This thesis is about predicting the Euro against the US dollar foreign exchange returns.

Bachelor Thesis in Finance

Predictability of Foreign Exchange Returns

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SUMMARY

This thesis is about understanding the nature of the Foreign Exchange financial market, getting more insight into the factors that drive this market and how we can predict the foreign exchange returns.

Although the FX market has been growing in popularity among traders and investors, this market is still somehow in the shadow of stock markets. Information, theories and investment strategies about stock markets appear in the television, newspaper, articles, journals, academic books and internet. On the other hand there are few articles, journals and academic books that deal exclusively or at least partially with theories and investment strategies about the FX market. At this point, the purpose of this thesis is to shed some light on the biggest by daily turnover financial market. It is going to be shown that this market provides many advantages over traditional stock markets and that investors and traders can profit from the FX market the same way, or even more, as they do from stock markets.

Furthermore, the focus of this thesis is exclusively on Foreign Exchange Spot markets and not on Foreign Exchange Derivatives markets where options, futures, forwards and swaps contracts or instruments are traded on Foreign Exchange currencies. At this point, the terms Foreign Exchange or (FX) for short, refer to Foreign Exchange Spot market throughout the whole thesis.

The sample selection and data analysis are going to be focused on the Euro against the US dollar FX spot market or eur/usd FX market. It is going to be shown that this market does not follow random walk and may not always be efficient. After that, the focus is going to shift to the factors that drive this market. Multiple regressions analysis is going to be used for analysing the predictive power of the selected variables on the eur/usd returns. Furthermore, the highly debated approach of technical analysis is going to be explained and shown to add significant value to predicting and timing the eur/usd exchange rates and thus returns.

Finally, implications and recommendations will be offered for further research and practical application.

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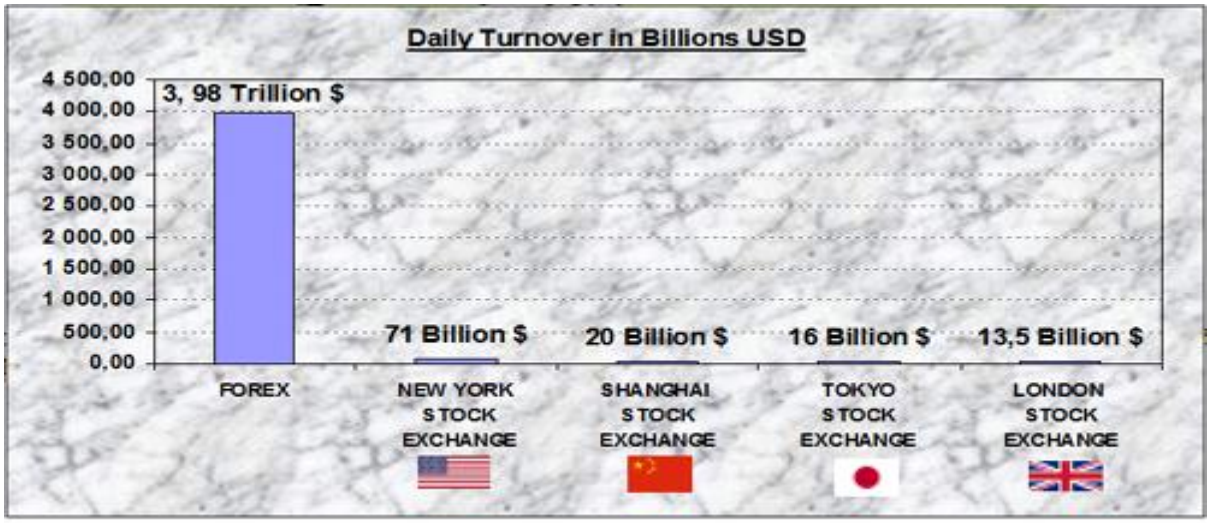
Chapter 1

1.1

What is the Foreign Exchange financial market?

The Foreign Exchange market is a financial market where traders and investors can trade currencies. It is the financial market with the highest daily turnover in the world. ‘’The estimated average daily trading volume of four trillion US dollar in 2010 corresponds to more than ten times that of global equity markets’’ (Mancini, Ronaldo & Wrampelmeyer, 2011). This high daily trading volume implies that the FX market might be the most liquid market in the world. However, the exact volume and thus liquidity remains in shadow because of the nature of the FX market. Graph 1 shows the daily turnover of the FX market compared to various stock exchanges.

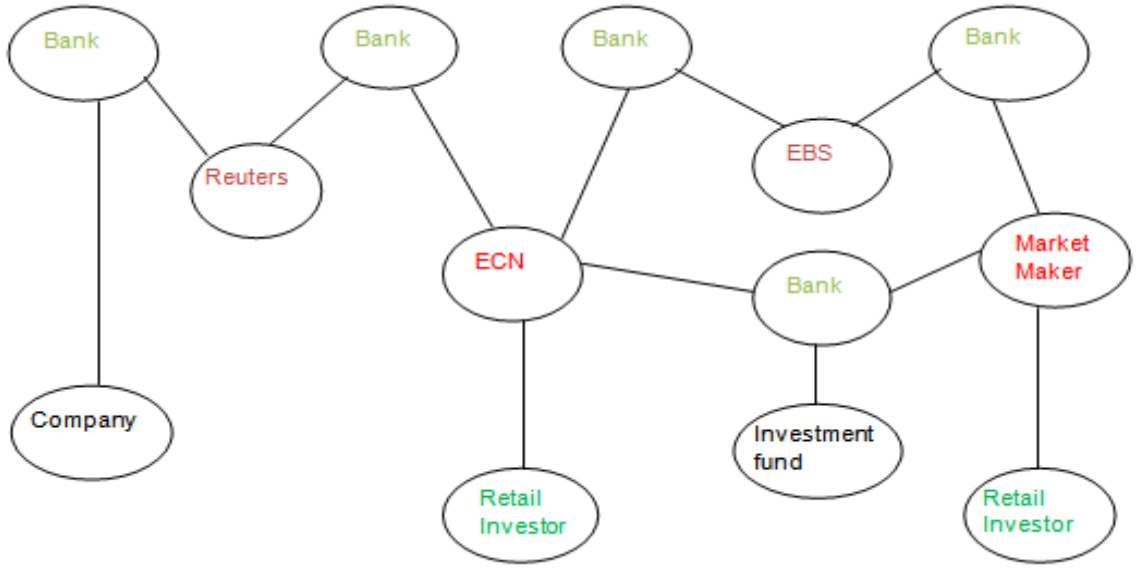
Graph 1



Source: World Federation of Exchanges, Bank of International Settlements

The reason for that is that the FX market is decentralised market. There is not centralised exchange such as NYSE or LSE that can track the volume of currencies trading. Instead, trading takes place Over-the-Counter through the help of electronic trading systems where buyers and sellers meet each other directly or through brokers. ‘’The Forex market consists of a worldwide wired network of buyers and sellers of currencies, with trading all done over-the-counter (OTC), which means that there is no central and clearinghouse where orders are matched’’ (Cheng, 2007). Graph 2 shows the process of the FX trading.

