

The Performance of Exponential Moving Average, Moving Average Convergence-Divergence, Relative Strength Index and Momentum Trading Rules in the Pakistan Stock Market

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Abstract

Objective: To examine the performance of exponential moving average, moving average convergence and divergence, relative strength index and momentum rules in Pakistan stock market. **Methods/Statistical Analysis:** Exponential moving average, moving average convergence and divergence, relative strength index and momentum rules are applied on the daily closing prices of the KSE -100 index of Pakistan stock market covering the period 1st January 1997 to 31st December 2013. The predictability and profitability of these rules in Pakistan stock market was assessed by using simple t-test and “double or out strategy” respectively. **Findings:** Whole sample period results obtained by the application of EMA, MACD, RSI and MOM rules provided empirical evidence about EMA and MOM that all the variants of these rules possessed substantial prognostic capability and were able to make earnings superior to position trading. Nonetheless in the presence of transaction costs, only (1, 50, 1) and (1, 50, 0) variants of EMA, (12, 26, 9) and (8, 17, 9) variants of MACD and both variants of MOM were found to be profitable in Pakistan stock market. The division of the whole sample data on the basis of financial crisis and non-crisis eras disclosed that the applied trading rules provided more revenues during crisis than in non-crisis periods. This study is a remarkable contribution to the current literature on Pakistan stock market as previously very little research work has been carried out on this stock market. **Application/Improvements:** The findings of this study are novel and are hoped to be helpful for investors in Pakistan to earn maximum revenues with minimum risk of losing their hard earned money.

Keywords: Exponential Moving Average, Momentum, Moving Average Convergence and Divergence, Pakistan Stock Market, Relative Strength Index

1. Introduction

Technical trading rules are employed by researchers to forecast upcoming price movements based on past price data in various financial markets. The most commonly applied technical trading rules by investigators include Variable Length Moving Average (VMA), Fixed Length Moving Average (FMA), and Trading Range Breakout (TRB), some variants of these rules are reported by many researchers to have considerable predictive power to

detect future movement of stock prices, and earn profits superior to simple buy-and-hold plan¹⁻¹⁰.

Since, technical analysis does not involve fundamental data, it strongly opposes any form of the Efficient Market Hypothesis (EMH), which states that the future direction of stock price movements cannot be predicted on the basis of past prices information when the stock market is at least weak form efficient. In economics literature the term ‘efficient market’ is applied to a market that adjusts quickly according to novel information. Consequently, a

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financial market is said to be efficient when all the available information about the stock is reflected by security prices^{11,12} supporters of EMH therefore, argue that it is impossible to generate risk-adjusted profits by applying technical trading rules on past stock prices data, unless market inefficiencies are there.

The objective of this research study is to examine the performance of EMA, MACD, RSI and MOM trading rules in Pakistan Stock market. This is the first study on Pakistan stock market in which the reported variants of EMA, MACD, RSI and MOM trading rules have been applied on full sample data as well as on five non-overlapping sub-sample periods. The purpose of division of the data into 5 sub-sample periods is to see the performances of these rules during and after Asian currency crises and global financial crises periods. Therefore, the findings of this study are novel and an important contribution in the literature on Pakistan stock market.

The remaining setting of this article is as follows: Section 2 provides the review of literature pertinent to application of EMA, MACD, RSI and MOM technical trading rules on various financial markets of the world, Section 3 describes the data and methodology, Section 4 presents the empirical results of applied technical trading rules on Pakistan stock market.

2. Literature Survey

Review of the literature published on the predictability and profitability of Exponential Moving Average (EMA), Moving Average Convergence-Divergence (MACD), Relative Strength Index (RSI) and Momentum (MOM) in various financial markets of the developed and developing countries revealed mixed results. For example, the relative strength trading rules applied by Levy (1967) on 200 US listed securities during 1960 to 1965, showed that these rules as against the buy-and-hold plan yielded superior profits¹³. Contrary to this, Jensen and Benington in 1970¹⁴ examined the success of two of Levy's relative strength trading rules on same 200 US listed securities for the period 1960-1965. These researchers found that after transaction costs, the tested rules failed to earn profits more than that of the buy-and-hold plan.

In¹⁵ examined the performance of the Moving Average and Relative Strength Index by utilizing the daily closing prices data of the Singapore stock market for the period January 1974 to December 1994. The authors concluded

that both MA & RSI rules were able to earn superior profits for the Singapore stock market.

The MACD And RSI rules were applied on Exchange FT30 Index for the period 1935-1994, to test if these rules are profitable in this market¹⁶. The authors found that both rules were able to earn profits in excess of simple buy-and-hold strategy. These investigators however, had not included the transaction costs in their study.

The provided evidence that application of momentum-based strategies in emerging currency markets is able to earn excess returns¹⁷.

In¹⁸ investigated Brazil, Russia, India and China stock markets by applying SMA, RSI MACD, MOM trading rules, using daily closing index return of these markets for the period 1995-2008. These investigators concluded that all the applied rules were most profitable in Russian stock market only. The SMA and EMA technical trading rules were employed on 20 largest companies of Tehran stock market data for the period from March 21, 2001 to June 21, 2010, to observe the profitability of these rules in this market¹⁹. The researchers found that both SMA and EMA rules were profitable even after adjustment for transaction costs. In²⁰ investigated the performance of RSI, MACD, MOM and stochastic rules in Spanish market during the period 1986 to 2009. These researchers concluded that higher profitability of a particular technical trading rule depends on the type of the stock exchange company.

In²¹ examined the profitability of MACD and RSI trading rules on closing prices of the indices in the stock exchanges of five OECD (Organisation for Economic Cooperation and Development) countries during the period January 1976 to December 2002. The authors found that RSI variant (21, 50) and MACD variant (12, 26, 0) were more profitable in Italian and Canadian stock markets, while RSI variant (14, 30/70) in the Dow Jones Industrial Index.

In²² assessed the profitability of MACD and RSI trading rules in the Australian stock market during the period 1996 to 2014. The researchers concluded that although MACD performed poorly in Australian stock market, RSI showed some profit potentials. In²³ evaluated the performance of momentum based technical trading rules on Dow Jones Industrial average for the period 1928-2012. The researcher noted slow growth of profits during the period mid 1960s to mid 1980s, and thereafter profitability became depended on the ability of investors to short-sell stocks. In²⁴ evaluated the profitability of

RSI, MACD, and few other trading rules on south-east Asia stock markets of Thailand, Malaysia, Singapore, Indonesia and Philippines over the period January 2000 to December 2013. These researchers observed that after inclusion of transaction costs, tested technical trading rules outperformed the simple buy-and-hold strategy only in the stock market of Thailand.

3. Data and Methodology

3.1 Data

Daily closing prices of the KSE -100 index covering the period 1st January 1997 to 31st December 2013 is obtained from Bloomberg DataStream. The whole sample period based on Asian currency crisis and global financial crisis is divided into five non-overlapping sub-sample periods (I to V). Of these, sub-sample periods I & II are of four years duration each, while III to V are of three years duration each. The purpose of this division is to see the behavior of applied trading rules in Pakistan stock market both during and after financial crises periods, since it is assumed that the performance of these rules will be different in different market situations.

The five non-overlapping sub-sample periods are:

Sub-sample period I: 1st January 1997 to 31st December 2000, (During Asian currency crisis)

Sub-sample period II: 1st January 2001 to 31st December 2004, (Post Asian currency crisis)

Sub-sample period III: 1st January 2005 to 31st December 2007, (Pre global financial crisis)

Sub-sample period IV: 1st January 2008 to 31st December 2010, (During global financial crisis)

Sub-sample period V: 1st January 2011 to 31st December 2013, (Post global financial crisis)

3.2 Methodology

3.2.1 Exponential Moving Average

In EMA, the latest data is given more weight and the weights of former data are consequently decreased²⁵. The shorter the length of EMA's period, the more weight is assigned to the most recent price.

