Technical analysis of Forex by MACD Indicator

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Abstract—In these days, trading automation is one of the major topics in the field of financial research. Buy and sell are the key rule to an automated trading system which is possible to generate by various technical indicators in Forex. Benefits and disadvantages of each indicators, has its own. Regarding to our first research result which was based on P-sar indicator and published in the IIAFC conference[1]. In this paper, we will focus on the MACD indicator for four currencies namely EURUSD, GBPUSD, USDCHF and USDJPY individually to identify effectiveness of the indicator regarding to the amount of profit generated, using hourly data of market stretch from January 2001 to December 2010. Virtual Historical Trading Software (VHTS) is developed for the purpose of computing the indicator based on its original formulas and interpretations; for applying the assumptions; for trading based on buy and sell signals generated by the MACD indicator.

Keywords— Forex, MACD, Technical analysis, Fundamental Analysis, Indicator.

I. INTRODUCTION

USING currencies in trading commenced in 1973 after breaking down the Bretton Woods agreement based on which the value of currency was underpinned by the gold owned by the central bank. Forex is a free market that defines the prices of currencies based on the supply and demand of a particular currency [2].

Compared to other financial markets, the Forex market has following benefits: 24-hour operation 5 days a week, an over-the-counter market, and no fixed location. Moreover, Forex market produces daily volume of USD 3.2 trillion that makes it as the biggest financial market [3]. Since, there is no limitation by the central bank for issuing the currencies, any currency can be traded [4]. According to Ding et al. (2010), quick technological changes have increased the effectiveness of Forex transactions and allowed the market to grow faster by overcoming geographical restrictions as well as decreasing the costs of entry and transactions.

A. Fundamental Analysis in Forex Trading

The best way for determining asset valuation based on key underlying factors is fundamental analysis (FA). Significant

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factors in forex transactions which would provide a basis to determine that country's currency's value are economic indicators of a country and predictions of future economic performance. Accent to arrive at a fair value of currency between that country and other countries is put on interest rate differentials, the agent who trade by using fundamental analysis is fundamentalist[5].

B. Technical Analysis in Forex

Technical analysis (TA) or charting that usually include price and volumes by utilizing historical data created by market reaches at future currency price movements[6]. TA has received little attention by academicians, though, it has been applied for more than hundred years [7-9].Quantitative and qualitative are two main analytical concepts for TA. The quantitative- based analysis tries to make indicators such as MACD and P-SAR while the qualitative-based analysis depends on clarification of the shape of geometric patterns like levels of support and resistance and double bottoms[8]. Successful TA is constructed on three basic principles [2]:

C. Profitability

Several studies support TA and revealed that TA offers significant financial signals [9]. In addition, the subsequent researchers concur with this actuality; Sweeney (1986, 1988); Brock, Lakonishok, and LeBaron (1992); Blume, Easley, and O'Hara (1994) ; Neely, Weller, and Dittmar (1997); Chan, Jegadeesh, and Lakonishok (1996, 1999); Gencay (1996, 1998, 1999); Brown, Goetzmann, and Kumar (1998); Rouwenhorst (1998); Neely and Weller (1999); Chang and Osler (1999); Lo, Mamaysky, and Wang (2000); Chan, Hameed, and Tong (2000); and Hsu and Kuan (2004) [10-19]. Their findings imply the popularity of TA over FA is due to the fact that the former can "beat the market".

Moreover, (Papadamou and Tsopoglou, 2001) indicated that TA approach can generate higher profit against a simple "buy and hold" strategy which is a fundamental analysis [20]. In during on 8 years from 1989 until 1996 for finding out whether TA is profitable, they tried to evaluate USDDEM and USDGBP in their study. In addition, Lui (1998) stated that more than 85% of Forex traders in Hong Kong used both technical and fundamental analysis to predict future price movements; however, they believed that TA is more helpful than FA in forecasting the trends [21].

