

APPLYING A COMBINED MAX-MIN SIMPLE MOVING AVERAGE TRADING STRATEGY TO MARKET INDEXES

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ABSTRACT. In this paper, we propose and recommend a new combined moving average trading rule based on max-min strategy. It outperforms the traditional simple moving average trading rules for Buy and Sell-day returns by a factor of 10 to 20 in the DJIA, the NASDAQ, and the S&P. It also outperforms the old traditional combined moving average trading rule based on max-max strategy proposed by Arnold and Rahfeldt in 2008 for Sell-day returns by a factor of 10 to 20 in the DJIA, the NASDAQ, and the S&P.

JEL codes: G10; G14

Keywords: combined moving average trading rule; efficient market hypothesis; max-max strategy; max-min strategy; rate of return; simple moving average trading rules

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1. Introduction

The weak form of the Efficient Market Hypothesis (EMH) asserts that all information contained in past price movements is fully reflected in current market price. If this were true, then information about recent trends in stock prices would be of no use in selecting stocks. In contrast, technical analysts

believe that past trends or patterns in stock price can be used to predict future stock prices (Brigham and Daves, 2016: 69–70).

Yen and Lee (2008) made an extensive review of EMH. Some of the influential studies about EMH are Bachelier (1900), Kendall (1953), Fama (1965), Samuelson (1965), Fama and Blume (1966), Mandelbrot (1966), Fama et al. (1969), Fama (1970), Fama (1991), Nichols (1993), Thaler (1993), Conrad (1995), Shanken and Smith (1996), Fama (1998), Malkiel (2003, 2005), and Jiang and Tian (2012).

On the other hand, increasing skepticism about the EMH led to support for trading rules. Examples of trend include Osborne (1959, 1962), Levy (1967), Jensen and Henington (1970), Rozeff and Kinney (1976), Basu (1977), Jensen (1978), Schneeweis and Woolridge (1979), Taylor (1982), Mishkin (1983), Renshaw (1984), Keane (1986), Sweeney (1988), Balvers et al. (1990), Campbell et al. (1993), Jegadeesh and Titman (1993), Blume et al. (1994), Lo and MacKinlay (1997), Haugen (1999), Schleifer (2000), Beckmann (2002), Shiller (2003), Avramov et al. (2006), Daniel and Sheridan (2006), Al-Khazali et al. (2007), Cooper et al. (2008), Cohen et al. (2009), Lakshmi and Roy (2012), Brown (2013), Almudhaf (2014), Malhotra et al. (2015), and Ross (2015).

One aspect of technical analysis involves analyzing historical market data to identify potentially profitable trades. According to Lento (2007), technical analysis is one of the earliest forms of investment analysis, because stock prices are publicly made available before other types of financial information. In Brock et al. (1992: 1735), one of the simplest and most widely used technical rules is the trading rule based on moving average-oscillators.

Under the moving average trading rule, buy and sell signals are generated by two moving averages of the returns: a long-period average return and a short-period average return. The moving average strategy is to buy or sell when the short-period moving average rises above (or falls below) the long-period moving average. That is, buy if $MA(S) > MA(L)$; otherwise, sell, where $MA(S)$ and $MA(L)$ is the short-period and long-period moving average, respectively. The rationale behind computing moving averages is to smooth out an otherwise volatile series. When the short-period moving average penetrates the long-period moving average, a trend is considered to be initiated. We denote the moving average trading rule with a short moving period of S , and a long moving period as $MA(S, L)$.

In this paper, the popular moving average rules with the short moving period of $S = 1$ and 5 and the long moving period of $L = 50, 100, 150$, and 200 are evaluated as replicate studies for their ability to forecast market returns, where the returns are defined to be $\ln(p_t) - \ln(p_{t-1})$ as in Fama (1965: 45).

