

Trading Performance Analysis: A Comparisons Between the Original MA Crossover and Modified MA Crossover Strategy

Afiruddin Tapa*

School of Economic, Finance and Banking, College of Business Universiti Utara Malaysia, Malaysia

Mohd Hasimi Yaacob

Faculty of Economics and Management, Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia

Ahmad Husni Hamzah

Universiti Sultan Zainal Abidin, Terengganu, Malaysia

Yean Soh Chuen

Universiti Utara Malaysia Kuala Lumpur, Malaysia

Abstract

This paper empirically analyses the Trading Performance by using technical analysis approach. The original moving-average (MA) crossover strategy as compare with the modified moving-average crossover strategy. The modified trading rules are the rules that been established to trading rules such as entry rule, exit rule, holding rule, and stop-loss rule. The results show The MAshort of 10-period for modified strategy underperform the original strategy, except for MA (10,100). The modified MA (20,200), (50,100), (50,200), and (100,200) underperform the original strategy. Only modified MA (20,50) and (20,100) outperform the original strategy. The outperformance and underperformance due to the stricter additional trading rule that reduces trading signals, and thus lower number of trades.

Keywords: Moving average crossover; Technical analysis; Trading strategies.



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1. Introduction

A crossover is the most basic type of signal and is favored among many traders because it removes all emotion. The most basic type of crossover is when the price of an asset moves from one side of a moving average and closes on the other. Price crossovers are used by traders to identify shifts in momentum and can be used as a basic entry or exit strategy. This strategy known as the most popular trend-following strategies and preferable among market practitioners, due to its simplicity in smoothing out market noise and able to identify changes in market trend. Financial practitioners have been using moving-average crossover trading rules for market timing for signal to buy or to sell securities.

Brock *et al.* (1992); LeBaron (1999); Neely *et al.* (2013); Wilcox and Crittenden (2009); Faber (2007); Zhu and Zhou (2009). They found that investment and trading based on the strategies of moving-average crossover has been able to generate higher return than the conventional simple buy-and-hold strategy. This study, analyzed the performance of original moving-average crossover trading strategy for securities in Malaysia. For modified moving-average crossover trading strategy, we have introduced several extra trading rules (entry rule, exit rule, stop-loss rule, holding rule) are added into the original MA crossover trading strategy and is tested whether it produce better risk-adjusted return than the original MA crossover trading strategy and the conventional simple buy-and-hold strategy.

Moving average is one of the tools in technical analyses and have attracted many researcher to study on this issue. The interest of academic literature in studying technical analysis of the financial market has been growing as some of the technical trading rules help investors to reduce massive losses during bear markets that happened in the 2000s, for example during the Dot-Com Bubble in 2001 and the global financial crisis in 2008 (Zakamulin, 2014).

Technical analysis has been applied for over a century by market practitioners, as a market-timing strategy. The first study on technical indicators on stock price time-series appeared in the 1930s explains correlation analysis. Until the 1960s, the development of "random walk" and "efficient market hypothesis (EMH)" framework suggesting that technical analysis at its weak form of efficient market, cannot earn above-average market return (excess return/alpha return) and disprove the value of analyzing historical prices to forecast future price movement in the market, refute trading rules and systems based on past prices. In other words, the use of technical analysis provides little to no value in examining past prices, as prices follows a random walk (there are randomness in prices) and there is no pattern in price movements.

There are several motivations for investors using technical analysis in their investment decision-making. One reason is that prices may not completely and rapidly reflect all available information in the market (i.e., prices may be reacting slowly towards new information). This signifies information inefficiency in the market. In the efficient

*Corresponding Author

market theory, information inefficiency can occur when market is other than strong-form (i.e., weak form and semi-strong form) which allows investors to earn excess return (alpha return). Another reason is the belief of technical analysis that market prices are largely determined by the trading activities that is unrelated to a rational analysis approach of underlying fundamental information. Therefore, technical trading strategies attempt to identify price patterns in trading activity on a timely basis that could be exploited for profit opportunities.

The core of technical analysis lays a belief where direction of future security prices can be predicted by using technical indicators derived from past historical prices. Among the most common presupposition is that security prices move in trends. So, the most widely used market-timing strategy is the trend-following strategy, where it attempts to follow the trend and ride on it.

The most popular strategy of trend-following strategy for market-timing is the moving-average crossover strategy. Among various technical indicators, the moving-averages predominantly show predictive power in the stock market where it matches or exceeds of those macroeconomic variables (Neely *et al.*, 2013). The use of moving-averages as market timing tool in making investment decision whether to buy, hold, or sell, is an active investment strategy that attempts to outperform the simple buy-and-hold passive strategy.