II. INDICATORS

The mathematical calculations based on currencies information such as volume and prices (opening, low, high and

closing) with a specific formula called indicators. TO forecasting future price changes can use from the value of result. They are used to offer more information about market to be applied by the investors in decision making. Indicators based on their functions are sorted to four groups; trend indicators, volume (strength) indicators, volatility indicators and momentum indicators as follow [6].

A. Trend Indicators

Explain continue to move in one direction in the exchange rate over time, called a trend. Trends have three directions; sideways, down and up. Trend indicators level variable rate data to produce a mix of market direction. There are some Trend Indicators for example Moving Averages (MA), MACD, P-SAR and Trend lines.

III. MACD

The MACD (Moving Average Convergence/Divergence) is in category of trend indicators which shows relationship between prices and moving averages. The MACD was introduced by Gerald Appel, in 1970s. It is the different between exponential moving averages for 26 and 12 days. There is a plot of another exponential average for 9 days which is placed on top of the MACD to indicate long/short opportunities; it is called "trigger" or "signal" [22].

The MACD is very simple to calculate; the difference between exponential moving averages for 26 and 12 days. There is a plot of another exponential average for 9 days which is placed on top of the MACD to indicate long/short opportunities; it is called "trigger" or "signal" (Appel, 2008).

Interpretation of MACD is easy to be used for traders. In this study whenever the MACD crosses the zero upward, it means there is a buy opportunity while if the MACD crosses the zero downward, there is a sell opportunity as shown in Figure 3.4. On the other hand, when the value of MACD in the first period (hour) is less than zero and in the second and third periods is more than zero, there is a buy signal in fourth period. While, when the value of MACD in the first period (hour) is more than zero and in the second and third periods is less than zero, there is a sell signal in fourth period.

Fig. 1 4 Buy and sell signal from MACD indicator

A. MACD advantages and Properties

One of the basic advantages of MACD is its potential to incorporate the aspects of both trend and momentum in a single indicator. As a trend-following indicator, MACD will not be erroneous for too long. Applying moving averages confirm that the indicator will finally follow the movements of the underlying security. Moreover, using Exponential Moving Averages (EMAs), opposite to Simple Moving Averages (SMAs) can remove some lags.

MACD as a momentum indicator can predict the moves in the underlying security. MACD divergences are basic elements in forecasting a trend alters. A Negative Divergence signal which bullish momentum is waning and a change in trend from bullish to bearish is possible, too. It warns the traders to take benefits in long positions or for violent traders setting off a short position.

Another advantage of MACD is its application in daily, weekly or monthly charts. In this regard, the divergence and convergence of two moving averages will be shown by the MACD. Although, the standard setting defined for the MACD is the difference between the 12 and 26-period EMA, any combination of moving averages can be applied. In addition, the set of moving averages to be applied in MACD can be changed for each individual security. For example, a faster set of moving averages may be suitable for weekly charts. On the other hand, slower moving averages may appropriate to help smooth the data for volatile stocks. Regarding this flexibility, the MACD can be adjusted to the trading style, risk tolerance and objectives of the traders.

IV. SCOPE OF THE STUDY

In this study real data of trading on hourly basis and for 10 years from January 2001 to December 2010 is used. This set of data with numerous transactions will produce more reliable results. The present study is aimed to assess the major indicator to forecast the right time for buy and sell in the market in order to avoid lose and gain profits.

In this study four currencies, namely, EURUSD, GBPUSD, USDJPY, and USDCHF are assessed with the employment of MACD at which buy and sell signals are identified. The period of the present study is ten years which is beginning from January 2001.

The currencies in this study evaluated separately to avoid the effects of one indicator on the other's result. That is, for each currency the indicator applied and examined separately. Hence, there are four currencies and one indicator and combination of them are called traders. Accordingly, each one of the four virtual traders works only with the indicator and currency.

V. METHODOLOGY, DATA ACQUISITION AND ASSUMPTIONS

The present study is developed based on reviewing related literature as mentioned in previous section. This section summarizes the research design of this study. Figure 2 illustrates the methodology of the study to reach the defined aims.

