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PERFORMANCE OF RSI INVESTMENT STRATEGY ON FOREIGN EXCHANGE MARKETS

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1. INTRODUCTION

1.1. Background of the survey

According to Efficient Market Hypothesis prices should fully reflect all available information, but can financial markets be efficient at the time when stock market bubbles and crashes exist? Could new information be random but reflect inefficiently in prices? Researchers have started to add behavioural attributes to old theories in behavioural finance in order to explain these phenomena and nowadays more investment strategies that contradict old theories are used when trying to exceed the market rate of return.

The foreign exchange market is the largest financial market in the world and during the last few years the volume of foreign exchange market transactions has increased substantially. At the same time electronic trading systems have advanced and the number of foreign exchange platforms offered to small investors has increased abundantly. According to the Efficient Market Hypothesis, the future exchange rates should be impossible to forecast by using historic data. Despite this, these platforms usually offer only technical analysis tools for traders.

Relative strength index (RSI) strategy is one of the most common technical analysis strategies. The RSI is an oscillating indicator, which compares underlying instrument's current price to its own previous price movement and tells when it is overbought or oversold.

1.2. The purpose and limitations of the survey

The aim of this study is to introduce the concept of efficient markets and the behavioural challenges to it. We will also examine if it is possible to create excess returns on foreign exchange markets by buying and selling currencies according to buy and sell signals produced by the relative strength index. Due to the good liquidity of foreign exchange markets and low transaction costs, it is an interesting environment to test if a trader using RSI-strategy can create positive return and

outperform, firstly, the buy and hold strategy with absolute profits, and secondly, the buy and hold strategy when the risk has been adjusted, and thirdly, the risk free rate of return.

Both the most common and some of the less common currencies will be used to be able to get the best overall view of the performance of the RSI strategy. Exchange rate data over the last ten years, three different computation periods and three different indicator levels for the RSI will be used.

The rest of the paper is organized as follows. Section 2 presents theoretical background of efficient markets, technical analysis and foreign exchange markets. In section 3 the data and measures used in this study are introduced. Section 4 presents the empirical results. Finally, section 5 concludes and gives suggestion for further research.

2. THEORETICAL BACKGROUND

In section 2.1 we will firstly look into efficient market hypothesis, followed by the behavioral challenges in section 2.2. Section 2.3 presents the concept of technical analysis and in section 2.4 foreign exchange markets will be introduced.

2.1. Efficient markets

An asset market is efficient if the asset price fully reflects all available information. Efficient Market Hypothesis (EMH) is based on the efficient exploitation of the information by economic actors (Hallwood and McDonald, 1994). EMH assumes that the market participants have rational expectations and there are no transaction costs that affect to the buying or selling decisions at the market. Shleifer (2000) also states that either rationality, independent deviations from rationality or arbitrage will lead to efficiency.

Effective market responds immediately to all available information, but in actuality, certain information may affect prices more quickly than other information. The efficient market hypothesis has historically been subdivided into three categories according to the different response rates that the information affects prices. These are weak form, semi strong and strong form efficiencies.

2.1.1. Weak Form Efficiency

When the prices include only information about past prices, markets are weak form efficient. The weak form states that an efficient market reflects information up to the point where the marginal benefit of information does not exceed the marginal cost of collecting it (Jensen, 1978). When weak form efficiency holds, there should not be

opportunities to make a return on a stock that is in excess[1] of a fair payment for the riskiness of the stock (Cuthbertson, 2004).

When market is weak-form-efficient, traders are not able to generate excess returns by using technical analysis, though some forms of fundamental analysis may still provide excess returns. Fundamental analysis includes the possibility of a short term mispricing and profits can be made by trading these mispriced securities before it reaches the "correct" price. Theoretically, fundamental analysis can be used to find underpriced and overpriced securities and profitable investment options can be found by researching financial statements. (Ross et al.2008: 370-382)

Mathematically weak form efficiency is presented as:

$$P_t = P_{t-1} + \textit{expected return} + \textit{random error}_t \quad (1)$$

This means that the price today equals to the sum of the last observed price plus the expected return on the stock plus a random component over the interval. The expected return is a function of a security's risk and the random component is due to the new information about the stock and it has an expectation of zero. If prices follow this equation, they are said to follow a random walk.

2.1.2. Semi-strong and Strong Form Efficiency

The prices at semi-strongly efficient markets include all public information and the prices of strongly efficient markets include all, public and private, information. Semi-strong-form efficiency implies that fundamental analysis techniques will not be able to reliably produce excess returns and when strong form efficiency holds, no one can earn excess returns. Strong form efficiency is impossible to reach if there are legal barriers for private information to become public, such as insider trading laws. According to Vaihekoski (2004), the efficiency categories can be defined today in the sense that weak-form efficiency concerns the predictability of returns, semi-strong-

1) Excess return: Price is determined on the basis of a 'fair game', which means that there is no way to use information available at a point of time (t) to earn return above normal.

form efficiency is understood as event studies and stock prices reactions to new public information and strong form efficiency is about testing private information.

2.1.3. Challenges to market efficiency

Most tests of the efficient market hypothesis simply deal with how fast information is incorporated, but don't deal with whether it is correctly incorporated in prices. Elton et al. (2007: 400) refer this as "informational efficiency". Many authors are also concerned whether prices accurately reflect investors' expectations about the present value of future cash flows. They refer to this as market rationality to distinguish it from informational efficiency, while some authors use the word "efficiency" to apply for both cases. If markets exhibit rationality, there should not be differences between share prices and the value of the security based on the present value of the cash flow to security holders. An example against market rationality is if market prices can be shown to respond to noneconomic variables, such as stock splits.

It has been found that a number of firm characteristics such as size, market value divided by book value, and earnings divided by price are related to excess returns. These are often referred to as market anomalies, since in an efficient market it shouldn't be possible to earn excess returns. There are few explanations for this. The first one is that the relationship is not real. With hundreds of researches searching for patterns, some relationships will be found. The second explanation is that the CAPM has been misspecified, causing apparent large returns when none exist. For example, if betas are systematically underestimated for small firms, then the estimate of expected returns for small firms would be too low and there would exist no excess returns if betas were correctly estimated. (Elton et al, 2007: 400-441)

The existence of excess returns of firm characteristics and time patterns provide evidence against market rationality. These include the anomalies such as the size effect, market value / book value - effect and January effect. The major direct evidence on stock market rationality consists of volatility tests[2], stock market crashes and tests of market overreaction. However, the consistent finding of an inability of

2) Volatility tests examine the volatility of share prices relative to the volatility of the fundamental variables that affect share prices.

market professionals to outperform indexes raises questions as to the usefulness of these patterns. Still there is a question how market bubbles and crashes can be formed in reality if market prices include all public information at all times. (Elton et al, 2007: 400-441)

2.1.4. Foreign Exchange Market Efficiency

According to Fama (1984), foreign exchange market is efficient, if it fully reflects all available information. Foreign exchange efficiency hypothesis can also be called as forward rate unbiasedness hypothesis (FRUH), because in an efficient market the forward rate should be unbiased predictor of the future spot rate. The majority of the empirical studies test Foreign exchange market (FOREX) efficiency with FRUH and this is suitable between developed countries. On the other hand, in developing countries the forward rates may be highly regulated, which makes it inappropriate to derive any inferences from FRUH about foreign exchange efficiency. Giannellis and Papadopoulos (2009) tested the efficiency in these countries using other methodology, which was based on the Behavioral Equilibrium Exchange Rate (Clark and MacDonald, 1998). They tested if the FOREX market will fully reflect all available information by observing if the actual exchange rate would not deviate significantly from its equilibrium rate and they got mixed results with different markets; the Poland/Euro FOREX market was efficient, the Czech/Euro FOREX market was not, while the Slovak/Euro FOREX market was quasi-efficient.

Fama examined efficiency in nine exchange rates using data from 8/1973 to 12/1982 and the market efficiency hypothesis could not be accepted because of a time varying risk premium. Similarly, Hakkio (1981) examined five exchange rates against US. Dollar from 4/1973 to 5/1977 and rejected the hypothesis of market efficiency. Zivot (2000) examined the foreign exchange market efficiency for the British pound, Japanese Yen, Canadian dollar against US. Dollar from 1/1976 to 6/1996. He compared cointegration models between the forward rate with the current spot rate and the forward rate with the future spot rate and noticed that the efficiency hypothesis had to be rejected in all exchange rates. Swarna and Dipak (1999) also examined the efficiency of foreign exchange markets and their results indicated that

FOREX market is not even weak form efficient with all major currencies of the European Economic Community (EEC).

Since then, the technology has developed and made trading much easier and quicker. The daily turnover has also increased and made the FOREX more liquid which makes it an attractive research interest.

2.2. Behavioral challenge to market efficiency

> "Even apart from the instability due to speculation, there is the instability due to the characteristics of human nature that a large proportion of our positive activities depend on spontaneous optimism rather than mathematical expectations, whether moral or hedonistic or economic"
>
> -John Maynard Keynes, *General Theory of Employment, Interest, and Money* (1936)

Central challenge to investors is the problem of decision making under uncertainty. In practice, an interesting dilemma is to find a reason why people buy lottery tickets when the expected value of such an 'investment' is less than the cost of the ticket, for example. Markowitz (1952: 151-158) explored the evidence for models in which risk aversion depends very much on the way the risks are framed and conceptualized by the investor. In these models investor psychology and mental heuristics play a large role in determining investor choice. Studies show that people tend to make mistakes in predictable ways that reflect the use of heuristics, or mental shortcuts. (Elton et al., 2007: 485-501)

EMH argues that competition between investors seeking abnormal returns drives prices to "correct" level. The EMH does not assume that all investors are rational, but it assumes that markets are rational. The EMH does not assume that markets can foresee the future, but it assumes that markets make unbiased forecasts of the future. In contrast, behavioral finance assumes that, in some circumstances, financial markets are informationally inefficient (Ritter, 2003).

Behavioral finance examines financial dilemmas from a wider viewpoint than traditional financial studies. It includes the influence of human behavior in the pricing process. There is abundant psychological literature that document people's systematic errors in the way they think. Ritter (2003) divides behavioral finance in two main sections, to cognitive psychology and to limits to arbitrage.

2.2.1. Cognitive biases

Cognitive psychologists have documented many patterns how people think and behave. Cognitive biases can be divided into subdivisions according to the patterns how people behave. Some of these are heuristics, overconfidence, mental accounting, framing, representativeness, conservatism and disposition effect.

Heuristics make decision making easier. It can also lead to suboptimal decisions due to generalization and conclusions based on limited information. In complex situations people tend to simplify things too much. Overconfidence is the tendency to overestimate one's personal ability to accurately estimate the range of outcomes of a gamble. Mental accounting is referred to the failure to consider all elements of the portfolio as an integrated whole, which means that people can think one part of their portfolio as an "nest egg" and other as a "lottery ticket", and the difference in attitudes towards risk will cause suboptimal decisions (Shefrin and Statman, 2000; Massa & Simonov, 2003). Framing refers to the way the situation is presented for the investor. People are more willing to buy if they feel that they will get a discount, compared to a situation when the price is identical, but there is no discount (Barber and Odean 2001). Representativeness means that people will draw conclusions from insufficient data (Ross et al.,2008: 383). Disposition effect refers to the phenomenon that people avoid to realize losses and seek to realize gains. This can be seen as many small gains and only few small losses been realized. (Shefrin and Statman, 1985)

Earlier, Shleifer (2000) stated that either rationality, independent deviations from rationality or arbitrage will lead to efficiency. On the other hand, he also argues that

none of the three conditions is likely to hold in reality. According to behavioral view, all investors are not rational all the time[3].

Independent deviations from rationality can be explained with conservatism, which means that people are too slow in adjusting their beliefs in new information. In other words, they anchor on the ways things have normally been (Ross, 2008: 383). For example, some studies show[4] that prices seem to adjust slowly to new information contained in earnings announcements.[5]

2.2.2. Limits to arbitrage

Arbitrage is explained as an action in which professional investors can find an underpriced security after which they could buy the underpriced ones while selling correctly priced or overpriced substitutes, which might undo any mispricing caused by emotional amateurs. Trading with this strategy is likely to be more risky as it looks like, because even if professionals generally believe that a security is mispriced, it is difficult for few investors to eliminate the mispricing, especially if amateur traders have opposite opinions, when the prices would come back into line only if the professionals have bigger positions. According to Shleifer and Vishny (1997) who analyze the limits of arbitrage, in a world in which speculators need to borrow funds to purchase sales, even the smartest speculator faces the risk of bankruptcy and due to that cannot always arbitrage away deviations from the SML. Even if the smart investor knows the price of an asset is wrong, there is no way to exploit that knowledge when everyone believes otherwise. Unexpected news is also a risk, which would cause the professionals to register large losses. When opportunities to exploit mispricings are limited, or the financing for such activity is constrained, asset prices may reflect the beliefs, emotions, and biases of ordinary investors. (Elton et al.,2007: 485-501)

3) For example, See Barber B., & Odean, T.,"The Courage of Misguided Convictions" Financial Analysts Journal (November/December1999).
4) For example, See Singal, V., *Beyond the Random Walk*. New York. Oxford University Press, 2004.
5) More information of cognitive biases can be found, for example, from Elton et al., 2007: 488-490; Ritter, 2003; Barber & Odean, 2001.

Lamount and Thaler (2003) have found that short sales constraints appear to restrict arbitrageurs from exploiting overpriced securities. In these situations when it does not pay arbitrageurs to exploit the spread in prices, the prices may deviate from fundamental values.

There is also the risk of further mispricing, if amateurs have mispriced the stock today, why cannot it continue tomorrow? Even if the professional investor's view is correct, it may take long time for the prices to change to the right level, which creates near-term risk and makes this strategy less attractive. In conclusion, the irrationality may be related across investors rather than canceling out across investors and the arbitrage strategies may involve too much risk to eliminate market efficiencies, because you can never know if the masses will never or soon enough realize the mispricing. (Ross et al. 2008: 383-384)

Shleifer (1986) examined all the cases in which index funds had to buy or sell a stock because it was added or deleted from S&P 500 index. In the case the supply of the stock was independent of its economic value. Shleifer found that the prices of stocks dropped from the index fell significantly when the change was made, while the prices of stocks added rose significantly – even though, in both cases the fundamental value of the securities remained unchanged[6]. This is an interesting founding, because it shows that arbitrageurs are not able to entirely counterbalance the influence of large trades not motivated by economic valuation. This sets off a question whether the capital supply stocks –unrelated to economic valuation of the assets – can move the aggregate price of the market and in other words, whether stock market bubbles can exist.

6) Also, Goetzmann and Massa (2003), found that market moved up on days when investors were buying (money flowed into the funds) and down on days they were selling (money outflows). Edelen and Warner (2001) documented this effect for the universe of equity mutual funds as a whole and Warther (2005) found strong positive correlation between mothly equity fund flows and market returns.

2.3. Technical analysis

Technical analysis is the study of market action for forecasting future price trends. It is another traditional analysis method along with the fundamental analysis. Technical analysis uses historical data, which makes it opposite to fundamental analysis that uses financial statements and other public information in price determination. The functionality of the technical analysis has usually been questioned by stating that it is against both the market efficiency hypothesis and the random walk theory. It is also against the rational functionality of the markets, because if there was a supreme strategy, which would generate abnormal profits, these profits should vanish based on the laws of supply and demand when the strategy would become commonly known. On the other hand, there are multiple studies which show the usefulness of technical analysis when used commonly known methods, for example Korn (1996), Neely et al. (1997), Neely and Weller (1998) and Cooper (1999). Also Blume et al. (1994), Lo and MacKinlay (1997), Grundy and Martin (1998), Friesen et al. and Papadalou and Tsopoglou (2001) have indirectly indicated the profitability of technical trading strategies.

Another reason for the criticism pointed by the academics have been the fact that technical analysis is usually based on subjective interpretation instead of numerical, statistical and probability calculations used by the quantitative financial researchers. However, in recent years more fundamental analysts have started to pay attention also to technical analysis, potential purchase targets have been identified by using fundamental analysis and the exact purchase time has been chosen with technical analysis. (Aby et al. 1998:60)

It has been shown that the technical analysis has an effect on prices. It is said that technical analysis makes market more volatile. For example, it has been proved that automatic computer-based trading systems made the “Black Monday” stock crash stronger in 1987 (Hunt 1999). The use of technical trading methods may also have been a factor which made the Financial Services Authority to prohibit short selling financial stocks in the United Kingdom for more than five months in January 2009 (United Kingdom Financial Services Authority, 2009).

There has also been speculation that only the belief of the functionality of technical strategies will make them work, because that can make prices move differently around certain price levels, which then perpetuates itself. For example, if people imagine a bearish trend and start to sell an instrument, increasing excess supply should make the trend even stronger.