In Arnold and Rahfeldt (2008, AR hereafter), a trading rule is created by combining information from two simple moving averages (MA). That is, buy

when the actual price crosses above both moving averages and exit the market when the price crosses below either moving average. Namely, it means

[Buy: if $p_t > \text{MA}(S)$ and $p_t > \text{MA}(L)$;
 [Sell: if $p_t < \text{MA}(S)$ or $p_t < \text{MA}(L)$,

where p_t is the closing price at time t , $\text{MA}(S)$ and $\text{MA}(L)$ are short and long moving averages up to closing price at time $t-1$. Short MA period of $S = 5$ and 10 days, and long MA period of $L = 50, 100, 150$, and 200 days are examined in Chang et al. (2006). Let us denote those decision rules as AR-MA(S, L), where S and L are short and long moving average periods, respectively. Chang et al. (2006) found that AR-MA(S, L) rules provide more useful information for investor to identify profitable opportunities compared to MA(S, L) in the Taiwan stock markets.

In this study, we examine MA(S, L) and AR-MA(S, L) rules, along with other two suggested variation forms of AR-MA(S, L) rules, to compare their profitability on the Dow Jones Industry Averages (DJIA), the National Association of Securities Dealers Automated Quotations (NASDAQ), and the Standard and Poor 500 (S&P). We propose a new combined trading rule based on simple MA(S, L) methods. The new trading rule improves the Buy and Sell-day returns by a factor of 10 to 20 when applied to the DJIA, the NASDAQ, and the S&P.

2. Data and Trading Rules

As a replicate comparison study, 5,780 observations each from the DJIA, the NASDAQ, and the S&P in Yahoo Finance are examined. We use data from 1/29/1985 to 12/27/2007 in comparison to the study of MA(S, L) trading rules on the DJIA (Brock et al., 1992), the NASDAQ (Metghalchi et al., 2011), and the S&P (Metghalchi et al., 2005), where $S = 1, 5$, and $L = 50, 100, 150, 200$.

From Chang et al. (2006), AR-MA(S, L) trading rules outperform regular moving average trading rules in the Taiwan Stock market. In this study, we examine if AR-MA(S, L) will outperform under a more efficient market in the United States. The three market indices that we will consider are the DJIA, the NASDAQ, and the S&P.

In addition to the AR-MA(S, L) decision rule studied in Chang et al. (2006), mathematically, we can come up with three other similar versions of AR-MA(S, L) trading rules as follows. The differences among those rules are underlined.

[Buy: if $p_t > \text{MA}(S)$ and $p_t > \text{MA}(L)$;
 [Sell: if $p_t < \text{MA}(S)$ and $p_t < \text{MA}(L)$,

Buy: if $p_t > MA(S)$ and $p_t > MA(L)$;
 Sell: if $p_t < MA(S)$ or $p_t < MA(L)$,

Buy: if $p_t > MA(S)$ or $p_t > MA(L)$;
 Sell: if $p_t < MA(S)$ or $p_t < MA(L)$,

Buy: if $p_t > MA(S)$ or $p_t > MA(L)$;
 Sell: if $p_t < MA(S)$ and $p_t < MA(L)$.

We can rewrite the above four trading rules as follows where $MA(S)$ and $MA(L)$ are moving average with moving period of S and L , respectively:

Buy: if $p_t > \text{maximum}\{MA(S), MA(L)\}$
 Sell: if $p_t < \text{maximum}\{MA(S), MA(L)\}$ (1)

Buy: if $p_t > \text{maximum}\{MA(S), MA(L)\}$
 Sell: if $p_t < \text{minimum}\{MA(S), MA(L)\}$ (2)

Buy: if $p_t > \text{minimum}\{MA(S), MA(L)\}$
 Sell: if $p_t < \text{maximum}\{MA(S), MA(L)\}$ (3)

Buy: if $p_t > \text{minimum}\{MA(S), MA(L)\}$
 Sell: if $p_t < \text{minimum}\{MA(S), MA(L)\}$ (4)

An illustrative example below shows how these four rules work.