The data needed for this study are hourly opening, closing, high, and low prices as well as trade volume for four currencies within 24 hours a day of weekdays started from January 2001 till December 2010. The data are collected from online data base of Foreign Exchange Market on MetaTrader software.
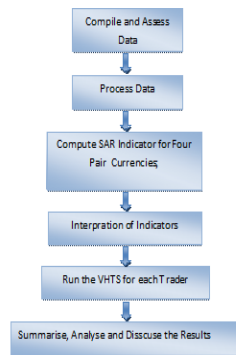
Fig. 2 The research process flow diagram

The data are transmitted to spreadsheets with 60,000 rows for each currency. Frequency is hourly for the time period of 2001-2010. An illustration of data on MetaTrader software is offered in Figure 3.The data then analyzed and processed in order to answer the first research question: what are the volume and open, high, low and close prices for each currency in hourly basis for the years 2001 -2010.
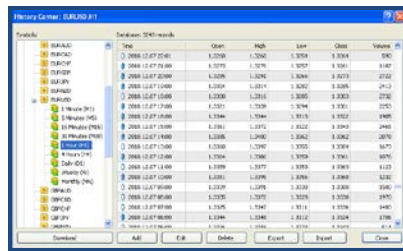

Fig. 3 An example of the data on MetaTrader software

MetaTrader as Forex trading online software that is used extensively by foreign exchange traders is one of the significant tools used in this study. Buying and selling is feasible via this software for traders. MetaTrader has provided graphs and charts of the indicator to facilitate traders' activities.

Microsoft Excel software is another tool applied for processing and analyzing the data. Regarding to the fact that calculations are based on each item as well as great volume of data, Virtual Historical Trader Software (VHTS) is developed based on Microsoft Excel. VHTS uses assumptions and trade based on them on historical data. In addition, TA-Lib program is added to Excel to increase accuracy of calculations by Microsoft Excel.

VHTS is provided to create a virtual situation like the real trading circumstances for investors by applying the assumptions. VHTS is able to compute indicator for each period of spreadsheet or each row based on the data. Moreover, sell and buy orders can be opened and closed based on signals and assumptions generated by the indicator. Finally, profit or loss for each/all order can be calculated by VHTS.

In order to evaluate the effectiveness of using SAR indicator applied on four currencies, empirical method has been applied. To ensure that the data are required ones, historical data collected from Meta Trader software were evaluated. Then, the

indicator was calculated by the evaluated data. By using unique formula in VHTS and default assumptions suggested by its inventor, the indicator was calculated. Besides, all formulas and assumptions were rechecked to avoid any mistakes in VHTS. Furthermore, to make sure that the results are reliable, the software has been run several times. It helped us to answer the second research question: what are the hourly values of the selected indicators for each currency?.

VI. DATA COLLECTION AND ASSUMPTIONS

After computing and interpretation of MACD indicator, VHTS provided the results as shown in Table 1. Even though the results are different for each currency, it is considerable that the circumstances of all currencies for using MACD are the same; trading with the same assumptions and interpretations. Moreover, the results indicate MACD is not a suitable indicator for these currencies with applying its interpretations considering this study's assumptions. However, application of MACD for EURUSD is more profitable compared to other currencies since it generated 182 pips profit. Although, this profit could not increase the capital due to time which it is created.

Table I demonstrates results of implementing MACD for four different pair-currencies which are shown in four separate columns. First three rows are showing produced profit that is split to two parts, sell and buy profit. The same thing is displayed for loss in second three rows. The third three rows are demonstrating total profit/loss and its sell and buy division. Fourth three rows are showing the number of sell and buy transactions and total number of transactions for each pair-currency. Finally, the last three rows are displaying ending balance, last trading date and paid commission to broker.