Graph 2



(*Source: fxstat*)

Furthermore, the trading volume continues to expand due to the technology revolution which allows not only big players such as central banks, investment banks and hedge funds to trade but also corporate traders, institutional trades and retail traders. ‘’FX trading volume has exploded reflecting an electronic revolution that has lowered trading costs, attracted new groups of market participants, and enabled aggressive new trading strategies’’ (King, Osler & Rime, 2011).

Traders and Investors can trade any currency on the FX market ranging from prime currencies such as euro against the dollar to exotic currencies such as the US dollar against the Danish krone. However, the most transactions take place between the major pairs such as Euro against the US dollar (eur/usd), US dollar against the Japanese yen (usd/jpy), US dollar against Swiss franc (usd/chf), US dollar against Canadian dollar (usd/cad), the British pound against the US dollar (gbp/usd) Euro against the Swiss Franc (eur/chf) and Australian dollar against the US dollar (aus/usd). In fact, the US dollar, Euro, British pound and Japanese yen form the major currencies which are traded against other.

‘’Another unchanging aspect of FX markets is the dominance of the US dollar (USD), which is still involved on one side of roughly three-quarters of all spot transactions. The euro (EUR) is involved in 46 per cent of trades, in part because it serves as the vehicle within the euro zone. The next most actively traded currencies are the Japanese yen (JPY, 20 per cent),

and the UK pound (GBP. 14 per cent). Together, these four currencies are known as '' the majors'' or (G4)'' (King, Osler & Rime, 2011). Table 1 shows the currencies traded accompanied with their average daily turnover

Table 1

Currency	2004		2007	
	Average daily turnover	% share	Average daily turnover	% share
USD	247	83.5	317.3	82.8
EUR	177	60.1	232.5	60.7
JPY	39	13.3	44.5	11.6
GBP	45	15.3	48.2	12.6
CHF	28	9.5	35.9	9.4
CAD	5	1.6	9.1	2.4
AUD	6	2.1	11.6	3.0
SEK	7	2.2	7.2	1.9
HKD	1	0.5	5.9	1.6
NOK	4	1.4	6.3	1.6
DKK	3	1.2	6.4	1.7
SGD	1	0.3	2.7	0.7
ZAR	1	0.4	2.3	0.6
MXN	1	0.3	1.2	0.3
KRW	0	0.0	0.4	0.1
NZD	1	0.3	3.5	0.9
PLN	3	1.2	4.5	1.2
BRL	0	0.1	0.9	0.2
RUB	0	0.1	1.6	0.4
TWD	0	0.1	0.4	0.1
CZK	2	0.5	2.7	0.7
INR	0	0.0	0.1	0.0
THB	0	0.0	0.1	0.0
HUF	2	0.7	2.8	0.7
Other currencies	15	5.1	18.1	4.7
Total	**590**	**200**	**766**	**200**

(*Average daily turnover in billions of US dollars. Source: European Central Bank*)

The FX currencies can be traded in many ways. The most widely used and the most growing in popularity is the spot FX. This means that two parties agree to buy and sell currency at the same point in time with immediate delivery. Spot FX is responsible for almost the half of the transactions on the FX market and thus half of the volume. The other instruments are swaps, forwards, futures and options. These instruments are traded mainly for hedging and thus they do not directly affect the exchange rates.

''The dominance of spot FX trading is another area of relative stability. Daily spot turnover in 2010 was 1.5 trillion. A number of other currency-related instruments – FX

futures, currency options, FX swaps and currency swaps – swell average daily turnover in FX markets beyond $4 trillion. These assets are traded entirely separately from spot and forward contracts and for entirely different purposes, so they generally have little influence on exchange rates'' (King, Osler & Rime, 2011). Table 2 shows the most traded FX instruments.

Table 2

Global foreign exchange market turnover[1]

Daily averages in April, in billions of US dollars

Instrument/maturity	1998	2001	2004	2007	2010
Foreign exchange instruments	**1,527**	**1,239**	**1,934**	**3,324**	**3,981**
Spot transactions[2]	568	386	631	1,005	1,490
Outright forwards[2]	128	130	209	362	475
Up to 7 days	65	51	92	154	219
Over 7 days	62	80	116	208	256
Foreign exchange swaps[2]	734	656	954	1,714	1,765
Up to 7 days	528	451	700	1,329	1,304
Over 7 days	202	204	252	382	459
Currency swaps	10	7	21	31	43
Options and other products[3]	87	60	119	212	207
Memo:					
Turnover at April 2010 exchange rates[4]	*1,705*	*1,505*	*2,040*	*3,370*	*3,981*
Estimated gaps in reporting	*49*	*30*	*116*	*152*	*144*
Exchange-traded derivatives[5]	*11*	*12*	*26*	*80*	*168*

[1] Adjusted for local and cross-border inter-dealer double-counting (ie "net-net" basis). [2] Previously classified as part of the so-called "Traditional FX market". [3] The category "other FX products" covers highly leveraged transactions and/or trades whose notional amount is variable and where a decomposition into individual plain vanilla components was impractical or impossible. [4] Non-US dollar legs of foreign currency transactions were converted into original currency amounts at average exchange rates for April of each survey year and then reconverted into US dollar amounts at average April 2010 exchange rates. [5] Sources: FOW TRADEdata; Futures Industry Association; various futures and options exchanges. Reported monthly data were converted into daily averages of 20.5 days in 1998, 19.5 days in 2001, 20.5 in 2004, 20 in 2007 and 20 in 2010.

Table B.1

Unlike stock markets, the FX market has its own characteristics that make it unique and distinguished.

First, since it is a decentralised market the FX market is open 24 hours starting from 20:15 GMT on Sunday until 22:00 Friday. This is because there is no exchange where opening hours are fixed. Thus, traders and investors can trade 24 hours because when the banks in one country close the banks in other country opens because of the time zone differences. '' The spot foreign exchange (FX) market is an around-the-clock, around-the-globe, decentralized, multiple-dealer market characterized by an enormous trading volume'' (Jorda & Marcellino, 2002). The busiest trading hours take place during the European session or more precisely during the London banks opening hours followed by the New York opening and the opening in Asia. ''Physically, FX trading remains heavily concentrated in

London, which captures over one-third of global trading, and New York, which captures almost one-fifth of trading''(King, Osler & Rime, 2011).

