical tool for analyzing data in a different way than analysts have been doing it in western cultures. Generally, the same techniques which are used for bar charts, can be applied, nevertheless the visual presentation is different. Due to this distinct presentation, traders are able to analyze the price action faster and more efficiently (Person 2004, p. 43). The main advantage is that traders can immediately see the open, the high, the low and the close. In addition, many traders use the possibility of presenting candlesticks with a lower close than the open in a different color (generally black or red, see Figure 16) than for ones where the close is higher than the open (mostly white or green, see Figure 17). Nevertheless the candle includes

no information about the relationship to the previous one. It tells the trader only if the close was higher or lower than the open of each certain candle. Another advantage of this method is that it can be applied for every time frame, from very short term movements like one minute or one hour to longer time periods like a week or a month (Person 2007a, p. 107-108).

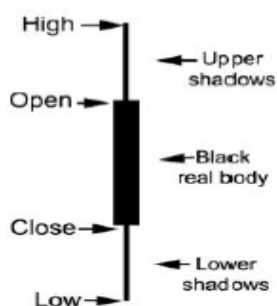


Figure 16 Selling/Short
Source: Person 2007a, p. 108

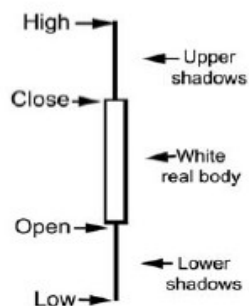


Figure 17 Buying/Long
Source: Person 2007a, p. 108

4.2.1 Components of a candlestick

According to analysts like Murphy (1999) and Person (2007a) there are several parts of a candle chart that are very important for a quick and efficient analysis like: (see Figures 16 and 17 above)

- “The candle body or real body which is represented by a wider portion of the bar which measures the distance between the open and the close.
- The colors of the real body: If the close is higher than the open, the real body is white (positive). If the close is lower than the open, the real body is black (negative)
- The shadow which refers to a thin line, illustrating the day's price range from the high to the low.
- The size of the shadow
- The length of a candle” (Murphy 1999, p. 67).

Furthermore there are some helpful guidelines in order to easily interpret the formation of a candlestick chart. As the first step, looking at the distance between the open and closing price, traders are talking about 'long days' or 'short days'. The first one occurs when the range between the opening and the closing price is great, whereas short days appear if the difference is small. It is important to mention that these two terms refer only to the size of the body and not to the distance between the high and low within a trading session. If a candlestick has a small body with upper and lower shadows which are larger than the body, it is called 'spinning tops', which are often described as 'days of indecision' (Murphy 1999, p. 300).

Moreover, an analyst should examine the relationship between the open and the close, or in other words only looking at the candle body. In uptrends, candle charts are mostly white or

green and assigned with a positive reading, since the closing price is above the open and on the open bulls dominate the market. How many long positions are entering the market can be read by the distance between the open and the close.

“If the market opens on the low and has a large range where it closes at the high of the session, that signifies that the bulls are in strong control. However, if the market has a wide-range session and the market prices closes back near where it opened – say, in the middle of the range – that is not a sign that bulls dominate the market for that particular time period“ (Person 2007, p. 189-190).

On the contrary, in the case of a strong downtrend, black or red colored bodies are more common. If there are bearish market conditions, sellers overlook the market. By how much prices are declining during a trading session determines if bears are in control of the market. “If the market opens on the high and prices decline where the close is at or near the low, this shows that the bears are firmly in control” (Person 2007, p. 190). Many analysts attribute a negative reading with this situation (Person 2007, p. 190).

Furthermore the shadows, and in particular its relationship to the real body, might include additional information about the market’s situation. Analysts might figure out if, for example after a long downtrend, there will follow a revival. This is often the case if long shadows/ tails are observable. The size of the shadows is determined by the “distance of a low and/a high in relation to the real body as created by the open and the close” which “can really illustrate the market’s denial of a support or a resistance level” (Person 2007, p. 190). As mentioned before, long wicks (as they are also called) might signal that a recovery after a strong decline is pending since demand is rising and supply is diminishing. In the case of indicating a possible downturn, meaning that supply is increasing and demand is shrinking, one has to look at the tails at the tops of real bodies (Person 2007, p. 190).

Another point, which might be important, is the size of the overall candle. A long green or white candle might have considerable importance. If there was a strong downtrend and suddenly a trader observes a long green/white candle, this might signal that a major trend reversal will be very likely. In the case of a long uptrend and all of a sudden a white/green candle appears, it might be very possible that exhaustion will occur. For a downtrend works exactly the opposite. A red or black colored candle might hint at exhaustion after a strong downturn. If a red/black candle appears after a substantial and steady price advance, a major reversal is very likely (Person 2007, p. 190).

4.2.2 Candle Formations

Individual candles which show a special formation, also have some descriptive names. They allow analysts to identify and determine the current or future market environment easier due to their clearly visual manner (Person 2007, p. 190).

4.2.2.1 The Doji

A candlestick is called a doji, if it closes at the same price as it opened. If this occurs, there is indecision in the market. As the Figures 18 and 19 below show, the candle has no real body since opening and closing price are equal. Buyers and sellers have lost confidence in the market due to several intraday noises and uncertainty dominates the market. It is a very undesirable situation for declining or increasing markets (Person 2007a, p.110).

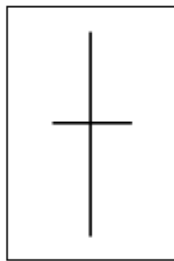


Figure 18 The Doji
Source: Person 2007a, 9.110



Figure 19 The Doji - Livechart
Source: Forex-Charts-Books, 2006-2013

This special formation of a candle is very important in the case of an upcoming trend reversal, especially after a long preceding candlestick, either bearish or bullish.

“In a strong uptrending market, usually the prices will close near a high since larger capitalized traders will hold positions overnight. If the large money traders are not confident that the market will move higher in price, then usually the market closes back near the open” (Person 2007a, p. 110).

It occurs when buyers and sellers are not able to on the one hand push the price (in the case of the buyers) and on the other hand to press the price down from its opening (in the case of the sellers). The result is that prices close at the same level as they opened (Forex-Charts-Books 2006-2013).

There are several modifications of dojis (see Figures 20-23), like the 'gravestone' or the 'dragonfly' which all have the same characteristic - its closing price is equal to the opening price. In general, it can be observed that when one of these doji candle charts occurs, a major trend will soon come to an end and a trend reversal will take place (Person 2007a, p. 110). The gravestone doji becomes meaningful after a long candlestick during a strong upward trend at the peak of this bullish movement. It implies that sellers were stronger to push the price down to its opening level, although buyers “were confidently trying to push the price up” (Forex-Charts-Books 2006-2013). In this situation it might be recommended to exit a long position or set a stop just below the closing price in order to benefit from the movement (Forex-Charts-Books 2006-2013).

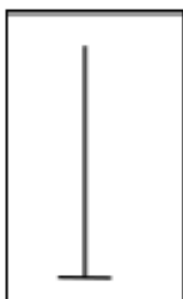


Figure 20 Gravestone
Source: Person 2007a, p. 111



Figure 21 Gravestone - Livechart
Source: Forex-Charts-Books 2006-2013

The formation of a dragonfly candlestick might appear at the bottom of a bearish market movement. “It should be treated seriously when spotted at the bottom of a downtrend while following after a long red candle, as it signals that buyers have got enough strength to return price from its advancing low progress to the starting open point” (Forex-Charts-Books 2006-2013).



Figure 22 Dragonfly
Source: Person 2007a, p. 111



Figure 23 Dragonfly - Livechart
Source: Forex-Charts-Books 2006-2013

4.2.2.2 Hammer

The special candlestick known as 'hammer' and shown in Figure 24, is very important in a bearish market environment. As with the doji, the hammer also signals that a reversal is coming after a downtrend. According to Person (2004, p. 112) there are three characteristics which have to be fulfilled for the underlying candle to be called a hammer:

1. The real body is at the upper end of the trading range. The color is not important.
2. The lower part, or the shadow, should be at least twice the length of the real body.
3. The body should have little or no upper shadow and look like a shaved head candle.

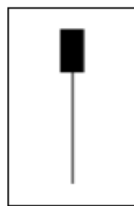


Figure 24 Hammer
Source: Person 2004, p. 45

4.2.2.3 Shooting Star

After explaining the hammer, its opposite, the 'star' (often called the 'shooting star' candle) needs to be examined. It occurs at the top of an uptrend and as with the hammer indicates an upcoming reversal. In contrast to the hammer, the candle body is at the lower end of the trading range having a long shadow (see Figure 25). It is characterized by the follows: it opens near to the low of the day. Afterwards a substantial rise in prices is observable, which is finally not strong enough and subsequently it closes near to the low of the day. If it appears at the bottom of a bearish market, then it is known as 'inverted hammer' (Person 2007a, p. 113).

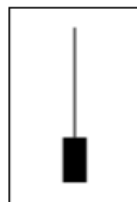


Figure 25 Shooting Star
Source: Person 2007a, p. 112

To sum up, a shooting star indicates bearish signals and that a price reversal after a strong uptrend might be likely (see Figure 26). The long shadows in both cases show that sellers are able to get control of the market – “it’s apparent that bears managed to stop the price from advancing and seriously pulled it down” (Forex-Charts-Books 2006-2013). It is important to mention that before opening new positions, the following candle needs to be a red or black

colored one, in order to have enough confirmation for the upcoming price reversal (Forex-Charts-Books 2006-2013).

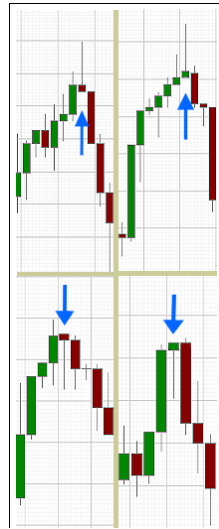


Figure 26 Shooting Star and Hanging Man - Livechart
Source: Forex-Charts-Books 2006-2013

4.3 MACD

The Moving Average Convergence Divergence Indicator is another very common technical tool used in financial analysis. It is based on the concept of a moving average (MA), which is defined as a “trend following or lagging indicator because it is based on past prices” (Investopedia 2014b). There are two main types of MA, the simple moving average (SMA) and the exponential moving average (EMA). The first one is rather self-explanatory, it measures the average of a security’s price over a certain time period, whereas with the EMA, recent prices are weighted more heavily. The aim of MA indicators is generally to detect a trend direction and to identify corresponding support and resistance levels (Investopedia 2014b).

4.3.1 Definition

The MACD indicator was established by Gerald Appel in 1979 and consists of two averages. “The first, called the MACD1 indicator, is the difference between two exponential averages, usually a 26-day and a 12-day average. The second, called Signal indicator, is the 9-day moving average of the MACD1 indicator” (Meissner et al. 2001, p. 3).

$MACD1 = EMA1 (12\text{-day closing prices}) - EMA2 (26\text{-day closing price})$

$Signal = EMA (9\text{-day MACD})$

The terms convergence and divergence can be explained by the directions of the shorter (12-day) average and longer (26-day) average. If the 12-day average line and the 26-day average

line are moving towards each other, analysts talk about convergence, whereas if these two averages move in the opposite direction, convergence takes place. Furthermore, most MACD movements are stemming from the shorter average line (Stockcharts 2014). As mentioned above, the purpose of this commonly used technical tool is to detect momentum, direction, strength and possible duration of an underlying trend. Consequently traders expect to take better buying and selling decisions resulting in higher trading profits. These buying and selling opportunities can be spotted by examining the difference between the two averages. According to Meissner et al. (2001)

“a buy signal is given, when the more volatile average, the MACD1 indicator, crosses the less volatile average, the Signal indicator, from beneath. If the MACD1 line crosses the Signal line from above, a sell signal is given. The bigger the angle of the crossing, the more significant the buy or sell signal” (Meissner et al. 2001, p. 3).

To get a better understanding of how the analysis of the MACD line functions, Figure 27 should be considered.



Figure 27 Seven Month MACD line of Home Depot Inc.
Source: Stockcharts 2014

As one can easily see, the MACD line fluctuates around the so called centerline, which is the zero line. If the shorter average line crosses the longer average, the zero line will be crossed. The direction, meaning if it falls or increases, is determined by the relationship between the two averages. If the 12-day EMA is greater than the 26-day average, a positive MACD occurs – this

positive territory is represented by the orange area. In this situation, the tendency that prices will further rise, increases. Furthermore, it is important to mention that during this positive territory the MACD line stayed below 1, indicating that the difference between the averages was rather small. If the direction is the other way round, meaning that the longer average is bigger than the shorter average, negative values will occur – illustrated by the yellow area. (Stockcharts 2014).

4.3.2 Crossovers

As described above, the most useful strategies with MACD is the analysis of buying and selling opportunities based on the direction, in particular the crossing of the two established MACD line and the Signal line, overbought/oversold conditions and divergence. The two main crossovers that might occur and that include the most substantial and decisive information are the Signal Line Crossover and Centre Line Crossover (Stockopedia Features 2012).

4.3.2.1 Signal Line Crossover

A Signal Line Crossover occurs when the MACD line crosses the Signal Line. There are two directions possible: analysts have to face a bearish crossover if the MACD line is in a downtrend and crosses below the signal line. In the case of a bullish crossover, exactly the opposite occurs – the MACD line shows an uptrend movement and crosses above the signal line. The strength of the move determines the duration of a crossover, meaning that if the trend is very strong, it can last from a few days to a few weeks. It is important to mention, that due diligence is very important when analysts are working and relying on MACD signals. In particular, high volatility in the underlying security is a common reason for a number of crossovers. Figure 28 below should help to understand the concept of a Signal Line Crossover more easily (Stockcharts 2014).

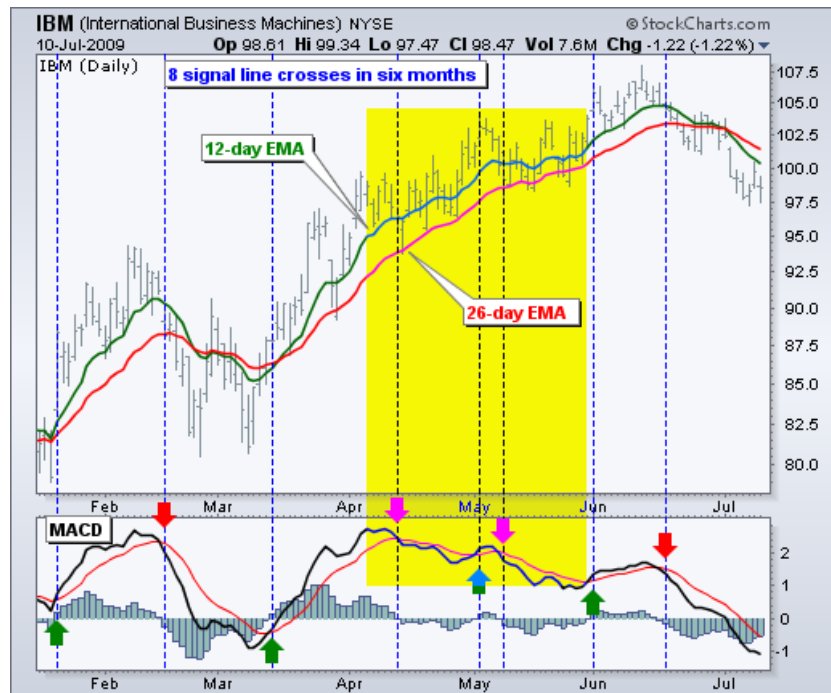


Figure 28 Signal Line Crossover of IBM
 Source: Stockcharts 2014

The development of the underlying stock contains, in total, eight signal line crossovers within six months. The green arrows illustrate the bullish ones and the bearish ones are represented by the red ones. In addition, a very strong good signal which occurred from mid-April until end of June is highlighted by the yellow area, since the MACD Line surged about 2 and therefore reached a positive extreme. In general the upward movements were stronger than the bad signals. This results from the movements from April to June. Although there were two bearish signals, one at the end of April and one at the middle of May. Although the upward trend decreased a little bit after the peak, the positive momentum overweighed the downside signals (Stockcharts 2014).

4.3.2.2 Centerline Crossover

The Centerline Crossover was already mentioned above with Figure 27, but should be repeated shortly for the sake of completeness. It occurs when the MACD line crosses the zero line. It can either be a bullish crossover –when the MACD line shows rising momentum and turns positive – or it is a bearish crossover – when it turns negative due to the fact that the MACD line moves below the zero line. Both directions derive from the relationship of the shorter and longer average lines. If the 12-day average is greater than the 26-day average, positive values are the result, meaning that upside potential is supported and entering long positions are favored. If the 12-day average is lower than the longer average, a bearish condition will take place, resulting in a downward movement and going short might be recommended. The duration of a centerline

crossover depends on the strength of the underlying trend. As long as, for example an uptrend is strong enough, a positive crossover might last from a few days until a few months. To get a better understanding, one should consider Figure 27, in particular the colored areas, again (Stockcharts 2014).

4.3.2.3 Divergence

Besides crossovers, another common signal which occurs less frequently is called divergence. It can be observed when the price movements of the underlying security diverge from the move of the MACD line. A bullish divergence takes place, when the market price shows a lower low from a previous low whereas the MACD line forms a higher low. This indicates that the underlying asset supports the current downtrend, but for the MACD line this downward momentum shows not enough strength. Nevertheless, the downside momentum is strong enough to outweigh upside potential, as long as the MACD is positive (Stockcharts 2014). Figure 29 illustrates what is happening in the case of a bullish divergence pattern.



Figure 29 A bullish divergence of Google Inc.
Source: Stockcharts 2014

Regarding the figure above, it is important to mention that the black line in the upper part of the chart derives from the closing prices of Google, since the MACD line is also based on closing prices. The bullish divergence pattern occurs in the period from October until November. That can be observed, since the MACD forms a higher low in November than in

October, whereas closing prices of Google recorded a lower low in November than a month before. At the beginning of December, the downward momentum came with a signal line crossover and a confirmed resistance breakout by the underlying security price to an end (Stockcharts 2014).

Of course, the explained pattern can also move in the opposite direction, meaning that the MACD line forms a lower high despite the fact that the underlying asset shows a higher high. In this case, the name changes to a bearish divergence. Although the upside momentum from the MACD is less, upside momentum is still stronger than a downward trend as long as the MACD line fluctuates in the positive territory (Stockcharts 2014).

4.3.3 MACD Histogram

In order to anticipate crossovers, chartists often use a MACD Histogram.

“The MACD Histogram represents the difference between MACD and its signal line (usually the 9-day Exponential Moving Average (EMA) of the MACD). Whenever MACD crosses the signal line, MACD-H crosses the zero line” (Forex Trading 2007).

The Histogram, represented by vertical colored bars, can be either positive or negative. As long as the MACD line is above its 9-day EMA, bars are in the positive array and frequently have a green color. For a negative histogram, exactly the opposite has to occur, meaning that the signal line has to be above the MACD line. The bars are drawn in the negative territory and often represented as red colored bars (see Figure 30). According to Murphy (1999), “crossings by the histogram above and below the zero line coincide with actual MACD crossover buy and sell signals” (Murphy 1999, p. 255). The main point of analyzing a MACD Histogram is, looking at the spread between the two average lines. When the histogram is in positive alignment, but the bars are decreasing in its length, the uptrend is weakening. For a downtrend loosening its momentum, a histogram moving upwards toward the zero line is essential. As long as the MACD-H does not crosses the zero line, no buying or selling signal can be supported, nevertheless the direction of the histogram might be an early predictor of an upcoming trend reversal. In particular, this early warnings can become very important in the case of exiting position at the right time. Using it for entering new long positions is often too dangerous (Murphy 1999, p. 255).