p_t	MA(S) or MA(L)	MA(L) or MA(S)	Rule #(1)		Rule #(2)		Rule #(3)		Rule #(4)	
			buy	sell	buy	sell	buy	sell	buy	sell
			> max	< max	> max	< min	> min	< max	> min	< min
1	3.5	7.5	sell		sell		sell		sell	
2	3.5	7.5	sell		sell		sell		sell	
3	3.5	7.5	sell		sell		sell		sell	
4	3.5	7.5	sell		neither		buy or sell		buy	
5	3.5	7.5	sell		neither		buy or sell		buy	
6	3.5	7.5	sell		neither		buy or sell		buy	
7	3.5	7.5	sell		neither		buy or sell		buy	
8	3.5	7.5	buy		buy		buy		buy	
9	3.5	7.5	buy		buy		buy		buy	
10	3.5	7.5	buy		buy		buy		buy	

*Rule #(3) and #(4) end up the same decision

In the fourth row, the current price is \$4, $MA(S)=\$3.5$ and $MA(L)=\$7.5$, or $MA(S)=\$7.5$ and $MA(L)=\$3.5$. For Rule #(1), because the current price of \$4 is less than $\text{max}\{\$3.5, \$7.5\}=\$7.5$, a buy action is triggered. For Rule #(2), because the current price \$4 is neither greater than $\text{max}\{\$3.5, \$7.5\}=\$7.5$,

nor less than $\min\{\$3.5, \$7.5\}=\$3.5$, the investor will neither buy nor sell the stock. For Rule #(3), because the current price \$4 is greater than $\min\{\$3.5, \$7.5\}=\$3.5$, and less than $\max\{\$3.5, \$7.5\}=\$7.5$, the investor can choose either to buy or sell the stock. For Rule #(4), because the current price of \$4 is greater than $\min\{\$3.5, \$7.5\}=\$3.5$, but it is not less than $\min\{\$3.5, \$7.5\}=\$3.5$, a buy action is triggered.

From this, we can see that the buy and sell actions are not exclusive when prices are between the minimum and maximum of MA(S) and MA(L) for Rule #(3). To simplify the decision making process, we will not consider the use of Rule #(3). Table 3 of Chang et al. (2006) shows that AR-MA(5, 100) performs the best. Therefore, in this study, we only examine the profitability from Rule #(1), #(2), and #(4) with short moving period of 5 and long moving period of 100 on the DJIA, the NASDAQ, and the S&P. The three rules are abbreviated as AR1-MA(5, 100), AR2-MA(5, 100), and AR4-MA(5, 100), respectively.

We extend the above study to a period from 1/29/1985 to 5/31/2017. The results, shown in Table 2, are very similar to the results shown in Table 1. Sub-sample analysis by most recent decade from 6/2/2008 to 5/31/2017 is shown in Table 3. The results are similar to those displayed in Table 1 and 2.

3. Results

Since observations on Buy and Sell-days might be dependent as addressed in Ren and Ren (2016), the regular T-test for one independent sample and the Student T-tests for two independent samples should not be applied to test the significance of $\mu_b > 0$, $\mu_s > 0$, and $\mu_b - \mu_s > 0$, where μ_b , μ_s are the means for the Buy and Sell-days, respectively. Therefore, in Table 1, we only list the descriptive statistics for returns when MA(1, 50), MA(1, 100), MA(1, 200), MA(5, 50), MA(5, 100), MA(5, 200) AR1-MA(5, 100), AR2-MA(5, 100), and AR4-MA(5, 100) are applied to the DJIA, the NASDAQ, and the S&P. Some of our findings from Table 1 are summarized below:

(1) We obtain the same results as the studies from Brock et al. (1992) about the DJIA and Metghalchi et al. (2005) about the S&P, and Metghalchi et al. (2011) about the NASDAQ. Therefore, the trading rule MA(S, L) is quite robust for Buy-day returns from the DJIA, the NASDAQ, and the S&P.

(2) Similar to previous research findings, the standard deviation for returns from Buy-days are about half of the size as those for returns from Sell-days.