2.3.1. Technical analysis as a concept

Technical analysis is based on the assumption that prices move in trends, which will continue as long as a change in the supply and demand will change it. Technical analysis concentrates on detecting these trends to be able to trade in line with them. According to Pring (1991), trends are generated by the changing attitudes of investors to a variety of economic, monetary, political, and psychological forces. Since the technical approach is based on the theory that the stock market is a reflection of mass psychology in action, it attempts to forecast future price movements on the assumption that crowd psychology moves between panic, fear and pessimism on one hand and confidence, excessive optimism, and greed, on the other. The art of technical analysis is concerned with identifying these changes at early stage. By studying these market trends the technically oriented investor is enabled to buy or sell stocks with a confidence, on the principle that once a trend is set in motion, it will perpetuate itself. The purpose is to maintain an investment posture until a reversal of that trend is indicated. Human tends to react to similar situations in consistent ways and by studying the nature of previous market turning points it is possible to develop some characteristics that can help to identify major market tops and bottoms. (Pring, 1991)

2.3.2. Dow theory

Charles Dow, one of the creators of Wall Street Journal has been considered as an originator of technical analysis (Edwards & Magee 1992: 13-15). He measured the overall performance of stock markets. His ideas stimulated his follower, W.P.Hamilton, to collect these ideas as a book ‘The Stock Market Barometer’, which

was released in 1922. Robert Rhea renewed the theory ten years later in his book Dow Theory and created its current form.

According to Rhea, there are three types of trends at the market – primary, secondary and minor trends. The primary trend was like a tide, which is the long term movement. The secondary trend was compared to the waves that made the tide. The minor trends are just like ripples on the waves. Secondary trends are considered as corrections from the primary trends, which usually last from three weeks to few months. These trends help to determine the changes in the primary trend. Naturally the purchase of the financial instrument should be done when the primary trend starts to turn upwards and selling should be done when the primary trend starts to decline. (Martikainen and Martikainen, 2002: 134-135, Murphy, 1986: 24-27)

2.3.3. The premises of technical analysis

There are some premises that need to be fulfilled to be able to use technical analysis. Otherwise the exploitation of it is impossible. The three most common premises are (look for example Murphy, 1986: 1-6 or Nordin et al. 1989: 8-10)

1) Market action discounts everything

The assumption that market action discounts everything has been considered as a cornerstone for technical analysis. A technician believes that anything that can possibly affect the market price is reflected in the price of an asset and therefore a study of price action is all that is required. The technician is claiming that the prices reflect shifts in supply and demand which on the other hand reflect the bullish or bearish psychology of the marketplace. Chartists know that there are reasons why markets go up or down but they don't believe that knowing what those reasons are is necessary in the forecasting process. (Murphy, 1986: 1-3)

2) Prices move in trends

Another essential concept to the technical approach is that the prices move in trends. The whole purpose of charting the price action is to identify trends in early stages to be able to trade in the direction of those trends. Another task for technical analysis is

to forecast whether a trend is going to continue or turn around. Trend in motion will continue in the same direction until it clearly can be seen reversed, which tries to prevent the generation of false buy and sell signals. It is also said that the trend in motion is more likely to continue than to reverse. (Murphy, 1986: 3-4)

The random walk theory[7] was questioned for the first time in 1953 by Maurice Kendall (Kendall 1964). Alexander in (1961, 1964) and Fama (1965) announced similar results to Kendall. The random walk hypothesis was supported by Malkiel in his book A random Walk Down Wall Street (1996), but Lo and MacKinlay abolished this hypothesis in their book A non-random Walk Down Wall Street (1999). Since then also Darrat and Zhong (2000) presented evidence against random walk theory.

3) History repeats itself

The study of market action has shown that the chart patterns which have been identified has appeared many times in the past and due to this it has also assumed to continue in the future. This assumption is based on the fact that the prices are determined according to the human behavior and this psychology tends not to change. The recent strong volatility at the market prices supports also this type of view, because when the markets are falling, people will sell their assets at almost any price and on the contrary when markets are booming, people will buy assets with huge premiums. This can be called as a reflection of mass psychology, the “crowd” in action, which media can also make stronger. “All price movements have one thing in common; they are a reflection of the trend in the hopes, fears, knowledge, optimism, and greed of the investing public. The total sum of these emotions is expressed in the price level, which is never what they (stocks) are worth but what people think they are worth”, as Garfield Drew (1968: 18) it expressed. (Murphy, 1986: 4-6)

7) Random walk model assumes that successive returns are independent and that the returns are identically distributed over time so that past returns are unrelated to future returns.

2.3.4. Relative Strength Index

People have invented numerous technical trading strategies, but the most common strategies are different moving averages, divergences, momentum strategies and relative strength strategy. In this study, we concentrate on the relative strength index.

The Relative strength index (RSI) was developed by Welles Wilder and presented in his book New Concepts in Technical Trading Systems, in 1978 (Greensboro, N.C.: Trend Research). The RSI is an oscillating indicator, which compares underlying instrument's current price to its own previous price movement and tells when it is overbought or oversold. Previously relative strength had been examined by comparing underlying instrument's price to price indexes[8].

As Wilder points out, there are two essential problems to be considered when using oscillators. One is that a single incident may affect substantially to the value of the oscillator. Sharp changes in the values of the underlying instrument during the computation period may cause erratic movement in the oscillator and it may give a signal even though current prices of the underlying show only little change. The second problem is the difficulty of comparing the values of oscillators if those have not been scaled. The RSI formula is a solution to these problems by providing the necessary smoothing and scaling of the values of the oscillator.

Mathematically the value of an RSI is calculated as follows:

$$RSI(n) = 100 - \frac{100}{1 + \left(\frac{U}{D}\right)} \qquad (2)$$

In which U = the average increase in price during time period (n)

D = the average decline in price during time period (n)

The RSI is plotted as a single line that can get values between 0 and 100. The indicator does not produce absolute signals, which makes it more difficult to interpret.

8) Reinganum 1988: 21-22 and Francis 1991: 533-534, for example.

There are different opinions about the best indicator readings to be used, because of the variety of trading strategies. As Wilder recommended, the underlying is usually considered overbought when the RSI rises above 70 and oversold when the line drops below 30. This means that during an uptrend it is a great time to buy when the RSI line crosses back above 30 and during a downtrend it is a great time to sell when the RSI line crosses back below 70. This tells that the dominant trend has experienced a slight pullback and when the indicator is moving back from its oversold or overbought territories, the dominant trend is resuming. Alternative ways to interpret the data in addition to the classic interpretation is to use values of 60-80 for a sell signal and values of 20-40 for a buy signal. (Murphy, 1986: 290-303)

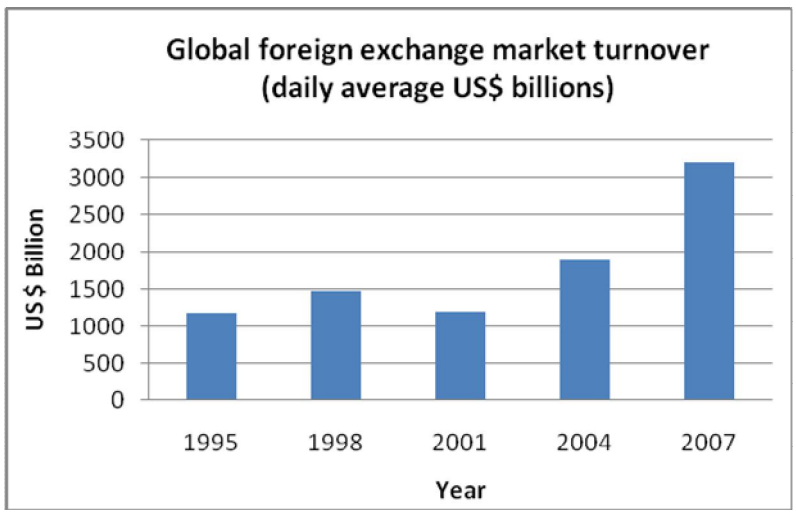
Historical data suggests that readings of 20 and 80 indicate more highly oversold or overbought conditions, respectively, and lead to larger, better-defined price moves and trends when compared to the classic values. However, the declines to the 30 level seem to be the first indication of oversold conditions, while advances to the 70 level indicate that the underlying is extended in price. (Aby et al., 1998: 59-72)

The length of the computation period is a critical factor for oscillators including the RSI, because it affects significantly to the nature of the indicator. Due to the formation of the formula, RSI will become more aggressive when computation period is shortened. The shorter the time period, the more sensitive the oscillator becomes and the wider is its amplitude. On the other hand, when the calculation period is extended the fluctuation will become more relent. The most popular computation period is 14 days, which is also the value that Wilder originally used, but RSI works best when its fluctuations reach upper and lower extremes. The trading strategy determines which values to be used and empirical research shows that a short-term trader should also use short computation period in the RSI. Shortening the calculation period will increase the number of the signals which will also increase the possibility of false signals. When using shorter time frames, longer indicator readings (from 30-70 levels to 20-80) could be used to sustain the accuracy of the signals. One of the biggest weaknesses of the RSI is that even if the value of the RSI goes above the sell signal, the market may still continue to go higher. (Pring, 1991: 147, Murphy, 1986: 298)

2.4. Foreign exchange markets

2.4.1. Overview of Foreign exchange markets

Foreign exchange (FOREX) market is a part of international money and capital markets. Its purpose is to support other financial markets by providing currency exchange services (Finanssialan keskusliitto 2008). It is the financial exchange on which governments, banks, hedge funds and individual investors exchange foreign currencies. It is the largest and most dynamic financial market in the world by volume (Eun and Reschnic, 2007: 112). The average daily turnover was 3.2 trillion US dollars in April 2007 (Bank for International Settlements 2007). It means that the average daily turnover is more than 25 times the average daily turnover of the NYSE Group in 2007 (World Federation of Exchanges 2008), annual turnover is almost 15 times world GDP (Worldbank 2008) and the daily volume is nearly $500 a day for every man, woman and child on earth (Population Reference Bureau 2008). This makes the market extremely liquid and it means that there are always a large variety of buyers and sellers on the market. The value of bid/ask spread is set by the liquidity of the instrument, which enables low transaction costs. For major currencies, the spread is usually less than five pips[9].



(Source: BIS, 2007)

9) A Pip is the smallest price increment in FOREX trading. Pip stands for percentage in point (1/10 000), which also means that in the currency prices it is the fourth decimal. See Forexyard, for example.

2.4.2. Market characteristics

One of the main differences compared to other financial markets is trading hours. The FOREX market is open 24 hours a day nearly 5 ½ days a week, opening at 10 pm GMT on Sunday and runs until 10 pm GMT on Friday. All that time there is enormous trading volume, because when the markets are closed in Europe, they are open elsewhere, in the USA or in Australia, for example. (Jagerson and Hansen 2006: 3-14)

For a small investor it is relatively easy to trade on FOREX market. There is always one price, which a trader will get. Then the trader can choose whether to buy or sell. However, the brokers that offer trading platforms for small investors usually take a spread around five pips when a trade is executed. When compared to a stock market, on FOREX market it is much easier to sell short, for example. Trades are executed using currency pairs, which mean that when one currency is bought, the other currency is always sold. This also means that a trader doesn't have to care about bearing markets, because they can trade on both directions with same costs.

3. DATA

Ten-year time series data of ten different currency pairs were used to test the RSI strategy in this survey. The data consist mainly of the most common currency pairs, but also less common ones were used to be able to study the performance of the RSI strategy in different circumstances. The U.S. Dollar was the base currency in every currency pair and no cross rates was used. The data was collected from Datastream-database and it consisted of daily values of the currency pairs from 2.1.1999 to 2.1.2009. The currencies used were The U.S. Dollar (USD), Euro (EUR), Australian Dollar (AUD), Canadian Dollar (CAD), Swiss Franc (CHF), British Pound (GBP), Japanese Yen (JPY), Norwegian Krone (NOK), Swedish Krona (SEK), Thai Baht (THB) and New Zealand Dollar (NZD).

Due to the oscillating nature of the RSI, which means that the indicator does not produce absolute buy or sell signals, three different valuation scenarios were observed to be able to test the usefulness of the strategy. In the first scenario, buy signal generated when the RSI index dropped below 20 and the sell signal generated when the value of the RSI crossed above 80. In the second scenario these values were 30 and 70 and in the third scenario 40 and 60.

Since the length of the computation period is a critical factor for oscillators, also three different computation periods were used, which were 7 days, 14 days and 25 days. This means that all in all, nine different scenarios with ten currency pairs were observed.

The time series used is rather long, which means that it includes many economic cycles, the global technologic bubble in the 2000s and the recession followed by that, for example. It also includes the start of the credit crisis in 2008. This can be seen as a change in volatility, which may have an effect on the performance of oscillating indicators. Long time series data should reveal the true long term-performance of the RSI strategy.

3.1. Presumptions of the survey

In this survey a presumption was made that every time the RSI line crossed under or below the observed RSI reading, a signal was generated to be able to observe continuously the usefulness of the strategy. This means that the strength of the signal[10] was not observed. In the practise, that is against the original purpose of the strategy and it makes a major part of the interpretation, but it would have been too complex to be taken into account in this survey. Also, every time when a buy or sell signal occurred, a trade took place. This means that there was an open trade during the whole observation period. In reality, this is not a preferable strategy according to Wilder (1978). Daily cumulative exchange rate values were used as results for the buy and hold strategy. Taxes or transaction costs were not taken into account.

3.2. Measures of the return

Risk and reward go usually hand in hand, which makes it important to pay attention to the riskiness of the instruments. Portfolio with smaller expected return can be more appealing when the risk involved has been taken into account. In this survey Sharpe ratios and Jobson-Korkie test were used to analyze the performance of the RSI strategy compared to buy and hold strategy. The Jobson-Korkie test compares the returns of different scenarios by using differences in Sharpe ratios that compare the risk adjusted returns.

3.2.1. Sharpe ratio

Sharpe ratio is a measure of risk-adjusted performance, which measures the excess returns relative to standard deviation of the returns. The main criticism against Sharpe ratio concerns the measure of risk, standard deviation, and the due to non-normally distributed profits. The second weakness of the ratio is negative excess returns (Israelsen 2003). As an example, there are two portfolios with excess returns

10) The longer and steeper the signal, the stronger it is.

of -9 % for both and standard deviations of 10% and 20%. According to the Sharpe ratios, it looks like the portfolio with the standard deviation of 20% is better. Obviously this cannot be true, because both portfolios have the same negative return and the one with less volatility should be better of these two. Israelsen suggests that in the case of negative excess return, an exponent of excess return divided by absolute value of the excess return should be added to the denominator. In the normal form Sharpe ratio can be written as follows:

$$S = \frac{R_i - R_f}{\sigma_i} \tag{3}$$

where R_i is the portfolio return, R_f is the risk free rate of return and σ_i is the standard deviation of the returns. $R_i - R_f$ form the excess return.

3.2.2. Jobson-Korkie test

Jobson-Korkie test measures the equality of the Sharpe ratios of any two time series. In other words, it tests if Sharpe ratios are statistically different (Steveson and Lee 2005). However, Jobson and Korkie noted that the statistical power of the test was low especially for small sample sizes. Christoph Memmel (2003) modified Jobson-Korkie test to be more accurate for calculating the statistical significances of Sharpe ratios. According to Memmel, the formula can be written as:

$$Z_{JK} = \frac{c_{JK}(\hat{u})}{\sqrt{\hat{\theta}}} = \frac{\hat{\sigma}_n \hat{\mu}_i - \hat{\sigma}_i \hat{\mu}_n}{\sqrt{\hat{\theta}}} \tag{4}$$

where θ is the asymptotic variance of the expressions in the numerator. Asymptotic variance can be written as follows:

$$\theta = \frac{1}{T}\left[2\sigma_i^2\sigma_n^2 - 2\sigma_i^2\sigma_n^2\sigma_{in}^2 + \frac{1}{2}\mu_i^2\sigma_n^2 + \frac{1}{2}\mu_n^2\sigma_i^2 - \frac{\mu_i\mu_n}{\sigma_i\sigma_n}\sigma_{in} \right] \quad (5)$$

σ_i = the standard deviation of the time series *i*

σ_n = the standard deviation of the time series *n*

T = number of observations

σ_{in} = covariance of returns

μ_i = the average return of the time series *i*

μ_n = the average return of the time series *n*

The null hypothesis is that Sharpe ratios do not differ from each other. The bigger the Z-value, the more Sharpe values differ from each other. Positive Z-values indicate that the RSI strategy has outperformed the buy and hold strategy and vice versa. However, the significance level indicates if the results can be assumed as true.

4. RESULTS

In this section the results are analyzed and presented. The results of the RSI strategies are analyzed from 16 different viewpoints. There are three different calculation periods for the RSI, which are 7 days, 14 days and 25 days. Also, three different RSI levels have been used, which are 20-80, 30-70 and 40-60. We also look if there are any differences between the ten currency pairs used. At first, we look the results in general, followed by Sharpe's risk adjusted analysis and Jobson-Korkie test's relative performance analysis.

Due to the nature of the RSI that generates buy and sell signals irregularly, the length of the inspection period is different in each scenario. For example, the 25-day scenarios are substantially shorter than the 7-day scenarios, because the longer the computation period, the longer it usually takes to generate the signal. Results have been examined from European investor's viewpoint. The RSI strategy returns have been added to the capital after each trade. In the buy and hold strategy, the return has been added to the capital daily.