In this study, 12 variants of EMA rules (6 each with zero percent and one percent bands respectively), i.e., (1,50,0), (1,100,0), (1,150,0), (5,150,0), (1,200,0),

(2,200,0), (1,50,1), (1,100,1), (1,150,1), (5,150,1), (1,200,1), (2,200,1) are examined.

EMA is calculated by using the formula:

$$EMA_t = \infty . P_t + (1 - \infty) EMA_{t-1} \quad (1)$$

Where,

∞ = the weight of recent data.

The value of ∞ is $\frac{2}{(1+n)}$, here n is length of EMA period.

The greater the value of ∞ , more weight is assigned to recent data. In EMA buy signal is indicated if short period EMA is greater than the long period EMA, while sell signal is detected when short period EMA is less than the long period EMA.

3.2.2 Moving Average Convergence Divergence

MACD developed by²⁶, is one of the simplest trading rules used to identify change in the trend. It is calculated by deducting longer EMA from a shorter EMA. Mostly 12 and 26 days are respectively used to measure shorter and longer EMAs to calculate MACD.

Following²¹, we also used MACD variants (12, 26, 0), (12, 26, 9) and (8, 17, 9) in this study.

The formula used to calculate MACD is:

$$MACD(n) = \sum_{i=1}^n EMA_k(i) - \sum_{i=1}^n EMA_d(i) \quad (2)$$

Where k=12 days EMA and d=26 days EMA.

In order to identify buy and sell signals, signal lines of zero day and nine day EMA of MACD are respectively plotted on top of the MACD. A buy/sell signal is generated when the MACD cuts the respective signal line from beneath/ above. Following a trading signal MACD is computed at the next day index value using fixed holding period of 10 days as adopted by many^{16,21,22,27}.

3.2.3 Relative Strength Index

RSI is a momentum oscillator developed by Wilder in 1978²⁸. It demonstrates the strength or speed of the asset price movements by comparing the individual uphill or downhill movements of the succeeding closing prices.

RSI is calculated as follows:

$$RSI_t = \text{average gain} / \text{average loss} \quad (3)$$

$$RSI = 100 - \left[\frac{100}{1 + RS_t} \right] \quad (4)$$

The RSI ranges in between 0 and 100, where 100 represent pure upward price movements and 0 pure downward price movements. RSI 50 (centerline) is a signal of no trend since it indicates that the stock is fairly priced. The market is supposed to be at top (oversold) when RSI is above 70 and bottom (overbought) when it is below 30. The range in between 30 and 70 is often considered as the cut-off point of weak and strong markets respectively. The RSI trading rule at time t is calculated as under:

$$B_t = RSI_t \leq 30 \quad (5)$$

$$S_t = RSI_t \geq 70 \quad (6)$$

According to this rule a buy signal is produced if the RSI crosses 30 from beneath and a sell signal when it crosses 70 from above. After the generation of trading signal, RSI is computed from the next day index value using fixed holding period of 10 days as adopted by others^{16,21,22}. In RSI trading signals are more stable and less frequent for longer time period than for shorter time period. Volatile markets as against the less volatile markets have shorter RSI.

Usually 14 days RSI is considered as the most popular length by traders, therefore, in this study 7, 14 & 21 days RSI trading rule with 30/70 and 50/50 is applied to gauge the asset price movement's trend in the Pakistan stock market.

3.2.4 Momentum

MOM indicator represents the speed or velocity of increase or decrease in stock prices. Market momentum, specifically, the N-day momentum of a selected number of preceding days 10 and 40 as a reference taken by¹⁸ is determined by subtracting the closing price from the current closing price at time t and plotting the obtained positive or negative values around a zero line. A buy signal is generated if the MOM crosses the zero line from below, while a sell signal when it crosses the zero line from above.

This indicator is said to be unique trend following tool that indicates both current trend and a changing trend. For example if stock prices are on rise and the momentum indicator is overhead the zero line then it is deduced that the current trend is strengthening. In case when stock

prices are going upwards but the momentum indicator dropping beneath the zero line, then it is interpreted as a signal of change in trend. The reverse is true for a declining market.

The formula used to calculate momentum is:

$$MOM_N(t) = P(t) - P(t - N) \quad (7)$$

3.2.5 Buy-and-Hold Strategy

In buy-and-hold strategy investors buy stocks in the beginning of test period and sell them in the end of the period. For calculation of daily and ten day non-overlapping returns⁹ is followed. The unconditional buy-and-hold returns of each index for whole sample period are calculated by using following formula:

$$R_t = \log(p_t) - \log(p_{t-1}) \quad (8)$$

Where,

R_t = Unconditional mean return at day t

p_t = day t closing price

p_{t-1} = day t-1 closing price

Unconditional 10 days returns are calculated by using the following formula:

$$R_{t10} = \log(p_{t+10}) - \log(p_t) \quad (9)$$

The conditional mean buy and mean sell returns are computed as under:

$$\mu_{(b)} = \frac{1}{N(b)} \sum R_b \quad (10)$$

$$\mu_{(s)} = \frac{1}{N(s)} \sum R_s \quad (11)$$

Where,

$\mu_{(b)}$ = mean buy days returns

$\mu_{(s)}$ = mean sell days returns

$N(b)$ = total number of buy days

(s) = total number of sell days

R_b = daily returns of buy days

R_s = daily returns of sell days

The conditional annual return for Pakistan stock market is computed with a fixed trading period of 240 days per year as following:

$$\text{Annual Return} = \text{Exp}(N * R) - 1 \quad (12)$$

Where,

N= number of days the investment is kept in (240 days per year)

R= daily average return

Predictability of Technical Trading Rules:

The predictability of technical trading rules applied in this study is assessed by using the simple t-test as proposed by²⁷ technical trading rules are considered to have predictive ability when buy signals generate positive returns and sell signals generate negative returns, and these on average yield returns significantly different from the returns earned by a simple buy-and-hold strategy.

The formula used to calculate the mean buy (sell) returns is given as under:

$$\frac{\mu_r - \mu}{\sqrt{\frac{\sigma^2}{N} + \frac{\sigma^2}{N_r}}}$$

Where:

μ_r = mean return (buy or sell)

N_r = number of signals (buy or sell)

μ = the unconditional mean return

N = the number of observations

σ^2 = estimated variance of the entire sample.

The t-statistic for the buy-sell difference is calculated by using the following formula:

$$\frac{\mu_b - \mu_s}{\sqrt{\frac{\sigma^2}{N_b} + \frac{\sigma^2}{N_s}}}$$

Where:

μ_b = mean buy returns

μ_s = mean sell returns

Ns = the number of sell signals

Nb = the number of buy signals

σ^2 = the estimated variance of the entire sample.

If t-statistics value of returns yielded by a trading rule is significantly higher than the returns earned through simple buy-and-hold strategy than that rule is considered

to have significant predictive power to forecast future movement of stock prices.

3.2.6 Profitability of Technical Trading Rules

For assessing the profitability of technical trading rules applied in this study, a “double or out” strategy used by^{27,1,29} is revised. Under this strategy, a trader reacts to the buy signals by borrowing money at a risk-free rate to double his/her investments and to the sell signals by liquidating any equity holdings and investing in risk-free assets. The investor is assumed to take long position when neither buy nor sell signal is generated. The idea underlying this method is that with buy signals, investors make profits by doubling their investment and continuing in the upward trending market, while with sell signals investors earn profits in the form of cost savings by selling out their investments and leaving the downward trending market.