(3) Contradictory to the findings in Chang et al. (2006), MA(1, 50) and MA(5, 50) are not more successful than the other longer long-period simple moving trading rules in gaining profitability from Buy-days, except for returns

in the NASDAQ. Buy-day returns from trading rules MA(1, 50) and MA(5, 50) are bolded in Table 1.

(4) We have the same finding as in Chang et al. (2006), that the AR1-MA(S, L) trading rule based on max-max strategy outperforms MA(S, L) for Buy-day returns by a factor of 10 to 20 in the DJIA, the NASDAQ, and the S&P. For instance, as highlighted in bold in Table 1, the rates of return when applying the AR1-MA(S, L) trading strategy on the DJIA, the S&P, and the NASDAQ is 0.0042, 0.0041, and 0.0051, respectively. The rates of return when applying the MA(S, L) trading strategy on the DJIA, the S&P, and the NASDAQ is 0.0003, 0.0002 to 0.0003, and 0.0007 to 0.0009, respectively. The performance of the AR1-MA(S, L) strategy outperforms the MA(S, L) strategy when applied to the DJIA, the S&P, and the NASDAQ by a factor of 14 (0.0042/0.0003), 20 (0.0041/0.0002), and 7 (=0.0051/0.0007), respectively.

(5) Our proposed AR2-MA(S, L) trading rule based on max-min strategy performs just as well as AR1-MA(S, L) for Buy-day returns.

(6) From the study by Chang et al. (2006, Table 3), the AR1-MA(S, L) trading rule performs just as poorly as MA(S, L) on Sell-days. However, from Table 1, we can see that our proposed AR2-MA(S, L) trading rule can also outperform MA(S, L) by a factor of 10 to 20 times from Sell-days as explained in Item (4) above.

(7) Since the action of selling for trading rule AR2-MA(S, L) is triggered by the current price p_t being less than the minimum of MA(S) and MA(L), it will involve fewer discrete selling action. In general, the total amount of action days of selling from the trading rule AR2-MA(S, L) is only about 1/3 to 1/4 of the action days of selling from trading rule AR1-MA(S, L). This will reduce the total transaction cost. Therefore, our proposed trading rule AR2-MA(S, L) will be more profitable than AR1-MA(S, L).

(8) In the last two columns of Table 1, we list out the average return per unit standard deviation $\bar{x}_s/s_s$ and the coefficient of variation (c.v.) $s_s/\bar{x}_s$. As we can see, for a possible short sale on Sell-days, the average return per unit standard deviation from AR2-MA(S, L) is about double that of AR1-MA(S, L). For Sell-days, the c.v.'s for AR2-MA(S, L) is about half of the c.v.'s for AR1-MA(S, L), and only about 1/10th of the c.v.'s from traditional moving average trading rules MA(S, L). The extreme case is the c.v. = -1.995 for AR2-MA(5, 100) v.s. the c.v. = 4,547.11 for MA(1, 150) from the NASDAQ.

(9) Similar results for our data analysis from 1/29/2008 to 5/31/2017 of 8,151 observations are presented in Table 2. For instance, the rates of return for the Buy-days using the AR1-MA(S, L)/AR2-MA(S, L) strategy on the

DJIA, the S&P, and the NASDAQ is 0.0041, 0.0040, and 0.0050, respectively. The rates of return for the Buy-days using the MA(S, L) strategy on the DJIA, the S&P, and the NASDAQ is 0.0002 to 0.0003, 0.0002, and 0.0006 to 0.0007, respectively. The performance of the AR1-MA(S, L)/AR2-MA(S, L) strategy outperforms the MA(S, L) strategy on Buy-days at the DJIA, the S&P, the NASDAQ by a factor of 14 (0.0041/0.0003), 20 (0.0040/0.0002), and 7 ($=0.0050/0.0007$), respectively.

The total number of sell action days from the trading rule AR2-MA(S, L) is roughly a quarter of the sell action days from the trading rule AR1-MA(S, L). Due to the reduction in total transaction costs, our proposed trading rule AR2-MA(S, L) will be more profitable than the AR1-MA(S, L) trading rule.