4.1. Overview of the returns

Overall, 62% of all the signals generated by the RSI strategy lead to a positive outcome, which also meant that 62% of the trades had a positive return (Table 1). 14 days was the best computation period and 40-60 was the best RSI level (Table 1). The cumulative outcome compared to the buy and hold strategy can be seen in the appendix 1, in which the RSI strategy outperformed the buy and hold strategy in 83 of 90 scenarios.

SCENARIO	NUMBER OF POSITIVE TRADES (COUNT)	NUMBER OF ALL TRADES (COUNT)	%	RANK
7PV	3003	4820	62	2
14PV	1141	1822	63	1
25PV	440	713	62	2
20 - 80	755	1212	62	2
30 - 70	1381	2251	61	3
40 - 60	2448	3892	63	1
CAD	515	759	68	1
NZD	471	736	64	2
CHF	466	734	63	3
GBP	473	749	63	3
EUR	458	728	63	3
JPY	470	748	63	3
NOK	473	755	63	3
AUD	464	744	62	8
SEK	413	711	58	9
THB	381	691	55	10

Table 1. Number of positive trades

SCENARIO	EUR	AUD	CAD	CHF	GBP	JPY	NOK	SEK	THB	NZD
7 DAY 20 - 80	95	99	115	87	98	92	108	92	81	90
7 DAY 30 - 70	155	149	165	147	154	155	158	140	141	158
7 DAY 40 - 60	235	230	227	239	238	235	236	222	239	240
14 DAY 20 - 80	21	22	24	22	18	27	18	27	19	18
14 DAY 30 - 70	55	62	50	57	64	59	53	53	47	44
14 DAY 40 - 60	105	104	110	111	104	99	114	104	97	114
25 DAY 20 - 80	4	3	4	3	3	5	2	4	8	3
25 DAY 30 - 70	15	19	14	21	18	23	16	22	18	19
25 DAY 40 - 60	43	56	50	47	52	53	50	47	41	50

Table 2. The number of trades in all scenarios.

25-day 20-80 scenario had least values, which may have had an effect on the results (Table 2 and appendix 4). It had only few trades during the whole ten-year computation period. If the RSI line don't reach the chosen RSI levels for several months, it indicates that the computation period is too long and for this scenario, the 25-day computation period was definitely too long. Canadian dollar, Swiss Franc and British Pound were the best currencies. (Appendixes 1, 4)

Weekly euribor returns were used as a measure of the risk free rate of return, since we examined the strategy from a European trader's perspective. The daily cumulative risk free rate for the inspection period was 39 %. The RSI outperformed

this rate of return in 63% of the scenarios. In other words, it also meant that in 37% of the scenarios, the RSI strategy did not reach even the risk free rate of return. (Table 3)

SCENARIO	RSI EXCEEDS RISK FREE RATE (COUNT)	ALL SCENARIOS (MAX)	RSI EXCEEDS RISK FREE RATE (%)	RANK
7PV	15	30	50	3
14PV	20	30	67	1
25PV	17	30	57	2
20 - 80	17	30	57	2
30 - 70	23	30	77	1
40 - 60	14	30	47	3
CAD	7	9	78	1
CHF	7	9	78	1
GBP	7	9	78	1
EUR	6	9	67	4
JPY	6	9	67	4
NOK	6	9	67	4
NZD	6	9	67	4
SEK	4	9	44	8
AUD	4	9	44	8
THB	1	9	11	10

Table 3. Outcomes of RSI strategies compared to risk free rate of return.

4.2. Risk-adjusted performance

On a daily basis, the change in the price of the underlying was the same in all scenarios, because the only difference between RSI and buy and hold strategies was the possibility of RSI strategy to take short positions. Due to this the Sharpe ratios were expected to be quite close to each others in all scenarios.

Sharpe ratios were almost equal. The biggest value was 0.12 (25-day 20-80 NOK) and the smallest -0.07 (14-day 20-80 THB). However, the buy and hold strategy had, in general, better Sharpe ratios (in 63 % of the cases). As stated in the section 3.2.1., negative Sharpe ratios created a problem for comparing the results, because only 26% of the Sharpe ratios were positive. Noteworthy is that even though only 26% of the Sharpe ratios were positive, RSI strategy outperformed the buy and hold strategy in 37% of the scenarios. (Appendix 2)

In Jobson-Korkie test, Z-values enabled to compare the Sharpe ratios of different scenarios. When analyzing the RSI strategy Sharpe ratios against the buy and hold

strategy Sharpe ratios, the best ones were 14-day and 20-80 scenarios (Tables 4-7). The 14-day scenarios were slightly better than the 7-day scenarios and the Z-values of the 40-60 indicator level also outperformed the 30-70 scenarios. Overall, the 25-day 20-80 NZD had the best Z-value of 1.41 with the significance of 0.159. The Best 14-day 20-80 currency was CHF with Z-value of 1.22. It had statistical significance with 75% confidence level. (Appendix 2)

SCENARIO	RSI OUTPERFORMING BUY & HOLD (COUNT)	(%)	RANK
7PV	12	40	2
14PV	13	43	1
25PV	9	30	3
20 - 80	14	47	1
30 - 70	8	27	3
40 - 60	12	40	2
CHF	9	100	1
JPY	7	78	2
EUR	6	67	3
CAD	6	67	3
NOK	3	33	5
AUD	1	11	6
SEK	1	11	6
NZD	1	11	6
GBP	0	0	
THB	0	0	

Table4. RSI Outperforming Buy and Hold based on Z-values.

SCENARIO	5% SIGN. (COUNT)	15% SIGN. (COUNT)	25% SIGN. (COUNT)	MAX	RANK
7PV	0	0	1	30	3
14PV	0	0	4	30	1
25PV	0	0	3	30	2
20 - 80	0	0	4	30	1
30 - 70	0	0	2	30	2
40 - 60	0	0	2	30	2
CHF	0	0	3	90	1
CAD	0	0	2	90	2
JPY	0	0	2	90	3
NZD	0	0	1	90	4
EUR	0	0	0	90	
AUD	0	0	0	90	
GBP	0	0	0	90	
NOK	0	0	0	90	
SEK	0	0	0	90	
THB	0	0	0	90	

Table 5. Dispersion of significant observations (RSI)

SCENARIO	BUY & HOLD OUTPERFORMING RSI (COUNT)	(%)	RANK
7PV	18	60	2
14PV	17	57	3
25PV	21	70	1
20 - 80	16	53	3
30 - 70	22	73	1
40 - 60	18	60	2
GBP	9	100	1
THB	9	100	1
AUD	8	89	3
SEK	8	89	3
NZD	8	89	3
NOK	6	67	6
EUR	3	33	7
CAD	3	33	7
JPY	2	22	9
CHF	0	0	10

Table6. Buy & Hold outperforming RSI based on Z-values.

SCENARIO	5% SIGN. (COUNT)	15% SIGN. (COUNT)	25% SIGN. (COUNT)	MAX	RANK
7PV	2	3	3	30	3
14PV	3	3	4	30	1
25PV	3	3	3	30	2
20 - 80	3	3	4	30	1
30 - 70	3	3	3	30	2
40 - 60	2	3	3	30	3
THB	7	8	8	90	1
GBP	1	1	1	90	2
EUR	0	0	0	90	
AUD	0	0	0	90	
CAD	0	0	0	90	
CHF	0	0	0	90	
JPY	0	0	0	90	
NOK	0	0	0	90	
SEK	0	0	0	90	
NZD	0	0	0	90	

Table7. Dispersion of significant observations(Buy & Hold).

Overall, 33 scenarios had positive Z-values that stood for 37% of all scenarios. 8.9% had also statistical significance with 75% confidence level. When taken also into

account the cumulative profits of 1.49 to 3.07 that stand for 49% and 207% returns over the 10-year period, an assumption can be made that these scenarios have performed better than the buy and hold strategy. (Appendixes 1, 2)

On the basis of Z-values, five currencies stand out; Swiss Franc, Japanese Yen, Canadian dollar, Euro and the New Zealand dollar. Overall, the Swiss Franc was the best one, because RSI was the best strategy in every CHF-scenario. Canadian dollar had the largest Z-values in all 7-day scenarios and Swiss Franc in all 14-day scenarios. Swiss Franc, Japanese Yen and New Zealand dollar had the largest Z-values of the 25-day scenarios. (Table 4 and Appendix 2)

Significance levels revised mainly the results of the Z-values. When the significance levels were observed, was found that the significances were more remarkable with the extreme Z-values. This is understandable, because with these Z-values the difference between the time series was the greatest. Swiss Franc, Canadian Dollar, Japanese Yen and the New Zealand Dollar seemed to be the best ones with the RSI strategy. (Appendix 2)

On the other hand, there were also statistically significant negative Z-values, which mean that the buy and hold strategy outperformed the RSI strategy. Thai Baht turned out to be statistically most significant reaching the 95% confidence level in 7 of 9 scenarios and once the 85% confidence level. The Pound Sterling was also once statistically significant with 95% confidence (25-day 20-80). This means that the null hypothesis that there are no difference between the strategies had to be discarded. Buy and hold strategy outperformed the RSI strategy every time with these currencies. Interesting is that when 75% significance level was observed, only two currencies had statistically significant values in favor of buy and hold strategy while four currencies had significant values in favor of RSI strategy. (Table 7 and appendix 2)

From the RSI point of view when significance levels were observed, the 14-day computation period turned out to be the best. Surprisingly, the results of 25-day scenarios were more significant than the 7-day scenarios, because the Z-values showed contrary results. This outcome may be distorted resulting from the small number of observations. However, predictably the 20-80 scenarios were the most

statistically significant, because the more extreme the RSI values are, the stronger the RSI signal is supposed to be.

The credit crisis had an enormous effect on RSI strategy in 2008. Although it may deform the absolute cumulative results, it did not affect to risk-adjusted measures. Moreover, it was interesting to notice that in every scenario investor using RSI strategy was able to trade to the right direction. (Appendix 4, Graphs 1-60)

All in all, there were only few strategies that can be regarded statistically significantly either outperforming or underperforming buy and hold strategy and not any universally supreme strategy was found. (Appendix 2)

5. SUMMARY AND CONCLUSIONS

The aim of the study was to examine if it is possible to make profits using Relative Strength Index strategy on the foreign exchange markets. Nine different investment strategies were used, 16 different viewpoints and totally 90 different scenarios were analyzed. Sharpe ratios and Jobson-Korkie test were used to identify the performance of the relative strength index strategy compared to buy and hold strategy. Examination period was ten years starting from 2.1.1999 and ending to 2.1.2009.

In general, mixed results were found. Cumulative results are in favor of the RSI strategy, due to the fact that the RSI outperformed the buy and hold strategy in 87 of 90 scenarios. However, risk adjusted measures revealed contrary results. Jobson-Korkie test showed that buy and hold strategy outperformed RSI strategy significantly in 95% confidence level in 10% of the scenarios caused by two currencies. Moreover, none of the RSI scenarios could consistently be better than other scenarios. On the other hand, RSI strategy outperformed buy and hold strategy with four currencies but only with 75% confidence level in 9% of the scenarios.

Based on the graphs and overall performance of the strategies, the comparison of Sharpe ratios seem to give a quite truthful image of the portfolio performance, despite the weaknesses discussed earlier. The results would probably have been more favorable towards buy and hold strategy if the inspection period would have ended in 2007. Even though, it was interesting to see that the RSI strategy recognized the new trend in 2008 and was able to generate abundant profits in almost every scenario. One of the most interesting observations was to see that the RSI seemed to work best with some of the most common currencies, such as Swiss Franc, Canadian Dollar and Japanese Yen. On the contrary, the poor performance with the less liquid currency, Thai Baht was a big surprise. However, the shortage of observations in few strategies aggravates the interpretation of the research findings.

All in all, the RSI strategy seem to have potential, but in this case, buy and hold strategy clearly outperformed the RSI. The time horizon was quite good, because it included both, bullish and bearish business trends. Although, it would be interesting

to continue the inspection period to see the total effect of the recession seen in the prices in 2008. It would also have been interesting to analyze shorter time frames, such as 1- or 4-hour charts, for example. Another interesting research target would have been to add different moving averages and divergences to the model and see if this type of combined signal generators would have produced different results.

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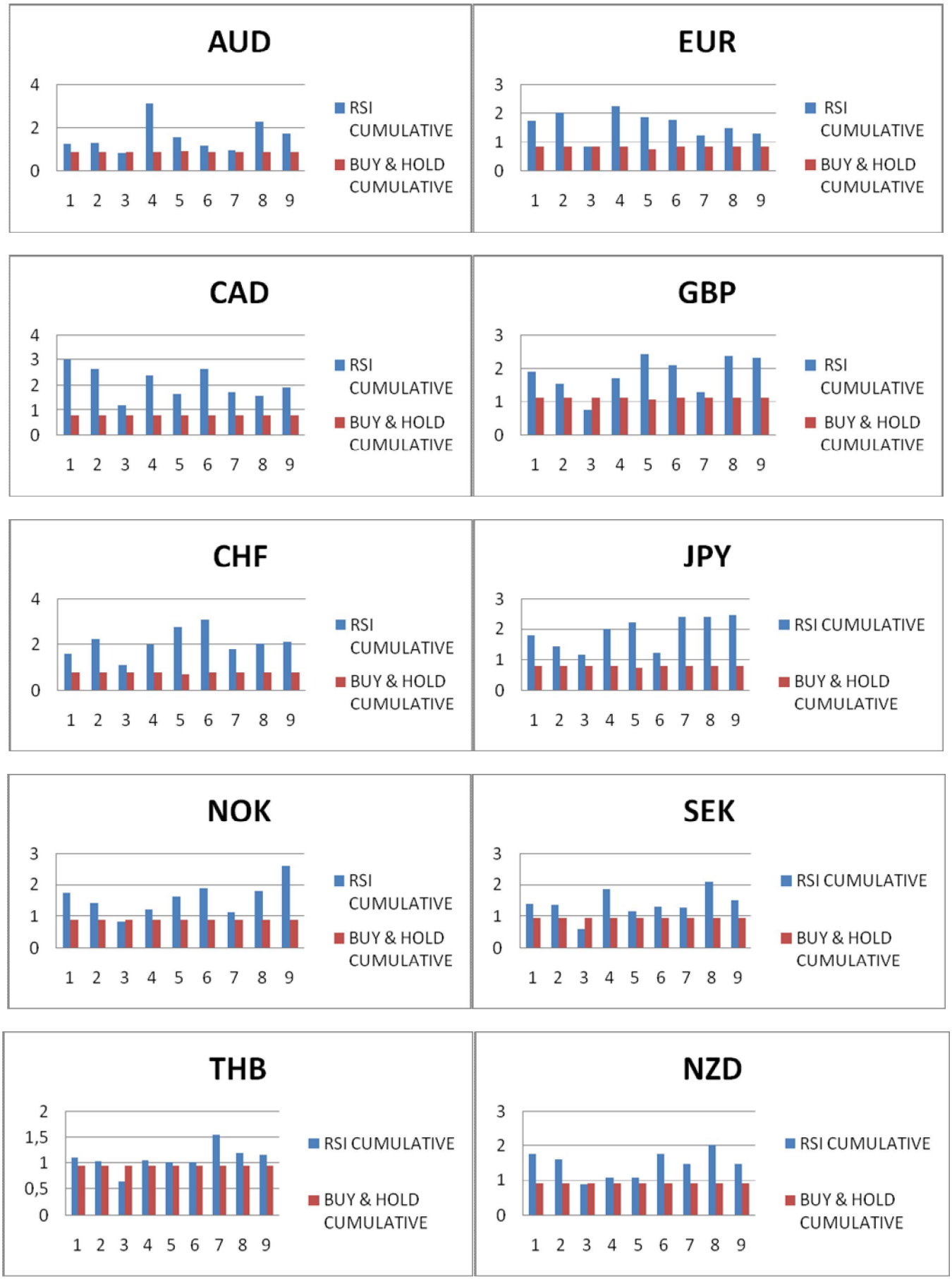
Appendix 1: Cumulative RSI compared to cumulative buy and hold.



1=7DAY 20-80; 2=7DAY 30-70; 3=7DAY 40-60; 4=14DAY 20-80; 5=14DAY 30-70; 6=14DAY 40-60; 7=25DAY 20-80; 8=25DAY 30-70; 9=25DAY 40-60

Appendix 2: Sharpe ratios, Z-values and significance levels.