Figure 30 MACD Histogram
with Buying and Selling Signals of E-mini Nasdaq 100 Future
Source: Online Trading Concepts (2007-2012)

4.3.4 False Signals

Due to the fact that the MACD is based on past prices, it is a lagging indicator and hopefully will give buying or selling signals shortly after a peak or trough in the underlying price movement had occurred. It works best if there is a clearly bullish or bearish market movement. In the event of a neutral market, it might be more likely that the MACD gives false signals. That means, that for examples market prices of the security are increasing, whereas the MACD gives a sell signal. But the indicator can also indicate a buying signal, although prices are declining (Stock Trading Infocentre 2009-2014).

However, to address this problem, the refinements of the original MACD by Albin, Gunter and Kain have to be elaborated. They introduced the MACD-R1 as the first refinement and later on the MACD-R2. With their improvement they tried to overcome two main problems, one regarding the entry point, the other one referring to the exit point: “By the time the entry signal is generated, the price is reaching the reversal” and at the exit point “by the time the crossover takes place for closing the trade, the price already reverses so much that the profits realized are much less than what it should be” (ArticlesBase 2005-2014).

According to the first improvement, the MACD-R1 Albin et al. suggest to take no further decision on entering or exiting a position over three periods (e.g.3 days on daily chart) after a crossover has taken place. If during these three periods there occurs a new crossover, the first

one has to be eliminated and traders should wait for another 3 periods. The second guideline is suggested to address the other problem of finding the right exit point. Traders should predetermine profit taking levels. That means that “close the trade after 3% or 5% after the entry. In case the crossover happens before this pre-decided target of 3% or 5% then also close the position” (ArticlesBase 2005-2014).

Using these guidelines there are some weaknesses which have to be mentioned. On the one hand, there still might occur several numbers of false signals and on the other hand traders have to face forgone profits in the case of a stronger trend. They exit the position at the predefined level and consequently might lose the possibility of making a higher profit. However, in order to overcome these problems, MACD-R2 was introduced by Albin et al. With MACD-R2 another condition was established, namely a pre-defined difference between the MACD line and the signal line after the 3 periods waiting period has to be reached for opening or closing a position. For example, a trader can set a minimum difference of 1,2% - if the difference is less, then he should not do anything, if the differences is higher than this level, he can enter/ close a position (ArticlesBase 2005-2014).

4.4 Pivot Points

This chapter represents the heart and soul of the theoretical part of the thesis, since the understanding of the concept of using pivot points for trading will be essential for the empirical analysis presented in the subsequent part. Consequently, all mathematical calculations as well as how to use pivot points for trading, will be described in great detail.

4.4.1 Definition

The methodology of a pivot point analysis is a very common and widely used trading strategy. The mathematical formulas used for calculating the various points for the analysis were established by Henry Wheeler Chase in the 1930s. The idea behind this method is to “determine the next time period’s range based on the previous time period’s data, which includes the high, the low, and the close or settlement price” (Person 2007a, p. 66). Person (2007) defines a pivot point and at the same time highlights the importance of this method as follows:

“...the pivot point is the average of the high, the low and the closing price. Pivot point analysis is mainly used as support and resistance levels. The pivot point is the heartbeat of the analysis: without it, projected ranges and market conditions cannot be determined. It does act as a support or resistance level as well” (Person 2007, p. 124).

So one of the major advantages of this methodology, compared to the previous explained indicators like candlestick charts, trendlines and MACD, is that it is a leading indicator instead

of a lagging one. That is very useful for traders, because “it gives a trader the early advanced target levels that, in many cases, turn out to be the actual high or low and sometimes even both for a given trading session...” (Person 2004, p. 93). Furthermore, another great benefit is that it can be applied to different markets and on different time frames (Person 2004, p. 95).

4.4.2 Calculation

All of these various trading strategies have in common that they should help traders to figure out when it is the right time to enter or exit positions. The same can be applied to pivot point analysis – using this method, support and resistance or current highs and lows should be predicted and consequently earning a higher trading profit should be possible. According to Person (2007), these support and resistance levels need to be calculated every day with the previous day's prices based on the following formulas:

- “Pivot point- the pivot point (P) is the sum of the high (H), the low (L), and the close (C) divided by three.

$$P = (H + L + C) / 3$$

- Resistance Level 2 – R-2 is the pivot point number plus the high and minus the low.

$$R-2 = P + H - L$$

- Resistance Level 1 – R-1 is the pivot point number times two minus the low.

$$R-1 = (P \times 2) - L$$

- Support Level 1 – S-1 is the pivot point number times two minus the high.

$$S-1 = (P \times 2) - H$$

- Support Level 2 – S-2 is the pivot point number minus the high plus the low”.

$$S-2 = P - H + L$$

In addition to these standard levels, some traders include a third level, called the Resistance Level 3 and the Support Level 3, to be prepared in the case of a price shock event. Person argues that

“the spot forex currency markets tend to experience a double dose of price shocks because they are exposed to foreign economic developments and U.S. economic developments that pertain to a specific country's currency. This tends to make for wide trading ranges” (Person 2007, p. 125).

The added formulas are:

- Resistance Level 3 – R-3 = $H + 2 (Pivot - Low)$ or $(P - S-1) + R-2$
- Support Level 3 – S-3 = $L - 2 (High - Pivot)$ or $P - (R-2 - S-1)$

Furthermore, some analysts tend to include the opening price in their calculations. In this case, the formula for the pivot point stays the same, only the opening price is added to the sum of the high, the low and the close, and divided by four instead of three.

- $P = (O + H + L + C) / 4$

An additional variation of this formula would be, if they use the new opening price instead of the old one and everything else stays the same, resulting in this formula: (Person 2007, p. 125).

- $P = (\text{newO} + \text{oldH} + \text{oldL} + \text{oldC}) / 4$

After representing the mathematical formulas, it is important to explain what information each of these levels contains with respect to the underlying market behavior. If the *Resistance Level 3* has been reached, an extreme bullish market behavior will be observable. Positive market news might be the reason for it. A result will be an overbought market in which traders might profit from a quick scalp trade, i.e. buying at the Bid price and selling at the Ask price very quickly. The main idea behind *Resistance Level 2* is to close a long position at the right moment. It is also interpreted as a very bullish market condition and represents the high of a given trading session. Person states that “the market often sees significant resistance at this price level and will provide an exit target for long positions” (Person 2007, p. 126). The next level on a scale from bullish to bearish market conditions, is *Resistance Level 1*, reflecting a mild bullish to bearish situation. In trading sessions with low volatility and low volume, this level might represent the high within this time period. The strongest point of the different levels is the *Pivot Point*, which represents the average of the prior trading day (high, low and close). Most of the time, prices fluctuate around the pivot point, before prices shift strongly in one particular direction (Person 2007, p. 126). “As a general guideline, if the market opens above the primary pivot, be a buyer on dips. If the market opens below this level, look to sell rallies”, states Person (2007). If traders have to face a mild bearish to bullish market environment, *Support Level 1* might be reached. Again as for the Resistance Level 1, there is only low volume and low uncertainty in the market and there is a tendency that prices fluctuate around this level in an uptrend mood but most of the time they remain below it. As soon as the market shows a stronger downward tendency, the breach of *Support Level 2* becomes more likely. Person describes it as “the market often sees significant support at or near this level in a bearish market condition and is a likely target level to cover shorts” (Person 2007, p. 126). The last level might be reached in the case of an extreme bearish market condition. It represents exactly the opposite of Resistance

level 3, i.e. oversold condition in which traders might profit from very fast scalp trading (Person 2007, p. 126).

According to another professional financial trader, Adam Milton, these mentioned explanations can be supported and even extended. At the beginning of each trading day, traders should look at the current pivot point and if the market closed above or below it. If the opening is higher than the pivot point, a bias for the day will be long trades, whereas for an opening price below the pivot point, a bearish sentiment will rather control the market. For him, the three most important levels are R-1, S-1 and the pivot point of the given trading session. If the levels S-2, S-3 or R-2, R-3 are broken, that might indicate an oversold or overbought situation. Milton as well as Person suggest one uses these signals to exit a position rather than enter a new one. Furthermore he explains that

“a perfect set would be for the market to open above the pivot level and then stall slightly at R1 then go on to R2. You would enter on a break of R1 with a target of R2 and if the market was really strong close half at R2 and target R3 with the remainder of your position” (Milton 2014).

4.4.3 Using Pivot Points

Person (2007a) emphasizes the importance of keeping things simple. He recommends that traders should not include too many numbers or levels for taking their trading decisions. Therefore it is important to remember the main purpose of pivot points: First, the calculated levels should help to find the right time for entering and exiting a position. Compared to other trading techniques, they are leading indicators instead of lagging ones. Another important characteristic is, that this method can be used for every time frame, i.e., for daily, weekly or monthly periods. Furthermore, he points out that the recalculation of new data has to be made at the end of the specific time period, i.e. after every day, every week or every month (Person 2007a, p. 71-72).

4.4.3.1 Bearish Pivot Point Filter

The interpretation of each level always depends on the surrounding market condition. In particular, the pivot point becomes very important in an extreme bullish or bearish market sentiment and thus will represent the high or low of the trading session. In the case of a down trending market, the pivot point illustrates the target high for the given time period, whereas in an up trending phase it will be the low for the session. Person adds some guidelines to limit the number of needed levels as follows: (see Figure 31) R-2 cancels out, since the highs as well as the lows should be lower than the previous ones. Consequently, it is very unlikely that R-2 will be reached and the final levels are R-1, PP, S-1 and S-2. If it is a very bearish environment,

S-1 can also be eliminated, since it can be assumed that the prices will fall even more and finally reach S-2 (Person 2007a, p. 72-74).

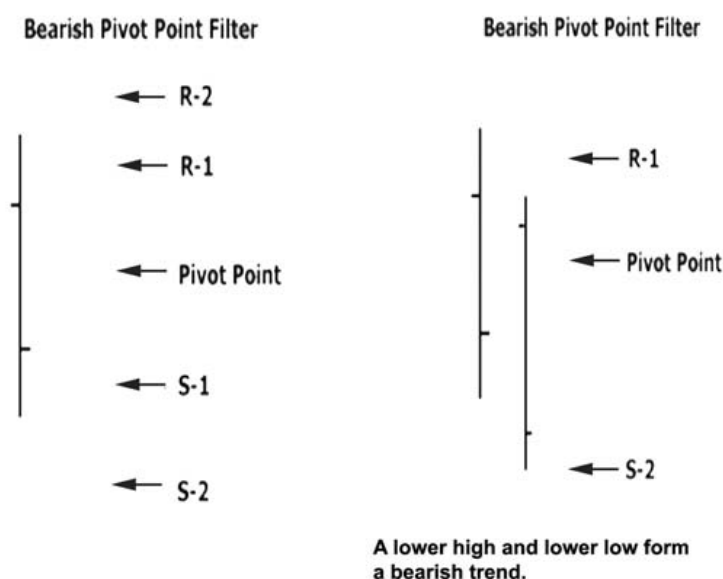


Figure 31 Bearish Pivot Point Filter
Source: Person 2007a, p. 74

4.4.3.2 Bullish Pivot Point Filter

The same procedure can be used for a bullish market condition (see Figure 32). Contrary to a bearish market, traders expect that highs as well as lows will be higher than in the prior session. Consequently, it is rather unlikely that Support Level S-2 will be reached, thus Person (2007a) suggests using Support Level S-1 as the target low and Resistance Level R-2 as the target high for the given trading session. As a result the expected range is fixed and R-1 as well as S-2 cancel out (Person 2007a, p. 75).

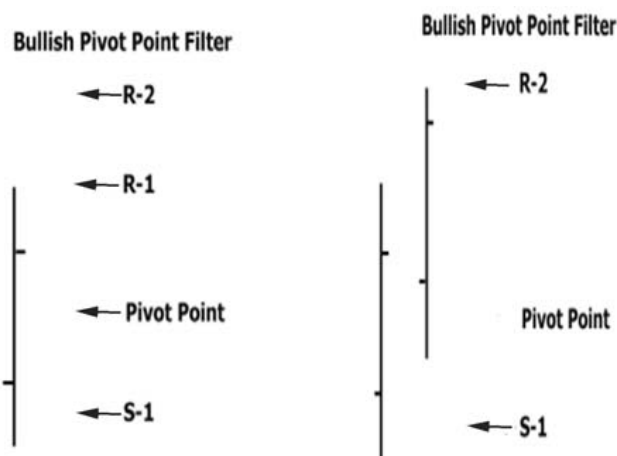


Figure 32 Bullish Pivot Point Filter
Source: Person 2007a, p. 75

However, it cannot be denied that if a trader wants to reduce the number of levels he primarily needs to stipulate accurately and with substantial validity, whether a market is bullish, bearish or neutral. One method that Person (2007a) suggests is, to look at the relationship between opening and closing prices. He describes it as

“if after a prolonged uptrend prices close below the open (black candles: $C < O$) after at least two or three consecutive sessions, and there is a close below prior lows, then you will know the market internals have switched from bullish to bearish or from uptrend to a consolidation phase. Therefore, you could choose the R-1 to the pivot point to target the high of the next session down to the S-2 number “ (Person 2007a, p. 75).

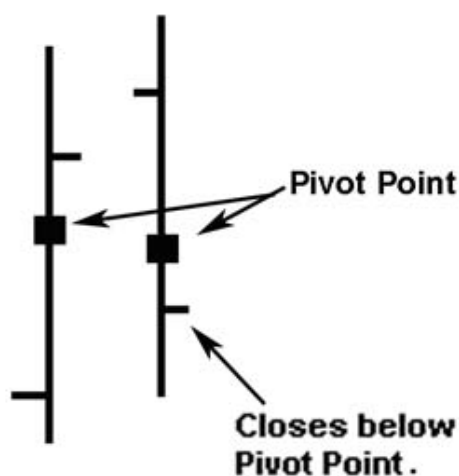


Figure 33 Bearish Indication
Source: Person 2007a, p. 75

On the contrary, the same works for a bullish market. If the current closing price is higher than the previous closes as well as the pivot point, S-2 can be eliminated and the next trading spread will range from S-1 up to the pivot point to R-2 (see Figure 34) (Person 2007a, p. 75-76).

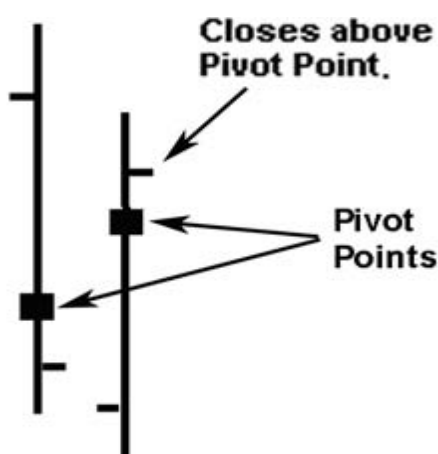


Figure 34 Bullish Indication
Source: Person 2007a, p. 76

4.4.3.3 Pivot Point Bounce

One strategy for using Pivot Points is the Pivot Point Bounce method. This method can be used if traders have a very good sentiment about the direction of the market. Traders use the concept, explained in 4.4.2. by Milton, that if markets open above the PP there is a bullish bias, whereas

if the opening price is below the PP, a bias for short trades will be more likely. In the case of a bullish sentiment, traders should go long at or near the given PP. In general

“for a long trade, the price bars should be making new lows as they move towards the pivot point, and for a short trade the price bars should be making new highs as they move towards the pivot point. Enter your trade when the high (or low) of the first price bar that fails to make a new low (or high) is broken” (Milton 2014).

In more detail, that means that traders should buy if as the first step “the pivot point is touched, secondly the subsequent price bar fails to make a new low and third, the following price bar breaks the high of the previous bar”, according to Milton (2014). On the contrary, short trades should be entered after the PP has been touched and subsequently no new high occurs and in addition the price bar breaks the low of the previous price bar. In the figure below (Figure 35) the concept should become clear (Milton 2014).

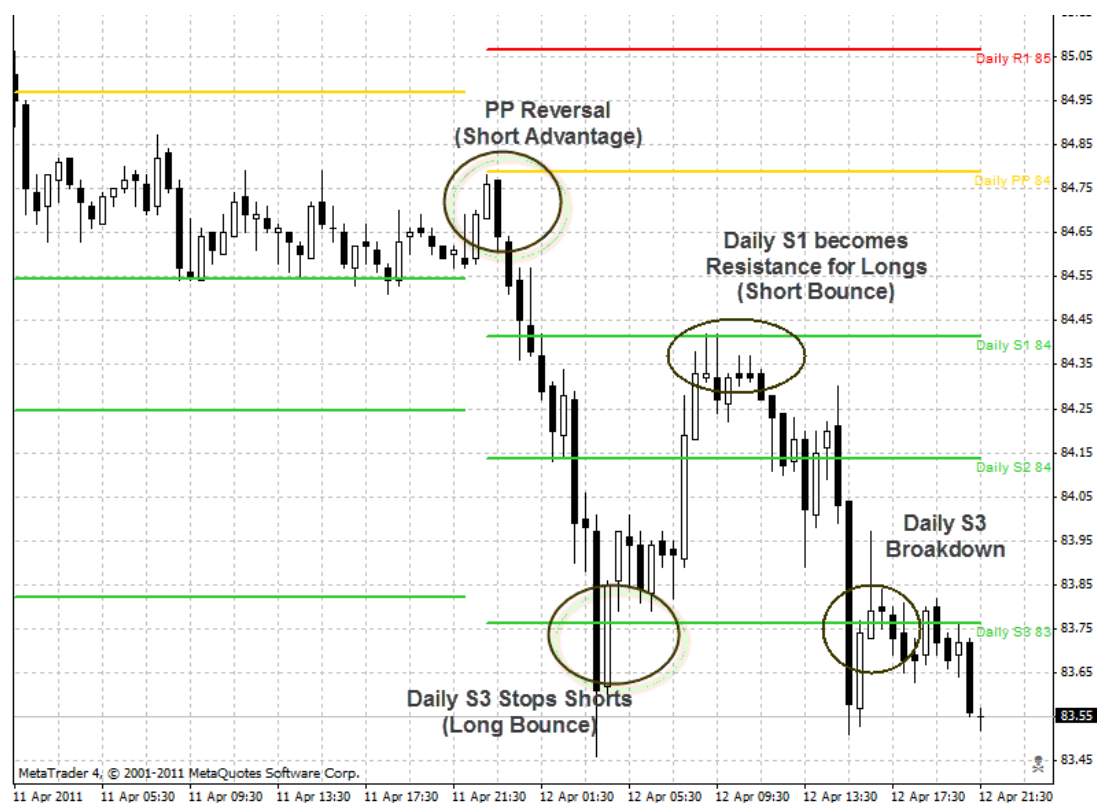


Figure 35 Pivot Point Bounce Trading
Source: Forexrazor 2014

The market opened just below the PP, consequently a short bias will accompany the day. In this case, traders should go short and wait until S-2 or in this example S-3 is reached, to take a profit and close the position (Long Bounce). After prices have reached S-3, a strong uptrend is observable and traders should take advantage of this oversold condition by entering long

positions. By the time S-1 was reached, they could profit again by going short (Short Bounce) (Forexrazor 2014).

