Performance Comparison of Three Automated Trading Systems (MACD, PIVOT and SMA) by Means of the d-Backtest PS Implementation

D. Th. Vezeris and C. J. Schinas

Abstract—**State-of-the-art trading systems are automated and are executed on computers through trading platforms. They generate and execute trades, based on optimized parameters and algorithmic trading strategies. In the current research, such software for automated trading systems was developed, utilizing the following technical indicators, the MACD (oscillator), the SMA (moving average) and the PIVOT points (price crossover).The systems traded on hourly timeframes, using historical data of closing prices over weekly based periods of parameters' optimization and using the d-Backtest PS method.**

Through this research, and the interpretation and evaluation of results, two findings or rather conclusions were drawn. These findings are presented sequentially as follows: In terms of profitability, the adaptive MACD trading system was the most effective one, followed by PIVOT trading system and the SMA was ranked as the least profitable trading system. There is a weak correlation of back testing periods among the above trading systems.

Index Terms—**d-Backtest PS method, MACD, PIVOT, SMA, FOREX trading systems.**

I. INTRODUCTION

The bibliography comprises an analysis of a plethora of conventional trading systems that hinge on technical indicators and were scrutinized both separately and conjointly.

They were applied to historical data either for immediate performance estimation, or **as** a means of training neural networks to optimize predictions. The back-testing method developed by [1] was employed to optimize and ratify results.

II. RELATED WORK AND BACKGROUND

The majority of modern trading systems, according to [2] and [3], are based on conventional and timeless technical indicators such as MACD, RSI, CCI, Bollinger Bands or Donchian Channel which either follow trend by means of moving averages or monitor price levels. The indicators are used individually or collectively.

An unsophisticated combination of technical indicators (MOM, MA, SLMA, RSI, MACD, MAD, RCI, PL, SLEMA) was used by [4], who proved that a combination of various indicators applied to an assortment of stocks, produced the most profitable results.

In the current research, we utilize unsophisticated trading systems with embedded forecasting, as [5] did. The trading systems are based on the implementation of MACD, SMA and PIVOT, proving each time the increase in profitability by introducing individually the innovative optimizations that are surveyed in the current research.

Buy and sell rules which will be analyzed promptly, are as uncomplicated as the ones used in the paper by [6]. However, there is a disparity between our findings and theirs, as can be seen from the following tables.

They substantiated their conclusions [7] with regard to the increase in profitability, based on experimental findings too.

We are interested in the implementation of multi agent trading systems, as referred in the previous paper by [1], as well as the one by [8].

In our previous paper, we particularly studied back testing optimization and the selection of the ideal verification period which was validated by rolling windows timespans (in and out of sample training period) by [9], who used conventional technical indicators that measure market trend, price level and momentum (DSMA, DEMA, TEMA, MACD, DMI, RSI, SO, ATR, BB, to name a few).

Moreover, a genetic algorithm is used which we did not approve of as was substantiated in our previous paper.

However, [10], by means of a genetic algorithm, validates the supremacy of his system which is based on the «gene expression programming algorithm», as opposed to RW, MACD, ARMA, MLP, RNN, HONN models ,employing FTSE100, DAX30 and S&P500 data over a 15-year period(2000-2015).

III. RECOMMENDED EVALUATION AND COMPARISON METHOD

After the implementation of the dynamic back testing period selection method (d-Backtest PS method), and in accordance with the planning of our forthcoming research, we present an assortment of findings which optimize a high frequency, autonomous and dynamic trading system. In this particular research, we compare results of three trading systems which are based on three different technical indicators, MACD, PIVOT and SMA.

The results which were scrutinized and validated, are shown as follows:

1) Implementation of findings on naked systems, without stop loss & take profit functions and classification according to profitability scores.
2) Correlation of back-testing periods among different trading systems, by means of the d-Backtest PS method.