In this study following assumptions are formulated to combine twenty conditions of traders. Accordingly, each trader was prevented from any distractors of the results. The assumptions are formulated based on the experiences of the researcher in Forex market, studying Forex market, capital management, and risk management.

- Trading period is considered for ten years (2001-2010), since, shorter period generates unreliable results and longer period makes data processing complex and difficult.
- Only one of the four pair currencies, namely, EUR/USD, GBP/USD, USD/JPY and USD/CHF can be traded by the traders. The reason for choosing these currencies is Oh's (2007) viewpoint that theorized European, North American and Japan Forex market are more efficient than other foreign exchange markets and in its turn it helps to remove other variables' effect on results.
- Only one position can be opened by the traders at the same time and once the new order is offered, the earlier one will be closed.
- In 30 pips each order can take profit and stop loss. It makes the profits small and decreases the risks of losing large amount.
- The order amount should be less than 7% of the traders' capital balance. It reduces
- For each trader the primary capital is $10,000.

- The time for trading is upon receiving the buy or sale signal from the indicators and it is 24 hours a day per 5 days a week.
- In case there is no new order or a position do not attain the level of take profit or stop loss, after 10 hours the order automatically will be closed; hence, profit or loss will be calculated based on the last 10 hours.
- No restriction has been considered for each order, because it is only 7% of the capital balance.
- The least amount of the order is 0.01 of the lot.

TABLE I
SUMMARY OF THE FINAL OUTCOMES USING MACD INDICATOR AND ITS
RELATED INTERPRETATIONS FOR THE YEARS 2001 TO 2010

Indicator	Moving Average Convergence/Divergence (MACD)			
Currency	EURUSD	GBPUSD	USDCHF	USDJPY
Sell Profit (pip)	11,259	11,555	10,259	11,010
Buy Profit (pip)	13,165	12,836	10,146	10,655
Total Profit (pip)	24,424	24,391	20,405	21,665
Sell Loss (pip)	(12,783)	(14,562)	(12,670)	(11,428)
Buy Loss (pip)	(11,459)	(13,143)	(12,455)	(11,417)
Total Loss (pip)	(24,242)	(27,705)	(25,125)	(22,845)
Profit/Loss (pip)	182	(3,314)	(4,720)	(1,180)
Profit/Loss Sell (pip)	(1,524)	(3,007)	(2,411)	(418)
Profit/Loss Buy (pip)	1,706	(307)	(2,309)	(762)
Buy counter	955	926	832	848
Sell counter	944	930	846	854
Total Orders	1,899	1,856	1,678	1,702
Ending Balance	8,068.53	674.36	142.32	2,224.02
Date of Closing Trader	2010.12.29	2010.12.31	2009.04.30	2010.12.22
Paid commission (USD)	16,072.69	7,588.60	9,721.20	10,788.02

The spread or commission of the broker is based on real market rate. However, this rate is different for every currency and time of the day. For example, the broker's commission for EURUSD and USDJPY currencies is one pip at 8 am to 8 pm, while it is two pips at 9 pm to 7 am. For GBPUSD and USDCHF currencies the broker's commission is two pips while it is four pips at 9 pm to 7 am.

VII. PROCESS

Results and discussion of the study are presented based on applied methodology; that is, data collection, data assessment, data processing, and computing P-SAR by application of VHTS. Then, by interpreting the indicator for the four currencies EURUSD, GBPUSD, USDCHF and USDJPY, buy and sell signals have been determined. Afterward, based on the assumptions, proper trading software has been run to gain profit or loss of each currency regarding indicator application, therefore there are four virtual traders.