7PV 20-80 Currency	RSI Sharpe	Buy & Hold Sharpe	Z-Value	Significance	7PV 30-70 Currency	RSI Sharpe	Buy & Hold Sharpe	Z-Value	Significance
CAD	0,029	-0,011	1,377	0,168	CAD	0,020	-0,011	1,041	0,298
JPY	-0,004	-0,014	0,383	0,702	CHF	0,002	-0,017	0,687	0,492
NOK	0,002	-0,004	0,183	0,854	EUR	-0,001	-0,014	0,458	0,647
CHF	-0,017	-0,018	0,043	0,966	JPY	-0,014	-0,010	-0,165	0,869
EUR	-0,014	-0,015	0,042	0,966	NOK	-0,012	-0,004	-0,287	0,774
NZD	-0,004	0,000	-0,127	0,899	NZD	-0,009	0,001	-0,352	0,725
SEK	-0,013	-0,001	-0,387	0,698	SEK	-0,013	0,001	-0,486	0,627
AUD	-0,016	-0,001	-0,500	0,617	AUD	-0,016	-0,001	-0,495	0,620
GBP	-0,005	0,010	-0,503	0,615	GBP	-0,019	0,010	-0,958	0,338
THB	-0,056	-0,004	-2,136	0,033	THB	-0,061	-0,004	-2,515	0,012

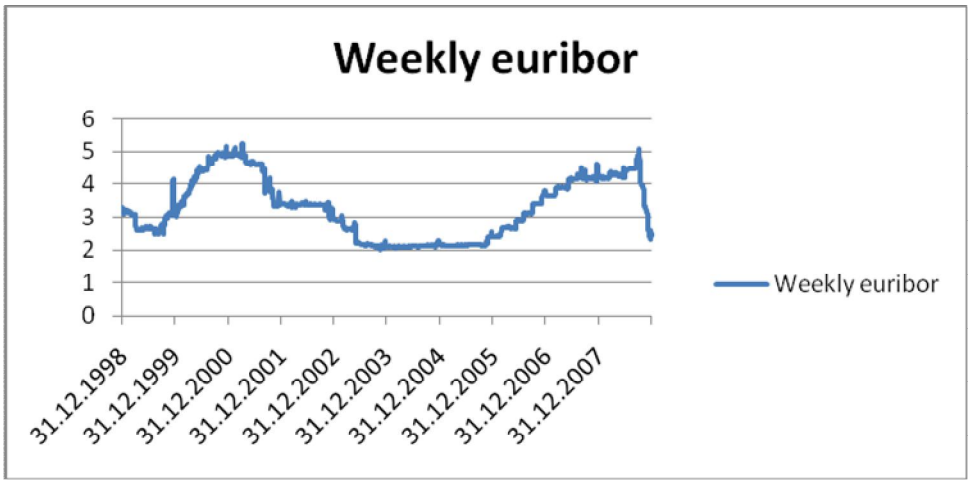
7PV 40-60 Currency	RSI Sharpe	Buy & Hold Sharpe	Z-Value	Significance	14PV 20-80 Currency	RSI Sharpe	Buy & Hold Sharpe	Z-Value	Significance
CAD	0,015	-0,011	0,839	0,401	CHF	0,007	-0,025	1,221	0,222
JPY	0,010	-0,011	0,762	0,446	JPY	0,008	-0,016	0,860	0,390
CHF	0,007	-0,005	0,451	0,652	EUR	0,008	-0,016	0,819	0,413
EUR	-0,004	-0,013	0,322	0,747	CAD	0,001	-0,013	0,417	0,677
AUD	-0,005	0,001	-0,192	0,847	AUD	0,006	-0,001	0,185	0,853
NZD	-0,005	0,001	-0,203	0,839	SEK	-0,012	0,000	-0,370	0,712
NOK	-0,010	-0,001	-0,312	0,755	NOK	-0,038	-0,005	-1,081	0,280
SEK	-0,023	0,001	-0,837	0,403	NZD	-0,034	0,000	-1,121	0,262
GBP	-0,021	0,008	-0,958	0,338	GBP	-0,032	0,011	-1,422	0,155
THB	-0,039	-0,003	-1,537	0,124	THB	-0,074	-0,008	-2,914	0,004

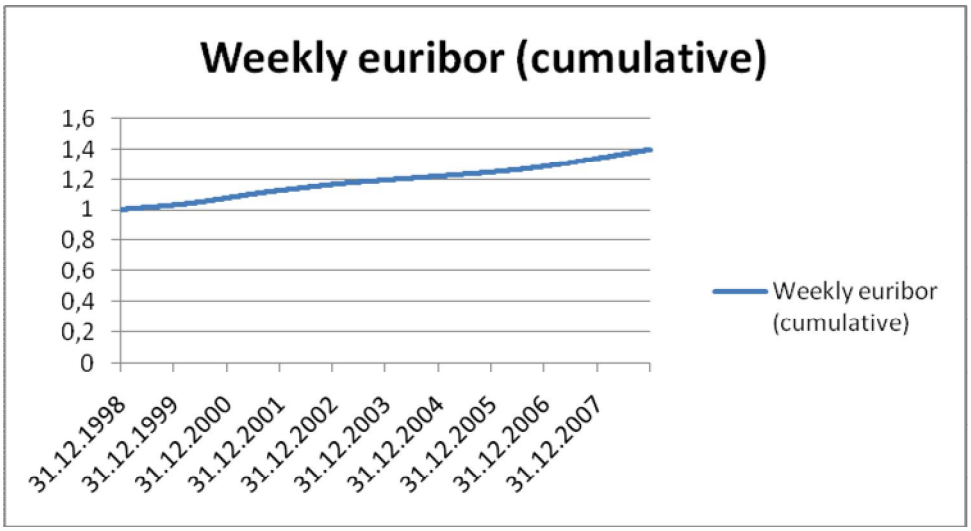
14PV 30-70 Currency	RSI Sharpe	Buy & Hold Sharpe	Z-Value	Significance	14PV 40-60 Currency	RSI Sharpe	Buy & Hold Sharpe	Z-Value	Significance
CHF	0,020	-0,019	1,289	0,197	CHF	0,019	-0,018	1,352	0,176
JPY	-0,003	-0,015	0,455	0,649	CAD	0,023	-0,013	1,264	0,206
EUR	-0,012	-0,016	0,145	0,885	EUR	-0,013	-0,015	0,094	0,925
CAD	-0,014	-0,013	-0,055	0,956	NOK	-0,003	-0,003	0,022	0,983
GBP	-0,003	0,009	-0,399	0,690	NZD	-0,007	0,002	-0,304	0,761
AUD	-0,013	0,000	-0,417	0,677	AUD	-0,017	0,001	-0,549	0,583
NOK	-0,024	-0,003	-0,673	0,501	JPY	-0,030	-0,014	-0,601	0,548
NZD	-0,029	0,001	-0,972	0,331	GBP	-0,012	0,010	-0,716	0,474
SEK	-0,036	-0,001	-1,099	0,272	SEK	-0,023	0,000	-0,747	0,455
THB	-0,065	-0,004	-2,525	0,012	THB	-0,061	-0,004	-2,387	0,017

25PV 20-80 Currency	RSI Sharpe	Buy & Hold Sharpe	Z-Value	Significance	25PV 30-70 Currency	RSI Sharpe	Buy & Hold Sharpe	Z-Value	Significance
NZD	0,061	0,010	1,409	0,159	JPY	0,024	-0,009	1,269	0,204
JPY	0,013	-0,022	1,282	0,200	CHF	0,000	-0,020	0,789	0,430
CHF	-0,014	-0,021	0,139	0,889	NZD	-0,005	-0,001	-0,116	0,907
EUR	-0,022	-0,021	-0,021	0,983	AUD	-0,005	0,001	-0,172	0,864
CAD	-0,024	-0,013	-0,243	0,808	NOK	-0,019	-0,013	-0,189	0,850
THB	-0,031	-0,022	-0,334	0,738	EUR	-0,024	-0,017	-0,273	0,785
AUD	-0,035	-0,009	-0,704	0,482	SEK	-0,010	-0,001	-0,307	0,759
SEK	-0,037	0,010	-0,858	0,391	CAD	-0,027	-0,013	-0,465	0,642
NOK	-0,106	0,121	-1,016	0,309	GBP	-0,012	0,011	-0,772	0,440
GBP	-0,053	0,004	-1,981	0,048	THB	-0,060	-0,008	-2,301	0,021

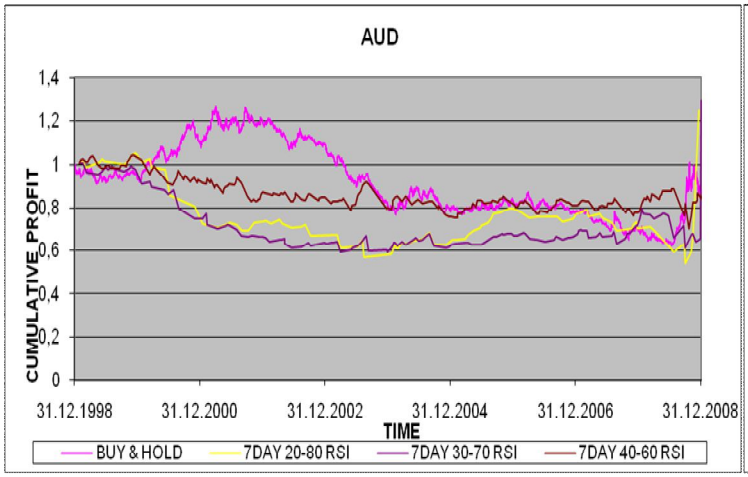
25PV 40-60 Currency	RSI Sharpe	Buy & Hold Sharpe	Z-Value	Significance
CHF	0,003	-0,019	0,736	0,462
JPY	0,013	-0,007	0,736	0,462
CAD	-0,005	-0,012	0,247	0,805
NOK	-0,003	-0,005	0,046	0,963
AUD	-0,009	0,000	-0,288	0,774
NZD	-0,016	0,001	-0,560	0,575
EUR	-0,034	-0,016	-0,639	0,523
SEK	-0,024	-0,001	-0,746	0,456
GBP	-0,015	0,010	-0,789	0,430
THB	-0,053	-0,005	-2,027	0,043

Appendix 3: Weekly Euribor levels.

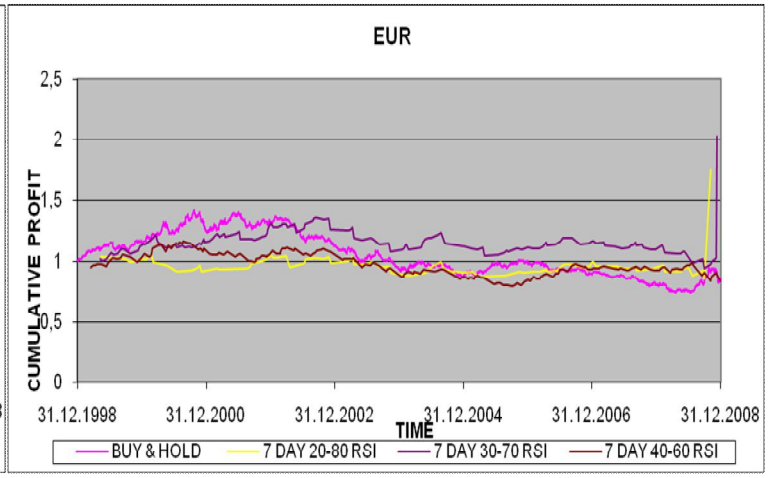




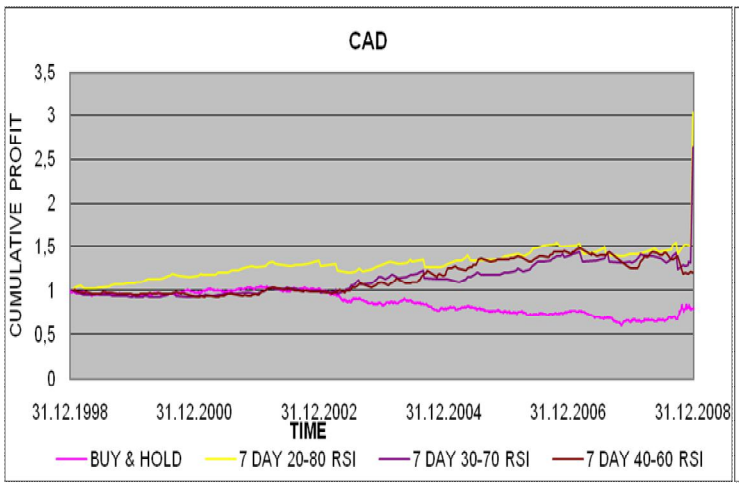
Appendix 4: Graphs of all scenarios.



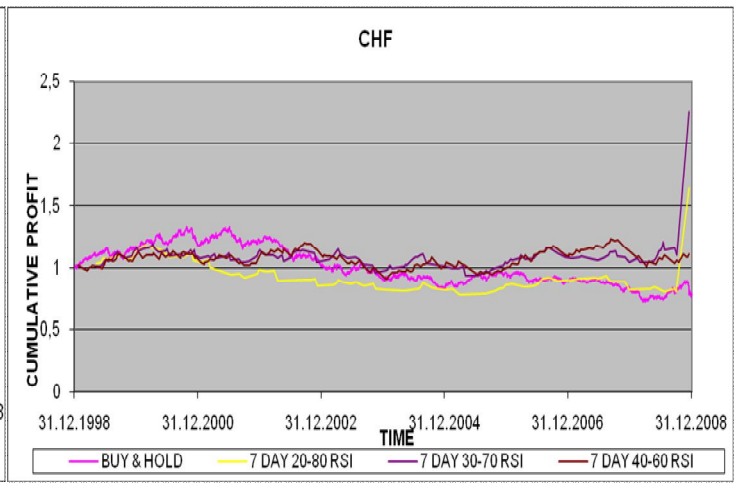
GRAPH 1. USD/AUD. 7 DAY SCENARIOS.



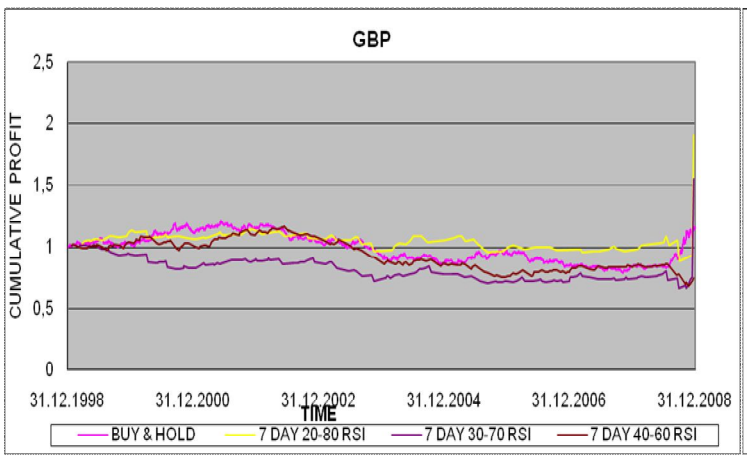
GRAPH 2. USD/EUR. 7 DAY SCENARIOS.



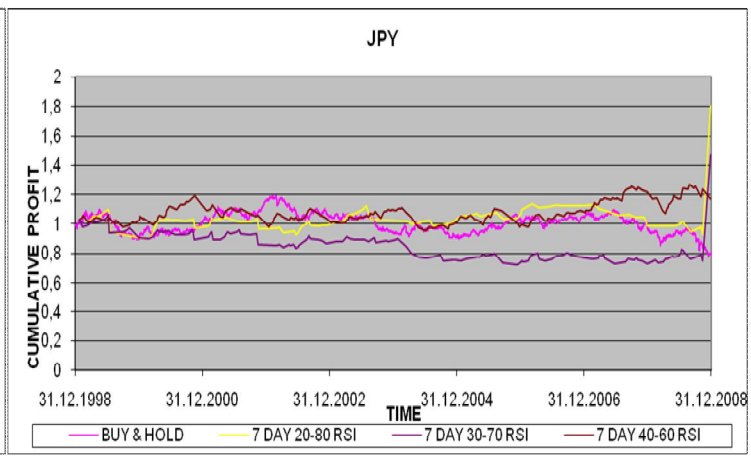
GRAPH 3. USD/CAD. 7 DAY SCENARIOS.



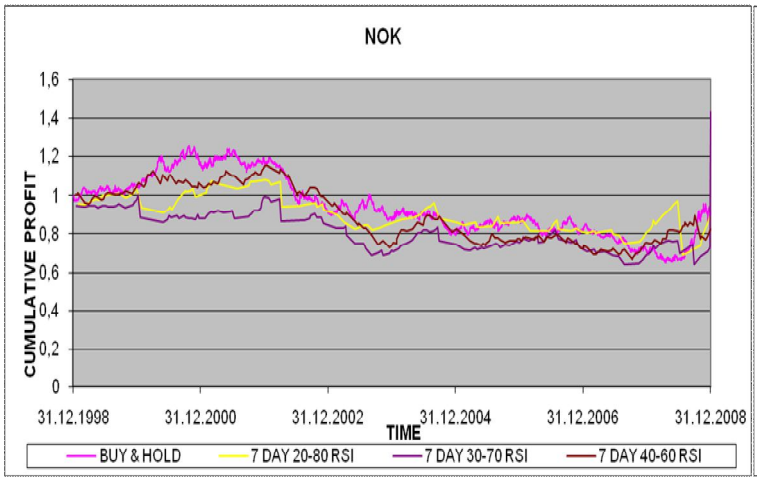
GRAPH 4. USD/CHF. 7 DAY SCENARIOS.