4.4.3.4 The Trading Channel

The trading channel occurs when the market is not very volatile and fluctuates within a certain range, e.g between the given PP and S-1. The idea behind the concept is to benefit from this not very volatile situation and trade within this channel. Figure 36 illustrates an example of the trading channel (Milton 2014).



Figure 36 Trading the Channel Line
Source: Milton 2014

As the market opened just below the PP, a bias for short trades is likely. Prices do not move a lot in a particular direction, but as soon as PP is touched, traders should enter into a short trade with the target of breaking the next pivot point level S-1. As soon as this level is reached they should take a profit by closing the position. In addition a stop loss should be set above the PP (Milton 2014).

4.4.3.5 Pivot Point Breakout

A Pivot Point Breakout occurs

“if the breakout candle closes above the resistance line for a bullish trade, or below the support line for a bearish trade opportunity (see Figure 37). This needs to be kept in view when setting profit targets so your unrealized profits are not taken out by retreating prices” (ForexBrokers 2014).

In addition, it should be mentioned that “bullish trades are taken 'on the bounce'. This means that a minor retracement to the nearest support after a break of the resistance line is a good point at which to re-enter (for traders who had cashed out earlier positions) or a place to pick up the crumbs that are still available in the market” (ForexBrokers2014).

According to these basic principles a trader can distinguish between the following three scenarios:

- A trader can take a profit if he enters a long position immediately after the PP has been touched with the target of R-1.
- If the trader needs more confirmation of the upward trend he waits until R-1 is broken for entering a long trade.
- A riskier strategy would be placing a Buy Stop placed just above R-2 targeting R-3. Nevertheless a trader following this strategy should be convinced that the upward trend has enough momentum to continue.

What all of these three cases have in common, is that a stop loss should be placed just below the nearest support level (ForexBrokers2014).



Figure 37 Pivot Point Breakout
Source: ForexBrokers2014

5 Introduction II

After analyzing various trading strategies in theory, the second part, namely the empirical analysis of one specific trading strategy starts. The trading strategy based on pivot points and additional buying and selling triggers has been elected due to an easy practicability without using any special trading tools. In addition, the before described rules and guidelines are relatively easy to follow. The main focus of this part is putting the trading strategy into practice via backtesting over a period of three months for three different indices. It is important to mention, that this strategy will be run once for each index independently and once two indices are combined and a so called “signal trading” will be tested. Thereafter, the total returns for the different indices and the two different methods will be compared and tested if an outperformance with the latter on is possible. The underlying research questions and various steps which have to be carried out are described in great detail in the subsequent chapters as follows: Section 6 is dedicated to formulating the main hypotheses. Afterwards the used data amount and required data formatting is described (Section 7). The next chapter focus on outlining the methodology including correlation methods and how the trading strategy will be applied. The most important information will be contained in Section 9, which focuses on the representation of the detected results. Finally, a conclusion will be drawn which can be found in Section 10 in order to bring the underlying and explained theoretical fundamentals in line with the empirical findings.

6 Hypotheses

The subsequent empirical analysis of three different indices will be based on four hypotheses. The data is based on the EURO STOXX 50 Index Futures (Ticker: FESX), the S&P 500 Index Futures (ticker: ES) and the Hang Seng Index Futures (ticker: HSI). For the FESX and HIS, future prices will be analyzed since Futures and Options Indices are traded on real stock exchanges in contrast to indices and available for a longer day-period. For the S&P 500 it was not possible to get access to this kind of data, so the analysis including the S&P500 will be restricted to the data coming from the index.

6.1 Hypothesis I and II

As the first step, the correlation of the price movements of the indices has to be examined. The first hypothesis is, that the different indices are correlated with each other. Since these indices are representatives of the three major stock exchange markets in the world of trading and finance, they might move in a certain relationship to each other involving dependence. Furthermore, this hypothesis should be extended and another hypothesis is added. It will be analysed, if the correlation during a trading day, e.g. 8.00 am – 5.00 pm CET (major trading session of the FESX index) differs. To be more precise, it is assumed that there are certain short trading windows when the dependence of one stock exchange to another one will be higher than for the rest of the trading day. Hence, it should be figured out, if one stock exchange opens or closes while another one is already trading, the correlation will increase. For example, looking at the FESX and the SE – it might be possible that from 3.30 pm and within the next 15 minutes (opening of the NYSE and NASDAQ on those the SE is trading on) the correlation between the two indices will be higher compared to the rest of the overlapping trading hours. Looking at the three indices, this hypothesis will be applied for the following trading windows: 8.00 am-8.15 am (trading opening of FESX), 03.30 pm-03.45 pm (trading opening of INX) and 04.45 pm-05.00 pm (trading close of HSI).

6.2 Hypothesis III and IV

The third hypothesis refers to testing one particular trading strategy, namely the Pivot Point analysis, which refers to buying and selling signals based on previous (day)-trading data. First of all, it has to be figured out, if this strategy works and would have provided a positive return with the underlying historical data. Moreover, the analysis will be expanded and hypothesis four is established. As the last step, it will be examined if using trading signals from one index and adopting them for another one, will result in an outperformance. For example, applying the

trading triggers at 03.36 pm-03.45 pm of the SE and adopt them on the FESX will create a higher return for the FESX as if I would run the strategy completely independent of the SE signals.

7 Data

As explained before, the aim of the thesis is to examine real data and test it for correlation and afterwards applying the Pivot Point strategy. Therefore valuable data is necessary. In order to include the three most influential financial markets, which are the Eurozone, America and Asia, one index for each continent is chosen. The fundamentals of the used data (EURO STOXX 50 Index, S&P500 Index and Hang Seng) will be explained in greater detail in the following section.

7.1 EURO STOXX 50® (Ticker: FESX)

The EURO STOXX 50 Index consists of 50 stocks from 12 European countries such as Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain. The included stocks “provide a Blue-chip representation of supersector leaders in the Eurozone” (STOXX 2014). It

“represents the performance of the 50 largest companies within the Eurozone portion of the Dow Jones STOXX Total Market Index. It is a free-float market capitalization weighted index that captures approximately 60% of the underlying market and covers approximately 95% of the free-float market capitalization of the investable universe in the Eurozone” (MarketsWiwi 2014).

The top 10 companies, ranked by their weight, are shown in the following table 1:

Company (Country)	Sector	Weight (%)
Total (FR)	Oil&Gas	5,91
Sanofi (FR)	Health Care	4,7
Siemens (DE)	Industrial Goods&Services	4,25
Bayer (DE)	Chemicals	4,24
BCO Santander (ES)	Banks	3,86
BASF (DE)	Chemicals	3,75
Daimler (DE)	Automobile & Parts	3,39
BNP Paribas (FR)	Banks	3,15
Anheuser-Busch NBEV (BE)	Food & Beverage	2,88
Allianz (DE)	Insurance	2,84

Table 1 Top 10 Companies by Weight of EURO STOXX 50®

Source: Own illustration based on STOXX (2014)

Concerning the top 10 sectors in the index, banks with around 16% are the absolute outperformers. Afterwards Industrial Goods & Services, Chemicals, Oil & Gas and the Insurance Sector, each compromising around 9%, follow. Food & Beverage, Utilities and the Automobile Sector contribute approximately 6 % to 7%. The two last most important sectors,

each compromising 5%, are companies from the Health care and Telecommunication Sector. Looking at the 12 countries, France, Germany and Spain are the biggest representatives, which can be seen in Figure 38.



Figure 38 Country Weighting of EURO STOXX 50 Index
Source. STOXX 2014

Since an index is a mathematical construct and cannot be directly be invested in, data of the EURO STOXX 50 Future, which is based on the EURO STOXX 50 Index is needed for the subsequent data analysis. The EURO STOXX 50 Futures and Options contracts are traded on the world's largest derivative exchanges Eurex which is based in Frankfurt (MarketsWiwi 2014). The trading hours of the EURO STOXX 50 Futures are the following:

“7:50 am CET to 22:00 (10:00 pm) CET

,except on last trading day, when trading ends at 12:30 pm CET (Eurex operates in three trading phases: pre-trading, trading and post-trading. The post-trading phase is further split in several periods where different functions are available. Pre-trading begins at 7:30 am CET, and post-trading ends at 22:30 (10:30 pm) CET, except on the last trading day, when trading ends at 12:00 CET)” (MarketsWiwi 2014)

7.2 S&P 500 (Ticker: SE)

The S&P 500 consists of 500 companies of various U.S. leading industries. It covers approximately 75% of U.S. equities, nevertheless it is often used as an ideal indicator for the movements of the total market. The Index Committee follows strict guidelines to ensure the stability of the index. These guidelines refer to the location of a company, its market capitalization, its financial viability, adequate liquidity, an appropriate company type etc. Concerning the sector division, no sectors are excluded beforehand – the allocation among the sectors can be seen in Figure 39 below (S&P Dow Jones Indices LL 2013).

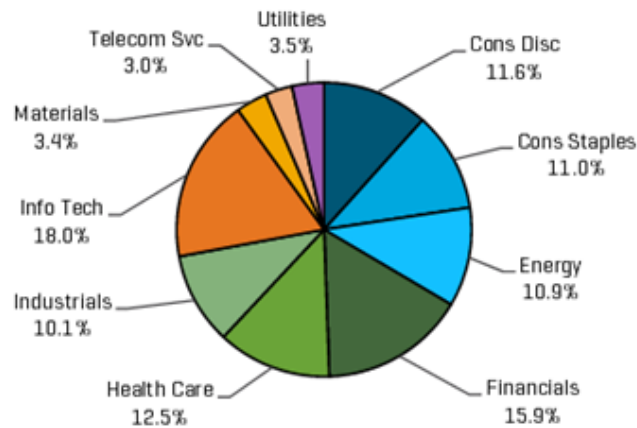


Figure 39 Sector Breakdown of S&P 500 Index
Source: S&P Dow Jones Indices LL 2013

Giving an overview of the 10 top components, table 2 should be considered:

Company	Sector	Weight (%)
Apple Inc.	Information Technology	2,97
Exxon Mobil Corp	Energy	2,89
General Electric Co	Industrials	1,72
Chevron Corp	Energy	1,65
Johnson & Johnson	Health Care	1,63
Intl. Business Machines Corp	Information Technology	1,6
Microsoft Corp.	Information Technology	1,54
Google Inc.	Information Technology	1,52
Proctor & Gamble	Consumer Staples	1,51
Pfizer Inc.	Helth Care	1,48

Table 2 Top 10 Companies by Weight of S&P 500®

Source: Own illustration based on S&P Dow Jones Indices LL 2013

As mentioned before, for the empirical analysis, data from a stock index future is necessary. That is why the subsequent analysis should be based on data from the S&P 500 Futures and Options which is traded at the following trading hours: (CME Group Inc. 2014)

Pre Open Electronic Trading (Weekdays) 11.45 pm - 10.00 pm CET
Electronic Trading 12.00 pm – 03.15 pm CET; 10.30 pm – 11.30 pm CET
Outcry: 3.30 pm – 10.15 pm CET

Due to access problems, the analysis including S&P 500 data will be restricted to the trading period of the outcry phase. As mentioned before, solely overlapping trading periods are of highest interest, and consequently the analysis has to be reduced even further. The final trading period, on which the analysis will be based on, ranges from 03.30 pm - 05.00 pm, since the HSI closes at 05.00 pm. However, this severe reduction will occur only if data from the S&P500 is involved.

7.3 Hang Seng Index (Ticker: HSI)

The Hang Seng Index is based on the 50 largest and most liquid stocks listed on the stock exchange of Hong Kong. It was launched in 1969. According to the included industries, the same as for the two other indices (SE and FESX) can be applied – The financial sector constitutes the biggest share of the index with 45,61%. The rest of the distribution over industries can be seen in Figure 40. (Hang Seng Indexes 2014)

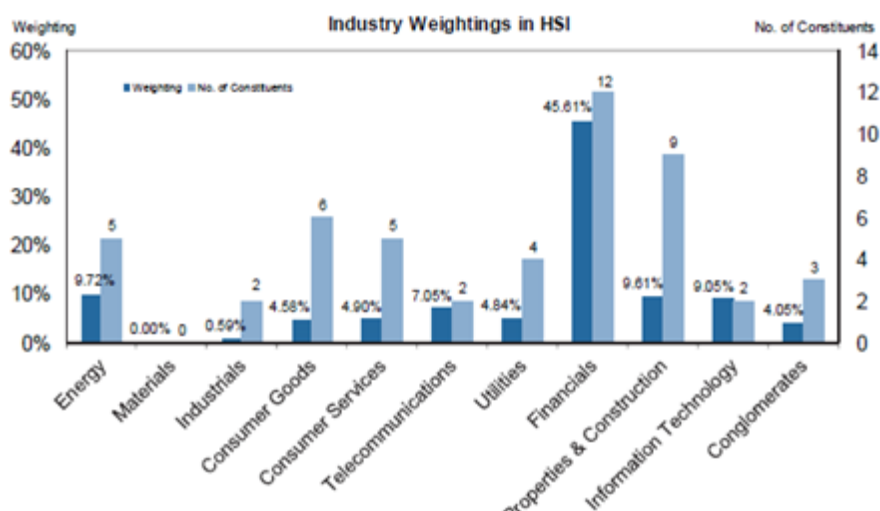


Figure 40 Industry Weightings in HSI
Source: Hang Seng Indexes 2014

The top 10 components are illustrated in the table below:

Company (Country)	Sector	Weight (%)
HSBC Hldgs	Financials	14,75
Tencent	Information Technology	8,18
CCB	Financials	6,42
AIA	Financials	6,27
China Mobile	Telecommunications	6,13
ICBC	Financials	4,69
Bank of China	Financials	3,93
CNOOC	Energy	3,18
Hutchison	Conglomerates	2,97
PetroChina	Energy	2,62

Table 3 Top 10 Companies by Weight of Hang Seng Index

Source: Own illustration based on Hang Seng Index 2014

For the empirical data analysis, data of the Hang Seng Index Future which trades at the following trading hours, will be used: (Hong Kong Exchanges 2010)

PreMarket Opening Period 2.45 am – 3.15 am; 6.30am – 7.00 am
Morning Session (Hang Seng Index Future) 3.15 am – 6.00 am CET
Afternoon Session 7.00 am – 10.15 am CET
AHFT Session 11.00 am – 5.00 pm CET

7.4 Overlapping trading hours

With regards to the explained hypotheses, the overlapping, in particular opening and closing sessions of the various stock exchanges, will be of highest significance. The timeline below shows at what time the three indices are trading simultaneously.

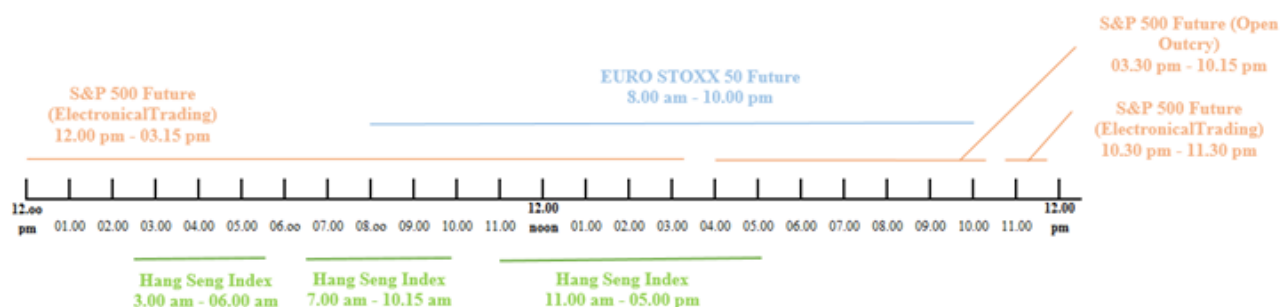


Figure 41 Trading hours of FESX Future, HSI Future and SE Future

Source: Own illustration based on HongKong Exchanges 2010, CME Group Inc. 2014 and MarketsWiwi 2014

Including all opening and closing sessions as well as any breaks, the final analysis should be based on this specific trading range:

08.00 am - 10.15 am CET; 11.00 am - 03.15 pm CET; 03.30 pm – 05.00 pm CET

Notably, as soon as data from the S&P500 is included the analysis will be reduced to a final time range from 03.30 pm until 05.00 pm CET, due to access problems for getting more and high quality data of the S&P500.

Nevertheless, a deeper and greater study is possible for the European and Asian market. The following timeline shows the overlapping trading hours of the FESX and HSI.

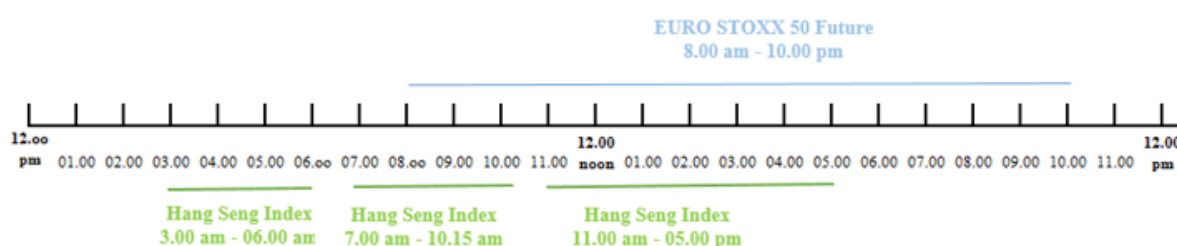


Figure 42 Trading hours of FESX and HSI

Source: Own illustration based on Hong Kong Exchanges 2010 and MarketsWiwi 2014

With regard to the overlapping periods, two trading sessions will be of high interest, the first one ranges from 08.00 am until 10.15 am CET and the second one from 11.00 am until 05.00 pm CET. In this case, two time slots will be of great importance, namely the opening session for the FESX at 08.00 am CET and the closing period for the HSI at 05.00 pm CET.

8 Methodology

The complete analysis process includes various steps, which will be explained in great detail in the following chapter. It starts with the explanation of the data formatting, followed by the first very important analysis, i.e., testing the correlation of certain data pairs within selected trading windows. The last, but very significant sub-section will be devoted to the detailed evaluation of the pivot point trading strategy.

8.1 Data Formatting

As described in the previous chapter, the analysis is based on intra-day data of the overlapping trading hours of the three different indices, Eurostoxx 50, S&P500 and Hang Seng Index during three months (March 2014 – May 2014). Due to download problems, not all of the given data is usable – resulting in a data amount of 10 trading days in March, 16 days in April and 13 trading days in May. Primary, the intention is to examine the trading hours from 08.00 am until 05.00 pm CET with a break between 10.15 am until 11.00 am and another interruption from 03.15 pm until 03.30 pm due to the trading hours of SE and HSI. However, due to limited download possibilities for the SE the intended data range has to be restrained to 03.30 pm until 05.00 pm, if data of the S&P500 is included. For the data pair HSI and FESX it is possible to hold on to the scheduled trading hours ranging from 08.00 am until 05.00 pm CET.

With respect to the subsequent correlation tests, the trading range has to be divided into three groups for all three indices from March 2014 until May 2014 as follows: 03.30 pm - 03.45 pm; 03.46 pm - 04.45 pm and from 04.46 – 05.00 pm. For HSI and FESX the analysis will be extended and the following windows can be added: 08.00 am – 08.15 am, 08.16 am – 10.00 am, 10.01 am – 10.15 am and 11.00 am – 03.30 pm. After specifying the trading windows, the given prices per second are aggregated to average prices per minute. The last step of the data formatting, is converting the index prices into log returns.