A. EURUSD

With the employment of MACD for EURUSD in order to identifying the signals to enter and exit the market, 1899 orders include 955 buy orders and 944 sell orders has been proceeded. Total numbers of buy and sell of EURUSD with the employment of Moving Average Convergence/Divergence (MACD) indicator during ten years (2001-2010) is presented in Figure 5.
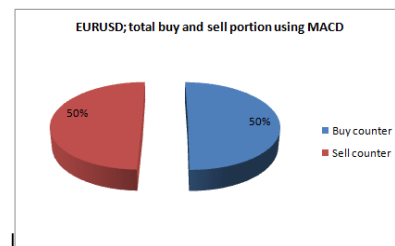

Fig. 5 Final percentage of EURUSD buy and sell using MACD indicator for the years 2001 to 2010

The ordering did not stop during 10 years period of this study which show the capital could reach to end of project. Moreover, the final profit generated by buy orders is 1706 pips which is resulted from 13165 pips profit and 11459 pips loss while the final loss created by sell orders is 1524 pips which is resulted from 11259 pips profit and 12783 pips loss. The profit resulted from buy orders is more than loss from sell orders and covered it and has extra 182 pips profit. This profit generated by 1524 pips loss from sell transactions and 1706 pips profit from buy orders.

The more detail results of using this indicator for EURUSD is given in Table II and as it is clear from the Table, 183 pips profit created within first 10 years.

TABLE II
YEARLY OUTCOME OF TRADING EURUSD USING MACD INDICATOR

Year	Profit/Loss Buy (pip)	Profit/Loss Sell(pip)	Profit/Loss(pip)
2001	(74)	36	(38)
2002	134	(72)	62
2003	238	(238)	0
2004	302	(115)	187
2005	(28)	(279)	(307)
2006	44	252	296
2007	104	(293)	(189)
2008	510	(34)	476
2009	243	(787)	(544)
2010	233	6	239
Final	1,706	(1,524)	182

In most of years the buy transactions generated profit while sell transactions resulted loss. Moreover, the MACD interpretations made profitable signals in five years while there is loss in four years and one year is neutral. Moreover, Table 4.8 shows MACD is producing more profitable buy signals compared to sell signals. However, the last result is positive and show profit but it could not add money to its capital due to the time of generation. It means at the beginning of the study period the amount of capital is full and since each order is 7% of capital balance, the amount of order also would be big. Therefore, the loss or profit for beginning of study time area would be bigger compare to end of study period. Since at the first MACD made loss the next generated profit had lower cash generation even their pips of profit are higher than their previous pips of loss.

B. GBPUSD

There are 1856 transactions including 926 buy and 930 sell orders which are created by employment of MACD indicator for GBPUSD which continued trading until end of study time scale. Total numbers of buy and sell of GBPUSD with the employment of Moving Average Convergence/Divergence (MACD) indicator during ten years (2001-2010) is presented in Figure 6.
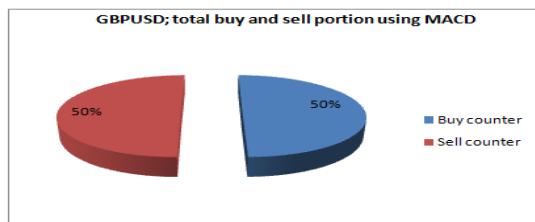
Fig. 6 Final percentage of GBPUSD buy and sell using MACD
indicator for the years 2001 to 2010

As a result of those transactions 3314 pips loss has been made which included 24391 pips profit and 27705 pips loss. In other word, 3007 pips loss of sell transactions and 307 pips loss of buy transactions created 3314 pips final loss within ten years. The 3314 pips loss which created by sell transactions included 11555 pips profit and 14562 pips loss. While, the 307 pips loss generated by buy orders included 12836 pips profit and 13143 pips loss.

Yearly details of profit and loss using the foresaid indicator for GBPUSD are presented in Table 3. The table shows the progress of the 3314 pips loss production within ten years. As it is clear in Table 4, the amount of profit in three years is considerable while it has been covered by the other years' losses. Moreover, it shows this indicator is producing more profitable buy signals compared to sell signals.