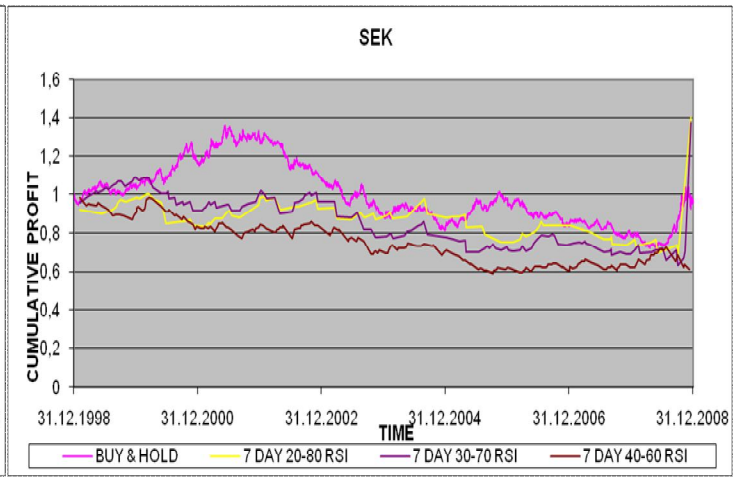
GRAPH 5. USD/GBP. 7 DAY SCENARIOS.



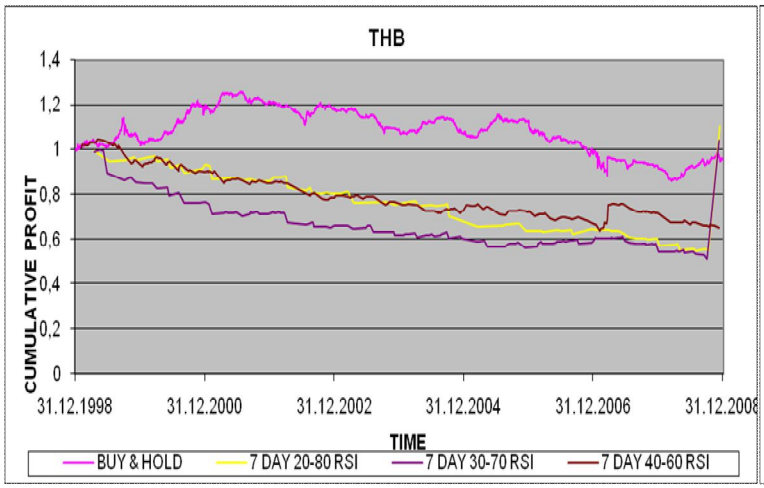
GRAPH 6. USD/ JPY. 7 DAY SCENARIOS.



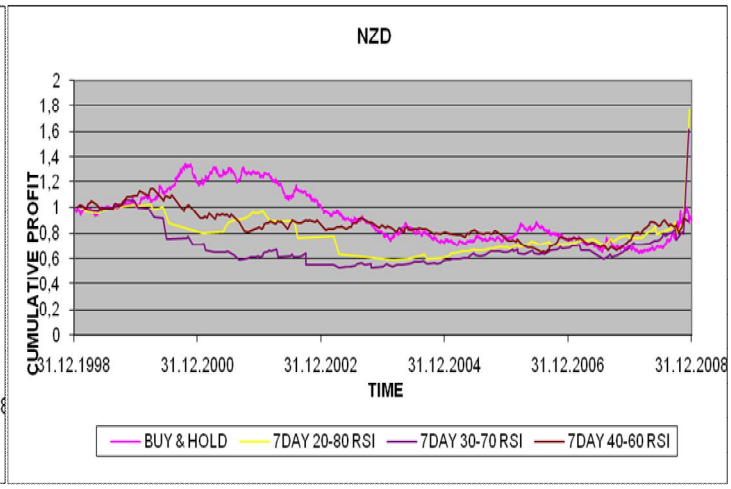
GRAPH 7. USD/NOK. 7 DAY SCENARIOS.



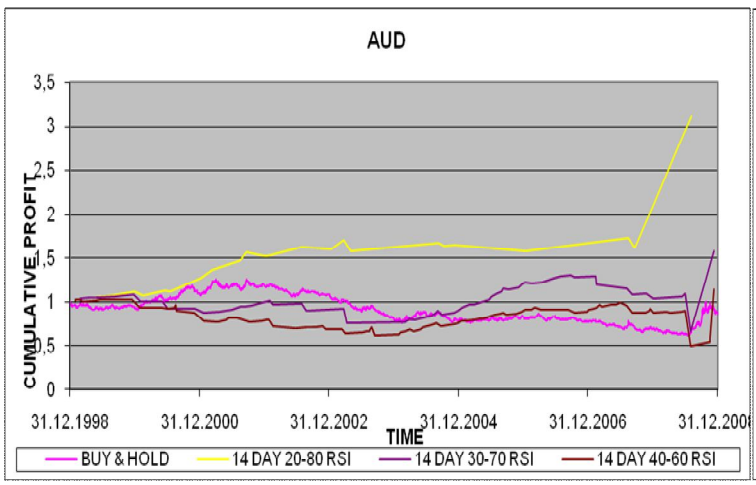
GRAPH 8. USD/SEK. 7 DAY SCENARIOS.



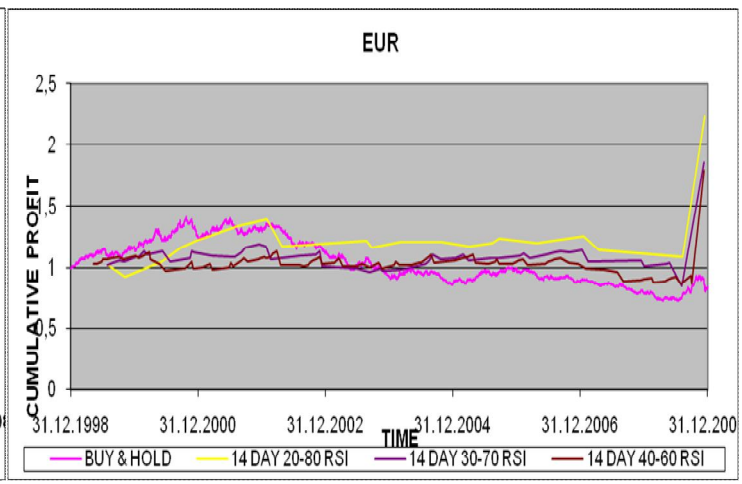
GRAPH 9. USD/THB. 7 DAY SCENARIOS.



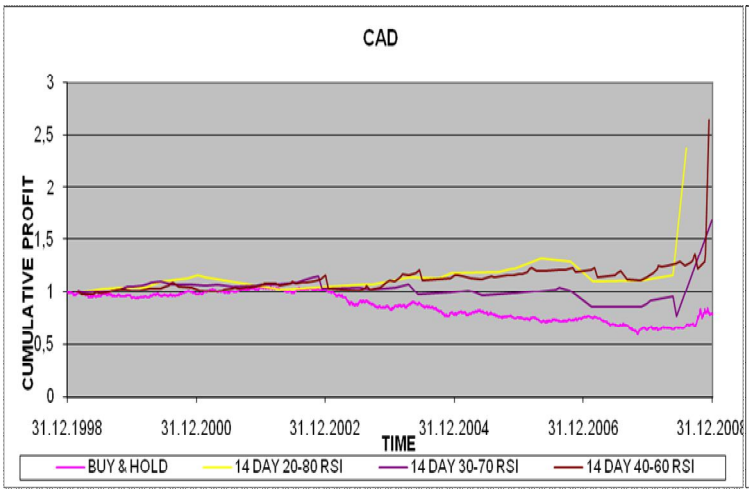
GRAPH 10. USD/NZD. 7 DAY SCENARIOS.



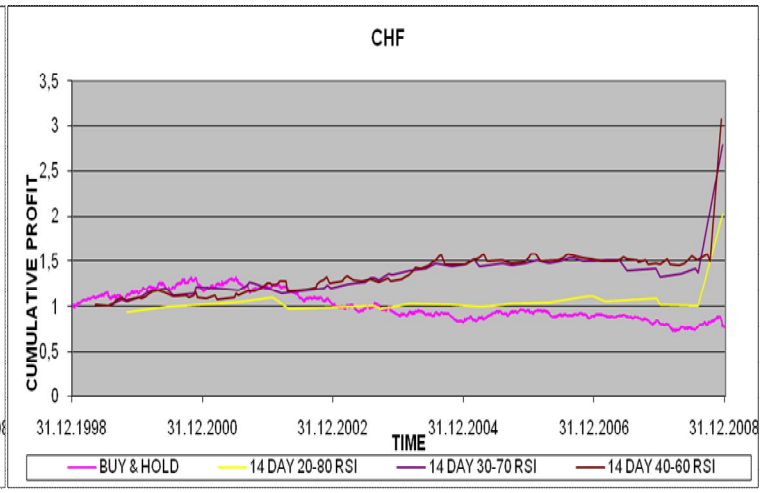
GRAPH 11. USD/AUD. 14 DAY SCENARIOS.



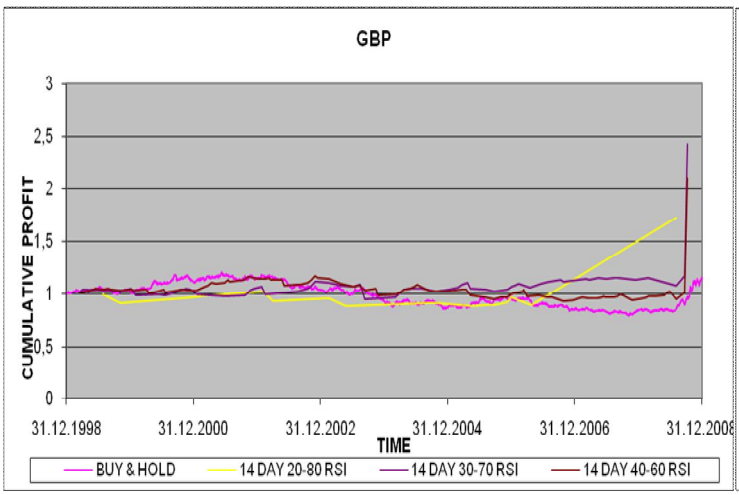
GRAPH 12. USD/EUR. 14 DAY SCENARIOS.



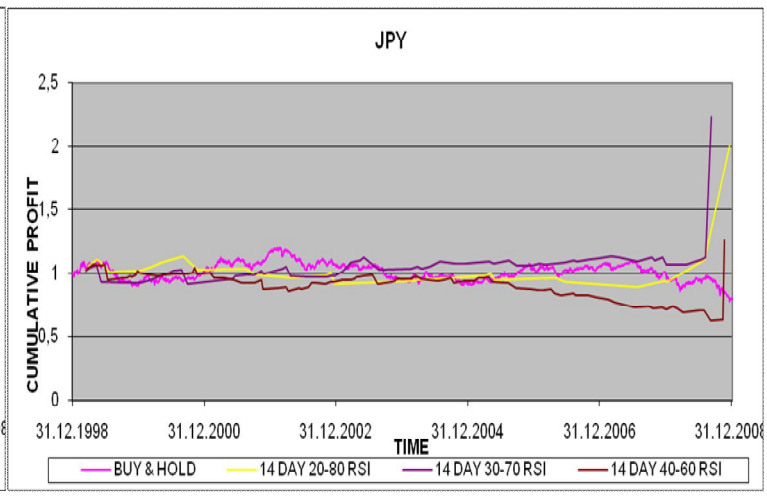
GRAPH 13. USD/CAD. 14 DAY SCENARIOS.



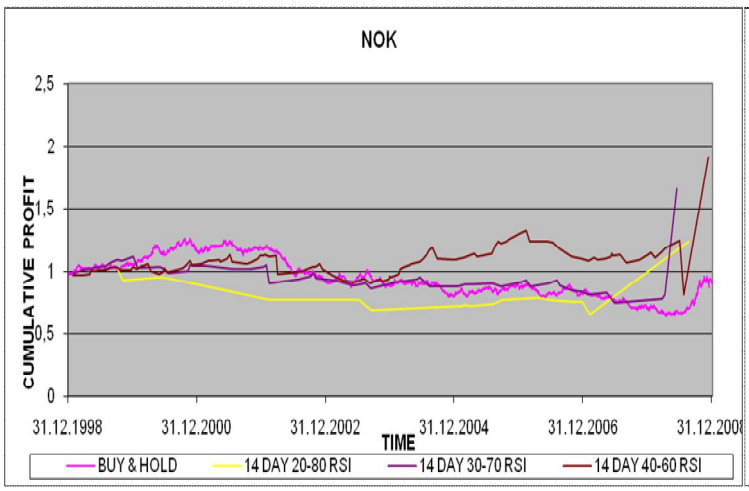
GRAPH 14. USD/CHF. 14 DAY SCENARIOS.



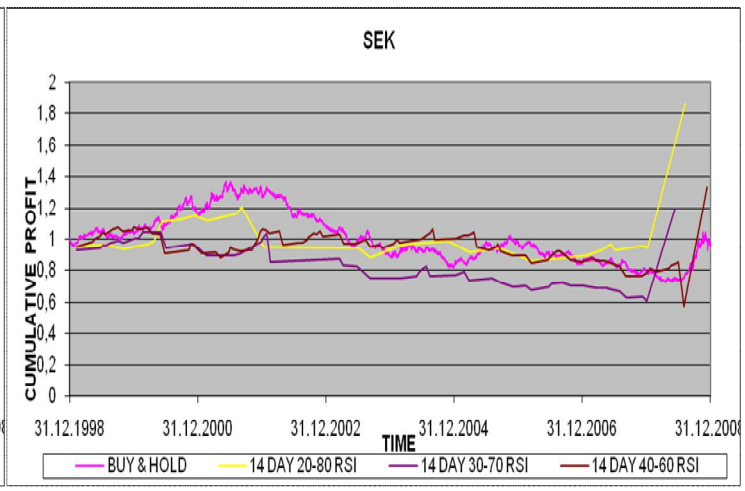
GRAPH 15. USD/GBP. 14 DAY SCENARIOS.



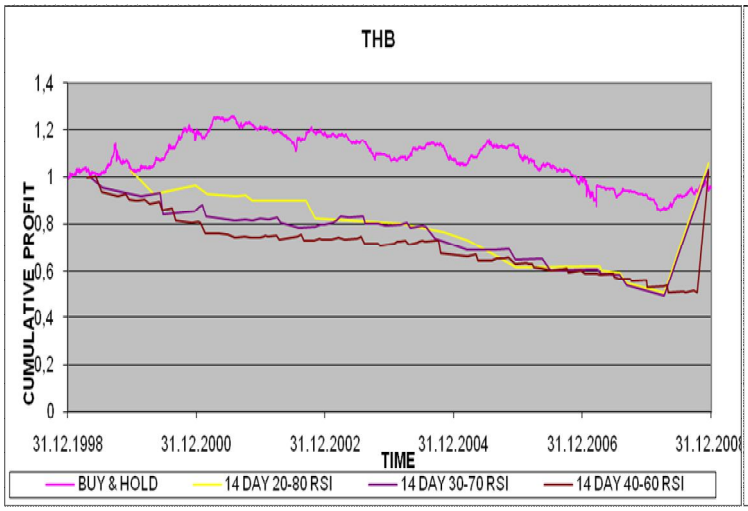
GRAPH 16. USD/JPY. 14 DAY SCENARIOS.



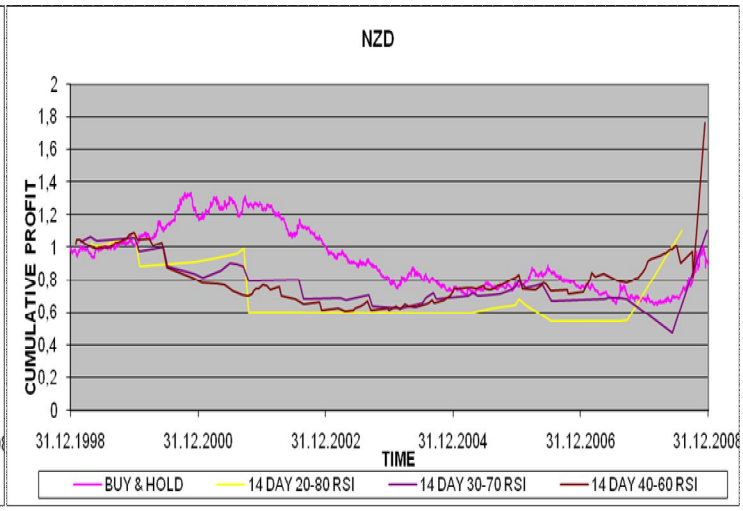
GRAPH 17. USD/NOK. 14 DAY SCENARIOS.



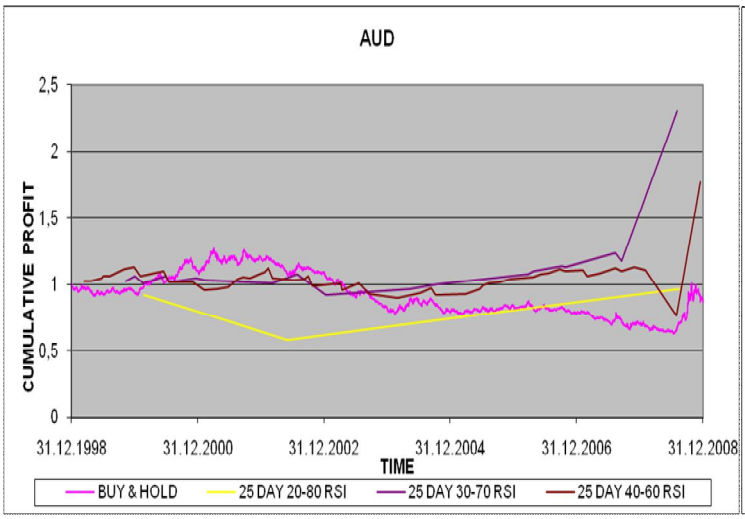
GRAPH 18. USD/SEK. 14 DAY SCENARIOS.