A. Implementation-Back Testing on Different Naked Trading Systems (without Take Profit & Stop Loss)

The strategies that are applied to the three trading systems hinge on three indicators, namely the MACD (oscillator), the PIVOT points and the SMA (moving average). The rules of each trading without stop loss & take profit functions are presented below:

```
//Automated trading system based on the MACD
OnTick()
{
    if(macd>signal)//if macd line is above signal line
    {
        if(isShortPositionOpened())//if short position opened, then close it
            CloseExistingShortPosition();
        if(!isLongPositionOpened())//if no long position opened, then open
long position
            OpenLongPosition();
    }//endif macd above signal line
    else if(macd<signal)//if macd line is below signal line
    {
        if(isLongPositionOpened())//if long position opened, then close it
            CloseExistingLongPosition();
        if(!isShortPositionOpened())//if no short position opened, then open
short position
            OpenShortPosition();
    }//end elseif macd below signal line
}//OnTick
//---------------------------------------------
```

```
//Automated trading system based on the PIVOT
OnTick()
{
    if(price>HighLine)//if price is higher than the highest price from the
previous bars
    {
        if(isShortPositionOpened())//if short position opened, then close it
            CloseExistingShortPosition();
        if(!isLongPositionOpened())//if no long position opened, then open
long position
            OpenLongPosition();
    }//endif price overcame high line
    else if(price<LowLine)//if price is lower than the lowest price from the
previous bars
    {
        if(isLongPositionOpened())//if long position opened, then close it
            CloseExistingLongPosition();
        if(!isShortPositionOpened())//if no short position opened, then open
short position
            OpenShortPosition();
    }//end elseif price overcame low line
}//OnTick
//---------------------------------------------
//Automated trading system based on the SMA with a PIVOT filter for
whipsaws avoidance.
OnTick()
{
    if(Price>sma)//if price is higher than sma
    {
        if(isShortPositionOpened())//if short position opened, then close it
            CloseExistingShortPosition();
        if(!isLongPositionOpened() && Price>pivot(high))//if no long
position opened and pivot confirms price's rise, then open short position
            OpenLongPosition();
    }//endif price is higher than sma
    else if (Price<sma)//if price is lower than sma
    {
        if(isLongPositionOpened())//if long position opened, then close it
```

```
            CloseExistingLongPosition();
        if(!isShortPositionOpened() && Price<pivot(low))//if no short
position opened and pivot confirms price's descent, then open short position
            OpenShortPosition();
    }//end elseif price is lower than sma
}//OnTick
//---------------------------------------------
```

B. Correlation among the Diverse BT Periods of Various Trading Systems

Through the implementation of the d-Backtest PS method on all validation periods involved in the three trading systems, we make calculations and draw useful conclusions about the correlation among back-testing periods.

This correlation employs standard mathematical functions:

Variance:

$$\sigma_{XX}^2 = \frac{1}{N}\sum_{i=1}^{N}(x_i - \mu_\chi)(x_i - \mu_\chi) = \frac{1}{N}\sum_{i=1}^{N}(x_i - \mu_\chi)^2 \quad (1)$$

Covariance:

$$\sigma_{XY}^2 = \frac{1}{N}\sum_{i=1}^{N}(x_i - \mu_\chi)(y_i - \mu_y) \quad (2)$$

Correlation coefficient:

$$\rho = \frac{\sigma_{XY}^2}{\sigma_X \sigma_Y} \quad (3)$$

IV. DATA AND IMPLEMENTATION

The data on all the assets utilized in the current research were provided by FXTM for three consecutive years (2015, 2016, 2017 first half). Client software Metatrader 5 developed by Metaquotes was employed and three in total Expert Advisors were developed (AdMACD , AdPIVOT and AdSMA).

All the files comprising optimization parameters were created for all the back-testing periods. The most profitable ones were selected and the parameters were saved to a database.

All told, 3 systems were generated, multiplied by 52 weeks in a year, multiplied by 1.5 years, multiplied by 30 back-testing periods per week = 7.290 data files with results.

The files were saved on a Microsoft SQL Server 2012, and the results were classified by means of the d-Backtest PS method, while all the mathematical relationships and classification methods were put into effect, as was proven in the previous paper by [1]. To ensure accuracy, no genetic algorithm was utilized. All told, there were 4.700.000.000 entries.

V. RESEARCH TESTS AND RESULTS

In accordance with the aforementioned algorithm, the following tests were carried out:

1) All of the above mentioned results were applied to naked systems, namely, AdMACD, AdSMA, AdPIVOT, without stop loss & take profit functions, and afterwards they were compared against each other.
2) The correlation coefficient of all the back-testing periods employed by different systems was determined.