Two assumptions are made regarding determining the profitability of technical trading rules by a “double or out” strategy. Firstly, it is assumed that borrowing and lending rates in the market are same. Secondly, the risk in buying or selling the assets during buys and sell periods are same.

The excess return (π) produced by technical trading rules, without considering the transaction costs, are computed by using the formula:

$$\pi = \sum_{b=1}^{N_b} R_b - \sum_{s=1}^{N_s} R_s$$

As transaction costs incurred under technical trading rules are inevitable, hence to find out whether applied technical trading rules after inclusion of transaction costs are profitable or not, a method proposed by¹ is followed. According to this method, first breakeven costs (that are the percentage costs needed to counterbalance the additional returns generated by the technical trading rules compared to the simple buy-and-hold strategy) are computed. For this purpose we used following formula:

$$C = \frac{\pi}{n_b + n_s}$$

Where C represents the breakeven round-trip cost

The estimated breakeven costs are then compared with the estimated actual transaction costs in order to evaluate the profitability of technical trading rules. Now, if the breakeven costs of a trading rule are greater than

the estimated actual transaction costs, then that technical trading rule is considered to have profitability. But, if the breakeven costs are less than the estimated actual transaction costs, then that technical trading rule is taken as having no profitability.

We have used the same variants of technical trading rules as reported in literature by others, in order to avoid any likelihood of data snooping biases in addition to be able to compare the results of my study with that of the previous studies reported in literature.

3. Results and Discussion

The descriptive statistics of daily and non-overlapping 10-day returns for the full sample and five non-overlapping sub-sample periods is shown in Table 1. The highest daily and non-overlapping 10-day mean returns are noticed in sub-sample period II (Post-Asian currency crisis) followed by in sub-sample period V (Post-global financial crisis). Similarly, the lowest daily mean returns are observed in sub-sample period IV (During global financial crisis), followed by in sub-sample period I (During Asian currency crisis).

The highest and the lowest standard deviations (volatilities) for daily returns are noticed in sub-sample periods I and V respectively. While for non-overlapping 10 day returns in subsample periods IV and V respectively. This suggests that KSE-100 index was most volatile during

Asian currency crisis and global financial crisis periods, while least volatile after global financial crisis.

Skewness and Kurtosis index is used to see the normality of the returns data. The daily and non-overlapping 10-day returns of the data suggest symmetric distribution, since the values of skewness are between -2 to +2³⁰ and of kurtosis between -7 to +7³¹ respectively. This implies that t-test is appropriate to apply on KSE-100 index data.

The negative values of skewness obtained in full as well as in five sub-sample periods of both daily and non-overlapping 10-day returns indicate that the returns are negatively leptokurtic. Our descriptive statistics results for daily returns are in line with the study reported by¹⁰.

The statistical results for 12 EMA trading variants (6 each with zero percent and one percent bands respectively) are summarized in Table 2. In column 1 of the table, each variant is characterized as (short, long), where short and long represent the short and long moving average periods. Columns 2 and 3 of the table respectively show the number of buy and sell signals generated by EMA. In columns 4, 5 and 7, 8 respectively daily mean returns generated during buy days, during sell days and the standard deviations of returns for buy days, for sell days are presented. In column 6, the differences between mean buy and mean sell periods returns are shown. The numbers in the parentheses represent t-statistics for a two-tailed test. T-statistics values greater than 2.576, 1.96 and 1.645 respectively denote 0.01, 0.05 and 0.1 significance levels.

Table 1. Descriptive statistics for daily and non-overlapping 10-day returns

Section 1: Daily returns						
Pakistan Stock Market	Full sample period	Sub-sample period I	Sub-sample period II	Sub-sample period III	Sub-sample period IV	Sub-sample period V
	1997-2013	1997-2000	2001-2004	2005-2007	2008-2010	2011-2013
N	4115	937	940	686	661	695
Mean	0.00067	-0.00005	0.00159	0.00050	-0.00033	0.00107
S.D	0.01613	0.02158	0.01425	0.01622	0.01606	0.00893
Skewness	-0.34731	-0.30399	-0.13625	-0.59252	-0.10412	-0.33138
Kurtosis	5.67933	5.13503	4.28844	1.34737	2.10465	1.88839
Section 2: Non-overlapping 10- day returns						
N	411	93	93	68	65	69
Mean	0.00068	-0.0011	0.0155	0.0055	-0.0037	0.0111
S.D	0.05913	0.07580	0.05081	0.05615	0.07740	0.02810
Skewness	-1.14284	-0.66400	0.19493	-1.80351	-1.70957	-0.28072
Kurtosis	4.36845	0.61337	0.37572	6.70084	5.83827	1.19300

N= Return observations in the sample

Table 2. Summarized results for exponential moving average variants for full sample period (1997-2013)

(a) with zero percent band							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDb	SDs
(1,50)	2659	1456	0.0031	-0.0037	0.0068	0.0130	0.0199
			(5.9691) ^{***}	(-8.8950) ^{***}	(12.8751) ^{***}		
(1,100)	2796	1269	0.0024	-0.0030	0.0054	0.0133	0.0208
			(4.2810) ^{***}	(-7.0816) ^{***}	(9.8177) ^{***}		
(1,150)	2860	1155	0.0018	-0.0022	0.0040	0.0136	0.0210
			(2.8117) ^{***}	(-5.3085) ^{***}	(7.0336) ^{***}		
(1,200)	2907	1058	0.0017	-0.0023	0.0040	0.0137	0.0214
			(2.6350) ^{***}	(-5.3061) ^{***}	(6.8721) ^{***}		
(2,200)	2916	1049	0.0015	-0.0017	0.0032	0.0137	0.0214
			(2.0679) ^{**}	(-4.2413) ^{***}	(5.4649) ^{***}		
(5,150)	2866	1149	0.0013	-0.0010	0.0024	0.0138	0.0209
			(1.6286)	(-3.1811) ^{***}	(4.1746) ^{***}		
Average	2834	1189	0.0020	-0.0023	0.0043	0.0135	0.0209
Annual			59.7607	-42.5887			
(b) with one percent band							
(1,50)	2352	1209	0.0034	-0.0048	0.0082	0.0130	0.0209
			(6.5214) ^{***}	(-10.3562) ^{***}	(14.3370) ^{***}		
(1,100)	2636	1141	0.0025	-0.0032	0.0057	0.0132	0.0213
			(4.5937) ^{***}	(-7.1509) ^{***}	(9.9854) ^{***}		
(1,150)	2768	1040	0.0019	-0.0025	0.0044	0.0135	0.0216
			(3.1911) ^{***}	(-5.6557) ^{***}	(7.5538) ^{***}		
(1,200)	2817	971	0.0018	-0.0024	0.0042	0.0137	0.0219
			(2.8284) ^{***}	(-5.3210) ^{***}	(6.9599) ^{***}		
(2,200)	2818	963	0.0015	-0.0017	0.0032	0.0137	0.0218
			(2.1395) ^{**}	(-4.0351) ^{***}	(5.2712) ^{***}		
(5,150)	2772	1058	0.0012	-0.0011	0.0023	0.0137	0.0214
			(1.4443)	(-3.1604) ^{***}	(3.9966) ^{***}		
Average	2694	1064	0.0021	-0.0026	0.0047	0.0135	0.0215
Annual			64.2726	-46.3976			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

= p<0.05, *= p<0.01

Test results show that the number of buy signals produced by each variant of EMA is significantly larger than the number of sell signals, indicating an up trending of the KSE-100 index throughout the sample period. On average more returns are generated by buy than the sell

signals. Buy (sell) signals for all variants of EMA yielded positive (negative) returns. The mean buy returns for 10 of the 12 EMA variants are statistically significantly higher than the mean returns earned through 1-day buy-and- hold plan. Likewise, the mean sell returns for all

EMA variants are statistically significantly different from the mean returns earned through buy- and- hold plan. The buy-sell differences in returns for all variants of EMA are positive and statistically significant at the 0.01 level. This infers that our null hypothesis of equality with zero i.e., the mean daily buy earnings and the mean daily sell

earnings generated through exponential moving average are equal to daily mean earnings obtained through simple buy and hold strategy or the equality of mean buy returns with mean sell returns is rejected.