TABLE III
YEARLY OUTCOME OF GBPUSD TRADING USING MACD INDICATOR

Year	Profit/Loss Buy (pip)	Profit/Loss Sell(pip)	Profit/Loss(pip)
2001	(124)	(651)	(775)
2002	(557)	(681)	(1,238)
2003	350	(598)	(248)
2004	334	(286)	48
2005	(395)	131	(264)
2006	120	(630)	(510)
2007	(69)	175	106
2008	(407)	(124)	(531)
2009	338	(469)	(131)
2010	103	126	229
Final	(307)	(3,007)	(3,314)

C. USDCHF

With the implement of MACD for USDCHF in order to discovering the signals to buy and sell the market, 1678 orders include 832 buy orders and 846 sell orders has been proceeded. Total numbers of buy and sell of USDCHF with the employment of Moving Average Convergence/Divergence (MACD) indicator during ten years (2001-2010) presented in Figure 7.
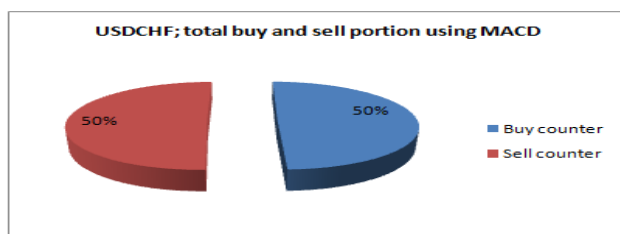

Fig. 7 Final percentage of USDCHF buy and sell using MACD
indicator for the years 2001 to 2010

The ordering is stopped in April 2009 since the capital was not enough to continue the trading. It means trading with MACD results loss more than benefit and it caused decreasing capital while the time is passing. Moreover, the final loss created by buy orders is 2309 pips which is resulted from 10146 pips profit and 12455 pips loss while the final loss created by sell orders is 2411 pips which is resulted from 10259 pips profit and 12670 pips loss. Finally, there are 4720 pips loss created by sell and buy orders from 20405 pips profit and 25125 pips loss.

According to Table 4 there is no clear relationship between profit/loss of buy and sell transactions since in some years the profit/loss of buy orders are opposite the profit/loss of sell transactions and in some years the relationship is straight. Finally the losses which generated by sell and buy orders are so close to each other.

TABLE IV
YEARLY OUTCOME OF USDCHF TRADING USING MACD INDICATOR

Year	Profit/Loss Buy (pip)	Profit/Loss Sell (pip)	Profit/Loss (pip)
2001	(408)	19	(389)
2002	174	(526)	(352)
2003	(364)	(696)	(1,060)
2004	(326)	(210)	(536)
2005	(591)	(444)	(1,035)
2006	(114)	73	(41)
2007	(286)	297	11
2008	(214)	(906)	(1,120)
2009	(180)	(18)	(198)
Final	(2,309)	(2,411)	(4,720)

D. USDJPY

MACD signals for USDJPY results 1180 pips loss which included 21665 pips profit against 22845 pips loss and the trading period did not last within the ten years. This 1180 pips loss contained 418 pips loss from sell transactions and 762 pips loss from buy transactions. There are 854 sell orders and 848 buy orders generated by MACD interpretations. Total numbers of buy and sell of USDJPY with the employment of Moving Average Convergence/Divergence (MACD) indicator during ten years (2001-2010) is presented in Figure 8.
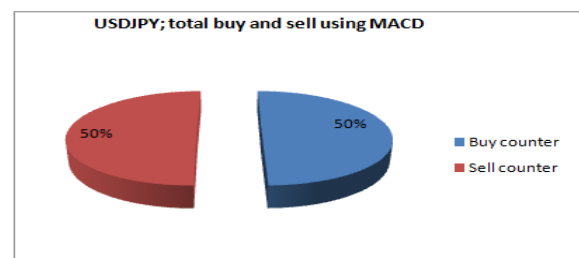

Fig. 8 : Final percentage of USDJPY buy and sell using MACD
indicator for the years 2001 to 2010

Moreover, these sell orders made 418 pips loss which includes 11010 pips profit and 11428 pips loss while buy transactions generated 762 pips loss which includes 10655 pips profit and 11417 pips loss.