(10) Table 3 shows a sub-sample analysis by most recent decade of 2,265 observations from 6/2/2008 to 5/31/2017. The table presents results similar to those shown in Tables 1 and 2. The performance of the AR1-MA(S, L)/AR2-MA(S, L) strategy outperforms the MA(S, L) strategy on Buy-days when applied to the DJIA, the S&P, and the NASDAQ by a factor of 10 to 13, respectively. The total number of sell action days from the trading rule AR2-MA(S, L) is only about $1/3$ to $1/4$ of the sell action days from the trading rule AR1-MA(S, L). This will reduce total transaction costs, resulting in greater profits.

4. Conclusion

Our proposed trading rule AR2-MA(S, L) based on max-min strategy performs just as well as AR1-MA(S, L) based on max-max for Buy-days, but reduces our trading transaction costs and may bring profit from selling short on Sell-days. Therefore, we recommend the use of our proposed trading rule AR2-MA(S, L) based on max-min strategy, but not AR1-MA(S, L), AR3-MA(S, L) and AR4-MA(S, L) rules based on max-max, min-max, and min-min strategies, respectively.

Table 1 Descriptive statistics for returns for Buy and Sell-days,
data from 1/29/1985 to 12/27/2007

Index	Rules	n_b	n_s	$\bar{x}_b$	s_b	$\bar{x}_s$	s_s	$\bar{x}_b/s_b$	$s_b/\bar{x}_b$	$\bar{x}_s/s_s$	$s_s/\bar{x}_s$
DJIA	MA(1, 50)	3712	1868	0.0003	0.008	0.0006	0.014	0.036	27.777	0.041	24.275
	MA(1, 100)	4020	1560	0.0003	0.008	0.0007	0.015	0.034	29.654	0.046	21.780
	MA(1, 150)	4069	1511	0.0003	0.009	0.0007	0.015	0.032	31.250	0.049	20.541
	MA(1, 200)	4261	1319	0.0003	0.009	0.0007	0.016	0.037	27.115	0.042	23.637
	MA(5, 50)	3702	1878	0.0002	0.009	0.0008	0.014	0.024	41.393	0.055	18.082
	MA(5, 100)	4023	1557	0.0003	0.009	0.0007	0.015	0.034	29.516	0.045	22.015
	MA(5, 150)	4067	1513	0.0003	0.009	0.0008	0.015	0.030	33.300	0.052	19.373
	MA(5, 200)	4249	1331	0.0003	0.015	0.0042	0.014	0.031	32.690	0.053	18.788