Results suggest that with exception to variants (5, 150, 0) and (5, 150, 1), remaining EMA variants have signifi-

Table 3. summarized results for moving average convergence divergence variants for full sample period (1997-2013)

Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDb	SDs
(12,26,0)	42	46	0.0258 (1.9848)**	-0.0093 (-1.7528)*	0.0351 (2.7834)***	0.0443	0.0504
(12,26,9)	84	92	0.0078 (0.1482)	-0.0030 (-1.4370)	0.0108 (1.2158)	0.0500	0.0726
(8,17,9)	93	112	0.0045 (-0.3343)	0.0046 (-0.3368)	-0.0001 (-0.0177)	0.0533	0.0673
Average	74	84	0.0015	-0.0005	0.0020	0.0051	0.0068
Annual			43.3891	-11.5814			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

*= p<0.1, **= p<0.05, ***= p<0.01

Table 4. summarized results for relative strength index variants for full sample period (1997-2013)

Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDb	SDs
(7,50)	94	117	0.0037 (-0.4509)	-0.0033 (-1.6262)	0.0070 (0.8581)	0.0600	0.0464
(14,50)	78	86	0.0043 (-0.3416)	0.0019 (-0.6900)	0.0023 (0.2534)	0.0642	0.0569
(21,50)	67	59	0.0089 (0.2777)	-0.0087 (-1.8737)*	0.0176 (1.6660)*	0.0464	0.0553
Average	80	87	0.0056	-0.0033	0.0090	0.0569	0.0529
Annual			287.6540	-55.1410			
(7,30/70)	100	140	-0.0044 (-1.6927)*	0.0053 (-0.2546)	-0.0097 (-1.2512)	0.0497	0.0507
(14,30/70)	73	101	-0.0035 (-1.3632)	0.0036 (-0.4828)	-0.0071 (-0.7780)	0.0775	0.0471
(21,30/70)	46	81	0.0053 (-0.1605)	0.0080 (0.1669)	-0.0027 (-0.2451)	0.0614	0.0556
Average	73	107	-0.0009	0.0056	-0.0065	0.0629	0.0511
Annual			-18.4969	285.6552			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns

*= p<0.1

Table 5. Summarized results for momentum variants for full sample period (1997-2013)

Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDb	SDs
(10)	210	211	0.0107 (8.7789)***	-0.0125 (-11.5582)***	0.0232 (14.7414)***	0.0135	0.0163
(40)	97	97	0.0117 (6.6490)***	-0.0121 (-7.7328)***	0.0238 (10.2886)***	0.0148	0.0168
Average	154	154	0.0112	-0.0123	0.0235	0.0141	0.0166
Annual			1366.5672	-94.7881			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy period returns and the mean sell period returns.

***= $p < 0.01$

cant predictive power to detect future changes in share price movements in Pakistan stock market. Our result is in agreement with¹⁹. EMA variants (1,50,1) and (1,50,0) yielded statistically significantly higher mean buy returns as compared to daily mean buy-and-hold returns. This implies that the recent past prices as compared to old ones are important for correct prediction of the future movement of stock prices by EMA in the Pakistan stock market.

The average daily buy returns with zero and one percent bands are approximately 0.20% and 0.21 % respectively, that is equivalent to 59.76% and 64.27% annually. Similarly, the average daily sell returns are approximately -0.23% and -0.26% respectively, that is equivalent to -42.59% and -46.40% annually. Compared to conditional EMA returns, the annual one day mean unconditional returns are 17.57%. The introduction of 1% band had although decreased the number of both buy and sells signals, it had increased the overall profitability.

In all EMA variants, it is seen that the standard deviations for sell days are higher than that of the buy days, indicating that KSE-100 index was more volatile during sell days than the buy periods.

Table 3 shows the statistical results for 3 trading variants of MACD. The number of buy and sell signals produced by MACD variants are significantly less than the EMA variants. This is because MACD is computed at the next day index value following a trading signal using fixed holding period of 10 days.

The only MACD variant that yielded significantly higher mean buy (sell) returns as compared to 10-day buy-and-hold plan is (12, 26, 0). Our observation is in full agreement with the report of²¹, who also found highest profitability of this MACD variant in Italian and Canadian stock markets.

The buy-sell difference in returns for 1 of the 3 MACD variants is statistically significant at the 0.01 level. This suggest that our null hypothesis of equality with zero i.e., the mean daily buy earnings and the mean daily sell earnings generated through MACD are equal to the mean earnings obtained through 10 day buy and hold strategy or the equality of mean buy returns with mean sell returns is accepted.

The annual mean buy (sell) returns for MACD is 43.39% (-11.58%). In comparison to this, the annual 10-day mean unconditional returns are 477.21%.

In all variants of MACD, it can be observed that the standard deviations for sell days are higher than the buy days, indicating that KSE-100 index was more volatile during sell days than the buy periods. Our result is in accord¹⁷.

In Table 4, results for six variants of RSI are presented. The number of buy and sell signals produced by each variant of RSI are markedly less than that of the EMA variants, but are considerably more than that of the MACD variants. This is because RSI after the generation of trading signal is computed from the next day index value using fixed holding period of 10 days.

It is interesting to note that unlike other employed trading rules, buy signals for 2 of the 6 RSI variants generated negative returns, while sell signals for 4 of the 6 RSI variants yielded positive returns. Amongst the RSI variants, (21, 50) provided the highest mean buy returns. The annual mean buy (sell) returns for RSI rule is 287.65% (-55.14%). Compared to this the annual 10-day mean unconditional returns are 477.21%. These results therefore, indicate that RSI rule has no predictive power to forecast future trends in share price movements in KSE-100 index. This implies that our null hypothesis of equality

with zero i.e., the mean daily buy earnings and the mean daily sell earnings generated through RSI are equal to the mean earnings obtained through simple buy and hold strategy or the equality of mean buy returns with mean sell returns is accepted.

Table 5 depicts summarized results for 2 variants of MOM. The data show that the number of buy and sell signals produced by each variant of MOM is significantly greater than both MACD and RSI but is less than the EMA variants. Both buy and sell signals generated by each variant of MOM is equal; buy signals generated positive returns, while sell signals provided negative returns. Both mean buy and mean sell days returns for MOM variants are statistically significantly higher than the mean returns earned through simple buy- and- hold plan. Similarly, buy-sell differences in returns for both variants of MOM are positive and statistically significant at the 0.01 level. Consequently, our null hypothesis of equality with zero or the equality of mean buy returns with mean sell returns is rejected.