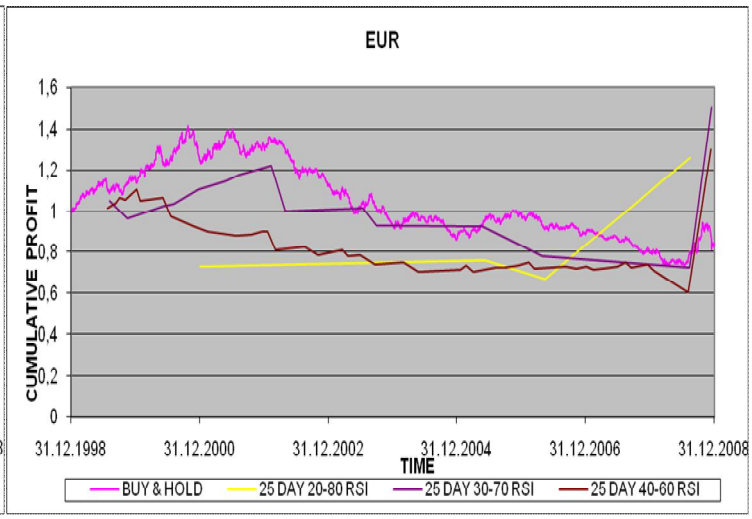
GRAPH 19. USD/THB. 14 DAY SCENARIOS.



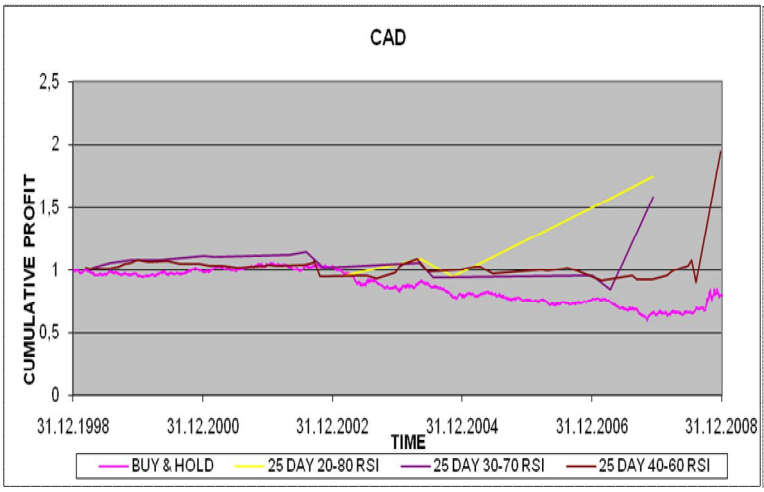
GRAPH 20. USD/NZD. 14 DAY SCENARIOS.



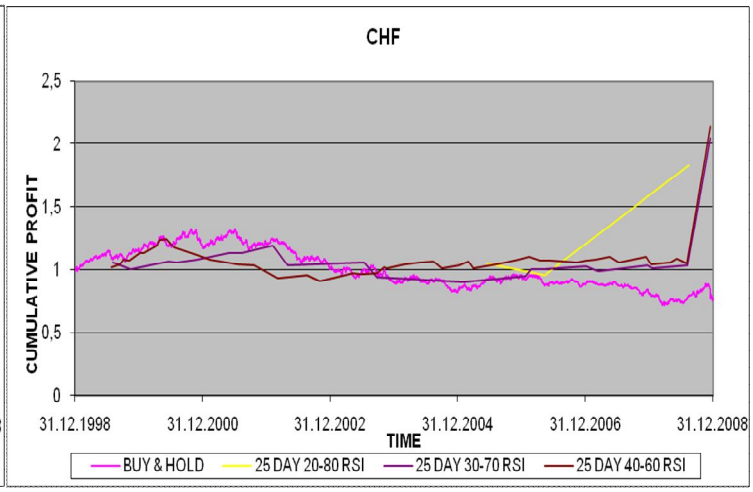
GRAPH 21. USD/AUD. 25 DAY SCENARIOS.



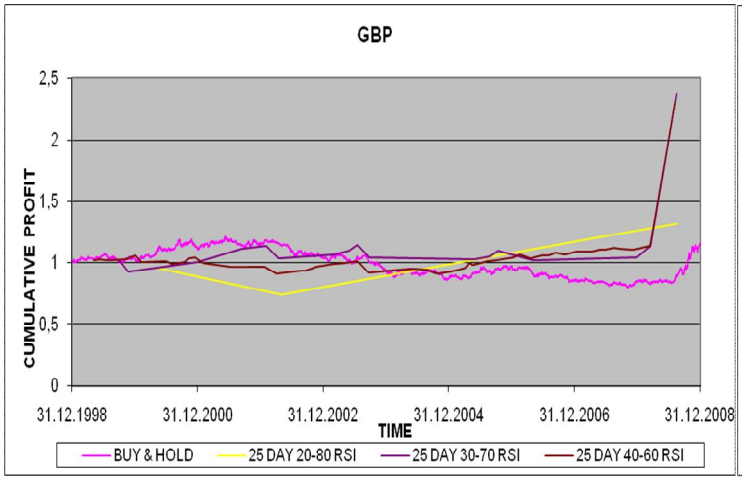
GRAPH 22. USD/EUR. 25 DAY SCENARIOS.



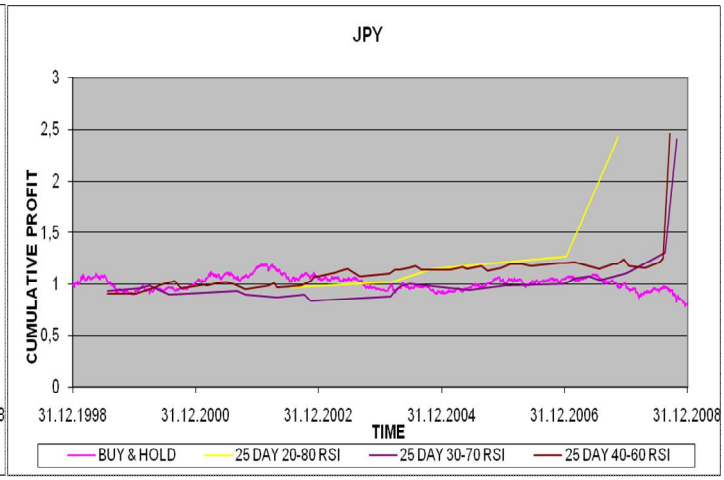
GRAPH 23. USD/CAD. 25 DAY SCENARIOS.



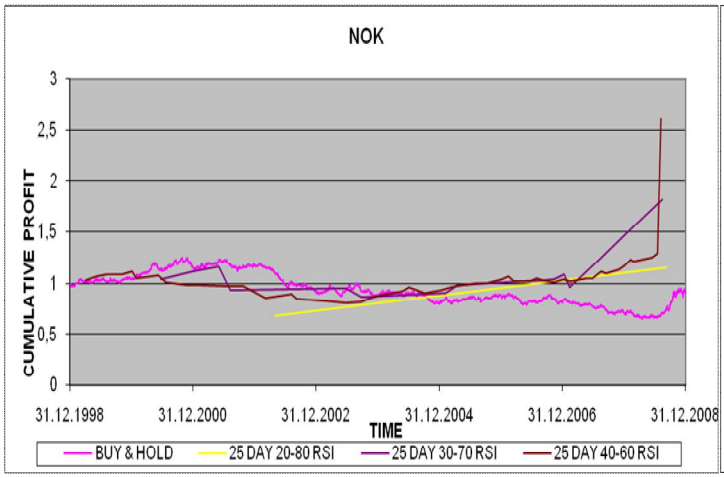
GRAPH 24. USD/CHF. 25 DAY SCENARIOS.



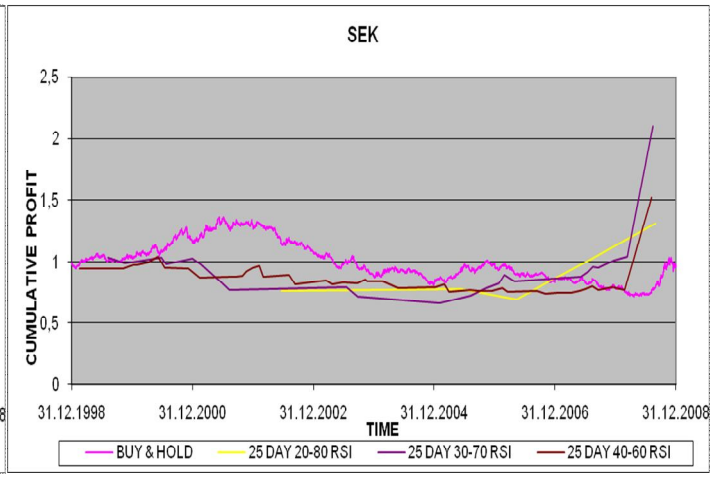
GRAPH 25. USD/GBP. 25 DAY SCENARIOS.



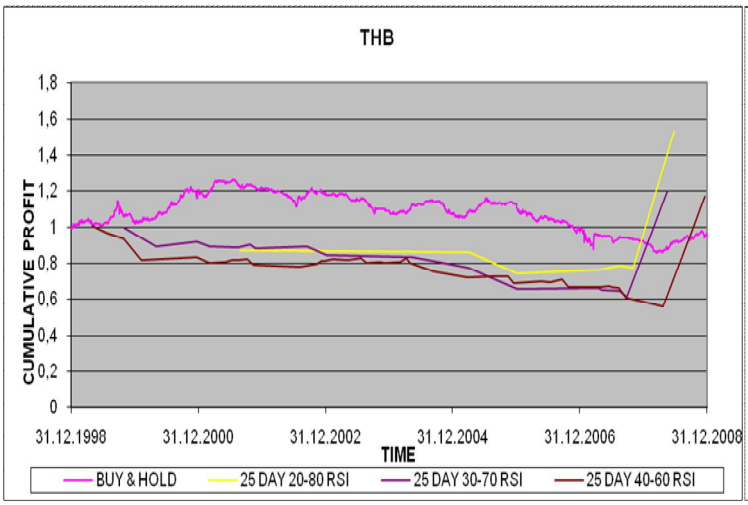
GRAPH 26. USD/JPY. 25 DAY SCENARIOS.



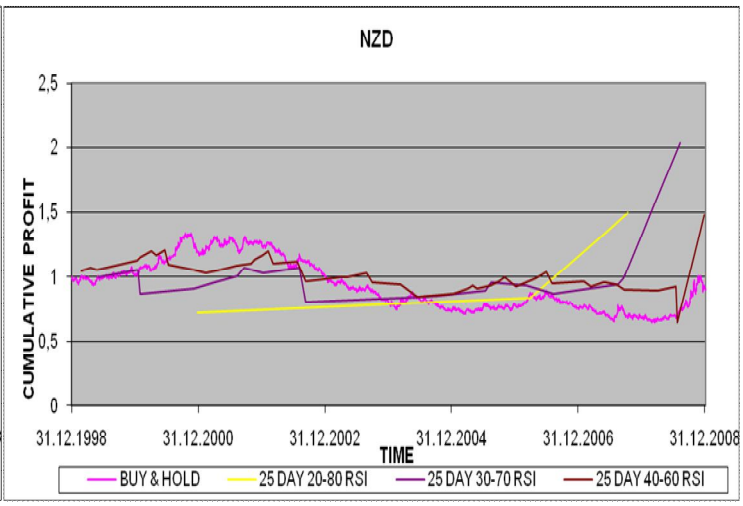
GRAPH 27. USD/NOK. 25 DAY SCENARIOS.



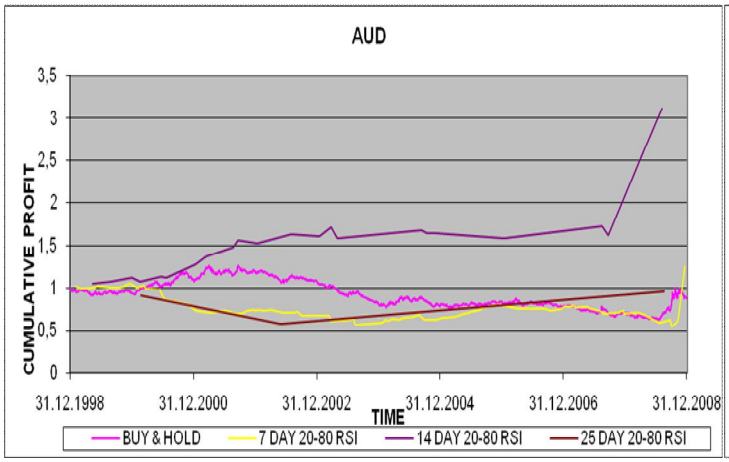
GRAPH 28. USD/SEK. 25 DAY SCENARIOS.



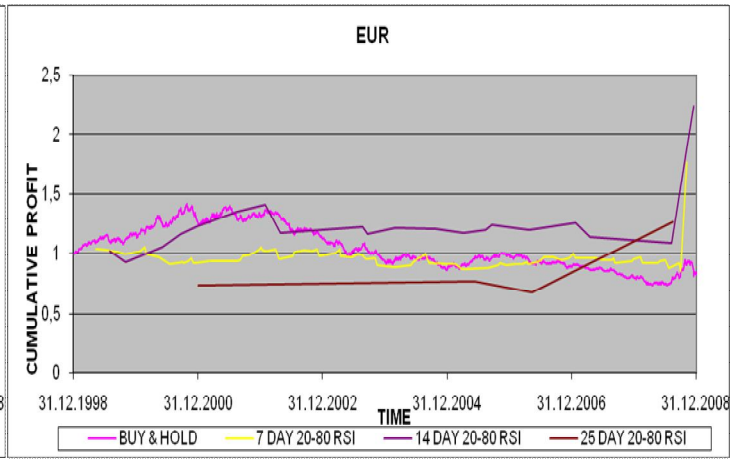
GRAPH 29. USD/THB. 25 DAY SCENARIOS.



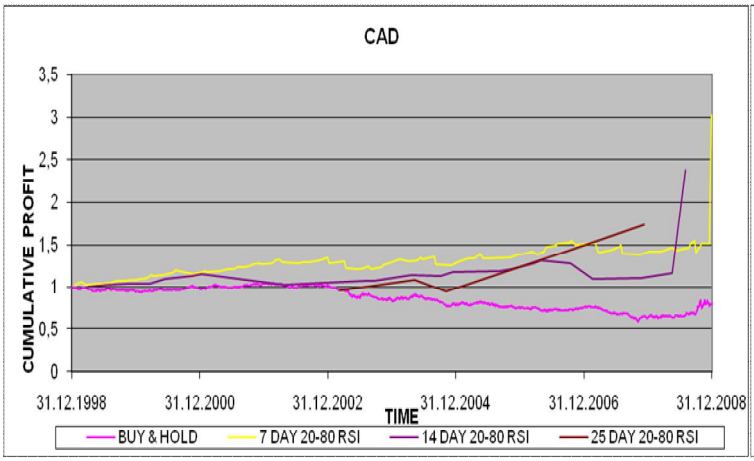
GRAPH 30. USD/NZD. 25 DAY SCENARIOS.



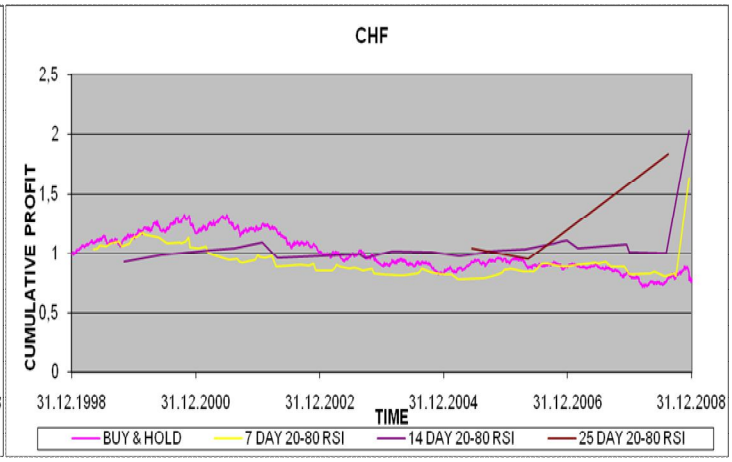
GRAPH 31. USD/AUD. 20-80 SCENARIOS.