8.2 Correlation Test

After the raw data has been prepared for further analysis, the focus is on testing for correlation. Therefore, reasonable data pairs have to be stipulated. Since the available data should be contained, three different groups are formed: HSI + FESX, HSI + SE and FESX + SE. For these three groups it will be tested if any statistical relationship between each of these two sets of data

is observable. Consequently the resulting combinations with respect to the already determined trading windows are:

FESX + HSI_05: 03.30-03.45pm; 03.46 – 04.45 pm; 04.46-05.00 pm

FESX + HSI_04: 03.30-03.45pm; 03.46 – 04.45 pm; 04.46-05.00 pm

FESX + HSI_03: 03.30-03.45pm; 03.46 – 04.45 pm; 04.46-05.00 pm

FESX + SE_05: 03.30-03.45pm; 03.46 – 04.45 pm; 04.46-05.00 pm

FESX + SE_04: 03.30-03.45pm; 03.46 – 04.45 pm; 04.46-05.00 pm

FESX + SE_03: 03.30-03.45pm; 03.46 – 04.45 pm; 04.46-05.00 pm

SE + HSI_05: 03.30-03.45pm; 03.46 – 04.45 pm; 04.46-05.00 pm

SE + HSI_04: 03.30-03.45pm; 03.46 – 04.45 pm; 04.46-05.00 pm

SE + HSI_03: 03.30-03.45pm; 03.46 – 04.45 pm; 04.46-05.00 pm

For the data pair HSI + FESX, the trading range can be extended from 08.00 am until 03.30 pm, resulting with the following combinations:

FESX + HSI_05:

08.00 am - 08.15 am; 08.16 am – 10.00 am; 10.01 am -10.15 am; 11.00 am - 03.30 pm

FESX + HSI_04:

08.00 am - 08.15 am; 08.16 am – 10.00 am; 10.01 am -10.15 am; 11.00 am - 03.30 pm

FESX + HSI_03:

08.00 am - 08.15 am; 08.16 am – 10.00 am; 10.01 am -10.15 am; 11.00 am - 03.30 pm

The statistic evaluation of the correlation will be run by SPSS Statistics as well as Excel. To measure the dependence and in particular the strength and direction of two variables, the Pearson's correlation (Pearson product-moment correlation coefficient) is applied. It can be described as

“a measure of the strength of a linear association between two variables and is denoted by r . Basically, a Pearson product-moment correlation attempts to draw a line of best fit

through the data of two variables, and the Pearson correlation coefficient, r , indicates how far away all these data points are to this line of best fit“ (LundResearch Ltd. 2013). The values range from +1 to -1, indicating the strength of the relationship between the tested data set. Achieving a value of +1 / -1 includes that the data pair is perfectly positive / negative correlated, meaning that an increase/decrease of one variable implies exactly the same change for the other variable. In order to draw a valid result from the Pearson's coefficient, the following four assumptions have to be fulfilled:

- The data pair has to be continuous.
- There must exist a linear relationship between the two variables.
- There should be no significant outliers.
- The dataset should be approximately normally distributed.

As soon as an assumption is violated the evaluation of Spearman's Rho and Kendall's Tau rank correlation coefficient are added. Spearman's coefficient is defined as

“a nonparametric (distribution-free) rank statistic proposed as a measure of the strength of the association between two variables. In principle, r_s , is simply a special case of Pearson's product-moment coefficient in which the data are converted to ranks before the calculation of the coefficient” (Hauke and Kossowski 2011, p. 89).

However these coefficients are calculated in a different way. As a consequence they might not be equivalent but close to each other and leading to the same conclusion. Nevertheless, if they differ significantly, the lower value should be used (Hauke and Kossowski 2011, p. 88)

8.3 Pivot Point Strategy Test

Testing the trading strategy based on pivot points is divided into three major steps. To begin with, the pivot point strategy has to be ascertained for each index separately and independent from each other. Afterwards a signal trading analysis will be carried out. As a last step a one-tailed t-test has to be conducted to test for significance of the potential achieved outperformance. Each of these evaluations, will be explained in great detail in the next subsections.

8.3.1 Trading with Pivot Points

Initially, the pivot point strategy will be run for each index separately. The strategy is executed for the FESX and SE from 03.36 pm to 03-45 pm for March 2014 until May 2014. For the combination of FESX and HSI, two time ranges are of great importance, from 08.06 am until

08.15 am and at 04.51 pm until 05.00 pm. For the latter one, only data for one month (May 2014) is analysed. The reason for these certain data pairs and trading windows is explained in section 8.2.2. “Signal trading”. In order to implement a pivot point analysis for the determined trading windows, the pivot point, resistance level 1 R1, midpoint 1 MP1, support level 1 S1 and midpoint 2 MP2 have to be calculated. As described in 3.4.2 “Calculation of Pivot Points”, prior data needs to be used in order to calculate the pivot point and the associated other levels. In addition, the applied formulas for the different levels can be also found in this chapter. As a result, the following calculation and trading scheme has been set up (see table below):

	Calculation of PP and associated levels	Trading based on PP strategy
FESX 03/2014 – 05/2014 and SE 03/2014 – 05/2014	03.30 pm – 03.35 pm	03.36 pm – 03.45 pm
HSI 05/2014 and FESX 05/2014	04.45 pm – 04.50 pm	04.51 pm – 05.00 pm
HSI 03/2014 – 05/2014 and FESX 03/2014 – 05/2014	08.00 am – 08.05 am	08.06 am – 08.15 am

After the different levels have been computed for each day, the trading via backtesting begins. Having in mind the trading rules as explained in the theoretical analysis, the strategy works as follows (see also Figure 43) : a long position has to be entered when MP 1 has been reached and as soon as R1 or the PP level has been broken through, it has to be closed, either with a profit or a stop loss, respectively. The same process works for the downside movement. Going short occurs when MP 2 is crossed and the position has to be exited with a profit at S1 or with a stop loss at the PP level. At the end of the trading session (03.45 pm or 05.00 pm) every open position has to be closed with the last available price. For example, after going long at 03.43 as MP1 has been crossed, but neither R1 nor PP is reached until 03.46, the position has to be closed anyway. Consequently, one buys at 03.43 pm and exits the position at 03.45 pm with the corresponding price.

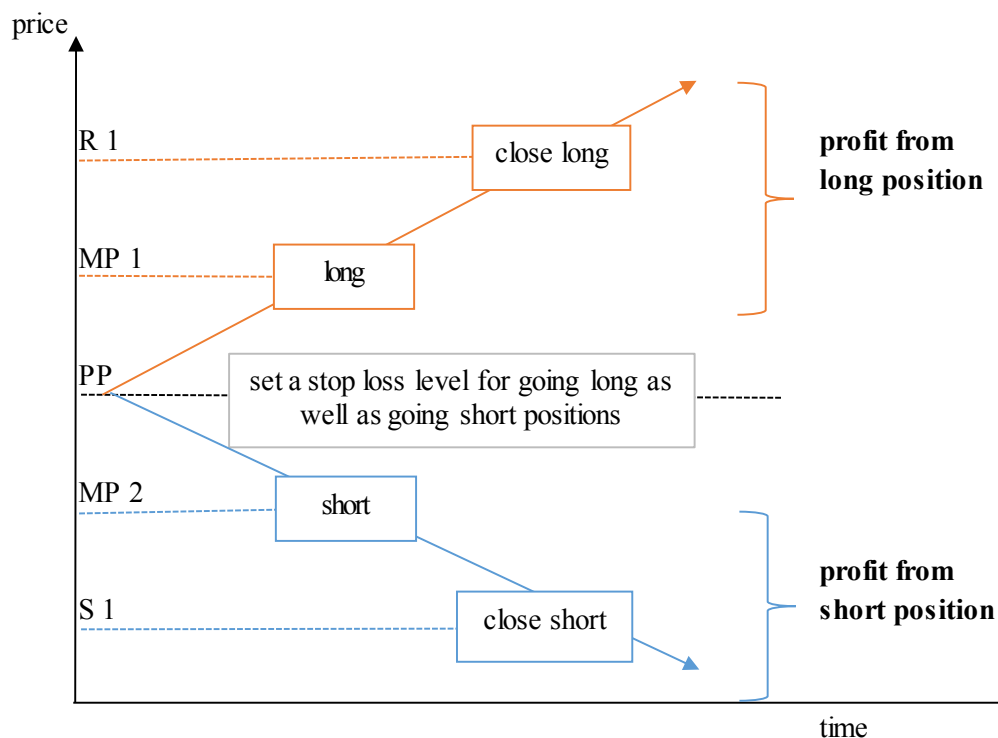


Figure 43 Trading strategy based on PP and 4 corresponding levels
Source: Own illustration

8.3.2 Signal Trading with Pivot Points

After running the pivot point strategy for each index independently, the trading process is extended and two indices are combined with each other, i.e the trading signals of one index are applied on another one. Therefore, the Granger Causality is required to stipulate in which direction the signals should be applied. This statistic test determines, if variable X is useful for predicting variable Y or the other way round. Consequently there are two null hypotheses and their alternative hypotheses that have to be examined:

- I: $H_0: Y \neq f(X)$, X does not cause Y
 $H_1: Y = f(X)$
- II: $H_0: X \neq f(Y)$, Y does not cause X ;
 $H_1: X = f(Y)$

Following statistical procedures, the significance, determined by the p-value has to be stipulated and afterwards a conclusion can be drawn if one variable can predict another one (Anil 2007). The Free Statistics Software from Wessa P. (2013) is used in order to check for the bivariate Granger Causality in two directions. Once, for the returns of the FESX and SE from 03.30 pm

until 03.45 pm and once, for the returns of FESX and HIS ,once from 04.45 pm until 05.00 pm and once from 08.00 am until 08.15 am. The result of the Granger Causality test will affect the further signal trading analysis. For example, a significant result of SE, meaning that the return of trading the SE is useful for predicting the return of FESX, is decisive for the signal trading. Hence, the signals coming from the SE are applied on the FESX. Nevertheless, if no significant results occur, the further analysis will be continued with the following rationales. The trading signals coming from the SE between 03.36 pm – 03.45 pm will be used for trading the FESX during the same time frame. For combining HSI and FESX it has to be differentiated between the morning and the afternoon session. Signals from the HSI will be adopted for the FESX from 04.51 pm until 05.00 pm, whereas in the morning this method has to be changed, i.e., signals from the FESX will be applied on the HSI. The reason behind this decision is, that NYSE opens at 03.30 pm, Hong Kong stock exchange closes at 05.00 pm and Eurex opens at 08.00 am which might indicate that an index trading on the exchange which opens/closes contains more profitable trading signals at this specific moment. Consequently, applying the signals from one exchange on another one might lead to an outperformance, compared to trading the index independently.

After checking if an outperformance has been achieved, a t-test should be undertaken to assess the statistical significance of these values (Zaiontz 2014). The parameters will be tested on significance with a one-tailed t-test, since it is only interesting if an outperformance, i.e. the mean of the data row is bigger than 0, has been obtained. Thus, the null hypothesis and alternative hypothesis are defined as:

$H_0: \mu \leq 0$, no significant outperformance

$H_1: \mu > 0$, significant outperformance

The t-test will be conducted in Excel and using the p-value the significance of the possible outperformance will be determined.

9 Results

The following chapter is of great importance, because all results from the empirical analysis will be represented. The different outcomes will be illustrated in the same order as they have been introduced in the previous section 8 “Methodology”. Hence, firstly the correlation findings will be presented, followed by the performance of the pivot point trading strategy, which will be analysed step by step.

9.1 Correlation Results

The correlation results will be split in two subsections. Initially, outcomes containing the entire data amount of all three indices will be elaborated. Thereafter, the analysis comprising data of the FESX and HSI will be demonstrated. This separation has to be made, since only for the data pair FESX + HSI an extended analysis from 08.00 in the morning until 05.00 pm is possible, due to download restrictions of SE data.

9.1.1 FESX_HSI_SE_03.30 pm – 05.00 pm

First of all, the correlation results comprising all three indices will be elaborated. Hence, the focus will be on the trading range from 03.30 pm until 05.00 pm over three months. The findings will be represented via SPSS outputs as well as scatter plots providing a statistical and graphic editing, respectively. In order to maintain a good overview of all relevant results, some of the findings are aggregated and only scatterplots of high significance are shown. The rest of the evaluation, in particular the SPSS outputs, will be attached in the appendix.

The following table (Table 4) contains the correlation results (parametric and non-parametric) over the entire data rows ranging from 03.30 pm-05.00 pm for the analysed three months (March 2014 – May 2014).

Correlation Results						
	March 2014		Apr. 14		May 2014	
	Parametric	Non-Parametric	Parametric	Non-Parametric	Parametric	Non-Parametric
HSI + FESX	P: 0,154** S: -0,003 K: -0,002		P: 0,049 S: 0,278** K: 0,191**		P: 0,646** S: 0,416** K: 0,291**	
HSI + SE	P: 0,551** S: 0,002 K: 0,002		P: 0,441** S: 0,445** K: 0,315**		P: 0,334** S: 0,343** K: 0,242**	
FESX + SE	P: 0,150** S: 0,344** K: 0,244**		P: 0,054* S: 0,061* K: 0,042*		P: 0,621** S: 0,520** K: 0,378**	

Table 4 Pearson (P), Spearman-Rho (S) and Kendall-Tau (K) Correlation
(March – May 2014 for HSI, FESX and SE for the entire data row (03.30 pm - 05.00 pm))

Source: Own illustration

The results of March show conspicuous values, since the differences between Pearson's correlation and non-parametric tests are remarkable, especially for the data rows including the HSI. However, the data pair of FESX + SE show the strongest relation for the non-parametric statistic measures in this month. On the contrary, April provides complete different values. The data set of HSI + SE show the highest coefficients, whereas FESX + SE the lowest ones. Furthermore, HSI + FESX are also not highly correlated, which changes in May considerably. Generally the figures in May vary a lot compared to the previous months, in particular to April. First, it has to be mentioned that the values of the parametric and non-parametric tests move in the same direction in terms of their magnitude as well as level of significance. Data rows including the FESX show the highest values, possibly indicating the dependence of the European stock exchange to other ones. Hong Kong closes at 5.00 pm and New York opens at 03.30 pm which might cause these strong impacts on Europe. To maintain also a visual overview, the scatterplots of May (Figures 44-46) are demonstrated, since for all three data pairs a strong relationship can be observed, which is in addition maintained for all three statistic measures.

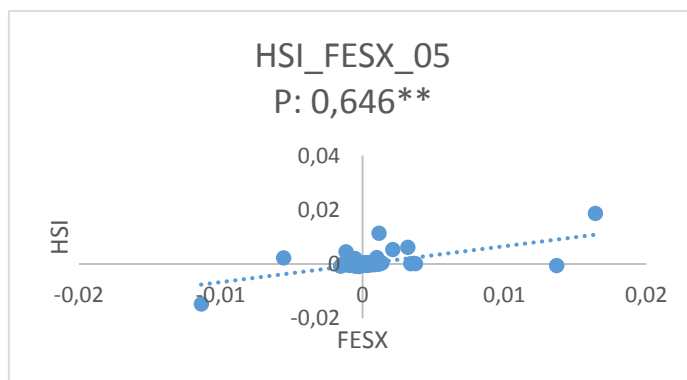


Figure 44 Scatterplot of HSI and FESX (05/2014)
Source: Own illustration

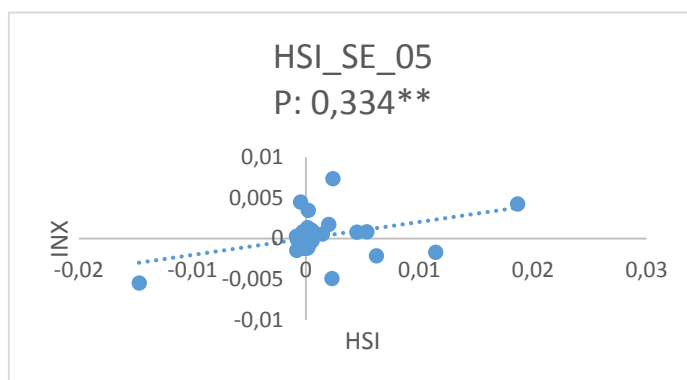


Figure 45 Scatterplot of HSI and SE (05/2014)
Source: Own illustration

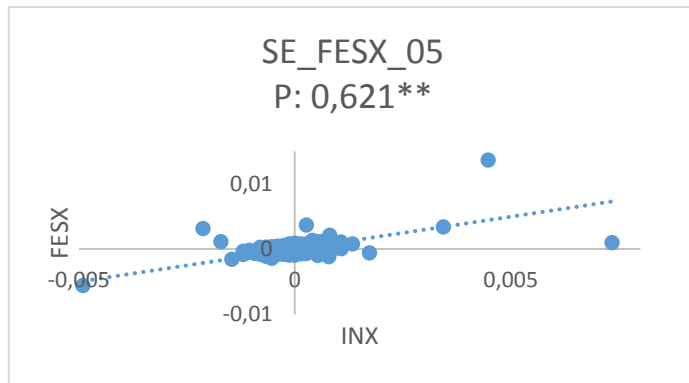


Figure 46 Scatterplot of SE and FESX (05/2014)
Source: Own illustration

After considering the correlation results of the complete data rows, the specific trading windows will be examined (Table 5,6,7). The table below (Table 5) contains the findings of parametric as well as non-parametric tests in March.

	Correlation Results					
	03.30 pm-03.45 pm		03.46 pm-04.45 pm		04.46 pm-05.00 pm	
March 2014	Parametric	Non-Parametric	Parametric	Non-Parametric	Parametric	Non-Parametric
HSI + FESX	P: 0,602**	S: -0,024 K: -0,021	P: 0,64*	S: 0,038 K: 0,027	P: 0,688**	S: 0,075 K: 0,046
HSI + SE	P: 0,622**	S: -0,055 K: -0,043	P: 0,700**	S: 0,045 K: 0,031	P: 0,526**	S: 0,114 K: 0,08
FESX + SE	P: 0,696**	S: 0,613** K: 0,454**	P: 0,68**	S: 0,514** K: 0,37**	P: 0,626 **	S: 0,557** K: 0,416**

Table 5 Pearson (P), Spearman-Rho (S) and Kendall-Tau (K) Correlation
(March 2014 for HSI, FESX and SE)
Source: Own illustration

It can be seen that the results of the non-parametric measures are very similar to each other, in terms of their magnitude as well as their level of significance. Only the data set of FESX + SE show positive significant relations (at the 1% significant level) over the three trading windows. On the contrary, FESX + HSI as well as SE + HSI show non-significant values. It is very interesting that the non-parametric values for the first trading window show negative values (Spearman-Rho -0,024, Kendall's Tau -0,021). For the other two timing frames, the values are positive, but substantial lower than the values of the Pearson's correlation. Compared to the Pearson relation, a strong difference can be seen. In this case, all values show significant results at the 1% significant level and higher correlation values. Nevertheless, with regards to the different data pairs, it can be stated that including data of the Hang Seng Index leads to the highest correlation coefficients (for all three measures) in the last trading window, i.e. from 04.46 pm until 05.00 pm, possibly due to the close of the Hong Kong stock exchange at 05.00 pm. Containing data of the S&P500 shows the highest value in the first trading window (again

for all three measures) and the reason might be the opening of the NYSE at 3.30 pm. In this case the results of the parametric and non-parametric measures do not differ strongly. Pearson's correlation ranges from 0,626 until 0,696, whereas Spearman's Rho and Kendall's Tau are approximately 10% - 20% lower than this array. To support these findings, the scatterplot SE + FESX trading at 03.30 pm – 03.45 pm is shown below.