Table 6. Breakeven transaction and estimated actual costs for EMA rules

Rule	EMA
(1,50,0)	0.33%
(1,100,0)	0.26%
(1,150,0)	0.19%
(1,200,0)	0.19%
(2,200,0)	0.15%
(5,150,0)	0.12%
(1,50,1)	0.39%
(1,100,1)	0.27%
(1,150,1)	0.21%
(1,200,1)	0.19%
(2,200,1)	0.16%
(5,150,1)	0.12%
Estimated Actual Cost	0.25%

Table 7. Breakeven transaction and estimated actual costs for MACD rules

Rule	MACD
(12,26,0)	1.72%
(12,26,9)	0.53%
(8,17,9)	-0.05%
Estimated Actual Cost	0.25%

Table 8. Breakeven transaction and estimated actual costs for RSI rules

Rule	RSI
(7,50)	0.35%
(14,50)	0.10%
(21,50)	0.88%
(7, 30/70)	-0.49%
(14, 30/70)	-0.35%
(21, 30/70)	-0.32%
Estimated Actual Cost	0.25%

Table 9. Breakeven transaction and estimated actual costs for MOM rules

Rule	MOM
(10)	1.16%
(40)	1.19%
Estimated Actual Cost	0.25%

MOM results indicate that both the variants of MOM have significant predictive power to detect future changes in share price movements in KSE-100 index. The annual mean buy (sell) returns for MOM are 1366.57% (-94.79%). In comparison to this, the annual one day mean unconditional returns are 17.57%.

In both variants of MOM, it can be observed that the standard deviations for sell days are higher than that of the buy days, indicating that KSE-100 index was more volatile during sell days than the buy periods.

In Tables 6, 7, 8 and 9 we respectively report the profitability of EMA, MACD, RSI and MOM rules after adjusting for transaction costs. It is observed that 4 of the 12 EMA variants, 2 of the 3 MACD variants, 2 of the 6 RSI variants; and both MOM variants are profitable as their breakeven costs are greater than the estimated actual transaction costs in Pakistan stock market.

Summarized sub-sample period results for each variant of EMA, MACD, RSI and MOM rules (shown in appendix 'A') are consistent with the full sample period results, therefore only important findings of sub-sample period results are described here.

It is observed that EMA rule with exception to sub-sample period I (in which EMA produced more sell signals than the buy) has generated considerably more buy than the sell signals. In sub-sample period IV, highest number of EMA variants yielded statistically significantly more mean buy returns than the mean returns obtained by simple buy-

and-hold plan. Similarly in sub-sample period II, highest number of EMA variants is found to yield statistically significantly more mean sell returns than the mean returns obtained by simple buy-and-hold plan. The highest and the lowest average buy signals are recorded in sub-sample periods II and IV respectively. Similarly the highest and the lowest average sell signals are noticed in sub-sample periods I and V respectively. The highest and the lowest average daily buy (sell) returns generated by EMA rule are recorded in sub-sample periods II (after Asian currency crisis) and V (post-global financial crisis) respectively. The highest and the lowest buy (sell) standard returns generated by EMA rule are recorded in sub-sample periods II (after Asian currency crisis) and V (post-global financial crisis) respectively. The highest and the lowest buy (sell) standard deviations (volatilities) are seen in sub-sample periods I (during Asian currency crisis; period of financial instability) and V (after global financial crisis; period of economic and financial stability) respectively. In all sub-sample periods, EMA variants (1, 50, 0) and (1, 50, 1) provided excess returns than the remaining EMA variants.

Results for MACD rule show that the highest and the lowest buy (sell) signals are recorded in sub-sample periods I and IV respectively. The highest and the lowest average buy returns generated by MACD variants occurred in sub-sample periods III and I respectively. The highest buy and sell standard deviations (volatilities) are recorded in sub-sample periods I and IV respectively. Similarly, the lowest buy (sell) standard deviations are noticed in sub-sample period V. In all sub-sample periods except II, MACD variant (12, 26, 0) yielded highest mean buy days returns.

Similarly results for RSI rule demonstrate that the highest and the lowest buy signals are generated in sub-sample periods I and V respectively. The highest and the lowest average buy returns yielded by RSI variants occurred in sub-sample periods II and IV respectively. The highest buy and sell days volatilities are observed in sub-sample periods IV and I respectively. Similarly the lowest buy and sell days volatilities are seen in sub-sample period V.

Results for MOM rule show that the highest and the lowest buy (sell) signals occurred in sub-sample periods I and III respectively. The highest and the lowest average buy returns generated by MOM variants are noted in sub-sample periods I and V respectively. The highest buy and sell standard deviations are recorded in sub-sample periods II and I respectively. Similarly, the lowest buy (sell) standard deviations are noticed in sub-sample period V. In all sub-sample periods both variants of MOM yielded

statistically significantly higher mean buy returns than the mean returns obtained by simple buy-and-hold plan.

5. Conclusion

In this study 10 of the 12 EMA and both MOM variants are found to generate significantly more buy than the sell signals indicating an upward trend in the KSE-100 index throughout the sample period. Buy days returns and buy-sell differences in returns for all variants of EMA and MOM are noted to be positive, while sell days returns for all variants of EMA and MOM are negative. The mean buy returns for 10 of the 12 EMA variants and for both variants of MOM are statistically significantly higher than the daily mean returns earned through buy- and- hold plan. Likewise, the mean sell returns for all EMA and MOM variants are statistically significantly different from the daily mean returns earned through buy- and- hold plan. The buy-sell differences in returns for all variants of EMA and MOM are positive and statistically significant at the 0.01 level. These results suggest that 10 of 12 EMA variants and both of the MOM variants have significant predictive power to detect future changes in share price movements in Pakistan stock market.

We found that EMA variant (1, 50, 1), MACD variant (12, 26, 0), RSI variant (21, 50) and MOM variant (1, 40, 0) yielded highest mean buy returns and mean buy-sell differences in returns as compared to corresponding remaining variants of EMA, MACD, RSI and MOM. EMA variants (1, 50, 1) and (1, 50, 0), MACD variants (12, 26, 9) and (8, 17, 9) and MOM variants (10) and (40) are found to be profitable in Pakistan stock market even after inclusion of the transaction costs.

The observation that in all EMA, and MOM variants, the standard deviations for sell days are higher than the buy days in all sub-sample periods, indicate that KSE-100 index was more volatile during sell days than the buy periods.

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APPENDIX 'A'

Sub-sample results of Pakistan Stock Market

EMA results with zero percent band for sub-sample period I (1997-2000)							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDb	SDs
(1,50)	445	492	0.0045 (3.6565)***	-0.0042 (-3.4198)***	0.0087 (6.1283)***	0.0187	0.0232
(1,100)	404	483	0.0034 (2.7187)**	-0.0029 (-2.3453)**	0.0063 (4.3485)***	0.0185	0.0243
(1,150)	369	468	0.0018 (1.3550)	-0.0019 (-1.5232)	0.0037 (2.4346)**	0.0194	0.0242
(1,200)	351	436	0.0019 (1.4484)	-0.0022 (-1.6913)*	0.0041 (2.6312)***	0.0196	0.0247
(2,200)	352	435	0.0013 (0.9746)	-0.0017 (-1.2830)	0.0029 (1.8882)*	0.0197	0.0247
(5,150)	370	467	0.0009 (0.7317)	-0.0013 (-0.9920)	0.0022 (1.4529)	0.0196	0.0242
Average	382	464	0.0023	-0.0023	0.0046	0.0193	0.0242
Annual			73.6094	-42.9283			
EMA results with one percent band for sub-sample period I (1997-2000)							
(1,50)	382	417	0.0050 (3.8522)***	-0.0049 (-3.8437)***	0.0099 (6.4967)***	0.0192	0.0245
(1,100)	371	451	0.0037 (2.8138)***	-0.0030 (-2.3736)**	0.0067 (4.4033)***	0.0188	0.0247
(1,150)	349	432	0.0020 (1.5044)	-0.0024 (-1.8944)*	0.0044 (2.8414)***	0.0197	0.0249
(1,200)	318	394	0.0022 (1.5719)	-0.0022 (-1.6754)*	0.0044 (2.6877)***	0.0201	0.0257
(2,200)	323	393	0.0015 (1.0802)	-0.0017 (-1.2961)	0.0032 (1.9652)**	0.0201	0.0257
(5,150)	346	441	0.0007 (0.5823)	-0.0013 (-1.0069)	0.0020 (1.3197)	0.0199	0.0247
Average	348	421	0.0025	-0.0026	0.0051	0.0197	0.0250
Annual			82.3706	-46.3876			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