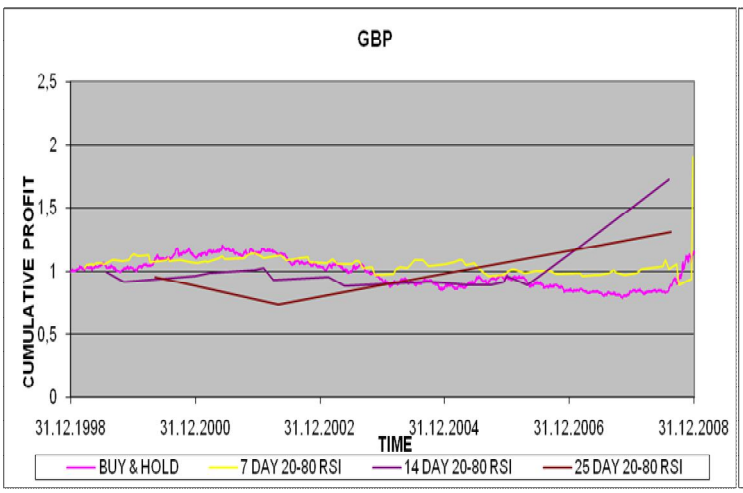
GRAPH 32. USD/EUR. 20-80 SCENARIOS.



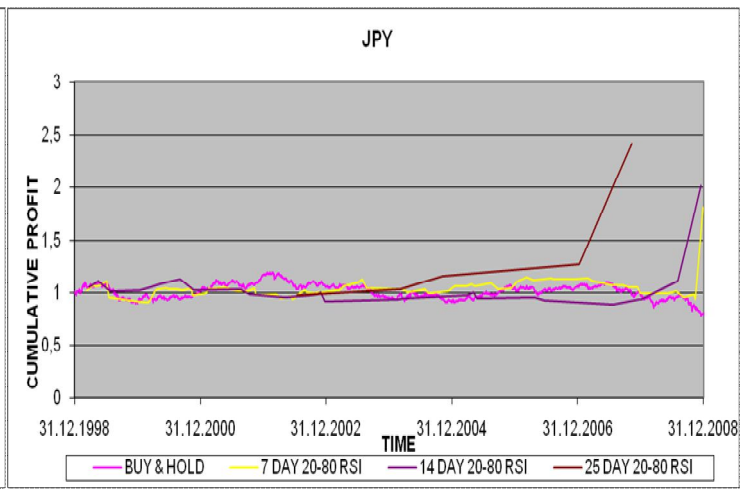
GRAPH 33. USD/CAD. 20-80 SCENARIOS.



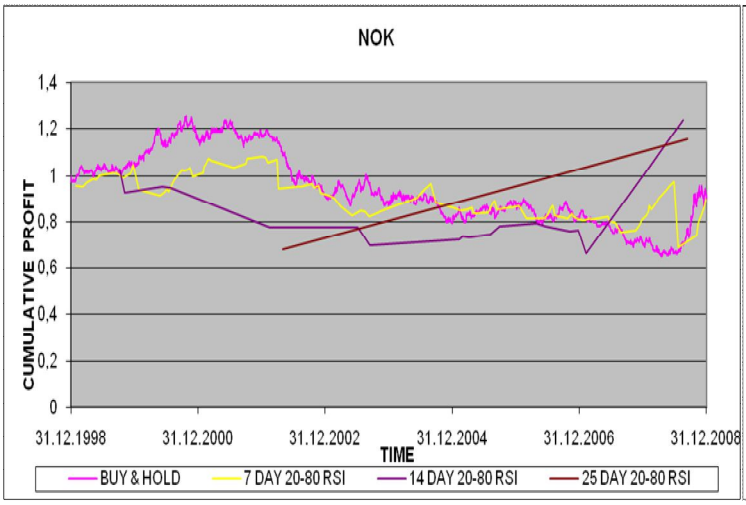
GRAPH 34. USD/CHF. 20-80 SCENARIOS.



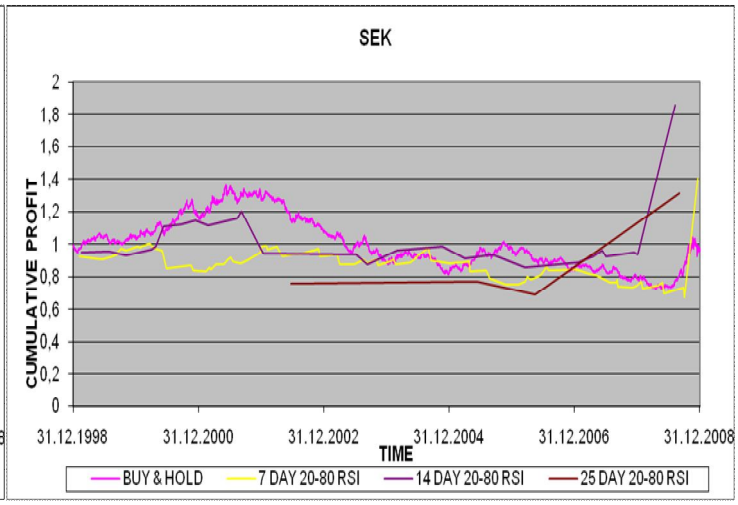
GRAPH 35. USD/GBP. 20-80 SCENARIOS.



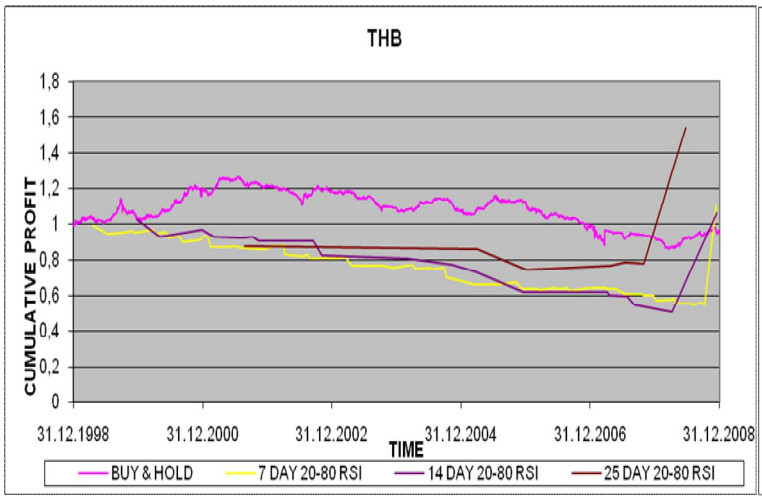
GRAPH 36. USD/JPY. 20-80 SCENARIOS.



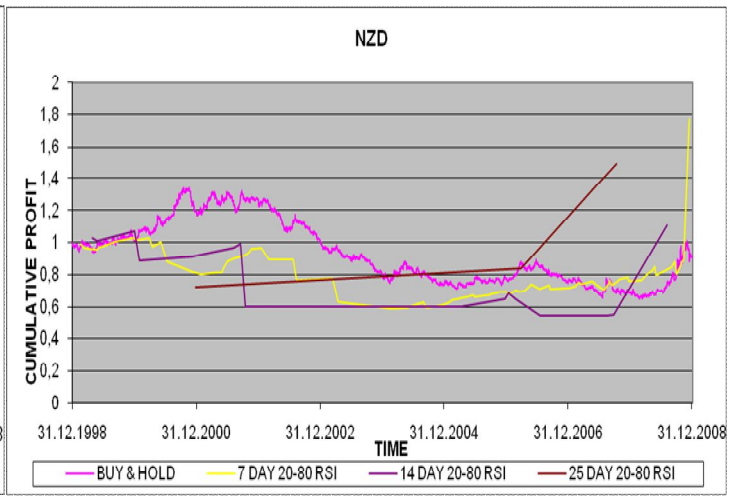
GRAPH 37. USD/NOK. 20-80 SCENARIOS.



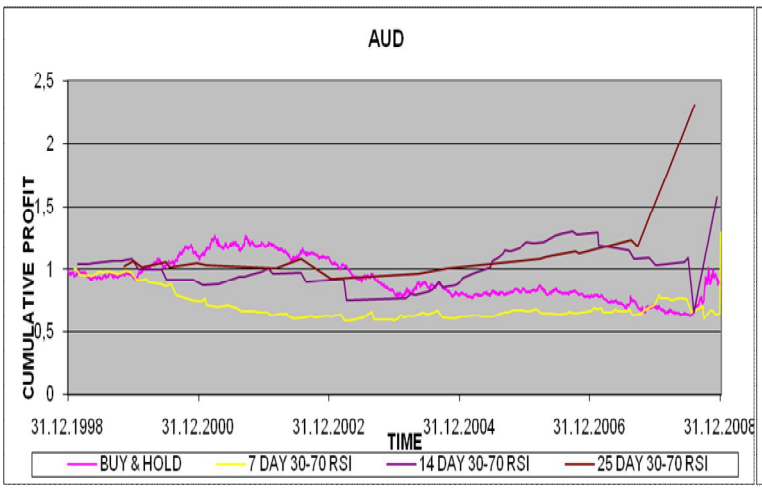
GRAPH 38. USD/SEK. 20-80 SCENARIOS.



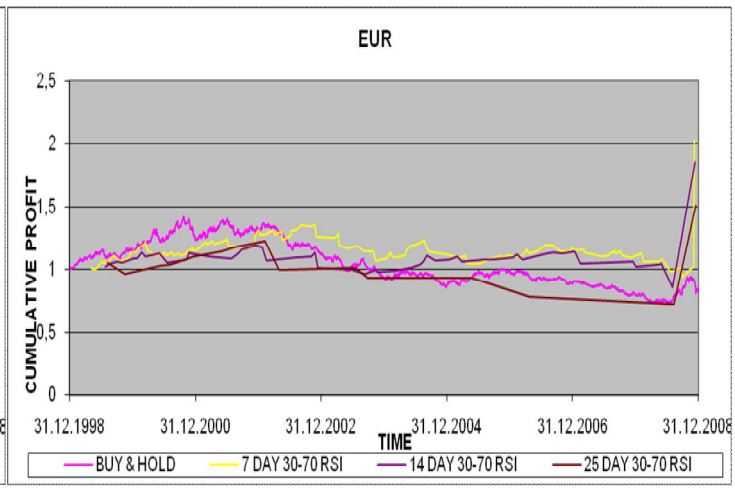
GRAPH 39. USD/THB. 20-80 SCENARIOS.



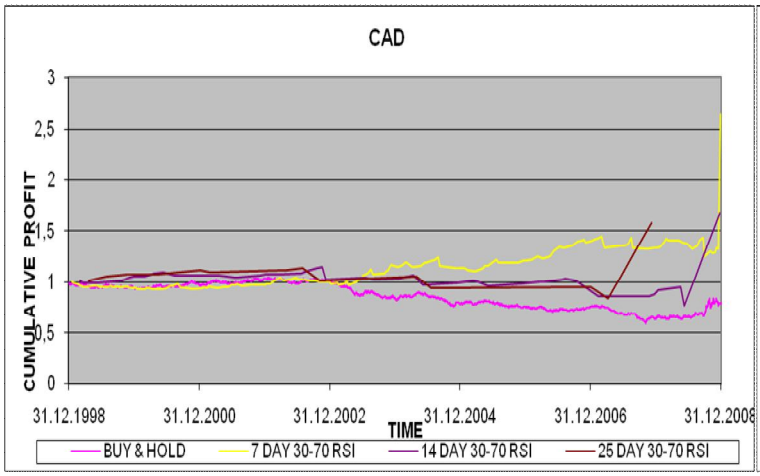
GRAPH 40. USD/NZD. 20-80 SCENARIOS.



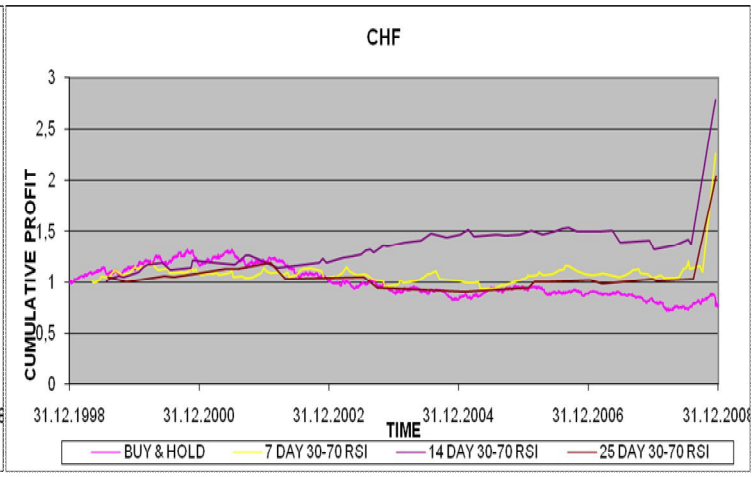
GRAPH 41. USD/AUD. 30-70 SCENARIOS.



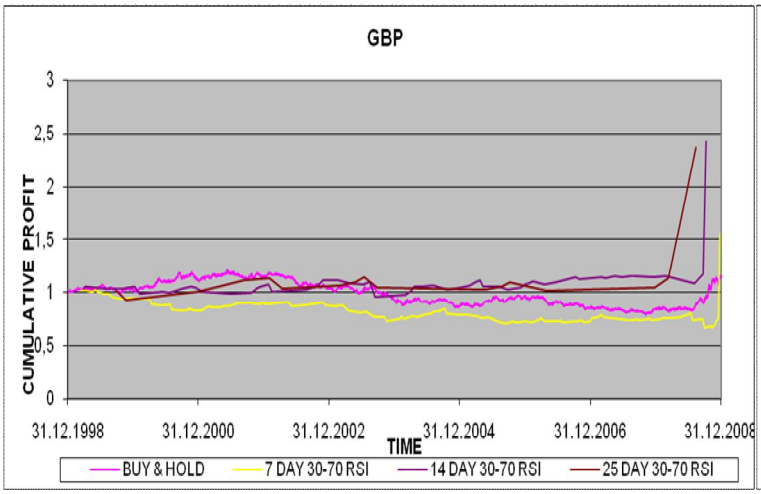
GRAPH 42. USD/EUR. 30-70 SCENARIOS.



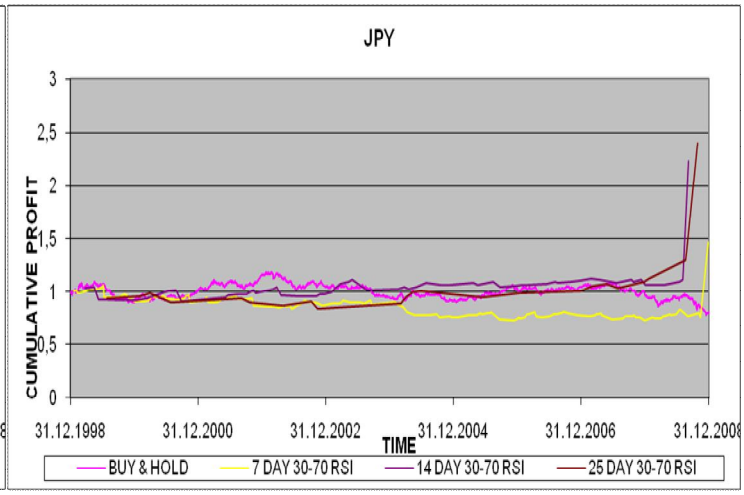
GRAPH 43. USD/CAD. 30-70 SCENARIOS.



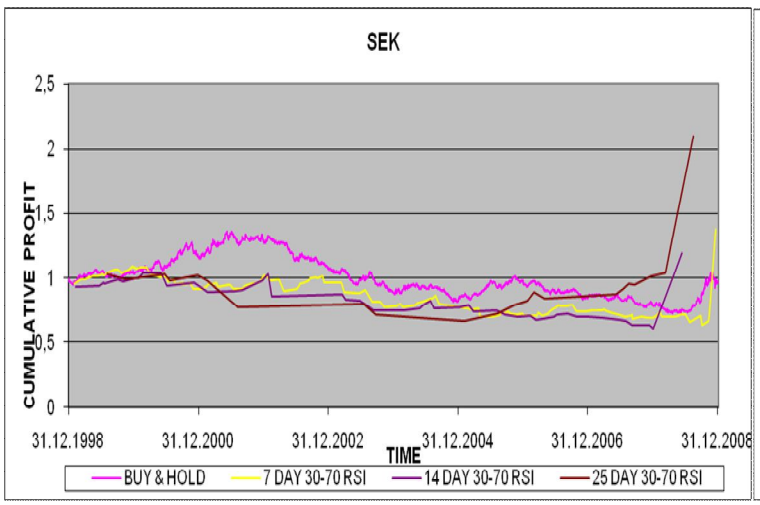
GRAPH 44. USD/CHF. 30-70 SCENARIOS.