Second, the FX market provides enormous liquidity. Thus, traders and investors usually do not have to worry about lack of liquidly to match their orders. This is especially the case when the major or (G4) currencies are traded. The reason is that the euro and the dollar are the currencies that are traded most and they are usually the one currency against which others are traded. ''The forex market is the planet's most liquid market. With more than $2 trillion changing hands every day, traders have no worries about liquidity when it comes to trading any of the big-economy currencies: USD, GBP, EUR, CHF, JPY, CAD, AUD and NZD. This is especially the case when they are paired up with the US dollar – at least 80 per cent of foreign exchange transactions have a dollar leg''(Cheng, 2007).

Third, the FX market allows not only going long on currencies but also going short at any time without any restrictions unlike stock markets where often in times of crises short selling is limited or not allowed. '' You can short a currency pair anytime you want, without any restrictions. This is different from some stock markets whereby short – selling is only allowed on an uptick'' (Cheng, 2007).

Fourth, the bid – ask spreads and this transaction costs are relatively small especially when trading the (G4) currencies. ''Spot markets for foreign exchange are widely characterized as the most efficient of asset markets. Transaction costs are small, volume is huge, and information is impounded in prices extremely rapidly'' (Payne, 1999).

Fifth, the FX market is extremely leveraged with low margin requirements. This gives traders and investors a unique opportunity for profits but also for losses. ''In the case of stocks, the initial margin is 50 % of transaction value and in the case of futures it is set by the relevant exchange as an amount on a per contract. In the case of forex, margin can be as low as 1% or even 0.5% of the amount of currency exchanged. Retail forex traders can control $100 000 by depositing as little as $1000'' (Harris, 2009).

Sixth, traders and investors can profit not only from the exchange rate differences but also from the interest rates of the two currencies involved. This is because currencies are traded in pairs and when traders buy one currency they simultaneously sell the other one. Thus, very often traders ''carry trade'' or selling a currency that gives low interest rate and buying the one the gives high interest rate. ''The carry trade refers to the investment strategy

of going long in high – yield currencies and short in low – yield currencies'' (Jorda & Tylor, 2009). In other words, the principal is similar to borrowing and lending money. In the former case, one has to pay interest. Thus, if the interest paid is lower than the interest received the person makes profit.

Technical analysis is the technique of studying historical price levels of a security with the purpose of predicting the future prices. Technical analysis is set on the idea that the price discounts everything and thus it is the ultimate source of information about any security. '' Technical analysis believes that the market is always correct. In other words, rather than trying to consider all the factors that will influence the demand for Gadget International's newest electronic gadget and all the items that will influence the company's cost and supply curve to determine the outlook for the stock's price, the technical analysis believes that all of these factors are already factored into the demand and supply curves and, thus, the price of the company's stock'' (Kirkpatrick & Dahlquist, 2010).

Furthermore, technical analysis considers not only that the price discounts fundamental information about a company's stock but also psychological factors and biases of investors and traders. ''We find that stock prices (and prices for any security in freely traded markets) are influenced by psychological factors as well, most of them indecipherable. Greed, fear cognitive bias, misinformation, expectations, and other factors enter into the price of a security, making the analysis of the factors nearly impossible'' (Kirkpatrick & Dahlquist, 2010).

Technical analysis also assumes that prices tend to move in trends and thus the term of trend is the core principal of the technicians or chartists. ''The technical approach to investment is essentially a reflection of the idea that prices move in trends that are determined by changing attitudes of investors toward a variety of economic, monetary, political, and psychological forces. The art of technical analysis, for it is an art, is to identify a trend reversal at a relatively early stage and ride on that trend until the weight of the evidence shows or proves that the trend has reversed''(Pring, 2002). Nowadays, technical analysis is getting more and more attention by novice traders and investors.

The organization named market technician association (MTA) is currently known to be the best in the world in technical analysis education. It provides the renowned title named chartered market technician (CMT) to all students who complete three level exams.

1.2

Predicting the currencies prices and thus return is not an easy task. This is because of the huge turnover and liquidity that make the currencies prices oscillate every second. Furthermore, when traders and investors trade currencies they trade one nation's national currency against another. The traders and investors have to analyse a lot of factors that affect not only one representative currency but two because currencies are traded in pairs.

Thus, extensive knowledge with regards to different micro and macroeconomic, monetary, political, fundamental and even psychological variables is required in order for traders and investors to get clearer picture of where the currencies prices might be heading to in the future. However, with the right variables and approach traders and investors are able to gain competitive edge in predicting the currencies pries and thus returns. At this point, the problem statement of this thesis is;

1.3

How can foreign exchange returns be predicted?

1.4

Before answering the research question, several subs – research questions will be answered. Thus, the subs – research questions considered are;

1. ***Are the FX markets efficient?***
2. ***Do the FX markets follow random walk?***
3. ***Factors affecting the FX markets***
4. ***Can Technical Analysis be used to predict FX returns?***

Chapter 2

2.1

The Efficient Market Hypothesis claims that markets are efficient meaning that the price of a security can only change based on new information which will be incorporated in a price of security immediately when available. ‘’A market in which prices always fully reflect available information is called efficient’’ (Fama, 1970).

The FX market can be said to be efficient since the prices of currencies incorporates new information extremely rapidly based on the low transaction costs, volume and liquidity. ‘’ Spot markets for foreign exchange are widely characterised as the most efficient of asset markets. Transaction costs are small, volume is huge and information is impounded in prices extremely rapidly. Further, it is widely believed that information asymmetries in these markets are of minor importance’’ (Payne, 1999).

However, the FX market can also be extremely noisy. Even though the huge volume, low transaction costs and liquidly make the FX market efficient, they also add to very high speculation where the prices of currencies will often fluctuate below their average. A perfect example of FX market inefficiency is the case with George Soros that ‘’broke the Pound’’ in 1992. ‘’The market mechanism fails to bring currencies back into alignment. On the contrary, speculation tends to exaggerate currency moves. The system of freely floating currencies is cumulatively destabilizing’’ (Soros, 2003).