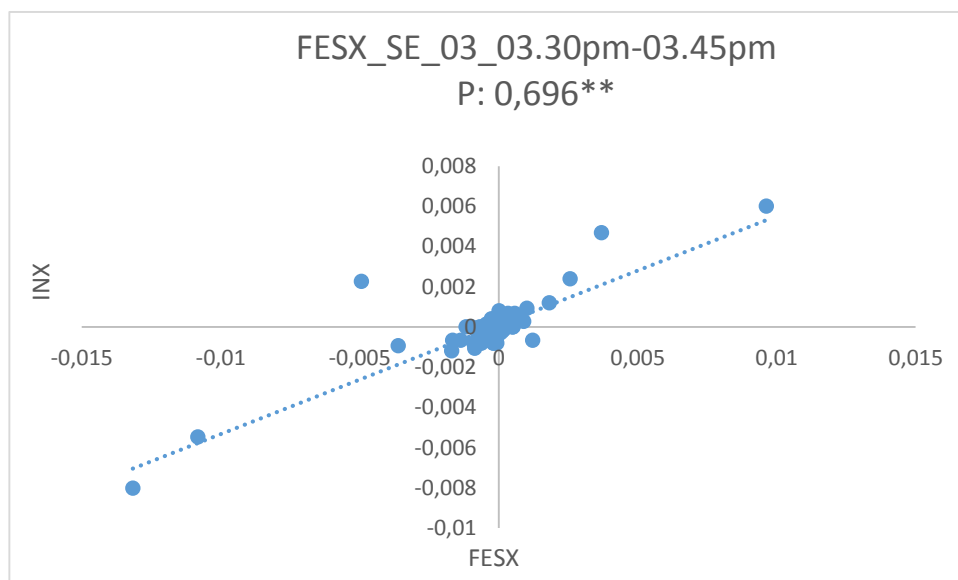


Figure 47 Scatterplot of FESX and SE 03/2014
(03.30 pm – 03.45 pm)
Source: Own illustration

Correlation Results						
April 2014	03.30 pm-03.45 pm		03.46 pm-04.45 pm		04.46 pm-05.00 pm	
	Parametric	Non-Parametric	Parametric	Non-Parametric	Parametric	Non-Parametric
HSI + FESX	P: -0,045	S: 0,156** K: 0,110**	P: 0,325**	S: 0,280** K: 0,195**	P: 0,226**	S: 0,301** K: 0,221
HSI + SE	P: 0,385**	S: 0,502** K: 0,374**	P: 0,545**	S: 0,431** K: 0,306**	P: 0,378**	S: 0,313** K: 0,228**
FESX + SE	P: 0,164**	S: 0,029** K: 0,021	P: 0,752**	S: 0,083** K: 0,057**	P: 0,789**	S: 0,223** K: 0,158*

Table 6 Pearson (P), Spearman-Rho (S) and Kendall-Tau (K) Correlation
(April 2014 for HSI, FESX and SE)
Source: Own illustration

Examining the correlation coefficients for April (see Table 6), the results differ considerably. Generally, it can be observed that all values are significant in terms of the Spearman-Rho coefficient, whereas for Pearson and Kendall-Tau this cannot be maintained. Especially the Pearson's Correlation coefficients in the first trading window have conspicuous values for all

three data pairs, since they are considerable lower than a month before (HSI + FESX -0,045, HIS + SE 0,385**, FESX + SE 0,164**). HSI and FESX are even negatively correlated. Furthermore, only HSI and FESX sustain the changes within the different trading windows, i.e. during 04.46 pm and 05.00 pm the correlation is highest compared to the other times. Especially, FESX and SE show contrary results than a month before. In this case, when NYSE opens, the coefficients (for all three measures) are lower than during the other trading windows.

Concerning May 2014 (see Table 7), the results are similar to the ones of March. First of all, it is notable, that all values are significant at the 1% significance level. Furthermore, the results in terms of their magnitude are relatively constant with the ones in March. However, it has to be mentioned that the data pairs including HSI show the highest correlation values (parametric as well as non-parametric) in the first trading window and not in the last one. There is also the fact that the values decrease over time, e.g looking at HSI + FESX which starts with a Spearman's Rho coefficient of 0,480, followed by a correlation of 0,413 from 03.46 pm-04.45 pm and ending with a value of 0,334 at 05.00 pm. The other statistic measures emerge in exactly the same way. For the dataset HSI + SE the reason might be that the opening of the NYSE has stronger effects than the closing of the Hong Kong stock exchange. The third data pair, FESX + SE, shows the strongest relations, in terms of magnitude, in all three windows. In particular, the Pearson coefficients present considerable values reaching a high of nearly 80%. As in March, from 03.30 pm until the next fifteen minutes, the highest correlation is reached indicating the intense impact of the NYSE opening. However, it has to be mentioned that for the Pearson correlation some corrections have to be added, since the coefficient of the first window (0,778) is slightly lower than of the third one (0,799). The reason might be the higher sensitivity to outliers for the Pearson correlation than for non-parametric tests. But this correction is not necessary for the non-parametric values, since they are constantly highest in the first trading window. To highlight the strength of the dependence of the American and European market, the scatterplot of FESX+SE is added (Figure 48).

Correlation Results						
May 2014	03.30 pm-03.45 pm		03.46 pm-04.45 pm		04.46 pm-05.00 pm	
	Parametric	Non-Parametric	Parametric	Non-Parametric	Parametric	Non-Parametric
HSI + FESX	P: 0,715**	S: 0,480** K: 0,348**	P: 0,639**	S: 0,413** K: 0,291**	P: 0,543**	S: 0,334** K: 0,232**
HSI + SE	P: 0,561**	S: 0,379** K: 0,278**	P: 0,418**	S: 0,341** K: 0,242**	P: 0,291**	S: 0,267** K: 0,191**
FESX + SE	P: 0,778**	S: 0,577** K: 0,433**	P: 0,747**	S: 0,498** K: 0,361**	P: 0,799**	S: 0,556** K: 0,425**

Table 7 Pearson (P), Spearman-Rho (S) and Kendall-Tau (K) Correlation
(May 2014 for HSI, FESX and SE)

Source: Own illustration

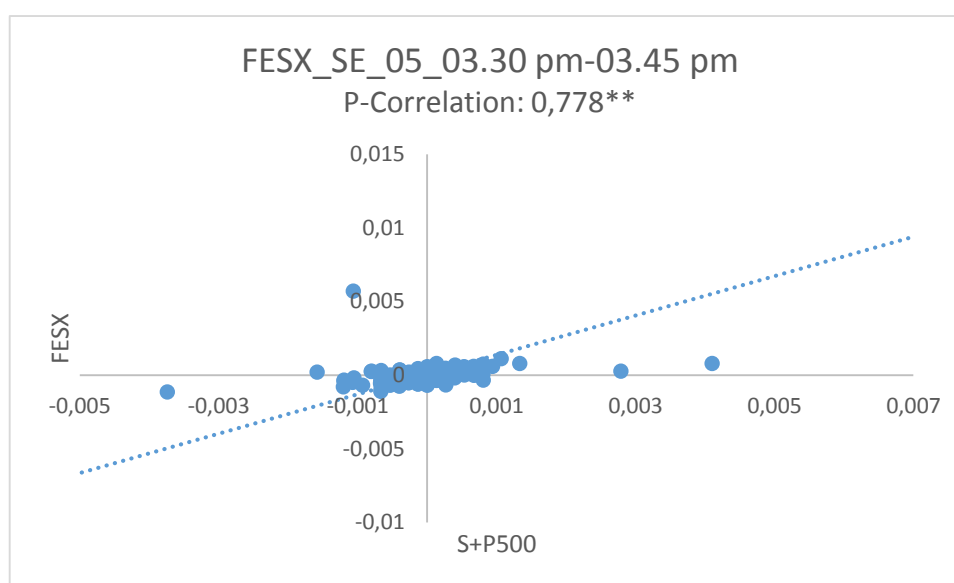


Figure 48 Scatterplot of FESX and SE 05/2014
(from 03.30 pm – 03.45 pm)

Source: Own illustration

9.1.2 HSI_FESX_08.00 am – 03.30 pm

This subsection refers to the correlation results for the extended trading range between FESX+HSI. Consequently, data from 08.00 am until 03.30 in the afternoon is examined. All findings over the examined four stages are accumulated in table 8 below.

Correlation Results								
HSI + FESX	08.00 am - 08.15 am		08.16 am - 10.00 am		10.01 am - 11.00 am		11.00 am - 03.30 pm	
	Parametric	Non-Parametric	Parametric	Non-Parametric	Parametric	Non-Parametric	Parametric	Non-Parametric
March 2014	P: 0,312** K: 0,107	S: 0,157	P: 0,414** K: -0,028	S: -0,042	P: 0,209* K: 0,003	S: 0,000	P: 0,188** K: -0,021	S: -0,03
April 2014	P: -0,031 K: 0,053	S: 0,076	P: 0,117* K: 0,105**	S: 0,153**	P: 0,013 K: 0,021	S: 0,029	P: 0,046** K: 0,066**	S: 0,095**
May 2014	P: 0,014 K: 0,093	S: 0,128	P: 0,412** K: 0,056**	S: 0,083**	P: 0,448** K: 0,106*	S: 0,158*	P: 0,559** K: 0,082**	S: 0,115**

Table 8 Pearson (P), Spearman-Rho (S) and Kendall-Tau (K) Correlation
(March - May 2014 for HSI and FESX)
Source: Own illustration

Generally it is noticeable, that the values are rising from the first to the fourth window in all three months. In addition, this finding is also consistent for the earlier examined afternoon session. In other words, it seems to be that the dependency of the two stock exchanges is lower or even lowest in the morning than for the rest of the day. The reason might be, that the closing of the Hong Kong stock exchange (at 05.00 pm) has a stronger impact on the correlation than the opening of the Eurex in the morning. Furthermore, it is obvious that the month May shows the highest values and April the lowest ones in terms of magnitude. This is consistent with the earlier studies from 03.30 pm – 05.00 pm. Another fact, which is remarkable is, that the significance varies a lot compared to the previous examined afternoon session. However, through all 4 stages, May has the most significant outcomes.

To sum up and considering the findings including all three indices, it has been shown that the different stock exchanges have an impact on each other. Consequently, the earlier formulated hypothesis I can be confirmed. Furthermore, it has to be mentioned that March and May move mostly in the same direction. SE + FESX show the strongest positive relationship out of the other data sets during these two months. Comparing the results of the entire data row with the selected trading windows, especially in March, it is interesting that for the complete row the values are lower than for the specific trading windows. For example, in March the Pearson Correlation is 0,150 whereas in the first time frame the correlation is around 0,696. Also for May this conclusion can be made most of the time. Consequently and with respect to hypothesis II, one can draw the conclusion, that there are certain time frames when the correlation is higher than for the rest of the trading period. Adding the extended analysis of FESX and HSI it has to be highlighted, that the correlation is lower or even lowest in the morning than for the rest of the day. This finding is consistent for all three analysed months. This might indicate, that the closing of the Hong Kong stock exchange has a stronger impact than the opening of the Eurex in the morning. Nevertheless, April seems to behave quite exceptional. All values are generally

lower in April than for the other months. In particular, FESX+SE which shows the strongest relationship in March and May, provide the lowest ones. Hence, considering all values in terms of significance as well as magnitude, the validity of the just mentioned conclusion diminishes, as the independence of each market appears and has to be taken into consideration. However, for the data pair SE and FESX the first trading window and for the data set, HSI and FESX the first window in the morning and the last one in the afternoon are of highest significance for the subsequent trading analysis.

9.2 Trading with Pivot Points

The following subsection is the core of this thesis, since the results of the trading strategy based on pivot points will be represented. The trading strategy will be completed during three different trading windows for two different data pairs: First of all, a trading phase of nine minutes of FESX + SE immediately after NYSE has opened, will be examined. Afterwards, the main emphasis will be on FESX + HSI trading at two different windows, once just before HSI closes (05.00 pm) and once just after FESX has opened (08.00 am). After indicating the trading results of each index separately, the subsection of applying signals from one index for another one follows.

9.2.1 FESX_SE_03.36 pm - 03.45 pm

The data pair FESX + SE has been chosen due to its high correlation results. The trading phase of nine minutes from 03.36 pm until 03.45 pm was determined by the opening of the NYSE on which SE is trading on. The data amount comprises 39 trading days from March 2014 until end of May 2014. After the pivot point and its corresponding four other levels for each day have been calculated, the back testing of the strategy is implemented via Excel VBA, which can be seen below in Figure 49. The row data are the prices of the index aggregated to average prices per minute. To ensure the perfect understanding of how the strategy is applied, a detailed instruction consisting of 6 steps is added.

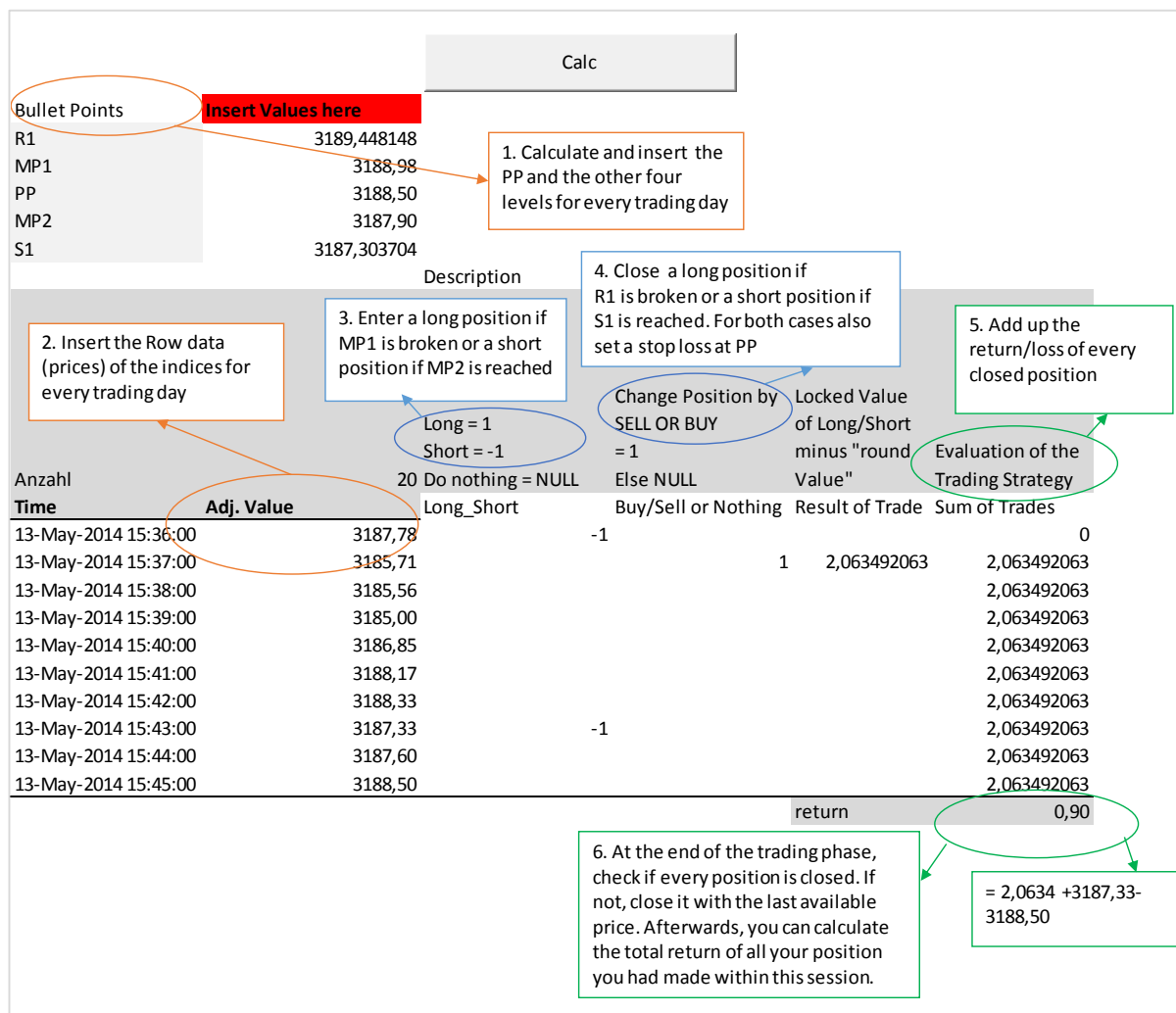


Figure 49 Implementation of the trading strategy based on PP (and its four corresponding levels for a trading session from 03.36 pm – 03.45 pm of May 13th 2014 for the FESX)
Source: Own illustration

This procedure has to be carried out for every trading day. Afterwards the performance of the strategy can be determined by adding up the returns of each single trading session. For the FESX over the given 39 trading days a total return of +26 index points has been achieved. In comparison, the SE performed worse and reached even a negative outcome of -3 index points.

9.2.2 FESX_HSI_04.51 pm - 05.00 pm

Considering, FESX and HSI, the outcome looks slightly different. In this case, 13 data points (only May 20014) are tested from 04.51 pm until 05.00 pm with exactly the same procedure as described before. FESX performs with a plus of 17 index points, whereas HSI reaches a positive value of 8 index points using the five trading trigger points.

9.2.3 FESX_HSI_08.06 am - 08.15 am

The results for the morning session vary quite a lot compared to the other trading sessions. Trading FESX and HIS separately, 32 trading points are analyzed. The difference to the earlier 39 data points results from download problems. Trading days which started later as 08.00 am, e.g. 9.20 in the morning, dropped out for the morning session. Applying the same strategy as before, HSI performs quite poorly with a return of -70 index points over the three months. On the contrary, FESX achieves a better outcome with a total return of 6 index points.

9.3 Signal Trading with Pivot Points

After the pivot point trading strategy has been run for each index independently, the signal trading can be implemented. The data pairs have been selected with regards to their correlation and specific events, i.e. opening and closing of the stock exchanges, which might have an impact each of the performance of the given indices. With the Granger Causality, it should be determined in which direction the signals should be applied. For example, considering the data pair FESX + SE, the Granger Causality should help to identify if FESX can be used to predict SE or the other way round. Consequently, adopting the trading signals of one market on another one might lead to an outperformance as both variables trade independently. The findings of this hypothesis will be demonstrated in the following subsections.