	AR1-MA(5, 100)	2569	3011	0.0042	0.007	-0.0028	0.012	0.589	1.697	-0.229	-4.368
	AR2-MA(5, 100)	2569	940	0.0042	0.007	-0.0068	0.016	0.589	1.697	-0.431	-2.318
	AR4-MA(5, 100)	4640	940	0.0019	0.009	-0.0068	0.016	0.211	4.741	-0.431	-2.318
S&P 500	MA(1, 50)	3722	1858	0.0003	0.008	0.0005	0.014	0.033	30.348	0.037	26.781
	MA(1, 100)	3991	1589	0.0002	0.008	0.0007	0.015	0.028	36.168	0.046	21.870
	MA(1, 150)	4102	1478	0.0003	0.008	0.0004	0.015	0.039	25.618	0.029	34.494
	MA(1, 200)	4231	1349	0.0004	0.009	0.0003	0.016	0.045	22.170	0.018	55.093
	MA(5, 50)	3705	1875	0.0002	0.009	0.0006	0.014	0.029	34.636	0.042	23.839
	MA(5, 100)	3991	1589	0.0002	0.008	0.0007	0.015	0.026	39.215	0.049	20.487
	MA(5, 150)	4094	1486	0.0003	0.009	0.0004	0.015	0.041	24.685	0.026	37.927
	MA(5, 200)	4243	1337	0.0003	0.015	0.0041	0.014	0.034	29.417	0.035	28.472
	AR1-MA(5, 100)	2531	3049	0.0041	0.007	-0.0027	0.012	0.587	1.702	-0.225	-4.447
	AR2-MA(5, 100)	2531	939	0.0041	0.007	-0.0069	0.015	0.587	1.702	-0.448	-2.234
	AR4-MA(5, 100)	4641	939	0.0018	0.009	-0.0069	0.015	0.208	4.807	-0.448	-2.234
NASDAQ	MA(1, 50)	3546	2034	0.0009	0.011	-0.0004	0.018	0.081	12.412	-0.024	-41.099
	MA(1, 100)	3663	1917	0.0007	0.011	-0.0001	0.019	0.063	15.870	-0.008	-130.78
	MA(1, 150)	3877	1703	0.0006	0.011	0.0000	0.020	0.053	19.040	0.000	4541.77
	MA(1, 200)	3951	1629	0.0006	0.011	-0.0001	0.019	0.053	18.933	-0.004	-249.88
	MA(5, 50)	3545	2035	0.0007	0.011	-0.0002	0.018	0.067	15.037	-0.011	-93.889
	MA(5, 100)	3654	1926	0.0006	0.011	0.0000	0.019	0.056	17.774	-0.002	-645.32
	MA(5, 150)	3859	1721	0.0005	0.011	0.0001	0.019	0.049	20.442	0.004	262.121
	MA(5, 200)	3954	1626	0.0005	0.019	0.0051	0.019	0.045	21.989	0.004	233.408
	AR1-MA(5, 100)	2434	3146	0.0051	0.008	-0.0033	0.016	0.618	1.617	-0.202	-4.963
	AR2-MA(5, 100)	2434	1120	0.0051	0.008	-0.0087	0.017	0.618	1.617	-0.501	-1.995
	AR4-MA(5, 100)	4460	1120	0.0027	0.012	-0.0087	0.017	0.224	4.463	-0.501	-1.995