Understanding whether the FX market is efficient, or at least to some extent, is important because in general market efficiency does not allow participants to profit from “buying low and selling high’’. ‘’The accepted view was that when information arises, the news spread very quickly and is incorporated into the prices of securities without delay. Thus, neither technical analysis, which is the study of past stock prices in an attempt to predict future prices, nor even fundamental analysis, which is the analysis of financial information such as company earnings, asset values etc., to help investors select undervalued stocks, would enable an investor to achieve returns greater than those that could be obtained by holding a randomly selected portfolio of individual stocks with comparable risk’’ (Malkiel, 2003).

Although the FX market is highly efficient, there is a room for predicting currencies prices and thus returns because of the fact that the most currencies traded have floating rates which gives rise to speculation, similar to that during 1992, that takes place very often.

2.2

The Random Walk Hypothesis claims that the prices of securities follow "random walk" meaning that predicting the future prices is impossible simply because the prices of securities are independent of one another.

''The logic of the random walk idea is that if the flow of information is unimpeded and information is immediately reflected in stock prices, then tomorrow's price change will reflect only tomorrow's news and will be independent of the price changes today. But news is by definition unpredictable and, thus, resulting prices must be unpredictable and random'' (Malkiel, 2003). Although the FX markets can be considered to be efficient, they do not follow random walk.

Graph 3

Source: Dukascopy

Graph 3 shows the Euro against the US dollar exchange rate from 1998-10-08 (the top circle) to 1999-07-12 (the bottom circle). During that period (almost one year) the Euro depreciated against the US dollar from approximately 1.2391 (the top) to 1.0119 (the bottom). This means that the Euro deprecated against the US dollar with more than 22 percents. Obviously this happened because of the eur/usd downtrend. This means that the

Random Walk Hypothesis fails with regards to the FX markets because prices can not simply follow random walk and trend at the same time.

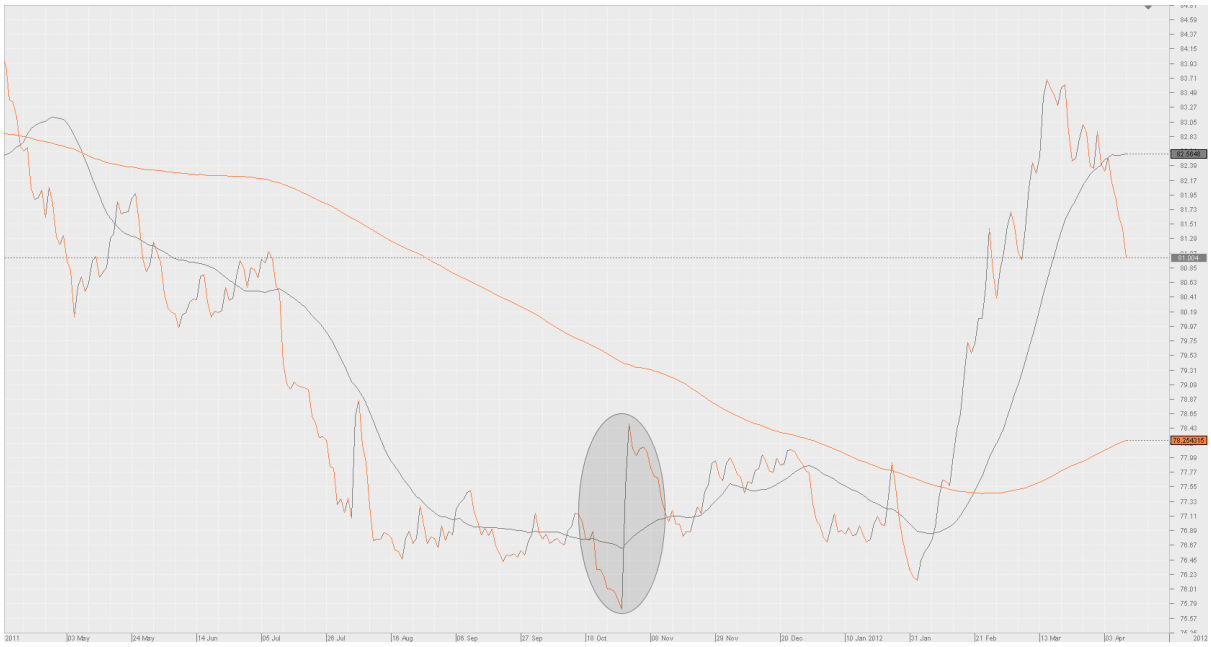
Trending implies that participants are selling Euros and buying dollars and thus keep building up the downtrend. This implies that the prices are not independent if they are trending. In other words, it can be said that the prices did have memory and did not behave randomly during the 1998-1999 period.

2.3

The factors affecting the FX market are many ranging from political, economic, and technical to psychological. This is because when traders and investors participate on the markets they trade one currency against another. This means that the participants are exposed to huge information flow coming not only from one country but from two.

The most significant economic drivers are releases about GDP, Inflation rates, Interest rates, Unemployment rates sand Trade balances. Thus, all of these drivers can make one currency depreciate/appreciate against its counterparty when actual numbers are higher/lower than expected numbers. Another important driver particularly strong in the FX markets is Monetary policy.

Graph 4



Introd*: Dukascopy*

Graph 4 shows the Intervention of Bank of Japan (BOE) on the Forex market during 2011-09-31. During that date the BOE decided to buy Japanese yens and sell US dollars (usd/jpy). The reason for that intervention was the monetary policy of Japan to weaken the strong yen relative to the US dollar because of the consequences that the strong yen can have on the country's export of goods.

''The Bank of Japan eased monetary policy by boosting its asset buying scheme in a rate review that was cut short by one day in the wake of Tokyo's solo intervention to weaken the yen'' (Reuters, 2011). During that single day the usd/jpy rate changed with more than 3 percents.

Psychology tends to play major role in the FX market. On this market, players often use ''rules of thumbs'' or "heuristics'' meaning that participants tend to use simple rules determining the direction of the market. This is because of the huge information flow that often cannot be assimilated in a timely manner because of cognitive limitations. Thus, terms like ''herding'' or ''going against'' the crowd play more important role in the FX market than any other financial market. At this point, behavioral finance can be extremely useful tool that can help traders and investors in their exchange rates predictions.

''Behavioral finance is the study of the influence of psychology on the behavior of financial practitioners and the subsequent effect on markets. Behavioral finance is of interest because it helps explain why and how markets might be inefficient'' (Sewell. 2010).

2.4

Having showed that the FX markets are not always efficient, they do not follow random walk and that there are many drivers, because of the nature of the FX markets, that can influence the exchange rates, technical analysis can be a valuable tool for predicting FX returns. However, there are numerous arguments and theories that refuse the use of technical analysis as an investment tool and deny its practical application.