*= p<0.1, **= p<0.05, ***= p<0.01

EMA results with zero percent band for sub-sample period II (2001-2004)							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDb	SDs
(1,50)	666	274	0.0033 (2.3424)**	-0.0025 (-4.2003)***	0.0058 (5.6709)***	0.0126	0.0170
(1,100)	736	154	0.0026	-0.0028	0.0054	0.0136	0.0176

			(1.4950)	(-3.5414)***	(4.3046)***		
(1,150)	771	69	0.0024	-0.0028	0.0052	0.0138	0.0219
			(1.1107)	(-2.4912)**	(2.9022)***		
(1,200)	775	15	0.0022	-0.0133	0.0155	0.0138	0.0244
			(0.8492)	(-4.0144)***	(4.1657)***		
(2,200)	778	12	0.0020	-0.0083	0.0103	0.0139	0.0276
			(0.6514)	(-2.3812)**	(2.4866)**		
(5,150)	773	67	0.0020	0.0014	0.0006	0.0141	0.0202
			(0.5654)	(-0.1238)	(0.3385)		
Average	750	99	0.0024	-0.0047	0.0071	0.0136	0.0214
Annual			78.5968	-67.7981			
EMA results with one percent band for sub-sample period II (2001-2004)							
(1,50)	593	225	0.0036	-0.0040	0.0076	0.0129	0.0174
			(2.7277)***	(-5.2517)***	(6.8049)***		
(1,100)	707	139	0.0027	-0.0032	0.0059	0.0132	0.0177
			(1.5782)	(-3.6773)***	(4.4484)***		
(1,150)	762	61	0.0025	-0.0014	0.0038	0.0138	0.0191
			(1.2371)	(-1.5785)	(2.0206)**		
(1,200)	763	9	0.0022	-0.0125	0.0147	0.0139	0.0296
			(0.8915)	(-2.9542)**	(3.0805)***		
(2,200)	763	8	0.0021	-0.0066	0.0087	0.0139	0.0254
			(0.6921)	(-1.6290)	(1.7223)*		
(5,150)	765	62	0.0019	0.0024	-0.0005	0.0138	0.0195
			(0.4283)	(0.4357)	(-0.2747)		
Average	726	84	0.0025	-0.0042	0.0067	0.0136	0.0215
Annual			82.0421	-63.5808			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

*= p<0.1, **= p<0.05, ***= p<0.01

EMA results with zero percent band for sub-sample period III (2005-2007)							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDb	SDs
(1,50)	473	213	0.0025	-0.0039	0.0064	0.0130	0.0212
			(2.0587)**	(-3.4833)***	(4.8022)***		
(1,100)	472	164	0.0022	-0.0021	0.0044	0.0120	0.0205
			(1.7922)*	(-1.8636)*	(2.9695)***		
(1,150)	484	102	0.0017	-0.0020	0.0037	0.0125	0.0217
			(1.2855)	(-1.4468)	(2.1096)**		
(1,200)	480	56	0.0015	-0.0041	0.0055	0.0132	0.0246
			(0.9970)	(-2.0208)**	(2.4090)**		
(2,200)	476	60	0.0013	-0.0023	0.0036	0.0132	0.0242
			(0.8107)	(-1.2715)	(1.6026)		

(5,150)	480	106	0.0012	0.0006	0.0006	0.0128	0.0208
			(0.7209)	(0.0616)	(0.3398)		
Average	478	117	0.0017	-0.0023	0.0040	0.0128	0.0222
Annual			51.6389	-42.3903			
EMA results with one percent band for sub-sample period III (2005-2007)							
(1,50)	426	175	0.0029	-0.0052	0.0081	0.0124	0.0221
			(2.4267)**	(-4.1260)***	(5.5588)***		
(1,100)	431	135	0.0023	-0.0034	0.0057	0.0122	0.0210
			(1.8355)*	(-2.5273)**	(3.5565)***		
(1,150)	465	82	0.0018	-0.0031	0.0049	0.0126	0.0230
			(1.3481)	(-1.8975)*	(2.5272)**		
(1,200)	459	42	0.0014	-0.0063	0.0077	0.0131	0.0267
			(0.9501)	(-2.6443)***	(2.9628)***		
(2,200)	460	39	0.0011	-0.0004	0.0015	0.0131	0.0267
			(0.6580)	(-0.3271)	(0.5606)		
(5,150)	458	89	0.0013	0.0008	0.0005	0.0128	0.0219
			(0.7950)	(0.1498)	(0.2684)		
Average	450	94	0.0018	-0.0029	0.0047	0.0127	0.0236
Annual			54.7488	-50.4434			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

*= p<0.1, **= p<0.05, ***= p<0.01

EMA results with zero percent band for sub-sample period IV(2008-2010)							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDB	SDs
(1,50)	386	275	0.0027	-0.0046	0.0072	0.0119	0.0198
			(2.9314)***	(-3.6732)***	(5.7199)***		
(1,100)	343	268	0.0019	-0.0029	0.0048	0.0120	0.0205
			(2.1007)**	(-2.2273)**	(3.6931)***		
(1,150)	323	238	0.0018	-0.0019	0.0037	0.0103	0.0201
			(1.9558)*	(-1.3034)	(2.7077)***		
(1,200)	314	197	0.0016	-0.0012	0.0028	0.0104	0.0204
			(1.7670)*	(-0.6741)	(1.9345)*		
(2,200)	312	199	0.0014	-0.0009	0.0023	0.0103	0.0205
			(1.5877)	(-0.4210)	(1.5773)		
(5,150)	321	240	0.0014	-0.0013	0.0026	0.0105	0.0200
			(1.5454)	(-0.7913)	(1.9309)*		
Average	333	236	0.0018	-0.0021	0.0039	0.0109	0.0202
Annual			54.0546	-39.9851			

EMA results with one percent band for sub-sample period IV(2008-2010)							
(1,50)	352	249	0.0027	-0.0050	0.0077	0.0119	0.0202
			(2.8669)***	(-3.9023)***	(5.7885)***		
(1,100)	321	246	0.0022	-0.0036	0.0058	0.0119	0.0211
			(2.3247)**	(-2.7118)***	(4.2565)***		
(1,150)	305	217	0.0018	-0.0021	0.0039	0.0104	0.0207
			(1.8958)*	(-1.4134)	(2.7228)***		
(1,200)	298	185	0.0017	-0.0016	0.0033	0.0103	0.0208
			(1.8180)*	(-0.9568)	(2.2055)**		
(2,200)	299	187	0.0014	-0.0012	0.0026	0.0103	0.0207
			(1.5410)	(-0.6642)	(1.7421)*		
(5,150)	303	218	0.0013	-0.0016	0.0028	0.0103	0.0206
			(1.4515)	(-0.9818)	(1.9972)**		
Average	313	217	0.0018	-0.0025	0.0044	0.0108	0.0207
Annual			55.8312	-45.2438			
Nb = Number of buy signals. Ns= Number of sell signals. Buy-Sell = Difference between the mean buy and the mean sell period returns. * = p<0.1, ** = p<0.05, *** = p<0.01							