n_b , n_s , $\bar{x}_b$, $\bar{x}_s$, s_b , and s_s are the number of buy and sell days, the sample means and the standard deviations from buy and sell days, respectively.

Table 2 Descriptive statistics for returns for Buy and Sell-days,
data from 1/29/1985 to 5/31/2017

Index	Rules	n_b	n_s	$\bar{x}_b$	s_b	$\bar{x}_s$	s_s	$\bar{x}_b/s_b$	$s_b/\bar{x}_b$	$\bar{x}_s/s_s$	$s_s/\bar{x}_s$
DJIA	MA(1, 50)	5253	2698	0.0003	0.008	0.0005	0.015	0.030	33.109	0.033	30.408
	MA(1, 100)	5621	2330	0.0003	0.008	0.0005	0.016	0.032	30.973	0.031	31.788
	MA(1, 150)	5749	2202	0.0003	0.008	0.0006	0.017	0.031	32.253	0.033	30.110
	MA(1, 200)	5953	1998	0.0003	0.008	0.0004	0.017	0.037	26.832	0.025	40.195
	MA(5, 50)	5236	2715	0.0002	0.008	0.0006	0.015	0.024	41.691	0.039	25.353
	MA(5, 100)	5646	2305	0.0003	0.008	0.0005	0.016	0.032	31.128	0.031	32.017
	MA(5, 150)	5768	2183	0.0003	0.008	0.0006	0.016	0.030	33.589	0.035	28.973
	MA(5, 200)	5945	2006	0.0003	0.016	0.0041	0.016	0.030	32.964	0.033	30.334
	AR1-MA(5, 100)	3618	4333	0.0041	0.007	-0.0028	0.013	0.595	1.680	-0.213	-4.685
	AR2-MA(5, 100)	3618	1401	0.0041	0.007	-0.0075	0.016	0.595	1.680	-0.470	-2.126
	AR4-MA(5, 100)	6550	1401	0.0020	0.009	-0.0075	0.016	0.220	4.545	-0.470	-2.126
S&P 500	MA(1, 50)	5270	2681	0.0002	0.008	0.0005	0.016	0.026	38.212	0.031	31.835
	MA(1, 100)	5651	2300	0.0002	0.008	0.0005	0.017	0.029	34.715	0.029	34.130
	MA(1, 150)	5796	2155	0.0003	0.008	0.0003	0.017	0.037	26.699	0.018	54.522
	MA(1, 200)	5943	2008	0.0004	0.008	0.0002	0.018	0.043	23.098	0.010	104.296
	MA(5, 50)	5253	2698	0.0002	0.009	0.0005	0.016	0.025	39.333	0.032	31.217
	MA(5, 100)	5668	2283	0.0003	0.008	0.0004	0.017	0.032	31.528	0.025	39.238
	MA(5, 150)	5788	2163	0.0003	0.008	0.0002	0.017	0.041	24.570	0.014	73.333
	MA(5, 200)	5952	1999	0.0003	0.017	0.0040	0.017	0.037	26.762	0.015	68.246
	AR1-MA(5, 100)	3641	4310	0.0040	0.007	-0.0028	0.013	0.590	1.694	-0.211	-4.748
	AR2-MA(5, 100)	3641	1367	0.0040	0.007	-0.0078	0.016	0.590	1.694	-0.473	-2.116
	AR4-MA(5, 100)	6584	1367	0.0020	0.009	-0.0078	0.016	0.214	4.667	-0.473	-2.116
NASDAQ	MA(1, 50)	5148	2803	0.0007	0.010	-0.0002	0.019	0.067	15.028	-0.011	-92.826
	MA(1, 100)	5331	2620	0.0006	0.010	-0.0001	0.019	0.059	17.038	-0.004	-243.23
	MA(1, 150)	5598	2353	0.0005	0.010	0.0002	0.020	0.046	21.806	0.008	127.885
	MA(1, 200)	5661	2290	0.0005	0.011	0.0000	0.020	0.050	20.145	0.001	957.140
	MA(5, 50)	5145	2806	0.0006	0.011	0.0000	0.019	0.057	17.591	-0.001	-677.68
	MA(5, 100)	5333	2618	0.0006	0.011	0.0000	0.019	0.054	18.533	0.000	-3976.6
	MA(5, 150)	5585	2366	0.0005	0.010	0.0002	0.020	0.045	22.053	0.008	131.828
	MA(5, 200)	5667	2284	0.0005	0.020	0.0050	0.020	0.044	22.854	0.007	139.227
	AR1-MA(5, 100)	3562	4389	0.0050	0.008	-0.0033	0.016	0.614	1.627	-0.203	-4.922
	AR2-MA(5, 100)	3562	1530	0.0050	0.008	-0.0093	0.018	0.614	1.627	-0.519	-1.926
	AR4-MA(5, 100)	6421	1530	0.0027	0.012	-0.0093	0.018	0.227	4.404	-0.519	-1.926

n_b , n_s , $\bar{x}_b$, $\bar{x}_s$, s_b , and s_s are the number of buy and sell days, the sample means and the standard deviations from buy and sell days, respectively.

Table 3 Descriptive statistics for returns for Buy and Sell-days, sub-samples from 6/1/15 to 5/31/17