''Technical analysis, also known as charting has been part of financial practice for many decades, but this discipline has not yet received the same level of academic scrutiny and acceptance as more traditional approaches such as fundamental analysis. One of the main obstacles is the highly subjective nature of technical analysis – the presence of geometric shapes in historical price charts is often in the eyes of the beholder'' (Lo, Mamaysky & Wang, 2000).

It can be said that technical analysis application is subjective and depends on the practitioners' skills. However, it can be concluded that fundamental analysis is subjective too. After all, if any analysis was objective then this would mean that every trader or investor would be successful and rich. At this point, technical analysis is not subjective on its own nature but depends merely on the practitioners' skills and expertise. Furthermore, technical analysis seems to work very well on the FX markets. This is because of the reason that exchange rates tend to trend. Trends can range from short term (1 – 6 months) to long term (1 – 3 years).

''Although modern technical analysis was originally developed in the context of the stock market, its advocates argue that it applies in one form or another to all asset markets. Since the era of floating exchange rates began in the early 1970s, foreign currency traders have widely adopted this approach to trading. At least some technicians clearly believe that the foreign exchange market is particularly prone to trending'' (Neely & Weller, 2011).

Chapter 3

3.1

In order to predict the eur/usd exchange returns a model will be constructed. This model will include one dependent variable (***eur/usd exchange rate***) and five independent variables (***volume***, ***rate of change***, ***pivot point***, ***brent crude oil*** and ***usd dollar index price***). At this point, the complete model that will be considered is going to be;

$$\mathbf{Y = \beta_0 + \beta_1 Vol + \beta_2 ROC14 + \beta_3 Pp + \beta_4 BCO + \beta_5 USDX}$$

Furthermore, the independent variables can be classified as being fundamental (***brent crude oil, usd dollar index*** and ***volume***) and technical (***rate of change and pivot point***). At this point, the main model is going to be divided into two models testing the predictive power of the fundamental and technical independent variables on the dependent variable. This division is going to be helpful in analysing and comparing the predictive power of both fundamental and technical analysis on the dependent variable (eur/usd exchante price).

Thus, the first sub model based on only independent fundamental variables that is going to be considered is;

$$\mathbf{Y = \beta_0 + \beta_1 VOL + \beta_2 BCO + \beta_3 USDX}$$

The second sub model based on independent technical variables is;

$$\mathbf{Y = \beta_0 + \beta_1 ROC14 + \beta_2 Pp}$$

Furthermore, the models are going to be tested using multiple regressions analysis. Before presenting the results of the multiple regressions analysis correlations and descriptive statistics are going to be presented for background information. After running the models and analysing the predictive power of the independent variables, the technical analysis approach is going to be presented with the purpose of applying technical rules that are going to be shown add value in predicting eur/usd exchange rates and thus returns.

In general the expected outcomes, and thus hypotheses, from the multiple regression analysis are;

H1 = *Volume has negative effect on eur/usd exchange rate*

H2 = *Brent crude oil price has positive effect on eur/usd exchange rate*

H3 = *US dollar index price has positive effect on eur/usd exchange rate*

H4 = *Rate of Change (14) has positive effect on eur/usd exchange rate*

H5 = *Pivot Point has positive effect on eur/usd exchange rate*

3.2

As it has been shown, the independent variables considered in the model can be described as fundamental and technical. Each of the independent variables has its own unique characteristics and application when it comes to the foreign exchange market.

Volume – Volume has always been an elusive part of the FX market. This is because of the lack of centralised exchange where deals are matched. At this point, the exact volume in FX market is unknown because deals are made OTC (over-the-counter). However, some brokers do provide the volume that they record during the day on every FX currency pair. At this point, traders and investors do have an approximation of how much trading activity is taking place.

The volume numbers that are going to be used in this model are going to be collected from a leading FX broker called Dukascopy. This broker is the largest FX liquidity provider in Europe that provides FX trading for institutional and private investors and trades. Thus, the volume that goes each day through this broker could be used as a benchmark for the whole FX trading volume in Europe. Logically, since almost half of the daily FX turnover takes place in Europe volume data collected from this broker could serve as an important proxy for the total daily volume in the FX market. The volume data is in millions.

Brent Crude Oil – This is one of the main types of oils that are traded. It is used as a benchmark for other types of oil classifications. This is important variable since crude oil prices are closely connected with the USD dollar exchange rate compared to its counterparties. A lot of traders and investors often hedge their currency exposures with the oil prices. The reason is that the crude oil prices are viewed as a counter measure to the USD dollar. Similarly like Gold, crude oil prices are expected to rise when the USD dollar depreciate against other currencies.

USDX (USD dollar Index) – The USD dollar index measure the value of the USD dollar compared to group of other currencies. Currently the currencies that the USD dollar is measured against are the EUR, GBP, CHF, JPY, SEK and CAD. At this point, the index is weighted average of the value of the USD dollar. The advantage of the USD dollar index is that it can also be traded as a single product for hedging purposes.

Pivot Point – The first technical independent variable is called Pivot Point. The Pivot Point is a point (price) of critical importance for the day the trading is taking place. It is a technical variable derived with the following formula; (**High + Low + Close / 3**). It can be calculated for each trading day on the basis of the previous trading day. It can also be calculated for weekly and monthly even annually data.

This technical variable is important because of its own nature of calculating the equilibrium price between buyers and sellers for the next day's trading range based on the trading range and activity of the previous day's closing price. Thus, it is used as a benchmark of what price is of critical importance for the next day. It is simple technical variable based on the formula and yet very useful one.

Using the Pivot Point traders and investors can take advantage of any price that might be higher or lower than the benchmark and thus designing suitable strategies for exploiting the price fluctuations.

Rate of Change (14) – The second technical variable considered in the model is called Rate of Change calculated for 14 periods or 14 daily closing prices. The Rate of Change is actually a pure momentum indicator. It is calculated using the formula; (**close today – close n periods ago/ close n periods ago**) ***100**. It measures the change in the current price compared to a price n periods ago. The result is often represented as a ratio. The calculated number can take any value ranging from minus to plus infinity. Thus, this technical indicator does not have any boundaries.

As a momentum indicator the Rate of Change is also simple and yet useful tool for comparing how fast prices of a security are accelerating. At this point, this indicator often reacts faster than the price itself to tell whether prices reach extremes. Thus, the Rate of Change is a leading and not lagging momentum indicator compared to a simple moving average. Since it is a momentum indicator traders and investors usually use it for timing the market. In other words, significant increase/decrease in the Rate of Change can suggest too high/low levels of price change. However, this indicator has also some drawbacks.