Table 5 showing the yearly details of buy and sell transactions, demonstrates that in the years 2002, 2006, 2009 and 2010, MACD signals generated profit although the profits were not enough to cover the losses created in the other years. Therefore, by the end of the trading period the outcome left

was loss. Furthermore, it can be seen that the sell signal worked better compared to buy signals since they created profit in 2002, 2003, 2004, 2008, 2009 and 2010 and the final loss of them is about half of buy orders' loss.

TABLE V
YEARLY OUTCOME OF USDJPY TRADING USING MACD INDICATOR

Year	Profit/Loss Buy (pip)	Profit/Loss Sell (pip)	Profit/Loss (pip)
2001	148	(180)	(32)
2002	31	20	51
2003	(290)	198	(92)
2004	(159)	21	(138)
2005	(137)	(533)	(670)
2006	345	(301)	44
2007	(135)	(376)	(511)
2008	(309)	148	(161)
2009	(166)	476	310
2010	(90)	109	19
Final	(762)	(418)	(1,180)

VIII. ANALYSIS

Final profit/loss of all four currencies trading with the employment of Moving Average Convergence/Divergence (MACD) indicator for the period of ten years (2001-2010) is presented in Figure 9.
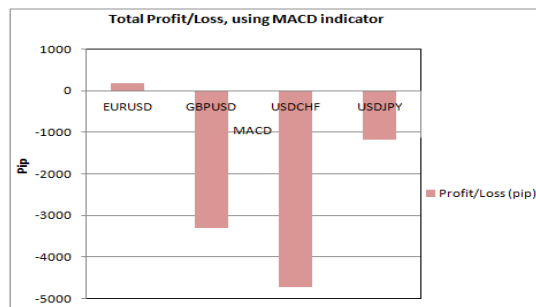

Fig. 9 Final profit/loss with the employment of MACD indicator for trading the four currencies within ten years (2001-2010)

IX. CONCLUSION

Effectiveness of the MACD indicator for four pair currencies; EURUSD, GBPUSD, USDCHF and USDJPY based on profitability of the buy and sell signals has been evaluated.

To unify the trading condition in order to make the results comparable, a series of assumptions has been applied as follows:

- Trading period was ten years starting from 1st January of 2001.
- Traders can only trade one of the four pair currencies which are EUR/USD, GBP/USD, USD/JPY and USD/CHF.
- Traders cannot open more than one position at the same time and upon a new order, the pervious order would be closed if still is open.
- Take profit and stop loss for each order is 30 pips.
- The volume of order cannot be more than 7% of the traders' capital balance.
- Initial capital for each trader is $10,000
- Trading time is 24 hours and 5 days a week and upon receive the buy or sale signal from the indicators

- If a position do not reach to its level of take profit or stop loss and there is no new order, the order will be closed automatically after 10 periods (hours) and profit/loss is calculated based on the last 10 hours.
- There is no limitation in amount of each order since it is 7% of the capital balance.
- Minimum order is 0.01 of the lot. These assumptions have been chosen based on researchers' experiences in Forex market and studying Forex market, capital management and risk management to make the result comparable and unify. The following findings have been obtained from the current study:
- MACD had better results with trading with EURUSD.
- The most effective combination of MACD-Currency regarding generation of profit has been identified to be MACD-EURUSD with considering the assumptions of this study. MACD performed not bad with EURUSD as it has created $8,068.53 cash at the end of ten years period of trading (Table 1).
- The other finding was that the total loss generated by buy signals for all four traders is 1,672 pips however sell signals generate 7,360 pips loss which the difference is considerable. It shows MACD produces more profitable buy signals than sell signals.
- One of the notable results generated from VHTS was computing the amount of commission each trader has been paid based on market rates. The commission paid is shown in Table 1 indicating that brokers made profit regardless of gaining or losing of traders

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