9.3.1 Granger Causality

The Granger Causality has been tested for all returns of the given data pairs, i.e FESX + SE from 03.30 pm – 03.45 pm, FESX + HSI from 04.45 pm – 05.00 pm and FESX + HSI from 08.00 am – 08.15 am. The results of the Granger Causality tests are shown below. Figure 50 below shows the results: if either FESX or SE can predict the other one (March, April and May 2014 respectively), the results of FESX and HSI from 04.45 – 05.00 pm for May 2014 and the non-significance for the data pair FESX and HSI testing from 08.00 am - 08.15 am. The outcome is for all data pairs the same – neither FESX + SE nor FESX + HSI show significant results, since the p-values are all bigger than 0,05. Consequently, from a statistical point of view, it cannot be determined in which direction the signals should be applied. Hence, the rationale, that either the closing or opening of a stock exchange might have a strong impact on another one, will be applied. As a consequence, the signals of a stock exchange which opens or closes will always be adopted on the other one.

month	time	variables	definition of variables	p-value
03.2014	03.30 - 03.45	Y= f(X)	Y= SE	0,594
		X= f(Y)	X= FESX	0,838
04.2014	03.30 - 03.45	Y= f(X)	Y= SE	0,99
		X= f(Y)	X= FESX	1,193
05.2014	03.30 - 03.45	Y= f(X)	Y= SE	0,594
		X= f(Y)	X= FESX	0,838
05.2014	04.45 - 05.00	Y= f(X)	Y= HSI	0,894
		X= f(Y)	X= FESX	0,909
03.2014	08.00 - 08.15	Y= f(X)	Y= SE	0,969
		X= f(Y)	X= FESX	0,747
04.2014	08.00 - 08.15	Y= f(X)	Y= SE	0,779
		X= f(Y)	X= FESX	0,938
05.2014	08.00 - 08.15	Y= f(X)	Y= SE	0,956
		X= f(Y)	X= FESX	0,993

Figure 50 Granger Causality of different data pairs at different trading windows
Source: Own illustration

9.3.2 FESX_SE_03.36 pm - 03.45 pm

The data pair FESX + SE is of very high significance, as it shows the highest correlation coefficients in the previous analysis. Although, April shows quite exceptional values in the correlation analysis, it definitely can be concluded, that there is a dependency between these two stock exchanges. As the Granger Causality test does not show any significant results, the signals from the SE are adopted on the FESX and afterwards the total return is calculated. The process is illustrated in the figures below. Figure 51 contains all trading signals from SE and Figure 52 shows how they are implemented for FESX.

Anzahl		Long = 1 Short = -1 20 Do nothing = NULL	Change Position by SELL OR BUY = 1 Else NULL
Time	Adj. Value	Long_Short	Buy/Sell or Nothing
20140513 15:36:00	1893,75	-1	
20140513 15:37:00	1893		1
20140513 15:38:00	1893,75	-1	
20140513 15:39:00	1894,5		1
20140513 15:40:00	1895,5		
20140513 15:41:00	1896		
20140513 15:42:00	1895,5		
20140513 15:43:00	1894,75	1	
20140513 15:44:00	1895,5		1
20140513 15:45:00	1896		

Figure 51 Signals from SE
on May 13th 2014 from 03.36 pm – 03. 45 pm
Source: Own illustration

	1 long 1- short signals from SE	close position	return/loss for each position
13-May-2014 15:36:C	3187,78	-1	
13-May-2014 15:37:C	3185,71		1 2,06
13-May-2014 15:38:C	3185,56	-1	
13-May-2014 15:39:C	3185,00		1 0,56
13-May-2014 15:40:C	3186,85		
13-May-2014 15:41:C	3188,17		
13-May-2014 15:42:C	3188,33		
13-May-2014 15:43:C	3187,33	1	
13-May-2014 15:44:C	3187,60		1 0,27
13-May-2014 15:45:C	3188,50		
total return			2,885714286

Figure 52 Applying signals of SE for FESX
on May 13th 2014 from 03.36 pm – 03. 45 pm
Source: Own illustration

Following these procedure for every trading day, a total return of 7 index points has been achieved. Comparing this figure to the performance of the FESX before (trading independently with a total sum of 26), it can be seen that no outperformance with using the signals of the SE has been reached. Quite the opposite occurred, only a negative performance of -19 points has been obtained, since 18 out of 39 data points performed with the signals of SE better than trading independently. Finally, a one-tailed t-test over the outperformance has been performed, resulting in a non-significant outcome (see Figure 53).

Ho:	$\mu \leq 0$
H1:	$\mu < 0$
Count	39
Mean	-0,47
St.Dev	2,83904977
St.Err	0,4546118
Hyp Mean	0
Alpha	0,05
Tails	1
df	38
t-stat	-1,02734826
p-value	0,15537595
t-critical	2,02439416
Sign	no

Figure 53 One-tailed t-test of the outperformance of signal trading of FESX from March-May 2014
Source: Own illustration

9.3.3 FESX_HSI_04.51 pm - 05.00 pm

For the data pair FESX and HSI, the same procedure as for FESX and SE is used. Due to the fact, that the Granger Causality test is not significant the before explained rationale becomes valid. Hence, buy and sell signals from the HSI are applied for the FESX and subsequently it has to be checked if an outperformance can be obtained. As before, the result is that the signal trading does not lead to a better performance, on the opposite a negative value of -24 index points has been obtained. Only 5 out of 13 data points performed better than traded individually. With a p-value of 0,2, also the executed one-paired t test shows no significant result (Figure 54)

	$\mu \leq 0$
H1:	$\mu < 0$
Count	13
Mean	-1,84
St.Dev	7,9230947
St.Err	2,1980536
Hyp Mean	0
Alpha	0,05
Tails	1
df	12
t-stat	-0,8822534
p-value	0,20914394
t-critical	2,17881283
Sign	no

Figure 54 One-tailed t-test of the outperformance of signal trading of FESX from May 2014
Source: Own illustration

9.3.4 FESX_HSI_08.06 am - 08.15 am

The results for FESX + HIS for the morning trading session are different to the ones from the afternoon session. As before, the Granger Causality shows non-significant values and consequently the signals of the stock exchange which in this case opens will be applied for the other one, i.e. signals from the FESX are adopted for HSI. Contrary to the earlier results, this strategy ends in an outperformance of substantial +191 index points. Trading the HSI with the signals from the FESX performs very well with a total return of +121 points over the three months (HSI alone : -70 points). It is remarkable that out of the 32 data points, 23 performed better than without the FESX signals. In addition, the outcome of one-tailed t-test supports this finding, since the p-value of 0,029 is smaller than 0,05 and hence H1 can be accepted (see Figure 55). Consequently, there is evidence for a significant outperformance for the analyzed three months.

	$\mu \leq 0$
H1:	$\mu < 0$
Count	32
Mean	5,98
St.Dev	17,193967
St.Err	3,03949266
Hyp Mean	0
Alpha	0,05
Tails	1
df	31
t-stat	1,96743361
p-value	0,02906826
t-critical	2,03951345
Sign	yes

Figure 55 One-tailed t-test of the outperformance of signal trading of HIS from March-May 2014
Source: Own illustration

Summarizing these results, it has been shown that using the trading strategy based on pivot points and using them independently, works. In particular, the FESX performed very well with this strategy, since for all three trading session a positive return was achieved. On the contrary, for HSI and SE it did not work as good as for the FESX and negative returns occurred. Only during the afternoon session, the HSI performed positively. With respect to the signal trading, the result is quite different. Solely applying the signals from the FESX on the HSI from 08.06 until 08.15 in the morning led to a significant outperformance. The other tested data pairs, i.e. adopting SE signals on the FESX at 03.36 pm - 03.34 pm and using HSI signals on the FESX at 04.51 pm – 05.00 pm, performed negatively and also a non-significant result of the implemented one-tailed T-test supported this negative result. As a consequence, the earlier explained hypothesis III and IV are confirmed to a certain extent, but due to the small data amount and partly contradictory results, no general nor significant conclusion can be formulated.

10 Conclusion

*Having trading discipline is the beginning;
keeping discipline is the progress;
staying discipline is the success.*

(Eli Radke, 2011)

This quotation emphasizes the importance of establishing a trading strategy and following its rules anytime. Since trading is not as easy as it seems to be in theory, it is important for every trader to set up some guidelines and subsequently respect and apply them for every trading decision. This statement fits perfectly to the conclusion that can be drawn from the theoretical and in particular empirical analysis which have been completed. Although, it is very common that traders have to face several trading days without success or even a loss, but with the help of a trading strategy they can figure out what the reasons behind this failure were and how they can be circumvented the next day. Since trading is embedded in a world of many unpredictable risk factors, following specific and constant rules might be very helpful in order to beware of these risks and consequently try to reduce or even overcome them.

The focus of this thesis was to study and analyze the theoretical background of various trading strategies in order to apply one specific strategy to various major stock market indices. The selected and examined trading strategy is based on so called pivot points and corresponding buying and selling levels. In addition, this strategy was extended and it was tested on three different stock exchanges at different trading windows. Initially, it was run for each of the three different indices (FESX, HSI and SE) independently to see the total performance using this strategy over a period of three months. Afterwards, various data pairs had been formed due to preferable high correlation coefficients and it was tested if an outperformance was reached with a so called 'signal trading strategy'. The signal trading refers to the application of buying and selling signals from one index, which trades on one specific stock exchange, and adopt it on another one. The selected data pairs were the SE + FESX trading from 03.36 pm-03.45 pm and the FESX + HSI, once trading at 04.51 pm-05.00 pm and once at 08.06 am-08.15 am. The reason behind choosing these specific pairs was on the one hand their relative high correlation coefficient and on the other hand certain events that took place during these specific trading windows (opening of NYSE at 03.30 pm CET, closing of Hong Kong stock exchange at 05.00 pm CET and opening of Eurex at 08.00 am CET). The assumption was, that the opening/closing of any stock exchange might have a substantial impact on another one and consequently using

trading signals of this specific stock exchange might lead to an outperformance for the other one. For example, for the combination of FESX + SE, it was tested if applying the trading signals of the first one had a positive effect on the latter one, i.e. leading to a higher total return than trading the FESX independently of any other trading signals. The results of the entire empirical analysis are outlined below, after a short overview of the structure of the paper has been given.

After an introduction in the world of trading and subsequently highlighting the importance of technical analysis, four different trading strategies were represented. Afterwards the focus was on the specific trading strategy working with pivot points, due to the easy understanding of its rules and realizability without using any special trading facilities or programs. By taking this decision, the second part of the thesis, namely the empirical analysis, started. At first, the main research questions were formulated, which contain two hypotheses concerning the correlation of the indices and another two concerning the examined trading strategy. This section was followed by the explanation of the analysed data. In section 8, the different methods and statistical tests, which were applied, were elaborated in great detail. Thereby, two major processes had been analysed. On the one hand, explaining the various correlation tests that have been carried out, and on the other hand describing step by step how the trading strategy was tested, individually as well as combined, were the major topics in this chapter. Therefore, several statistical tests, such as the Granger Causality or a T-test, were required in order to proof the significance of the underlying data. As the last step, all results and observations that have been figured out through this extensive analysis were presented.

After the structure of the paper has been depicted, the main findings of the entire evaluation should be highlighted. First of all, it could be observed that the different indices definitely have an association and move with a certain correlation to each other. Hence, every index which illustrates a representative for each of the three most important and influential stock market exchanges in the finance world, depends on the other ones. In particular, it was interesting to figure out, that the correlation varies over a trading day and mostly tend to be higher when one stock market exchange opens/ closes. For example, the SE + FESX showed most of the time the highest correlation coefficients (around 70%). Adding the extra analysis of the morning session for HIS + FESX it was remarkable, that the correlation increased continuously throughout a trading day. This might indicate, that the closing of the Hong Kong stock exchange

at 05.00 pm had a stronger impact than the opening of the Eurex at 08.00 am in the morning. Nevertheless, it has to be pointed out that it is not possible to draw a general conclusion, due to the small data amount that has been analysed. A period of three months has been examined, whereby March and May showed very constant outcomes, but April had very conspicuous figures, which indicate the independence each of the markets still has. This finding is also consistent for the results of the examined trading strategy. First of all, it has to be punctuated that the trading strategy worked. It was easy to follow the guidelines and calculate the individual levels for each trading day and validate it via backtesting. Firstly, by realizing it for each index individually and secondly by combining two indices with each other applying the already explained signal trading. For the first test, it was possible to verify the functionality of this trading strategy, for the latter one the same conclusion as for the correlation results can be drawn. For the afternoon session (FESX+SE, FESX + HSI), it was not possible to generate a significant outperformance using the signal trading strategy. But applying the signals from the FESX on the HSI in the morning, led to a considerable and significant outperformance. Hence, it can be summarized that the stipulated hypotheses can be supported to some extent but not for concluding a statistically proven and validated result. Consequently, this thesis provides a solid starting point for further research and a broader analysis in order to make a useable and highly valued contribution to the world of trading at some point.

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12 Appendix

Korrelationen

		FESX_03	S+P_03	HSI_03
FESX_03	Pearson-Korrelation	1	,150**	,154**
	Sig. (2-seitig)		,000	,000
	N	899	899	899
S+P_03	Pearson-Korrelation	,150**	1	,551**
	Sig. (2-seitig)	,000		,000
	N	899	899	899
HSI_03	Pearson-Korrelation	,154**	,551**	1
	Sig. (2-seitig)	,000	,000	
	N	899	899	899

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FESX_03	S+P_03	HSI_03
Kendall-Tau-b	FESX_03	Korrelationskoeffizient	1,000	,244**	-,002
		Sig. (2-seitig)	.	,000	,919
		N	899	899	899
	S+P_03	Korrelationskoeffizient	,244**	1,000	,002
		Sig. (2-seitig)	,000	.	,941
		N	899	899	899
	HSI_03	Korrelationskoeffizient	-,002	,002	1,000
		Sig. (2-seitig)	,919	,941	.
		N	899	899	899
Spearman-Rho	FESX_03	Korrelationskoeffizient	1,000	,344**	-,003
		Sig. (2-seitig)	.	,000	,918
		N	899	899	899
	S+P_03	Korrelationskoeffizient	,344**	1,000	,002
		Sig. (2-seitig)	,000	.	,953
		N	899	899	899
	HSI_03	Korrelationskoeffizient	-,003	,002	1,000
		Sig. (2-seitig)	,918	,953	.
		N	899	899	899

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

		FESX_04	HS_04	SP_04
FESX_04	Pearson-Korrelation	1	,049	,054*
	Sig. (2-seitig)		,065	,040
	N	1439	1439	1439
HS_04	Pearson-Korrelation	,049	1	,441**
	Sig. (2-seitig)	,065		,000
	N	1439	1439	1439
SP_04	Pearson-Korrelation	,054*	,441**	1
	Sig. (2-seitig)	,040	,000	
	N	1439	1439	1439

* . Korrelation ist bei Niveau 0,05 signifikant (zweiseitig).

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FESX_04	HS_04	SP_04
Kendall-Tau-b	FESX_04	Korrelationskoeffizient	1,000	,191**	,042*
		Sig. (2-seitig)	.	,000	,017
		N	1439	1439	1439
	HS_04	Korrelationskoeffizient	,191**	1,000	,315**
		Sig. (2-seitig)	,000	.	,000
		N	1439	1439	1439
	SP_04	Korrelationskoeffizient	,042*	,315**	1,000
		Sig. (2-seitig)	,017	,000	.
		N	1439	1439	1439
Spearman-Rho	FESX_04	Korrelationskoeffizient	1,000	,278**	,061*
		Sig. (2-seitig)	.	,000	,021
		N	1439	1439	1439
	HS_04	Korrelationskoeffizient	,278**	1,000	,445**
		Sig. (2-seitig)	,000	.	,000
		N	1439	1439	1439
	SP_04	Korrelationskoeffizient	,061*	,445**	1,000
		Sig. (2-seitig)	,021	,000	.
		N	1439	1439	1439

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

* . Korrelation ist bei Niveau 0,05 signifikant (zweiseitig).

Korrelationen

		FESX_05	HS_05	SP_05
FESX_05	Pearson-Korrelation	1	,646**	,621**
	Sig. (2-seitig)		,000	,000
	N	1169	1169	1169
HS_05	Pearson-Korrelation	,646**	1	,334**
	Sig. (2-seitig)	,000		,000
	N	1169	1169	1169
SP_05	Pearson-Korrelation	,621**	,334**	1
	Sig. (2-seitig)	,000	,000	
	N	1169	1169	1169

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FESX_05	HS_05	SP_05
Kendall-Tau-b	FESX_05	Korrelationskoeffizient	1,000	,291**	,378**
		Sig. (2-seitig)	.	,000	,000
		N	1169	1169	1169
	HS_05	Korrelationskoeffizient	,291**	1,000	,242**
		Sig. (2-seitig)	,000	.	,000
		N	1169	1169	1169
	SP_05	Korrelationskoeffizient	,378**	,242**	1,000
		Sig. (2-seitig)	,000	,000	.
		N	1169	1169	1169
Spearman-Rho	FESX_05	Korrelationskoeffizient	1,000	,416**	,520**
		Sig. (2-seitig)	.	,000	,000
		N	1169	1169	1169
	HS_05	Korrelationskoeffizient	,416**	1,000	,343**
		Sig. (2-seitig)	,000	.	,000
		N	1169	1169	1169
	SP_05	Korrelationskoeffizient	,520**	,343**	1,000
		Sig. (2-seitig)	,000	,000	.
		N	1169	1169	1169

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

		FESX_03_03.30pm-03.45pm	S+P_03_03.30pm-03.45pm	HS_03_03.30pm-03.45pm
FESX_03_03.30pm-03.45pm	Pearson Correlation	1	,696**	,602**
	Sig. (2-tailed)		,000	,000
	N	159	159	159
S+P_03_03.30pm-03.45pm	Pearson Correlation	,696**	1	,622**
	Sig. (2-tailed)	,000		,000
	N	159	159	159
HS_03_03.30pm-03.45pm	Pearson Correlation	,602**	,622**	1
	Sig. (2-tailed)	,000	,000	
	N	159	159	159

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FESX_03_15.30-15.45	S+P_03_15.30-15.45	HS_03_15.30-15.45
Kendall-Tau-b	FESX_03_15.30-15.45	Korrelationskoeffizient	1,000	,454**	-,021
		Sig. (2-seitig)	.	,000	,695
		N	159	159	159
	S+P_03_15.30-15.45	Korrelationskoeffizient	,454**	1,000	-,043
		Sig. (2-seitig)	,000	.	,431
		N	159	159	159
	HS_03_15.30-15.45	Korrelationskoeffizient	-,021	-,043	1,000
		Sig. (2-seitig)	,695	,431	.
		N	159	159	159
Spearman-Rho	FESX_03_15.30-15.45	Korrelationskoeffizient	1,000	,613**	-,024
		Sig. (2-seitig)	.	,000	,760
		N	159	159	159
	S+P_03_15.30-15.45	Korrelationskoeffizient	,613**	1,000	-,055
		Sig. (2-seitig)	,000	.	,492
		N	159	159	159
	HS_03_15.30-15.45	Korrelationskoeffizient	-,024	-,055	1,000
		Sig. (2-seitig)	,760	,492	.
		N	159	159	159

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

		FESX_03_15.46-16.45	SP_03_15.46-16.45	HS_03_15.46-16.45
FESX_03_15.46-16.45	Pearson-Korrelation	1	,680**	,640**
	Sig. (2-seitig)		,000	,000
	N	599	599	599
SP_03_15.46-16.45	Pearson-Korrelation	,680**	1	,700**
	Sig. (2-seitig)	,000		,000
	N	599	599	599
HS_03_15.46-16.45	Pearson-Korrelation	,640**	,700**	1
	Sig. (2-seitig)	,000	,000	
	N	599	599	599

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FESX_03_15.4 6-16.45	SP_03_15.46- 16.45	HS_03_15.46- 16.45
Kendall-Tau-b	FESX_03_15.46-16.45	Korrelationskoeffizient	1,000	,370**	,027
		Sig. (2-seitig)	.	,000	,320
		N	599	599	599
	SP_03_15.46-16.45	Korrelationskoeffizient	,370**	1,000	,031
		Sig. (2-seitig)	,000	.	,269
		N	599	599	599
	HS_03_15.46-16.45	Korrelationskoeffizient	,027	,031	1,000
		Sig. (2-seitig)	,320	,269	.
		N	599	599	599
Spearman-Rho	FESX_03_15.46-16.45	Korrelationskoeffizient	1,000	,514**	,038
		Sig. (2-seitig)	.	,000	,350
		N	599	599	599
	SP_03_15.46-16.45	Korrelationskoeffizient	,514**	1,000	,045
		Sig. (2-seitig)	,000	.	,270
		N	599	599	599
	HS_03_15.46-16.45	Korrelationskoeffizient	,038	,045	1,000
		Sig. (2-seitig)	,350	,270	.
		N	599	599	599