First, it just compares the price today to the price n periods ago and thus dropping the prices in between.

Second, it does not have any boundaries and thus tends to become subjective in a sense that traders and investors must rely on experience and own sense in determining what might be considered high and low levels of price change.

Despite the drawbacks inherited in this indicator, it often turns out to give a good indication of what is happening with the price of a security. The Rate of Change in this model is going to be calculated on 14 periods of daily closing prices.

Chapter 4

4.1

Although the factors affecting the FX markets are many, these variables are of little help when trying to study their relationship with the exchange rates. This is because of several reasons.

First, information about GDP, Trade balances, Inflation rates, Interest rates and Unemployment is released quarterly and not every day. Thus, these variables tend to be more macroeconomic than microeconomic variables. At this point, they would significant effect on exchange rates when the information is released but they usually are lagging exchange rates because they are not daily adjusted. Thus, exchange rates tend to fluctuate even without information release about these variables.

Second, most of the significant factors that affect the FX markets are not observable. For instance, psychological and monetary factors can not be objectively measured (fear, greed and policy of national banks are unknown, they can not be measured but their effect on the markets can be observed).

This is the reason why the independent variables described above are considered in the model. Data about the fundamental variables is available daily that match the daily time horizon of the dependent variable eur/usd exchange rates. The technical independent variables also lend themselves to daily calculations.

In order to collect data about the dependent variable eur/usd exchange rates, daily data of closing prices is going to be used. Closing prices are considered instead of open, high and low prices because the closing prices tend to be the more objective in a sense that they summarize the daily trading activity for the eur/usd exchange rate.

Closing prices also shows the final price at which deals are made. They also show the price at which traders and investors are willing to hold overnight (Saturday 00:00:01 GMT +1 to Sunday 00:00:00 GMT +1). Thus, the daily closing prices of eur/usd exchange rates are going to be collected from 01.11.2004 to 30.03.2012.

The data is going to be downloaded from the leading European FX liquidity provider Dukasocpy. Furthermore, since the FX market is a decentralized market that is operating 24

hours and the daily data is downloaded from a European Fx broker, a typical trading day is considered to start on Monday 00:00:01 GMT +1 and ends at 00:00:01 GMT + 1 on Tuesday. The same logic applies for the next days except Saturday

In order to collect volume numbers, the FX broker Dukascopy is going to be used. The volume is going to summarize the total volume traded for eur/usd currency pair on each day for the selected testing period. It is going to be represented in millions.

Data for the Brent Crude oil independent variable with the same range, as the eur/usd exchange rates, of daily closing prices is going to be collected from the Chicago Mercantile Exchange website.The Chicago Mercantile Exchange is the largest derivatives exchange in the world. Thus, it is the best source of information about derivatives on commodities because it provides the highest trading volume with regards to commodity trading. The Brent Crude Oil is a commodity itself that can be traded using futures or options. The data that is going to be collected is going to be based on futures contract prices and not on options.

The same logic applies to the USD dollar index. Information about daily closing prices is going to be collected from the CME Group website. Again, futures prices are going to be considered.

The calculation of the Pivot Point is going to be based on the following formula **(High + Low +Close)/3**. Thus, for each successive trading day data about high, low and closing prices of the previous trading day is needed. At this point, there is going to be a missing Pivot Point value on 01.11.2004 because the high, low and closing prices of the previous trading day are unknown.

In order to calculate the Rate of Change of 14 days of closing prices, the following formula is going to be used (**close today – close n periods ago/ close n periods ago**) ***100**. This means that the first value of Rate of Change of 14 days is going to be on 22.11.2004.

The reasons for choosing 14 periods of daily closing data is that this time horizon is the minimum horizon that allows traders and investors to observe a noticeable change in a trend in a currency pair. If the time horizon is too narrow the data is going to be too noise to have any significant meaning. Logically, if the horizon is too wider the indicator is going to be too slow in warning any potential signals about changing in price.

To summarize, the data about the fundamental independent variables are going to be collected directly from the broker Dukascopy and the CME Group website. Since the technical independent variables are derivatives of the eur/usd exchange rate (they derive their values from the exchange rates) they are going to be calculated for each trading day according the formulas above.

In addition, there might be days on which data for the Brent Crude Oil and US dollar index differs with that of the eur/usd exchange rate. This is because of national holidays or presidential elections. At this point, there might be days on which an exchange rate for the eur/usd is avaible but there is no closing price for the Brent Crude Oil and/or US dollar index. Thus, whenever this situation exists the missing closing prices for each day will be substituted with the closing price of the previous day.

Furthermore, in order to match the values of the dependent variable with the values of the independent variable the regressions analysis will be running from 19.11.2004 to 30.03.2012. This is because at that date all the values of the independent variables (in particular the *Pivot Point* and the *Roc14*) match with the values of the dependent variable.

4.2

Table 3

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
eur_usd_rate	1958	1.16700	1.59730	1.3499001	.09573149
volume	1958	.00000	789539.00000	206903.1731103	145654.66858485
roc14	1958	-9.49872	12.64975	.0514951	2.52806543
pivot_point	1958	1.16823	1.59410	1.3498808	.09559861
bco	1958	33.73000	143.95000	78.7003013	24.57164384
usdx	1958	8.10000	89.20000	56.7751788	32.94519313
Valid N (listwise)	1958				

Table 3 shows descriptive statistics of the dependent and independent variables. The maximum and minimum values for each variable can be observed together with their mean and standard deviation values. What is interesting in this table is the maximum price for a

Brent Crude Oil, almost $ 144 per barrel. Another interesting observation is the maximum value of the USD dollar index at $ 89.200. This means that for almost 8 years the USD dollar is still depreciated against the major currencies (originally the USD dollar index had a value of $100).