EMA results with zero percent band for sub-sample period V(2011-2013)							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDB	SDs
(1,50)	530	165	0.0020	-0.0019	0.0039	0.0079	0.0113
			(1.8051)*	(-3.8612)***	(4.9185)***		
(1,100)	549	96	0.0017	-0.0023	0.0040	0.0082	0.0120
			(1.3378)	(-3.4283)***	(4.0647)***		
(1,150)	506	89	0.0017	-0.0016	0.0033	0.0084	0.0121
			(1.2435)	(-2.6705)***	(3.2479)***		
(1,200)	490	55	0.0016	-0.0010	0.0027	0.0083	0.0107
			(1.0847)	(-1.6772)*	(2.1019)**		
(2,200)	489	56	0.0016	-0.0003	0.0018	0.0082	0.0112
			(0.9294)	(-1.0790)	(1.4513)		
(5,150)	503	92	0.0014	0.0001	0.0013	0.0084	0.0126
			(0.6797)	(-0.9799)	(1.3096)		
Average	511	92	0.0017	-0.0012	0.0028	0.0082	0.0116
Annual			49.6075	-24.4774			
EMA results with one percent band for sub-sample period V(2011-2013)							
(1,50)	476	115	0.0024	-0.0036	0.0060	0.0076	0.0113
			(2.4819)**	(-5.2136)***	(6.4723)***		
(1,100)	524	80	0.0019	-0.0023	0.0042	0.0079	0.0124
			(1.6249)	(-3.1623)***	(3.8935)***		
(1,150)	496	81	0.0017	-0.0019	0.0036	0.0083	0.0123

			(1.1672)	(-2.8433)***	(3.3581)***		
(1,200)	482	50	0.0016	-0.0015	0.0030	0.0083	0.0105
			(1.0014)	(-1.9263)*	(2.2979)**		
(2,200)	481	51	0.0016	-0.0006	0.0022	0.0083	0.0110
			(0.9842)	(-1.2830)	(1.6603)*		
(5,150)	494	81	0.0015	0.0000	0.0015	0.0082	0.0127
			(0.7371)	(-1.0488)	(1.3891)		
Average	492	76	0.0018	-0.0016	0.0034	0.0081	0.0117
Annual			52.8270	-32.6722			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

*= p<0.1, **= p<0.05, ***= p<0.01

MACD results for sub-sample period I (1997-2000)							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDB	SDs
(12,26,0)	13	12	0.0155	-0.0164	0.0319	0.0600	0.0545
			(0.7397)	(-0.6572)	(1.0506)		
(12,26,9)	19	23	-0.0045	-0.0119	0.0074	0.0592	0.0949
			(-0.1795)	(-0.6106)	(0.3129)		
(8,17,9)	23	25	-0.0030	0.0150	-0.0180	0.0652	0.0885
			(-0.1072)	(0.9423)	(-0.8212)		
Average	19	20	0.0008	-0.0011	0.0020	0.0066	0.0084
Annual			22.6057	-23.2545			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

MACD results for sub-sample period II (2001-2004)							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDB	SDs
(12,26,0)	9	8	0.0166	-0.0153	0.0319	0.0490	0.0559
			(0.0628)	(-1.6450)*	(1.2924)		
(12,26,9)	17	19	0.0355	0.0076	0.0279	0.0410	0.0540
			(1.4937)	(-0.6186)	(1.6466)*		
(8,17,9)	23	23	0.0182	0.0032	0.0151	0.0440	0.0553
			(0.2311)	(-1.0420)	(1.0053)		
Average	17	17	0.0027	-0.0002	0.0029	0.0044	0.0057
Annual			90.2286	-5.7920			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

*= p<0.1

MACD results for sub-sample period III (2005-2007)							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDB	SDs
(12,26,0)	7	9	0.0445 (1.7474)*	-0.0106 (-0.8074)	0.0550 (1.9447)*	0.0317	0.0521
(12,26,9)	14	16	0.0244 (1.1488)	-0.0164 (-1.4025)	0.0408 (1.9862)**	0.0341	0.0599
(8,17,9)	15	20	0.0022 (-0.2072)	-0.0039 (-0.6576)	0.0061 (0.3167)	0.0601	0.0589
Average	12	15	0.0028	-0.0007	0.0035	0.0049	0.0065
Annual			94.4488	-15.4422			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

*= p<0.1, **= p<0.05

MACD results for sub-sample period IV (2008-2010)							
Rules	Nb	Ns	Buy	Sell	Buy-Sell	SDB	SDs
(12,26,0)	5	6	0.0515 (1.5374)	-0.0013 (0.0718)	0.0528 (1.1277)	0.0425	0.0499
(12,26,9)	12	14	-0.0226 (-0.7762)	-0.0112 (-0.3303)	-0.0113 (-0.3725)	0.0706	0.1039
(8,17,9)	12	19	-0.0162 (-0.5150)	-0.0064 (-0.1308)	-0.0099 (-0.3464)	0.0740	0.0926
Average	11	14	0.0009	-0.0010	0.0019	0.0061	0.0085
Annual			24.6709	-21.6863			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

MACD results for sub-sample period V(2011-2013)							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDB	SDs
(12,26,0)	7	8	0.0057 (-0.4792)	-0.0071 (-1.7337)*	0.0129 (0.8838)	0.0142	0.0500
(12,26,9)	19	16	0.0039 (-0.9881)	0.0137 (0.3446)	-0.0099 (-1.0363)	0.0312	0.0334
(8,17,9)	18	20	0.0131 (0.2735)	0.0103 (-0.1089)	0.0028 (0.3079)	0.0223	0.0274
Average	15	16	0.0009	0.0007	0.0002	0.0029	0.0039
Annual			23.8688	16.9629			

RSI results for sub-sample period I (1997-2000)							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDB	SDs
(7,50)	28	29	0.0101 (0.6831)	-0.0067 (-0.3485)	0.0168 (0.8355)	0.0689	0.0635

(14,50)	22	24	0.0046	-0.0018	0.0064	0.0525	0.0787
			(0.3171)	(-0.0406)	(0.2862)		
(21,50)	18	14	0.0049	-0.0351	0.0399	0.0506	0.0685
			(0.3049)	(-1.5644)	(1.4788)		
Average	23	22	0.0065	-0.0145	0.0210	0.0573	0.0702
Annual			373.8578	43.4783			
(7,30/70)	26	29	0.0102	-0.0010	0.0112	0.0385	0.0675
			(0.6719)	(0.0031)	(0.5495)		
(14,30/70)	23	21	-0.0035	0.0009	-0.0045	0.0836	0.0664
			(-0.1371)	(0.1117)	(-0.1952)		
(21,30/70)	17	16	0.0128	0.0046	0.0081	0.0698	0.0907
			(0.6931)	(0.2782)	(0.3087)		
Average	22	22	0.0065	0.0015	0.0050	0.0640	0.0749
Annual			373.8578	43.4783			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns

RSI results for sub-sample period II (2001-2004)							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDB	SDs
(7,50)	15	28	0.0234	-0.0016	0.0249	0.0385	0.0385
			(0.5567)	(-1.5589)	(1.5344)		
(14,50)	14	21	0.0336	-0.0077	0.0413	0.0530	0.0450
			(1.2412)	(-1.8922)*	(2.3563)**		
(21,50)	14	16	0.0122	-0.0098	0.0219	0.0431	0.0571
			(-0.2291)	(-1.8371)*	(1.1791)		
Average	14	22	0.0230	-0.0064	0.0294	0.0449	0.0469
Annual			950.2804	1917.1209			
(7,30/70)	21	35	-0.0033	0.0111	-0.0143	0.0504	0.0444
			(-1.5283)	(-0.4390)	(-1.0223)		
(14,30/70)	16	23	0.0074	0.0080	-0.0006	0.0581	0.0416
			(-0.5890)	(-0.6299)	(-0.0391)		
(21,30/70)	8	21	0.0253	0.0184	0.0068	0.0531	0.0455
			(0.5223)	(0.2405)	(0.3234)		
Average	15	26	0.0098	0.0125	-0.0027	0.0539	0.0439
Annual			950.2804	1917.1209			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

*= p<0.1, **= p<0.05

RSI results for sub-sample period III (2005-2007)							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDb	SDs
(7,50)	18	19	0.0113 (0.3906)	-0.0154 (-1.4381)	0.0268 (1.4493)	0.0391	0.0496
(14,50)	13	15	0.0051 (-0.0259)	0.0139 (0.5262)	-0.0089 (-0.4168)	0.0495	0.0484
(21,50)	10	10	0.0334 (1.4683)	-0.0020 (-0.3964)	0.0355 (1.4122)	0.0347	0.0321
Average	14	15	0.0166	-0.0012	0.0178	0.0411	0.0433
Annual			-87.8827	-70.2836			
(7,30/70)	15	26	-0.0087 (-0.8847)	-0.0013 (-0.5293)	-0.0073 (-0.4019)	0.0468	0.0622
(14,30/70)	12	16	0.0011 (-0.2516)	-0.0097 (-0.9757)	0.0108 (0.5036)	0.0627	0.0546
(21,30/70)	7	14	-0.0188 (-1.0911)	-0.0041 (-0.5842)	-0.0147 (-0.5653)	0.0649	0.0643
Average	11	19	-0.0088	-0.0051	-0.0037	0.0581	0.0603
Annual			-87.8827	-70.2836			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

RSI results for sub-sample period IV (2008-2010)							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDb	SDs
(7,50)	19	16	-0.0366 (-1.6318)	0.0053 (0.4178)	-0.0420 (-1.5978)	0.0787	0.0441
(14,50)	14	11	-0.0410 (-1.6336)	0.0044 (0.3229)	-0.0454 (-1.4559)	0.1006	0.0681
(21,50)	12	8	-0.0226 (-0.7775)	0.0155 (0.6620)	-0.0381 (-1.0786)	0.0547	0.0615
Average	15	12	-0.0334	0.0084	-0.0418	0.0780	0.0579
Annual			-99.8772	930.3858			
(7,30/70)	20	23	-0.0361 (-1.6386)	0.0126 (0.8667)	-0.0487 (-2.0582)**	0.0660	0.0429
(14,30/70)	12	15	-0.0437 (-1.6441)	0.0085 (0.5500)	-0.0522 (-1.7406)*	0.1140	0.0471
(21,30/70)	9	13	-0.0040 (-0.0087)	0.0081 (0.5027)	-0.0121 (-0.3594)	0.0667	0.0368
Average	14	17	-0.0279	0.0097	-0.0376	0.0822	0.0423
Annual			-99.8772	930.3858			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

*= p<0.1, **= p<0.05

RSI results for sub-sample period V (2011-2013)							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDB	SDs
(7,50)	14	24	0.0150 (0.4811)	0.0014 (-1.4523)	0.0136 (1.4427)	0.0238	0.0279
(14,50)	12	14	0.0080 (-0.3477)	0.0088 (-0.2798)	-0.0008 (-0.0679)	0.0305	0.0240
(21,50)	11	10	0.0174 (0.6909)	-0.0017 (-1.3370)	0.0190 (1.5487)	0.0283	0.0375
Average	12	16	0.0135	0.0028	0.0106	0.0275	0.0298
Annual			1045.5680	813.1075			
(7,30/70)	18	24	0.0100 (-0.1367)	0.0071 (-0.6011)	0.0030 (0.3408)	0.0257	0.0268
(14,30/70)	10	23	0.0221 (1.1603)	0.0081 (-0.4394)	0.0140 (1.3158)	0.0400	0.0268
(21,30/70)	5	14	-0.0016 (-0.9765)	0.0125 (0.1757)	-0.0142 (-0.9669)	0.0227	0.0246
Average	11	20	0.0102	0.0092	0.0009	0.0295	0.0261
Annual			1045.5680	813.1075			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

MOM results for sub-sample period I (1997-2000)							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDB	SDs
(10)	57	57	0.0148 (5.0270)***	-0.0139 (-4.7033)***	0.0286 (7.0866)***	0.0146	0.0219
(40)	27	27	0.0099 (2.3495)**	-0.0136 (-3.2241)***	0.0235 (3.9975)***	0.0137	0.0209
Average	42	42	0.0123	-0.0138	0.0261	0.0142	0.0214
Annual			1815.2851	-96.3218			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

***= p<0.01

MOM results for sub-sample period II (2001-2004)							
Rules	Nb	Ns	Buy	Sell	Buy-Sell	SDB	SDs
(10)	52	51	0.0097 (3.9834)***	-0.0122 (-6.7097)***	0.0218 (7.7746)***	0.0148	0.0141
(40)	25	24	0.0094 (2.7054)***	-0.0120 (-4.6181)***	0.0214 (5.2589)***	0.0174	0.0160
Average	39	38	0.0095	-0.0121	0.0216	0.0161	0.0150
Annual			887.8185	-94.4946			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

***= p<0.01

MOM results for sub-sample period III (2005-2007)							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDB	SDs
(10)	30	31	0.0099	-0.0172	0.0272	0.0135	0.0167
			(3.1151) ^{***}	(-5.9515) ^{***}	(6.5358) ^{***}		
(40)	17	18	0.0133	-0.0124	0.0256	0.0124	0.0203
			(3.2041) ^{***}	(-3.3180) ^{***}	(4.6686) ^{***}		
Average	24	25	0.0116	-0.0148	0.0264	0.0130	0.0185
Annual			1515.5399	-97.1274			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

***= p<0.01

MOM results for sub-sample period IV (2008-2010)							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDB	SDs
(10)	35	35	0.0113	-0.0127	0.0240	0.0130	0.0135
			(4.1784) ^{***}	(-4.4456) ^{***}	(6.2575) ^{***}		
(40)	11	11	0.0179	-0.0141	0.0319	0.0166	0.0097
			(3.7243) ^{***}	(-2.8179) ^{***}	(4.6644) ^{***}		
Average	23	23	0.0146	-0.0134	0.0280	0.0148	0.0116
Annual			3210.8778	-95.9889			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

***= p<0.01

MOM results for sub-sample period V (2011-2013)							
Variant	Nb	Ns	Buy	Sell	Buy-Sell	SDB	SDs
(10)	35	36	0.0059	-0.0061	0.0120	0.0071	0.0082
			(3.1256) ^{***}	(-4.7036) ^{***}	(5.6679) ^{***}		
(40)	14	13	0.0088	-0.0077	0.0166	0.0094	0.0093
			(3.2158) ^{***}	(-3.5197) ^{***}	(4.8119) ^{***}		
Average	25	25	0.0074	-0.0069	0.0143	0.0082	0.0088
Annual			484.9178	-81.0193			

Nb = Number of buy signals.

Ns= Number of sell signals.

Buy-Sell = Difference between the mean buy and the mean sell period returns.

***= p<0.01