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

		FESX_03_16.46 -17.00	HS_03.16.46- 17.00	SP_03_16.46- 17.00
FESX_03_16.46-17.00	Pearson-Korrelation	1	,688**	,626**
	Sig. (2-seitig)		,000	,000
	N	139	139	139
HS_03.16.46-17.00	Pearson-Korrelation	,688**	1	,526**
	Sig. (2-seitig)	,000		,000
	N	139	139	139
SP_03_16.46-17.00	Pearson-Korrelation	,626**	,526**	1
	Sig. (2-seitig)	,000	,000	
	N	139	139	139

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FESX_03_16.46-17.00	HS_03.16.46-17.00	SP_03_16.46-17.00
Kendall-Tau-b	FESX_03_16.46-17.00	Korrelationskoeffizient	1,000	,046	,416**
		Sig. (2-seitig)	.	,424	,000
		N	139	139	139
	HS_03.16.46-17.00	Korrelationskoeffizient	,046	1,000	,080
		Sig. (2-seitig)	,424	.	,171
		N	139	139	139
	SP_03_16.46-17.00	Korrelationskoeffizient	,416**	,080	1,000
		Sig. (2-seitig)	,000	,171	.
		N	139	139	139
Spearman-Rho	FESX_03_16.46-17.00	Korrelationskoeffizient	1,000	,075	,557**
		Sig. (2-seitig)	.	,379	,000
		N	139	139	139
	HS_03.16.46-17.00	Korrelationskoeffizient	,075	1,000	,114
		Sig. (2-seitig)	,379	.	,180
		N	139	139	139
	SP_03_16.46-17.00	Korrelationskoeffizient	,557**	,114	1,000
		Sig. (2-seitig)	,000	,180	.
		N	139	139	139

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

		FESX_04_15.30-15.45	HS_04_15.30-15.45	SP_04_15.30-15.45
FESX_04_15.30-15.45	Pearson-Korrelation	1	-,045	,164**
	Sig. (2-seitig)		,476	,009
	N	255	255	255
HS_04_15.30-15.45	Pearson-Korrelation	-,045	1	,385**
	Sig. (2-seitig)	,476		,000
	N	255	255	255
SP_04_15.30-15.45	Pearson-Korrelation	,164**	,385**	1
	Sig. (2-seitig)	,009	,000	
	N	255	255	255

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FESX_04_15.30-15.45	HS_04_15.30-15.45	SP_04_15.30-15.45
Kendall-Tau-b	FESX_04_15.30-15.45	Korrelationskoeffizient	1,000	,110**	,021
		Sig. (2-seitig)	.	,009	,623
		N	255	255	255
	HS_04_15.30-15.45	Korrelationskoeffizient	,110**	1,000	,374**
		Sig. (2-seitig)	,009	.	,000
		N	255	255	255
	SP_04_15.30-15.45	Korrelationskoeffizient	,021	,374**	1,000
		Sig. (2-seitig)	,623	,000	.
		N	255	255	255
Spearman-Rho	FESX_04_15.30-15.45	Korrelationskoeffizient	1,000	,156*	,029
		Sig. (2-seitig)	.	,013	,650
		N	255	255	255
	HS_04_15.30-15.45	Korrelationskoeffizient	,156*	1,000	,502**
		Sig. (2-seitig)	,013	.	,000
		N	255	255	255
	SP_04_15.30-15.45	Korrelationskoeffizient	,029	,502**	1,000
		Sig. (2-seitig)	,650	,000	.
		N	255	255	255

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

* . Korrelation ist bei Niveau 0,05 signifikant (zweiseitig).

Korrelationen

		SP_04_15.46-16.45	FESX_04_15.46-16.45	HS_04_15.46-16.45
SP_04_15.46-16.45	Pearson-Korrelation	1	,752**	,545**
	Sig. (2-seitig)		,000	,000
	N	959	959	959
FESX_04_15.46-16.45	Pearson-Korrelation	,752**	1	,325**
	Sig. (2-seitig)	,000		,000
	N	959	959	959
HS_04_15.46-16.45	Pearson-Korrelation	,545**	,325**	1
	Sig. (2-seitig)	,000	,000	
	N	959	959	959

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			SP_04_15.46-16.45	FESX_04_15.46-16.45	HS_04_15.46-16.45
Kendall-Tau-b	SP_04_15.46-16.45	Korrelationskoeffizient	1,000	,057**	,306**
		Sig. (2-seitig)	.	,008	,000
		N	959	959	959
	FESX_04_15.46-16.45	Korrelationskoeffizient	,057**	1,000	,195**
		Sig. (2-seitig)	,008	.	,000
		N	959	959	959
	HS_04_15.46-16.45	Korrelationskoeffizient	,306**	,195**	1,000
		Sig. (2-seitig)	,000	,000	.
		N	959	959	959
Spearman-Rho	SP_04_15.46-16.45	Korrelationskoeffizient	1,000	,083*	,431**
		Sig. (2-seitig)	.	,010	,000
		N	959	959	959
	FESX_04_15.46-16.45	Korrelationskoeffizient	,083*	1,000	,280**
		Sig. (2-seitig)	,010	.	,000
		N	959	959	959
	HS_04_15.46-16.45	Korrelationskoeffizient	,431**	,280**	1,000
		Sig. (2-seitig)	,000	,000	.
		N	959	959	959

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

* . Korrelation ist bei Niveau 0,05 signifikant (zweiseitig).

Korrelationen

		FESX_04_16.46-17.00	HS_04_16.46-17.00	SP_04_16.46-17.00
FESX_04_16.46-17.00	Pearson-Korrelation	1	,226**	,789**
	Sig. (2-seitig)		,001	,000
	N	223	223	223
HS_04_16.46-17.00	Pearson-Korrelation	,226**	1	,378**
	Sig. (2-seitig)	,001		,000
	N	223	223	223
SP_04_16.46-17.00	Pearson-Korrelation	,789**	,378**	1
	Sig. (2-seitig)	,000	,000	
	N	223	223	223

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FESX_04_16.46-17.00	HS_04_16.46-17.00	SP_04_16.46-17.00
Kendall-Tau-b	FESX_04_16.46-17.00	Korrelationskoeffizient	1,000	,221**	,158**
		Sig. (2-seitig)	.	,000	,001
		N	223	223	223
	HS_04_16.46-17.00	Korrelationskoeffizient	,221**	1,000	,228**
		Sig. (2-seitig)	,000	.	,000
		N	223	223	223
	SP_04_16.46-17.00	Korrelationskoeffizient	,158**	,228**	1,000
		Sig. (2-seitig)	,001	,000	.
		N	223	223	223
Spearman-Rho	FESX_04_16.46-17.00	Korrelationskoeffizient	1,000	,301**	,223**
		Sig. (2-seitig)	.	,000	,001
		N	223	223	223
	HS_04_16.46-17.00	Korrelationskoeffizient	,301**	1,000	,313**
		Sig. (2-seitig)	,000	.	,000
		N	223	223	223
	SP_04_16.46-17.00	Korrelationskoeffizient	,223**	,313**	1,000
		Sig. (2-seitig)	,001	,000	.
		N	223	223	223

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

		FESX_05_15.30-15.45	HS_05_15.30-15.45	SP_05_15.30-15.45
FESX_05_15.30-15.45	Pearson-Korrelation	1	,715**	,778**
	Sig. (2-seitig)		,000	,000
	N	207	207	207
HS_05_15.30-15.45	Pearson-Korrelation	,715**	1	,561**
	Sig. (2-seitig)	,000		,000
	N	207	207	207
SP_05_15.30-15.45	Pearson-Korrelation	,778**	,561**	1
	Sig. (2-seitig)	,000	,000	
	N	207	207	207

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FESX_05_15.3 0-15.45	HS_05_15.30- 15.45	SP_05_15.30- 15.45
Kendall-Tau-b	FESX_05_15.30-15.45	Korrelationskoeffizient	1,000	,348**	,433**
		Sig. (2-seitig)	.	,000	,000
		N	207	207	207
	HS_05_15.30-15.45	Korrelationskoeffizient	,348**	1,000	,278**
		Sig. (2-seitig)	,000	.	,000
		N	207	207	207
	SP_05_15.30-15.45	Korrelationskoeffizient	,433**	,278**	1,000
		Sig. (2-seitig)	,000	,000	.
		N	207	207	207
Spearman-Rho	FESX_05_15.30-15.45	Korrelationskoeffizient	1,000	,480**	,577**
		Sig. (2-seitig)	.	,000	,000
		N	207	207	207
	HS_05_15.30-15.45	Korrelationskoeffizient	,480**	1,000	,379**
		Sig. (2-seitig)	,000	.	,000
		N	207	207	207
	SP_05_15.30-15.45	Korrelationskoeffizient	,577**	,379**	1,000
		Sig. (2-seitig)	,000	,000	.
		N	207	207	207

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

		FESX_05_15.45 -16.45	HS_05_15.45- 16.45	SP_05_15.45- 16.45
FESX_05_15.45-16.45	Pearson-Korrelation	1	,639**	,747**
	Sig. (2-seitig)		,000	,000
	N	779	779	779
HS_05_15.45-16.45	Pearson-Korrelation	,639**	1	,418**
	Sig. (2-seitig)	,000		,000
	N	779	779	779
SP_05_15.45-16.45	Pearson-Korrelation	,747**	,418**	1
	Sig. (2-seitig)	,000	,000	
	N	779	779	779

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FESX_05_15.4- 5-16.45	HS_05_15.45- 16.45	SP_05_15.45- 16.45
Kendall-Tau-b	FESX_05_15.45-16.45	Korrelationskoeffizient	1,000	,291**	,361**
		Sig. (2-seitig)	.	,000	,000
		N	779	779	779
	HS_05_15.45-16.45	Korrelationskoeffizient	,291**	1,000	,242**
		Sig. (2-seitig)	,000	.	,000
		N	779	779	779
	SP_05_15.45-16.45	Korrelationskoeffizient	,361**	,242**	1,000
		Sig. (2-seitig)	,000	,000	.
		N	779	779	779
Spearman-Rho	FESX_05_15.45-16.45	Korrelationskoeffizient	1,000	,413**	,498**
		Sig. (2-seitig)	.	,000	,000
		N	779	779	779
	HS_05_15.45-16.45	Korrelationskoeffizient	,413**	1,000	,341**
		Sig. (2-seitig)	,000	.	,000
		N	779	779	779
	SP_05_15.45-16.45	Korrelationskoeffizient	,498**	,341**	1,000
		Sig. (2-seitig)	,000	,000	.
		N	779	779	779

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

		FESX_05_16.46- -17.00	HS_05_16.46- 17.00	SP_05_16.46- 17.00
FESX_05_16.46-17.00	Pearson-Korrelation	1	,543**	,799**
	Sig. (2-seitig)		,000	,000
	N	181	181	181
HS_05_16.46-17.00	Pearson-Korrelation	,543**	1	,291**
	Sig. (2-seitig)	,000		,000
	N	181	181	181
SP_05_16.46-17.00	Pearson-Korrelation	,799**	,291**	1
	Sig. (2-seitig)	,000	,000	
	N	181	181	181

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FESX_05_16.46-17.00	HS_05_16.46-17.00	SP_05_16.46-17.00
Kendall-Tau-b	FESX_05_16.46-17.00	Korrelationskoeffizient	1,000	,232**	,425**
		Sig. (2-seitig)	.	,000	,000
		N	181	181	181
	HS_05_16.46-17.00	Korrelationskoeffizient	,232**	1,000	,191**
		Sig. (2-seitig)	,000	.	,000
		N	181	181	181
	SP_05_16.46-17.00	Korrelationskoeffizient	,425**	,191**	1,000
		Sig. (2-seitig)	,000	,000	.
		N	181	181	181
Spearman-Rho	FESX_05_16.46-17.00	Korrelationskoeffizient	1,000	,334**	,556**
		Sig. (2-seitig)	.	,000	,000
		N	181	181	181
	HS_05_16.46-17.00	Korrelationskoeffizient	,334**	1,000	,267**
		Sig. (2-seitig)	,000	.	,000
		N	181	181	181
	SP_05_16.46-17.00	Korrelationskoeffizient	,556**	,267**	1,000
		Sig. (2-seitig)	,000	,000	.
		N	181	181	181

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

		FESX_03_08.00am-08.15am	HSI_03_08.00am-08.15am
FESX_03_08.00am-08.15am	Pearson-Korrelation	1	,312**
	Sig. (2-seitig)		,000
	N	134	134
HSI_03_08.00am-08.15am	Pearson-Korrelation	,312**	1
	Sig. (2-seitig)	,000	
	N	134	134

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FESX_03_08.00 am-08.15am	HSI_03_08.00a m-08.15am
Kendall-Tau-b	FESX_03_08.00am-08.15am	Korrelationskoeffizient	1,000	,107
		Sig. (2-seitig)	.	,071
		N	134	134
	HSI_03_08.00am-08.15am	Korrelationskoeffizient	,107	1,000
		Sig. (2-seitig)	,071	.
		N	134	134
Spearman-Rho	FESX_03_08.00am-08.15am	Korrelationskoeffizient	1,000	,157
		Sig. (2-seitig)	.	,070
		N	134	134
	HSI_03_08.00am-08.15am	Korrelationskoeffizient	,157	1,000
		Sig. (2-seitig)	,070	.
		N	134	134

Korrelationen

		FESX_03_08.16 am-10.00am	HSI_03_08.16a m-10.00am
FESX_03_08.16am- 10.00am	Pearson-Korrelation	1	,414**
	Sig. (2-seitig)		,000
	N	944	944
HSI_03_08.16am-10.00am	Pearson-Korrelation	,414**	1
	Sig. (2-seitig)	,000	
	N	944	944

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FESX_03_08.16 am-10.00am	HSI_03_08.16a m-10.00am
Kendall-Tau-b	FESX_03_08.16am-10.00am	Korrelationskoeffizient	1,000	-,028
		Sig. (2-seitig)	.	,192
		N	944	944
	HSI_03_08.16am-10.00am	Korrelationskoeffizient	-,028	1,000
		Sig. (2-seitig)	,192	.
		N	944	944
Spearman-Rho	FESX_03_08.16am-10.00am	Korrelationskoeffizient	1,000	-,042
		Sig. (2-seitig)	.	,195
		N	944	944
	HSI_03_08.16am-10.00am	Korrelationskoeffizient	-,042	1,000
		Sig. (2-seitig)	,195	.
		N	944	944

Korrelationen

		FESX_03_10.01 am-10.15am	HSI_03_10.01a m-10.15am
FESX_03_10.01am- 10.15am	Pearson-Korrelation	1	,209*
	Sig. (2-seitig)		,019
	N	125	125
HSI_03_10.01am-10.15am	Pearson-Korrelation	,209*	1
	Sig. (2-seitig)	,019	
	N	125	125

* . Korrelation ist bei Niveau 0,05 signifikant (zweiseitig).

Korrelationen

			FESX_03_10.01 am-10.15am	HSI_03_10.01a m-10.15am
Kendall-Tau-b	FESX_03_10.01am-10.15am	Korrelationskoeffizient	1,000	,003
		Sig. (2-seitig)	.	,966
		N	125	125
	HSI_03_10.01am-10.15am	Korrelationskoeffizient	,003	1,000
		Sig. (2-seitig)	,966	.
		N	125	125
Spearman-Rho	FESX_03_10.01am-10.15am	Korrelationskoeffizient	1,000	,000
		Sig. (2-seitig)	.	,998
		N	125	125
	HSI_03_10.01am-10.15am	Korrelationskoeffizient	,000	1,000
		Sig. (2-seitig)	,998	.
		N	125	125

Korrelationen

		FE_03_11.00- 15.30	HS_03_11.00- 15.30
FE_03_11.00-15.30	Pearson-Korrelation	1	,188**
	Sig. (2-seitig)		,000
	N	2464	2464
HS_03_11.00-15.30	Pearson-Korrelation	,188**	1
	Sig. (2-seitig)	,000	
	N	2464	2464

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FE_03_11.00- 15.30	HS_03_11.00- 15.30
Kendall-Tau-b	FE_03_11.00-15.30	Korrelationskoeffizient	1,000	-,021
		Sig. (2-seitig)	.	,128
		N	2464	2464
	HS_03_11.00-15.30	Korrelationskoeffizient	-,021	1,000
		Sig. (2-seitig)	,128	.
		N	2464	2464
Spearman-Rho	FE_03_11.00-15.30	Korrelationskoeffizient	1,000	-,030
		Sig. (2-seitig)	.	,131
		N	2464	2464
	HS_03_11.00-15.30	Korrelationskoeffizient	-,030	1,000
		Sig. (2-seitig)	,131	.
		N	2464	2464

Korrelationen

		FESX_04_08.00 am-08.15am	HSI_04_08.00a m-08.15am
FESX_04_08.00am- 08.15am	Pearson-Korrelation	1	-,031
	Sig. (2-seitig)		,629
	N	239	239
HSI_04_08.00am-08.15am	Pearson-Korrelation	-,031	1
	Sig. (2-seitig)	,629	
	N	239	239

Korrelationen

			FESX_04_08.00 am-08.15am	HSI_04_08.00a m-08.15am
Kendall-Tau-b	FESX_04_08.00am-08.15am	Korrelationskoeffizient	1,000	,053
		Sig. (2-seitig)	.	,228
		N	239	239
	HSI_04_08.00am-08.15am	Korrelationskoeffizient	,053	1,000
		Sig. (2-seitig)	,228	.
		N	239	239
Spearman-Rho	FESX_04_08.00am-08.15am	Korrelationskoeffizient	1,000	,076
		Sig. (2-seitig)	.	,244
		N	239	239
	HSI_04_08.00am-08.15am	Korrelationskoeffizient	,076	1,000
		Sig. (2-seitig)	,244	.
		N	239	239

Korrelationen

		FESX_04_08.16 am-10.00am	HSI_04_08.16a m-10.00am
FESX_04_08.16am- 10.00am	Pearson-Korrelation	1	,117**
	Sig. (2-seitig)		,000
	N	1678	1678
HSI_04_08.16am-10.00am	Pearson-Korrelation	,117**	1
	Sig. (2-seitig)	,000	
	N	1678	1678

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FESX_04_08.16 am-10.00am	HSI_04_08.16a m-10.00am
Kendall-Tau-b	FESX_04_08.16am-10.00am	Korrelationskoeffizient	1,000	,105**
		Sig. (2-seitig)	.	,000
		N	1678	1678
	HSI_04_08.16am-10.00am	Korrelationskoeffizient	,105**	1,000
		Sig. (2-seitig)	,000	.
		N	1678	1678
Spearman-Rho	FESX_04_08.16am-10.00am	Korrelationskoeffizient	1,000	,153**
		Sig. (2-seitig)	.	,000
		N	1678	1678
	HSI_04_08.16am-10.00am	Korrelationskoeffizient	,153**	1,000
		Sig. (2-seitig)	,000	.
		N	1678	1678

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

		FESX_04_10.01 am-10.15am	HSI_04_10.01a m-10.15am
FESX_04_10.01am- 10.15am	Pearson-Korrelation	1	,013
	Sig. (2-seitig)		,850
	N	223	223
HSI_04_10.01am-10.15am	Pearson-Korrelation	,013	1
	Sig. (2-seitig)	,850	
	N	223	223