Table 4

Correlations

		eur_usd_rate	volume	roc14	pivot_point	bco	usdx
eur_usd_rate	Pearson Correlation	1	.245**	.176**	.995**	.591**	.558**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	1958	1958	1958	1958	1958	1958
volume	Pearson Correlation	.245**	1	-.062**	.248**	.408**	.589**
	Sig. (2-tailed)	.000		.006	.000	.000	.000
	N	1958	1958	1958	1958	1958	1958
roc14	Pearson Correlation	.176**	-.062**	1	.142**	.001	-.031
	Sig. (2-tailed)	.000	.006		.000	.958	.172
	N	1958	1958	1958	1958	1958	1958
pivot_point	Pearson Correlation	.995**	.248**	.142**	1	.592**	.560**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	1958	1958	1958	1958	1958	1958
bco	Pearson Correlation	.591**	.408**	.001	.592**	1	.499**
	Sig. (2-tailed)	.000	.000	.958	.000		.000
	N	1958	1958	1958	1958	1958	1958
usdx	Pearson Correlation	.558**	.589**	-.031	.560**	.499**	1
	Sig. (2-tailed)	.000	.000	.172	.000	.000	
	N	1958	1958	1958	1958	1958	1958

Table 4 shows the correlation between the variables in the model. What is particularly interesting to observe is the correlation between the dependent variable and the independent variable *pivot point*, correlation of almost 1. However, this is not a surprising fact knowing that the *pivot point* is a derivative of the eur/usd exchange rate. Another interesting fact is the positive correlation between the eur/usd exchange rate, the Brent Crude Oil and USD dollar index, 0.591 and 0.558 respectively. Thus means that it would not be a good idea to use the Brent Crude Oil and USD dollar index as a hedging instrument against depreciating eur/usd exchange rate since they tend to move together in a direction which is surprising.

Table 5

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Esti-mate
1	.996[a]	.991	.991	.00901849

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17.776	5	3.555	43712.048	.000[b]
	Residual	.159	1952	.000		
	Total	17.935	1957			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.019	.004		5.488	.000
	volume	-2.230E-009	.000	-.003	-1.240	.215
	roc14	.001	.000	.037	16.925	.000
	pivot_point	.983	.003	.982	329.066	.000
	bco	2.885E-005	.000	.007	2.626	.009
	usdx	2.198E-005	.000	.008	2.418	.016

Table 5 shows the results of the multiple regression analysis when considering the whole model. It turns out that the model is extremely predictive since the $\mathbf{R^2}$ is 0.991. In other words, 99 of the variation in the eur/usd exchange rate can be explained by the independent variables considered as a whole. The ANOVA table also shows the residual value meaning the unexplained part of the model which is 1.

However, when considering the independent variables individually the situation is very different. All of the independent variables are significant at 0.05 except *volume*. Next,

the slope of the independent variable *volume* turns out to be negative as well. Furthermore, the slopes of the Brent Crude Oil and USD dollar index are also with little positive values (2.885E-005 and2.198E-005 respectively) even though they are significant. From the two technical independent variables the *pivot point* turns out to have the strongest positive relationship with the eur/usd exchange because of it its slope of 0.983. Even more, when considering the whole model it turns out that the predictability of the model is highly influenced by the *pivot point* itself.

Table 6

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.685[a]	.469	.468	.06982580

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.408	3	2.803	574.827	.000[b]
	Residual	9.527	1954	.005		
	Total	17.935	1957			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.165	.005		219.822	.000
	volume	-1.355E-007	.000	-.206	-9.971	.000
	bco	.002	.000	.448	23.202	.000
	usdx	.001	.000	.456	20.942	.000

Table 6 shows the results of the multiple regression analysis when considering the predictive power of the fundamental independent variables on the dependent variable. When considering only the fundamental independent variables we can see that the prediction power of the model decreases to 0.469. However, under this model all the independent variables are significant at 0.05 including *volume*. Furthermore, volume still has a negative slope and the

slopes of the *Brent Crude Oil* and *USD dollar index* are still with very low predictive power even though they have positive relationship with eur/usd exchange rate.

Table 7

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Esti-mate
1	.996[a]	.991	.991	.00904558

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17.775	2	8.887	108619.246	.000[b]
	Residual	.160	1955	.000		
	Total	17.935	1957			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.012	.003		4.035	.000
	roc14	.001	.000	.036	16.549	.000
	pivot_point	.991	.002	.990	458.764	.000

Table 7 shows the results of the multiple regression analysis when considering the predictive power of the technical independent variables on the dependent variable. What is interesting to observe is that the model does not differ substantially from the complete model. The $\mathbf{R^2}$ is still 99%. The independent variables are still significant at 0.05 % and the pivot point still appears to have significant positive effect on eur/usd exchange rate because of its slope of 0.991%.

Chapter 5

The tables with descriptive statistics provide interesting information with regards to predicting the eur/usd exchange rates and thus returns.

First, from table 3 it is clear that the minimum daily eur/usd traded *volume* for the selected time period is 0 and the maximum is 789 539 millions. Knowing that the *volume* data for the eur/usd currency pair is obtained from the largest FX liquidity provider in Europe, it is interesting to observe that this provider can handle 0.05% at best on a given day of the total FX traded volume. Table 4 shows the correlation between *volume* and eur/usd exchange rates. The correlation appears to be positive with a value of 0.245. Knowing that the maximum correlations range between -1(perfectly negative) and +1(perfectly positive) we can say that although there is positive correlation between the volume and eur/usd exchange rate the correlation is not that strong.

Second, when considering *roc14* some interesting information is also presented in table 3 and 4. The minimum and maximum values of this variable are -9.49872 and 12.64975 respectively. On the one hand, it is difficult to interpret the negative and positive values of *roc14* since this variable is in fact a pure technical indicator without upper and lower bounds. On the other hand, knowing that the middle point is 0 that is, when the current day price is equal to the price 14 days ago, we can observe how distant the current price was relative to the price 14 days ago. Table 4 shows the correlation between *roc14* and eur/usd exchange rates, a correlation of 0.176. Here again there is a positive correlation but because of the value we can say that the correlation is not that strong.

Third, there is very interesting information with regards to the *pivot point*. There appears to be a pattern that can be seen form table 3. The minimum and maximum values of the *pivot point* are almost identical to the minimum and maximum values of the eur/usd exchange rates. One reason for this might be the fact that the pivot point is nothing more than just a derivative of the eur/usd exchange rates. The correlation that can be found in table 4 between the two variables also is also very convincing, a correlation of 0.995. Thus, this pattern found in table 3 is supported by the correlation coefficient found in table 4 in a sense that the *pivot point* is closely related to the eur/usd exchange rate.

Fourth, table 3 shows also the minimum and maximum values of the *Brent Crude oil*. The minimum and maximum price for the selected period is $ 33.73 and $ 143.95 per barrel.

Table 4 shows the correlation between the *Brent Crude oil* and the eur/usd exchange rates, a correlation of 0.591. The correlation between *Brent Crude oil* and eur/usd exchange rate is interesting to observe. This is because the *Brent Crude oil* tend to move together with eur/usd exchange rates which is contrary to the general view that when the USD dollar appreciates against the Euro, the *Brent Crude oil* tends to depreciate and vice versa. This correlation implies that it might not be a good idea to hedge eur/usd exposures with *Brent Crude oil* futures or options.