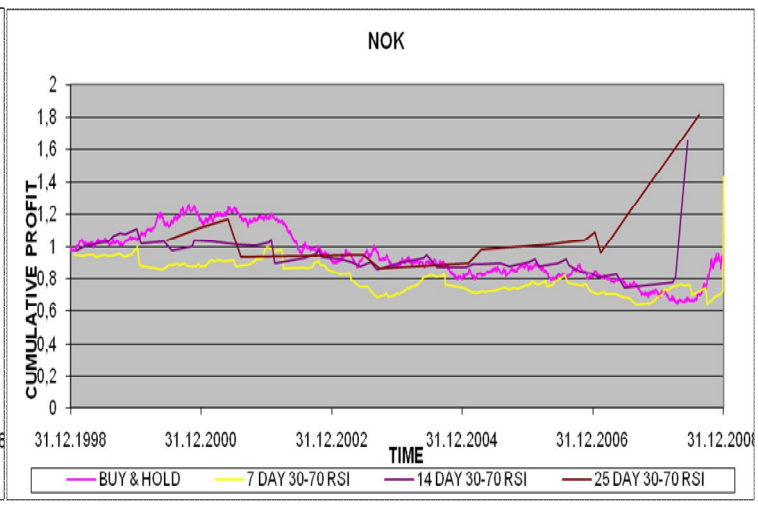
GRAPH 45. USD/GBP. 30-70 SCENARIOS.



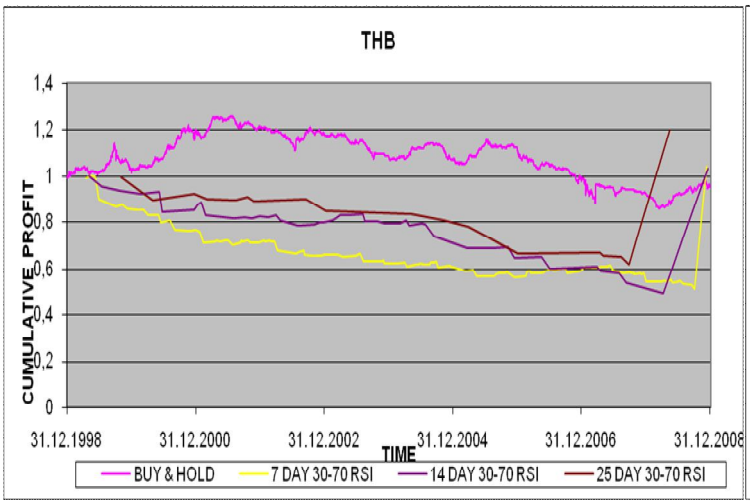
GRAPH 46. USD/JPY. 30-70 SCENARIOS.



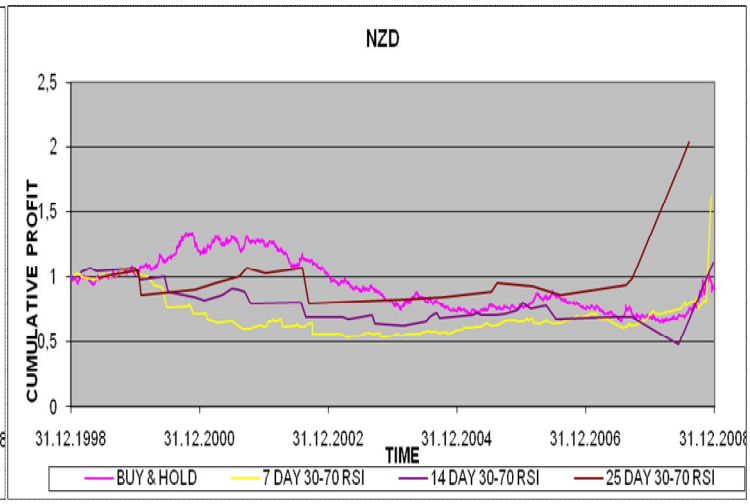
GRAPH 47. USD/NOK. 30-70 SCENARIOS.



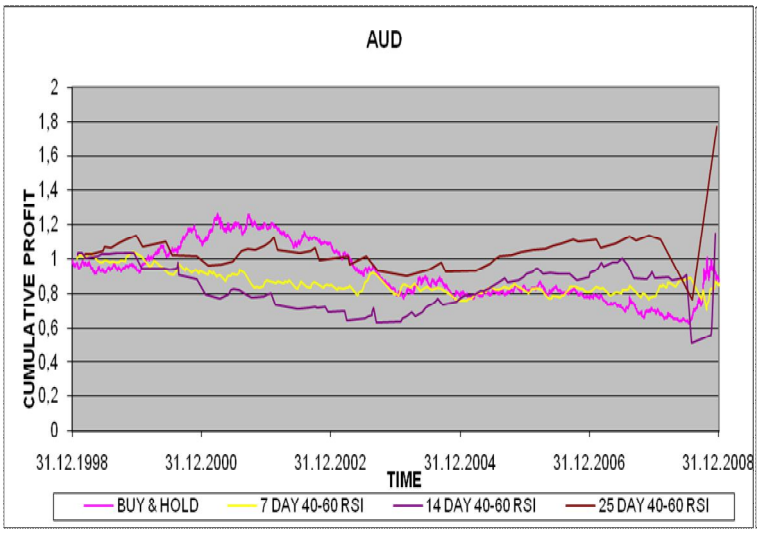
RAPH 48. USD/SEK. 30-70 SCENARIOS.



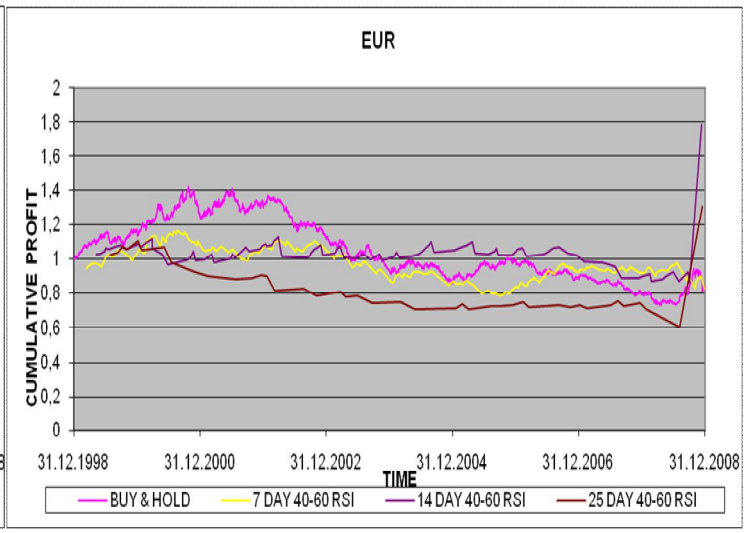
GRAPH 49. USD/THB. 30-70 SCENARIOS.



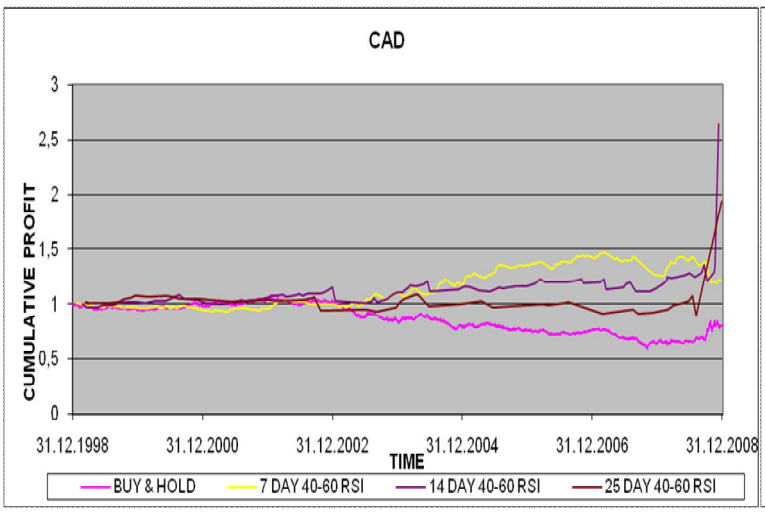
GRAPH 50. USD/NZD. 30-70 SCENARIOS.



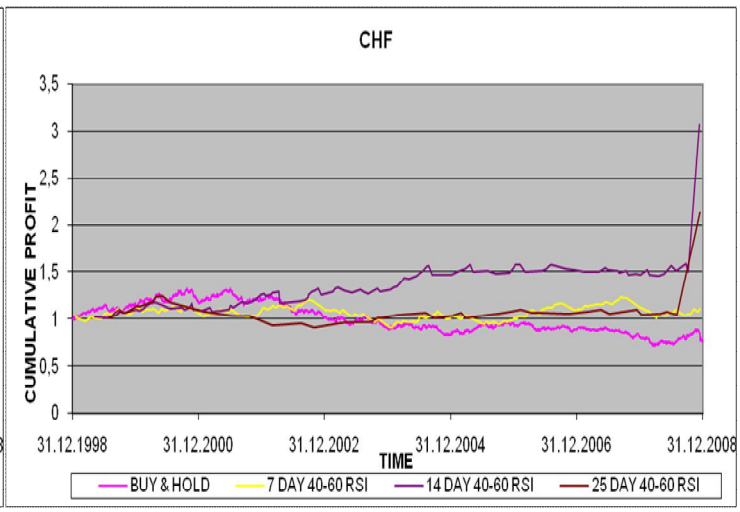
GRAPH 51. USD/AUD. 40-60 SCENARIOS.



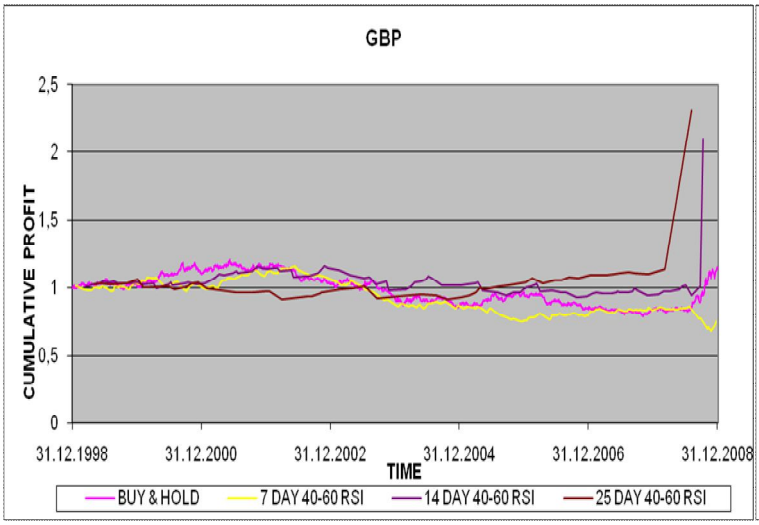
GRAPH 52. USD/EUR. 40-60 SCENARIOS.



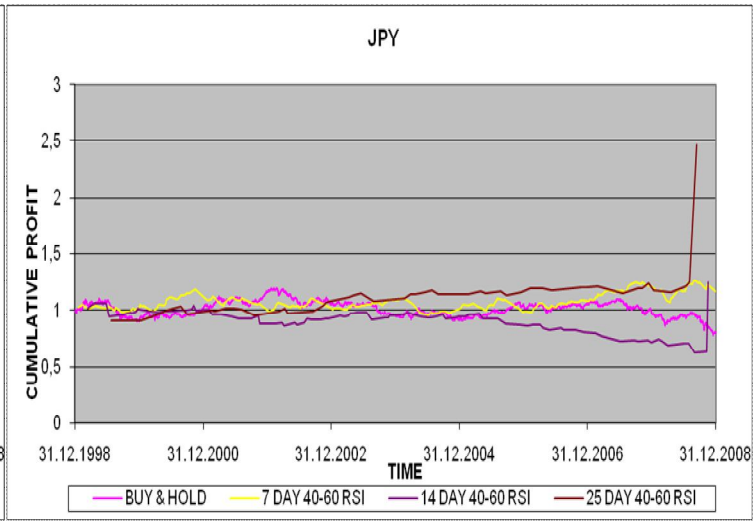
GRAPH 53. USD/CAD. 40-60 SCENARIOS.



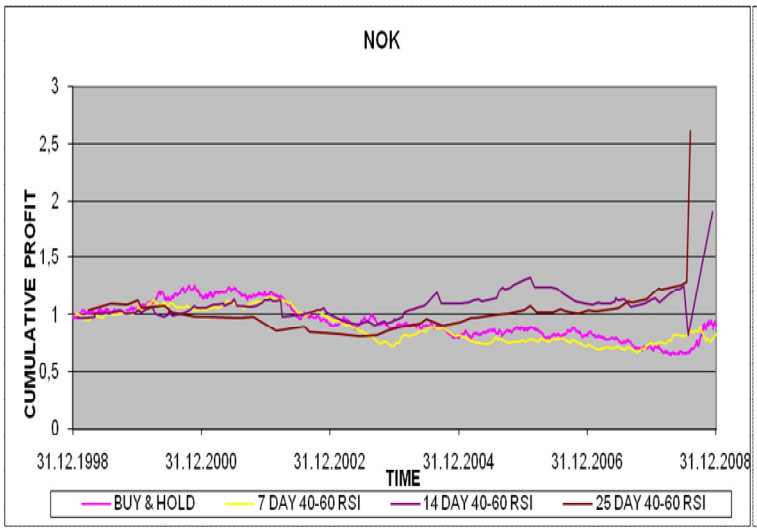
GRAPH 54. USD/CHF. 40-60 SCENARIOS.



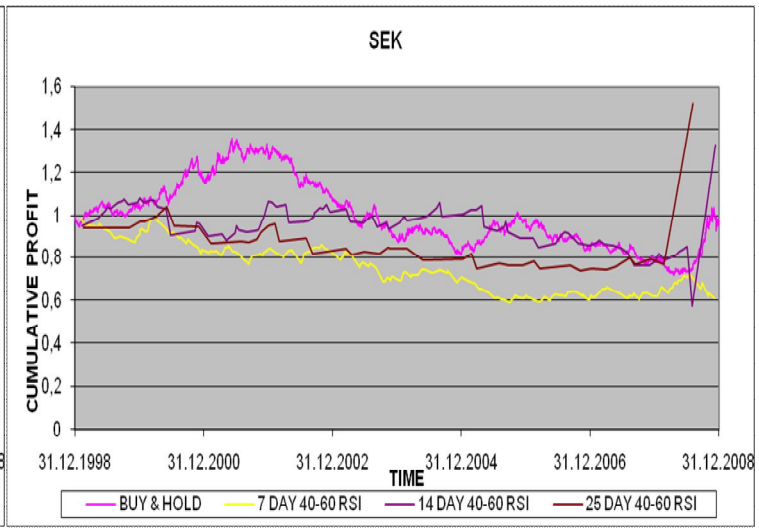
GRAPH 55. USD/GBP. 40-60 SCENARIOS.



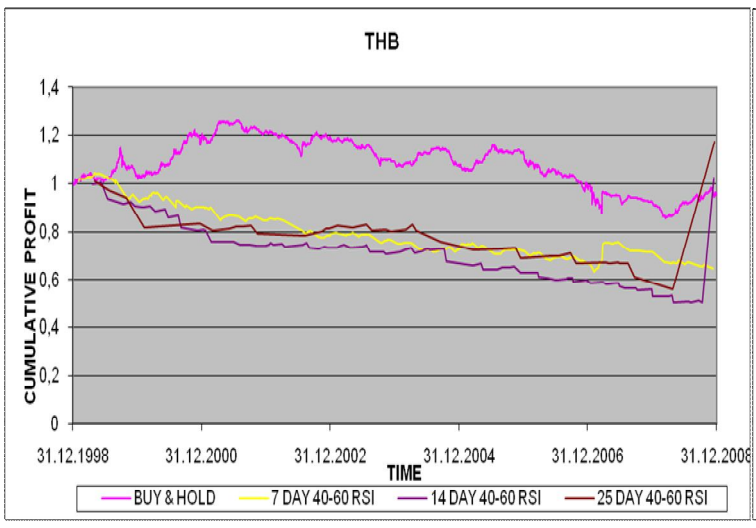
GRAPH 56. USD/JPY. 40-60 SCENARIOS.



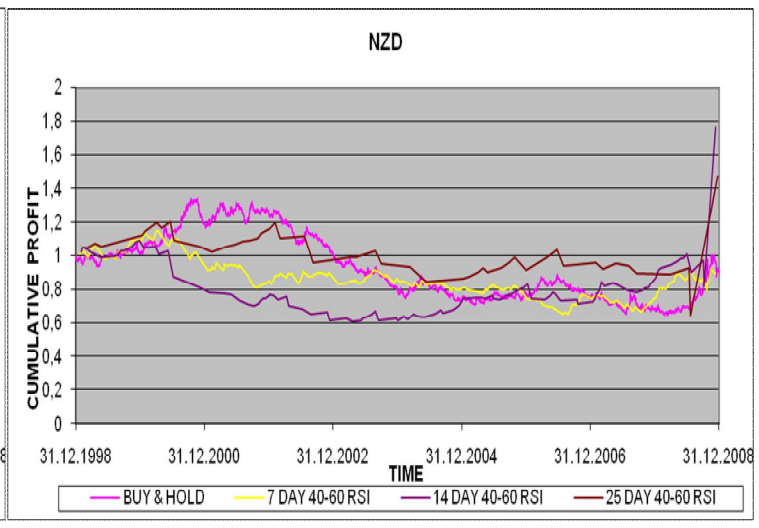
GRAPH. 57. USD/NOK. 40-60 SCENARIOS.



GRAPH 58. USD/SEK. 40-60 SCENARIOS.



GRAPH 59. USD/THB. 40-60 SCENARIOS.



GRAPH 60. USD/NZD. 40-60 SCENARIOS.