Korrelationen

			FESX_04_10.01 am-10.15am	HSI_04_10.01a m-10.15am
Kendall-Tau-b	FESX_04_10.01am-10.15am	Korrelationskoeffizient	1,000	,021
		Sig. (2-seitig)	.	,647
		N	223	223
	HSI_04_10.01am-10.15am	Korrelationskoeffizient	,021	1,000
		Sig. (2-seitig)	,647	.
		N	223	223
Spearman-Rho	FESX_04_10.01am-10.15am	Korrelationskoeffizient	1,000	,029
		Sig. (2-seitig)	.	,669
		N	223	223
	HSI_04_10.01am-10.15am	Korrelationskoeffizient	,029	1,000
		Sig. (2-seitig)	,669	.
		N	223	223

Korrelationen

		FESX_04_11.00 am-03.30pm	HS_04_11.00a m-03.30pm
FESX_04_11.00am- 03.30pm	Pearson-Korrelation	1	,046**
	Sig. (2-seitig)		,003
	N	3988	3988
HS_04_11.00am-03.30pm	Pearson-Korrelation	,046**	1
	Sig. (2-seitig)	,003	
	N	3988	3988

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FESX_04_11.00 am-03.30pm	HS_04_11.00a m-03.30pm
Kendall-Tau-b	FESX_04_11.00am-03.30pm	Korrelationskoeffizient	1,000	,066**
		Sig. (2-seitig)	.	,000
		N	3988	3988
	HS_04_11.00am-03.30pm	Korrelationskoeffizient	,066**	1,000
		Sig. (2-seitig)	,000	.
		N	3988	3988
Spearman-Rho	FESX_04_11.00am-03.30pm	Korrelationskoeffizient	1,000	,095**
		Sig. (2-seitig)	.	,000
		N	3988	3988
	HS_04_11.00am-03.30pm	Korrelationskoeffizient	,095**	1,000
		Sig. (2-seitig)	,000	.
		N	3988	3988

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

		FESX_05_08.00 am-08.15am	HSI_05_08.00a m-08.15am
FESX_05_08.00am- 08.15am	Pearson-Korrelation	1	,014
	Sig. (2-seitig)		,870
	N	134	134
HSI_05_08.00am-08.15am	Pearson-Korrelation	,014	1
	Sig. (2-seitig)	,870	
	N	134	134

Korrelationen

			FESX_05_08.00 am-08.15am	HSI_05_08.00a m-08.15am
Kendall-Tau-b	FESX_05_08.00am-08.15am	Korrelationskoeffizient	1,000	,093
		Sig. (2-seitig)	.	,118
		N	134	134
	HSI_05_08.00am-08.15am	Korrelationskoeffizient	,093	1,000
		Sig. (2-seitig)	,118	.
		N	134	134
Spearman-Rho	FESX_05_08.00am-08.15am	Korrelationskoeffizient	1,000	,128
		Sig. (2-seitig)	.	,139
		N	134	134
	HSI_05_08.00am-08.15am	Korrelationskoeffizient	,128	1,000
		Sig. (2-seitig)	,139	.
		N	134	134

Korrelationen

		FESX_05_08.16 am-10.00am	HSI_05_08.16a m-10.00am
FESX_05_08.16am- 10.00am	Pearson-Korrelation	1	,412**
	Sig. (2-seitig)		,000
	N	1111	1111
HSI_05_08.16am-10.00am	Pearson-Korrelation	,412**	1
	Sig. (2-seitig)	,000	
	N	1111	1111

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FESX_05_08.16 am-10.00am	HSI_05_08.16a m-10.00am
Kendall-Tau-b	FESX_05_08.16am-10.00am	Korrelationskoeffizient	1,000	,056**
		Sig. (2-seitig)	.	,005
		N	1111	1111
	HSI_05_08.16am-10.00am	Korrelationskoeffizient	,056**	1,000
		Sig. (2-seitig)	,005	.
		N	1111	1111
Spearman-Rho	FESX_05_08.16am-10.00am	Korrelationskoeffizient	1,000	,083**
		Sig. (2-seitig)	.	,005
		N	1111	1111
	HSI_05_08.16am-10.00am	Korrelationskoeffizient	,083**	1,000
		Sig. (2-seitig)	,005	.
		N	1111	1111

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

		FESX_05_10.01 am-10.15am	HSI_05_10.01a m-10.15am
FESX_05_10.01am- 10.15am	Pearson-Korrelation	1	,448**
	Sig. (2-seitig)		,000
	N	167	167
HSI_05_10.01am-10.15am	Pearson-Korrelation	,448**	1
	Sig. (2-seitig)	,000	
	N	167	167

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FESX_05_10.01 am-10.15am	HSI_05_10.01a m-10.15am
Kendall-Tau-b	FESX_05_10.01am-10.15am	Korrelationskoeffizient	1,000	,106*
		Sig. (2-seitig)	.	,042
		N	167	167
	HSI_05_10.01am-10.15am	Korrelationskoeffizient	,106*	1,000
		Sig. (2-seitig)	,042	.
		N	167	167
Spearman-Rho	FESX_05_10.01am-10.15am	Korrelationskoeffizient	1,000	,158*
		Sig. (2-seitig)	.	,042
		N	167	167
	HSI_05_10.01am-10.15am	Korrelationskoeffizient	,158*	1,000
		Sig. (2-seitig)	,042	.
		N	167	167

* . Korrelation ist bei Niveau 0,05 signifikant (zweiseitig).

Korrelationen

		FESX_05_11.00 -15.30	HS_05_11.00- 15.30
FESX_05_11.00-15.30	Pearson-Korrelation	1	,559**
	Sig. (2-seitig)		,000
	N	3138	3138
HS_05_11.00-15.30	Pearson-Korrelation	,559**	1
	Sig. (2-seitig)	,000	
	N	3138	3138

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Korrelationen

			FESX_05_11.0 0-15.30	HS_05_11.00- 15.30
Kendall-Tau-b	FESX_05_11.00-15.30	Korrelationskoeffizient	1,000	,082**
		Sig. (2-seitig)	.	,000
		N	3138	3138
	HS_05_11.00-15.30	Korrelationskoeffizient	,082**	1,000
		Sig. (2-seitig)	,000	.
		N	3138	3138
Spearman-Rho	FESX_05_11.00-15.30	Korrelationskoeffizient	1,000	,115**
		Sig. (2-seitig)	.	,000
		N	3138	3138
	HS_05_11.00-15.30	Korrelationskoeffizient	,115**	1,000
		Sig. (2-seitig)	,000	.
		N	3138	3138

** . Korrelation ist bei Niveau 0,01 signifikant (zweiseitig).

Granger Causality Test: Y = f(X)				
Model	Res.DF	Diff. DF	F	p-value
Complete model	155			
Reduced model	156	-1	0.284785846332356	0.594345871876369

Granger Causality Test: X = f(Y)				
Model	Res.DF	Diff. DF	F	p-value
Complete model	155			
Reduced model	156	-1	0.0419533442834055	0.837977456224531

Granger Causality FESX(X) and SE (Y) of 03/2014 at 03.30pm – 03.45pm

Granger Causality Test: Y = f(X)				
Model	Res.DF	Diff. DF	F	p-value
Complete model	177			
Reduced model	178	-1	0.0179034425348123	0.893709777853603

Granger Causality Test: X = f(Y)				
Model	Res.DF	Diff. DF	F	p-value
Complete model	177			
Reduced model	178	-1	0.0131637459681048	0.908786512602985

Granger Causality FESX(X) and SE (Y) of 04/2014 at 03.30pm – 03.45pm

Granger Causality Test: Y = f(X)				
Model	Res.DF	Diff. DF	F	p-value
Complete model	235			
Reduced model	236	-1	0.0785092763003944	0.779574341701213

Granger Causality Test: X = f(Y)				
Model	Res.DF	Diff. DF	F	p-value
Complete model	235			
Reduced model	236	-1	0.00619932132726237	0.937309796369109

Granger Causality FESX(X) and SE (Y) of 05/2014 at 03.30pm – 03.45pm

Granger Causality Test: $Y = f(X)$				
Model	Res.DF	Diff. DF	F	p-value
Complete model	130			
Reduced model	131	-1	0.00151488903906035	0.969012622958102

Granger Causality Test: $X = f(Y)$				
Model	Res.DF	Diff. DF	F	p-value
Complete model	130			
Reduced model	131	-1	0.10465110691635	0.746837764083906

Granger Causality FESX(X) and HSI (Y) of 05/2014 at 04.45pm – 05.00pm

Granger Causality Test: $Y = f(X)$				
Model	Res.DF	Diff. DF	F	p-value
Complete model	251			
Reduced model	252	-1	0.00015523019864002	0.990069197967778

Granger Causality Test: $X = f(Y)$				
Model	Res.DF	Diff. DF	F	p-value
Complete model	251			
Reduced model	252	-1	215.576675036939	1.1927995162075e-35

Granger Causality FESX(X) and HSI (Y) of 03/2014 at 08.00am – 08.15am

Granger Causality Test: $Y = f(X)$				
Model	Res.DF	Diff. DF	F	p-value
Complete model	203			
Reduced model	204	-1	0.274631090197352	0.600813680179402

Granger Causality Test: $X = f(Y)$				
Model	Res.DF	Diff. DF	F	p-value
Complete model	203			
Reduced model	204	-1	0.418173082692484	0.518580519868642

Granger Causality FESX(X) and HSI (Y) of 04/2014 at 08.00am – 08.15am

Granger Causality Test: $Y = f(X)$				
Model	Res.DF	Diff. DF	F	p-value
Complete model	130			
Reduced model	131	-1	0.00301928661235498	0.9562642195735

Granger Causality Test: $X = f(Y)$				
Model	Res.DF	Diff. DF	F	p-value
Complete model	130			
Reduced model	131	-1	7.47523960612177e-05	0.993114872380141

Granger Causality FESX(X) and HSI (Y) of 05/2014 at 08.00am – 08.15am

Abstract

Diese Masterarbeit ist in zwei große Teile aufgebaut. Die Unterteilung in einen theoretischen als auch einen praktischen Abschnitt, resultiert aus der Grundidee theoretisches Wissen einer Handelsstrategie in die Praxis umzusetzen. Zu Beginn wird ein kurzer Einblick in die Welt des Trading gegeben, wobei insbesondere auf die Wichtigkeit der Technischen Analyse von Finanzmärkten eingegangen wird. Themen wie verschiedene Stufen des Traden, Day-Trading oder Traden mit dem Trend werden insbesondere behandelt. Im vierten Kapitel wird der Fokus auf die Analyse einzelner Trading – Strategien gerichtet. Dabei werden die Strategien verbunden mit Trendlinien, Candlestick Charts, Moving Average Convergence Divergence und im Abschluss sogenannte Pivot Points behandelt. Vor allem der letztgenannten Strategie kommt besondere Bedeutung zu, da sie für die weitere empirische Analyse von signifikanter Wichtigkeit ist. Diese Trading Strategie wird nämlich aufgrund der relativ einfacheren Umsetzbarkeit anhand von Backtesting in die Praxis umgesetzt. Mit diesem Entschluss beginnt auch schon der zweite große Abschnitt der vorliegenden Arbeit, die empirische Analyse. In erster Linie geht es darum, die sogenannte Pivot Point Strategie anhand von drei verschiedenen Indices (Euro Stoxx 50, S&P 500, Hang Seng Index) zu testen. Diese Technik basiert auf Kauf und Verkaufssignalen die tagtäglich mit vorhergehenden Daten berechnet werden und beim Über- bzw. Unterschreiten dieser Levels wird ein Kauf und Verkauf bzw. Stop-Loss Signal gegeben. In dieser Arbeit wird eine Periode von 3 Monaten untersucht (März bis Mai 2014), was nach Kontrolle der Qualität der Daten schlussendlich zu 39 Trading Tagen führt. Durch die formulierten Fragestellungen (Hypothesen) wird diese Technik zu drei ausgewählten Zeitpunkten durchgeführt, nämlich immer dann, wenn eine der drei zugrundeliegenden Börsen (Eurex, NYSE, Hong Kong stock exchange) öffnet oder schließt. Daraus ergibt sich, dass um 08.00, um 15.30 und 17 Uhr für 9 Minuten getradet wird. Zuvor werden aber die Korrelationen zwischen den einzelnen Datenpaaren getestet, zum einen während der genannten Handelsfenster, zum anderen aber auch über den Rest eines Handelstages. Ein Trading-Tag reicht von 08.00 früh bis 17 Uhr abends (bestimmt durch europäische Handelszeit). Dabei sind die zuvor genannten Zeitpunkte von großer Bedeutung, da zu dieser Zeit immer eine Börse öffnet bzw. schließt, während eine andere schon aktiv ist. Zum Beispiel, Eurex öffnet um 08.00, wobei Hong Kong schon lange aktiv ist – somit wird dieser Punkt sehr interessant für die Kombination FESX und HSI sein. Um 15.30 öffnet NYSE und ab diesem Zeitpunkt sind alle drei Börsen für weitere 90 Minuten zeitgleich offen. Um 17 Uhr wird es nochmals interessant wenn Hong Kong's Börse schließt. Zunächst wird die PP Strategie für jeden Index einzeln gefahren und der Gesamtreturn über den drei-monatigen Zeitraum berechnet. Danach werden

ausgewählte Datenpaare kombiniert und ein sogenanntes „Signal Trading“ durchgeführt. Beim Signal Trading geht es darum, dass Handelssignale von einem Index an einen anderen eingesetzt werden. Im Anschluss wird geprüft, ob eine Outperformance durch dieses Vorgehen möglich ist.

Nachdem die Hintergründe dieser Masterarbeit kurz dargestellt wurden, sollen nun die wichtigsten Ergebnisse dargelegt werden. Die Korrelationsergebnisse zeigten für die Monate März und Mai sehr eindeutige und hohe Werte, während der April etwas niedrigere und nicht sehr aussagekräftige Zahlen lieferte. Daher sieht man, dass die einzelnen Börsen in Relation und gewisser Abhängigkeit sich bewegen, jedoch jede Börse eigenständig für sich selbst bleibt. Insbesondere SE und FESX zeigten größtenteils eine starke Abhängigkeit (zum Beispiel von 15.30 bis 15.45 lag die Korrelation nach Pearson für März und Mai bei ca. 70%). Bezüglich FESX und HSI war auffallend, dass die Korrelation über den Tag hindurch zunahm, d.h. um 08.00 früh war sie am geringsten und endete um 17 Uhr mit dem höchsten Wert. Dies könnte ein Hinweis darauf sein, dass das Schließen in Hong Kong einen stärkeren Einfluss als die Öffnung der Eurex um 08.00 hat. Bezüglich der Trading Strategie ist zunächst zu sagen, dass sie funktioniert. Es war relativ einfach die PP mit deren zugehörigen vier Levels zu berechnen und die daraus entstehenden Kauf und Verkaufssignale zu beachten. Im Einzelfall performte FESX sehr gut, während SE und HSI eher negative Ergebnisse erbrachten. Bei der kombinierten Vorgangsweise, das heißt als Signale von SE an FESX von 15.36 bis 15.45, Signale von HSI an FESX von 16.51 bis 17.00 und Signale von FESX an HSI von 08.06 bis 08.15 angewendet wurden, konnte ein positives Ergebnis bei der letztgenannten Kombination festgestellt werden. Die ersten beiden konnten keine Outperformance generieren. Auch der zugehörige einseitige T-test bestätigte diese Ergebnisse, es konnte nur beim Signal Trading von FESX an HS eine signifikante Überrendite erzielt werden.

Aus den dargelegten Ergebnissen, ergibt sich die Schlussfolgerung, dass die getesteten Indices eine gewisse Verbindung zueinander haben. Jedoch kann keine allgemein geltende Conclusio gezogen werden, da die Ergebnisse teilweise nicht eindeutig waren. Auch für die angewandte PP Strategie tritt dasselbe Fazit ein. Da die Ergebnisse sowohl positiv als auch negativ waren, kann keine signifikante und gültige Schlussfolgerung gezogen werden. In beiden Fällen könnte die kleine Datenmenge ein Grund dafür sein. Somit kann diese Masterarbeit den Startpunkt für weitere Analysen und Forschungsvorhaben liefern, da die zugrunde liegenden Hypothesen teilweise bestätigt wurden und für eine aussagekräftigere Conclusio noch etwas Recherche – und Forschungsarbeit besteht. Der Grundstein ist aber gelegt.

Schneider Elke Maria, BSc.



„Believe and Achieve – This attitude helps me to see every challenge as a new change to grow with it.

I am an ambitious, diligent lively and open person.“

Professional Career

- | | |
|--------------------------|--|
| 10/2014 – 11/2014 | confirmed internship at Janney Montgomery Scott LLC, Connecticut(USA)
Different projects in the field of Asset and Portfoliomanagement |
| 03/2013 – 06/2014 | Student Assistant at the Finance Department of the Faculty of Business, Economics and Statistics of University of Vienna
Assisting with the preparation and organization of lectures, Dealing with inquiries and problems of students, Assisting with the day-to-day business of the department |
| 07/2013 - 08/2013 | Internship at MED-EL Madrid
Accountancy services for the firm's office, Assisting in various other departments (Service Desk, HR, Clinical Engineering), Research of various competitors concerning their online performance |
| 08/2012 - 10/2012 | Internship at the Austrian Trade Commission in Mexico City
Assisting for the compilation and correction of various country reports, Research for various projects in Central America, Translations, Dealing with inquiries from Austrian companies concerning the Mexican market, Preparing and participating in the "Green Expo 2012" |
| 09/2011 - 04/2012 | Accountant at Mercatis Consulting GmbH
Accountancy services for the firm's office in Austria and Switzerland |
| 08/2011 | Internship at Erste Group Bank AG
Different administrative and organizational tasks |
| 10/2009 – 12/2009 | Accountant at Tax Consultant Greilinger
Accountancy services for different small businesses |

Education

Since 10/2013

Investment Managerin at Research Institute for Capital Markets, Vienna

Overseeing the performance of a portfolio with 11 other students, Analysis and presentation of upcoming investment possibilities, Constant monitoring and management of the portfolio, Attending Technical and Experts Meetings

Since 10/2012

Master Program of International Business Administration, Faculty of Business, Economics and Statistics of University of Vienna

Specialization in Corporate Finance; expected completion at the end of 09/2014
Master Thesis: Interdependencies of major stock market exchange trading hours and their effect on trading signal generation

10/2008 - 06/2012

Bachelor Program of International Business Administration, Vienna University of Economics and Business, BSc

Specialization in Finance and Accounting
Exchange Semester: 02–06/2011 at the Universidad de Autónoma de Madrid
Bachelor Thesis: Regulations of Globalization based on the Banking Sector vs. the Wine Sector

2000 - 2008

Erzbischöfliches Real- und Aufbaugymnasium Hollabrunn

Focus: Humanbiology and –psychology; A-Level

Additional qualifications

06/2014

Master Award of the University of Vienna

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Participant at The Negotiation Challenge 2014 in Iceland

01/2014

Awarding of Performance Scholarship of the University of Vienna

02/2011 – 06/2011

Erasmus Student at the University Autónoma de Madrid

03/2010 – 08/2010

Aupair in England (Beauworth)

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B driving licence

Languages

German

Mother Tongue

English

Fluent

Spanish

Very good

Interests

Travelling

Cooking

Sport like running, snowboarding or joint workouts

Music like playing the flute, piano or guitar

Vienna, September 2014

Elke Schneider