Fifth, table 3 shows the minimum and maximum values for the *USD dollar index*, $ 8.1 and $ 89.2 respectively. It is interesting to observe that the maximum value of the *USD dollar index* is under its initial value of $ 100. This means that the USD dollar is still highly depreciated against the major currencies it is traded against. The correlation coefficient, which can be found in table 4, between the *USD dollar index* and the eur/usd exchange rates is 0.558. Similarly as the Brent Crude oil the *USD dollar index* is positively correlated and it also appears not very wise decision being used as a hedge against eur/usd exposures.

The results from the multiple regression analysis are presented in table 5, 6 and 7. Table 5 provides the multiple regression analysis results of the complete model while tables 6 and 7 provide the multiple regression analysis results of the two sub models. These tables reveal some surprising information.

Table 5 shows the R^2 coefficient of the model when all the independent variables are considered. The maximum value this coefficient can take is 1 and it shows the predictive power of the independent variables on the dependent variable. In this case, the value of the R^2 is 0.991 very close to 1. This means that when taken together, the independent variables have significant effect on the eur/usd exchange rates. In other words, the selected independent variables as a set explain very well the movement of the eur/usd exchange rates. However, when looking at the independent variables individually there is another interesting observation. As said earlier, all independent variables are significant except *volume* with value of 0.215 which is greater than the allowed 0.05% significance level. Furthermore, from all the independent variables the *pivot point* turns out to have the strongest predictive power towards the eur/usd exchange rates with a *slope* of 0.983. This means that if the *pivot point* increases with 1 then the eur/usd exchange rates tend to increase with 0.983. The independent variable *roc14* also has relative higher slope (0.01) when compared with the other

independent variables. The independent variable volume has even a negative slope of -2.230E-009.

Table 6 shows the results of the multiple regression analysis when only the independent fundamental variables are considered. The R^2 of the model decreases to 0.469. However, when only the independent fundamental variables are considered all of them are significant at the significant level of 0.05% including *volume*. The independent fundamental variable *volume* still has a negative *slope* but the *slopes* of the *Brent Crude oil* and *USD dollar index* are higher than before with values of 0.02 and 0.01 respectively.

Table 7 shows the results of the multiple regression analysis when only the independent technical variables are considered. In fact, this model does differentiate too much from the complete model. The *roc14* and *pivot point* are still significant and have almost the same *slope* with attention on the *slope* of the pivot point which increases to the value of the R^2 of the complete model, being 0.991.

Thus, all of the alternative hypotheses stated earlier can be accepted except *H1*. The independent variable *volume* has a negative slope and thus has a negative effect on the eur/usd exchange rate.

It turns out that the only independent variable, from the selected independent variables that can be used for predicting the eur/usd exchange rates is the technical variable *pivot point*. The pattern between the pivot point, correlation coefficient, significance level and slope support the view that the *pivot point* is important variable in predicting the eur/usd exchange rates and thus returns. All other independent variables do not provide strong support that they can be qualified for predicting the eur/usd exchange rates. However, it turns out that it is better to consider the division between fundamental and technical variables. When considering mixing technical and fundamental variables as in the complete model, the fundamental variables perform more poorly than if considered individually.

Thus, knowing that pivot point is an important predictor for the eur/usd exchange rates, technical analysis rules can be applied because the *pivot point* is itself a technical indicator. As said earlier, technical analysis assumes that price discounts everything and prices tend to trend. The pivot point is not just a point calculated using the formula described earlier but a price with significant importance. Having explained earlier that the FX market is

not always efficient and that it does not follow random walk, *pivot points* can actually be used for trading and investing in predicting the eur/usd exchange rates and thus returns.

The technical analysis rule that can be applied is called ‘’**breakout**’’. As it names suggests a trader or investor can predict eur/usd exchange rates when the eur/usd exchange rate breaks out below or above its *pivot point*. When traders or investors are trading on the FX market they can *buy* and *sell* currencies without any restrictions compared to stock markets. Thus, any break from the *pivot point* can be traded enhancing the probability of success.

Furthermore, technical analysis are also called ‘**’chartists’’**. This means that representing the prices in charts can be done in any time frames ranging from seconds to months and even years. Thus, usually a price would be represented as one bar of the selected time horizon. This is extremely helpful because one day can actually be represented hourly, where one hour would be represented as one bar. Thus, a trader or investor can have 24 bars representing the whole trading day.

Representing one day as one hour bar chart can give the advantage of more timely execution of a trade. Having a daily pivot point, representing the eur/usd exchange rates as a hourly instead of daily chart and following the rule of ‘’breakout’’, traders and investors can actually gain an edge in predicting eur/usd exchange rates. Thus, whenever a hourly bar closes/opens below/above the daily pivot point can give trade signal that the trend is changing and thus prices might also change. The correlation between the pivot point and the pattern found earlier support the fact that the *eur/usd exchange rates* and the *pivot point* tend to move together. Even more, the slope and significance level of the *pivot point* also confirms the predictive power of this variable. Thus the direction of the eur/usd exchange rates can be predicted with *pivot points* that can be calculated for each successive day onwards.

As a conclusion, this thesis brought some light on the somehow neglected FX financial market. The FX market was analysed, showing its characteristics and how it differs from other financial markets. Furthermore, different factors that drive this market were presented together with the idea that the FX market may not always be efficient and it does not follow random walk. Technical analysis was explained as well and being used as a tool for timing the eur/usd FX market. Even more, it was shown how traders and investors can use

the technical analysis tool of ‘’breakout’’ to predict the direction of the eur/usd exchange rates and thus returns.

A final remark would be made with regards predicting the eur/usd exchange rates. Even though a technical variable that turned out to have significant predictive power on the eur/usd exchange rates and technical rule that can be applied with regards to predicting the eur/usd exchange rates were presented, traders and investors should know that trading and investing is not a science. Thus, there will never be any perfect rule, strategy or indicator that is going to beat the market on constant occasions.

Personally, I view money management more important than any buy or sell strategy. Without a proper money management any bad investment or trading decision can lead to ruin of capital no matter how many winning trades a strategy gives.

Further research can be done with regards examining more in depth the pivot point. A possible research that can be done could be based on second order derivative of the pivot point meaning taking derivative of the pivot point to calculate a second pivot point and even a third pivot point. Thus, there could be three pivot points for one day, one representing the benchmark price or the middle point for the current day, another representing the maximum upper boundary and another representing the minimum lower boundary anticipated. Thus, traders and investors can get not only a benchmark price but complete possible range of where the eur/usd exchange rates might be traded.

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