Index	Rules	n_b	n_s	$\bar{x}_b$	s_b	$\bar{x}_s$	s_s	$\bar{x}_b/s_b$	$s_b/\bar{x}_b$	$\bar{x}_s/s_s$	$s_s/\bar{x}_s$
DJIA	MA(1, 50)	1516	549	0.0005	0.009	0.0013	0.015	0.052	19.407	0.085	11.708
	MA(1, 100)	1612	453	0.0006	0.009	0.0012	0.016	0.059	16.810	0.074	13.474
	MA(1, 150)	1681	384	0.0004	0.009	0.0022	0.017	0.038	26.215	0.129	7.753
	MA(1, 200)	1700	365	0.0004	0.009	0.0019	0.017	0.048	20.948	0.108	9.281
	MA(5, 50)	1508	557	0.0005	0.009	0.0013	0.015	0.052	19.079	0.084	11.973
	MA(5, 100)	1621	444	0.0006	0.010	0.0012	0.016	0.058	17.358	0.078	12.808
	MA(5, 150)	1685	380	0.0005	0.010	0.0017	0.017	0.049	20.208	0.102	9.799
	MA(5, 200)	1704	361	0.0004	0.017	0.0046	0.017	0.046	21.911	0.114	8.747
	AR1-MA(5, 100)	1094	971	0.0046	0.008	-0.0037	0.013	0.604	1.655	-0.284	-3.518
	AR2-MA(5, 100)	1094	259	0.0046	0.008	-0.0086	0.015	0.604	1.655	-0.585	-1.709
	AR4-MA(5, 100)	1806	259	0.0020	0.010	-0.0086	0.015	0.205	4.878	-0.585	-1.709
S&P 500	MA(1, 50)	1483	582	0.0003	0.008	0.0012	0.014	0.033	29.853	0.090	11.095
	MA(1, 100)	1627	438	0.0003	0.008	0.0015	0.015	0.035	28.679	0.100	10.013
	MA(1, 150)	1687	378	0.0003	0.008	0.0016	0.017	0.040	25.003	0.094	10.599
	MA(1, 200)	1712	353	0.0003	0.008	0.0017	0.017	0.039	25.921	0.100	9.958
	MA(5, 50)	1483	582	0.0003	0.008	0.0012	0.014	0.033	30.540	0.092	10.899
	MA(5, 100)	1643	422	0.0004	0.008	0.0010	0.015	0.050	19.845	0.068	14.626
	MA(5, 150)	1689	376	0.0004	0.008	0.0014	0.016	0.044	22.772	0.086	11.632
	MA(5, 200)	1709	356	0.0004	0.016	0.0040	0.017	0.047	21.098	0.080	12.546
	AR1-MA(5, 100)	1091	974	0.0040	0.007	-0.0033	0.012	0.594	1.683	-0.277	-3.615
	AR2-MA(5, 100)	1091	262	0.0040	0.007	-0.0079	0.013	0.594	1.683	-0.596	-1.677
	AR4-MA(5, 100)	1803	262	0.0018	0.009	-0.0079	0.013	0.199	5.034	-0.596	-1.677
NASDAQ	MA(1, 50)	1479	586	0.0003	0.008	0.0011	0.012	0.037	27.179	0.085	11.783
	MA(1, 100)	1571	494	0.0003	0.008	0.0013	0.013	0.035	28.977	0.095	10.508
	MA(1, 150)	1672	393	0.0002	0.008	0.0017	0.015	0.030	33.065	0.114	8.748
	MA(1, 200)	1688	377	0.0003	0.007	0.0014	0.015	0.041	24.359	0.092	10.850
	MA(5, 50)	1469	596	0.0003	0.008	0.0010	0.012	0.038	26.174	0.082	12.163
	MA(5, 100)	1590	475	0.0003	0.008	0.0014	0.013	0.032	31.102	0.103	9.756
	MA(5, 150)	1692	373	0.0003	0.008	0.0016	0.014	0.033	30.380	0.113	8.837
	MA(5, 200)	1693	372	0.0002	0.014	0.0039	0.015	0.032	31.239	0.114	8.750
	AR1-MA(5, 100)	1030	1035	0.0039	0.006	-0.0028	0.011	0.617	1.621	-0.268	-3.735
	AR2-MA(5, 100)	1030	289	0.0039	0.006	-0.0071	0.012	0.617	1.621	-0.593	-1.686
	AR4-MA(5, 100)	1776	289	0.0017	0.008	-0.0071	0.012	0.211	4.732	-0.593	-1.686

n_b , n_s , $\bar{x}_b$, $\bar{x}_s$, s_b , and s_s are the number of buy and sell days, the sample means and the standard deviations from buy and sell days, respectively.

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