A. Results of Implementation to Three Simplified (without Stop Loss & Take Profit Functions) Trading Systems

In order to compare the performance of the 3 systems, we define a common back-testing period (28/2/2016-27/8/2017).

After running forex back-tests on 6 currency pairs and applying the results to future validation weeks, the following results were generated:

TABLE I: COMPARATIVE PROFIT TABLE ON THE THREE TRADING SYSTEMS USING THE RESULTS/CONCLUSIONS THAT HAVE BEEN GENERATED SO FAR

Symbols	Weeks (2016.02.28-2017.08.27)	AdMACD	AdPIVOT	AdSMA
AUDUSD	79	-313,5	-2166,51	-2206,32
EURUSD	79	410,23	-2424,13	-3237,81
GBPUSD	79	486,78	-1981,81	-1071,62
USDCAD	79	3955,84	-347,4	215,69
USDJPY	79	1265,88	-426,96	-1585,08
XAUUSD	79	146,75	613,62	-2514,87
Total		5951,98	-6733,19	-10400,00

TABLE II: TABLE OF CORRELATION COEFFICIENTS OF THE BACK-TESTING PERIODS EMPLOYED BY THE THREE SYSTEMS USING THE RESULTS THAT HAVE BEEN GENERATED SO FAR. AN EVALUATION OF THE RESULTS HIGHLIGHTS A WEAK CORRELATION AMONG ASSOCIATED BACK - TESTING PERIODS. MORE GRAPHS AND COMPREHENSIVE TABLES ARE DISPLAYED IN APPENDIX B

AUSUSD	AdMACD	AdPIVOT	AdSMA
AdMACD	1		
AdPIVOT	0,226	1	
AdSMA	0,499	0,245	1

EURUSD	AdMACD	AdPIVOT	AdSMA
AdMACD	1		
AdPIVOT	-0,122	1	
AdSMA	0,157	0,111	1

GBPUSD	AdMACD	AdPIVOT	AdSMA
AdMACD	1		
AdPIVOT	0,275	1	
AdSMA	0,071	-0,005	1

USDCAD	AdMACD	AdPIVOT	AdSMA
AdMACD	1		
AdPIVOT	0,214	1	
AdSMA	0,236	0,250	1

USDJPY	AdMACD	AdPIVOT	AdSMA
AdMACD	1		
AdPIVOT	0,086	1	
AdSMA	-0,127	-0,027	1

XAUUSD	AdMACD	AdPIVOT	AdSMA
AdMACD	1		
AdPIVOT	0,004	1	
AdSMA	-0,210	0,013	1

According to the cumulative results of the gain chart, the AdMACD yields the highest profits, while on occasion AdPIVOT excels on the XAUUSD currency pair.

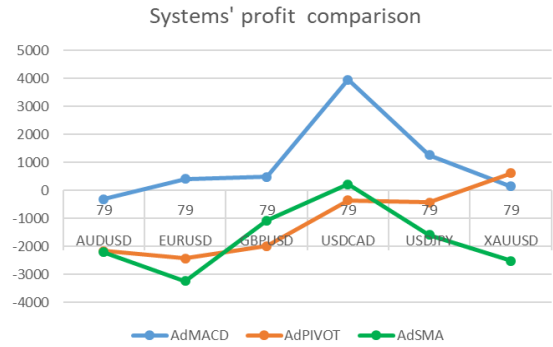Appendix A comprises a comprehensive list of results generated by the implementation of each of the systems.

Fig. 1. Graph which visualizes the profit profile per currency pair through the implementation of different systems.

B. BT Period Correlation

Through the implementation of the three trading systems (MACD, PIVOT & SMA), the correlation coefficient of the back-testing periods for the six symbols was calculated, based on prices over a six-month period (28/2/2016-27/8/2017). The coefficients per currency are displayed on the following table:

VI. CONCLUSION

Through the current research and the evaluation of results, two conclusions were drawn with regard to trading strategy optimization, as was mentioned above. These findings are classified and are presented as follows:

1) In terms of profitability, the adaptive MACD trading system was the most effective one, followed by PIVOT trading system and the SMA was ranked as the least profitable trading system.
2) There is a weak correlation among different back testing periods, employed by different trading systems.

The next stages of the research could provide a comparative evaluation of numerous trading systems, by means of the optimized d-Backtest PS method, incorporating the results and conclusions of the current research.

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