The problem with the original moving average crossover strategy does not incorporate risk-management approach in its existing strategy to manage its strategy downside risk, as it just only has entry and exit rule. The study tries to address the issue by adding additional technical trading rules to enhance the overall risk-adjusted return in the modified moving-average crossover strategy as compared to the original MA crossover strategy.

This study try to answer the question of does the modified MA crossover strategy by adding additional trading rules (entry rule, stop loss rule, holding rule) add any value in the trading system in enhancing trading performance? The objective of this study is to examine whether additional trading rules (entry rule, exit rule, stop-loss rule, and holding rule) in the MA crossover trading strategy enhance trading performance as compared to the original MA crossover strategy

2. Literature Review

Technical analysis is the use of past prices, volume and other statistical tools to make investment decisions. Technical analysis practitioners believe that data on past price and volume provide important and useful information in forecasting future price direction and movements in the financial market.

In reality, majority of the brokerage firms and investment advisory services publish commentary reports on the market using TA. Also, many asset management and trading firms practice some sort of technical trading strategies. Numerous technical indicators are employed in practice, such as candlestick chart patterns, levels of support and resistance, MA crossover strategies, relative-strength index (RSI), trading volume, and some other technical indicators developed using statistical and quantitative analysis. Practitioners utilize these technical tools in increasing their winning edge in making investment decisions to exploit profitable price patterns that results from repetitive behaviors in investors. Schwager (1995) discovers that many fund managers and top traders using TA. Also, Covel (2011) quotes examples of successful large hedge funds that extensively use technical analysis without having fundamental knowledge about the market.

Academics have long been skeptical regarding the practicality of TA, despite the popularity and adoption by market practitioners. Several reasons for academics doubt on the usefulness of technical analysis are: (1) early theoretical studies on random walk and efficient market models disregard excess return and profitability in technical trading (Cowles, 1933; Fama and Blume, 1966); (2) there is no theoretical basis on technical analysis being research; and (3) challenges in demonstrating the true effectiveness on technical trading rules mainly due to bias in data-snooping (Jegadeesh, 2000; Lo and MacKinlay, 1990; Sullivan *et al.*, 2003) where the same data set are frequently being used for model selection and implication. Thus, it is not astonishing that academics have yet to conclude the effectiveness of technical analysis.

Other past studies provide results that are consistent with the market efficiency through empirical testing that future price cannot be predicted by TA. For instance, the benefits of technical analysis A in generating excess return is offset when transaction costs are included (Bessembinder and Chan, 1995; Fama and Blume, 1966; Ready, 1997). Conversely, later on studies find that stock returns can be forecast by various economic models (Campbell, 1987; Fama and Schwert, 1977). Recent studies provide further proof on predictability of return using modern theoretical models (Campbell and Thompson, 2008; Cochrane, 2008). Hence, the stock return predictability allows the likelihood of profitable trading rules.

Even though with the contrary opinion in EMH, technical analysis is still being studied extensively by many researchers and market practitioners. Here, there are two philosophies that are contradictory with each other, the random walk efficient market theory and technical analysis. If practitioners' practice of technical analysis is based on hard fact, then it seems that the markets are inefficient. Otherwise, if the markets are informationally efficient, then it appears that the financial community is probably exhausting a huge sum of resources on TA.

Hypothetically, incomplete fundamental information is a major factor investor use TA. Brown and Jennings (1989) demonstrate that rational investors are able to make profit by establishing expectations from past prices. Besides that, Blume *et al.* (1994) confirm that investors who utilize market statistics have better performance than those who do not. It is in the circumstances of information insufficiencies, forecasting models that investors employ experiencing model uncertainty even though stock returns are fairly foreseeable.

Several researchers examine different technical trading rules and provide consistent result that technical analysis providing information beyond those that have already reflected in market price (Brock *et al.*, 1992; Lo *et al.*, 2000;

Neely *et al.*, 1997; Neftci, 1991). For example, Blume *et al.* (1994) show that if prices do not react instantly to new information, volume may provide information that is not available in the market.

Among many other studies, Brock *et al.* (1992), LeBaron (1999), and Neey (2002) show that using MA signals provides profitability and significant gain greater than stock indices. Wilcox and Crittenden (2009) also confirm that profitability on using TA. Besides that, MA strategies can also add value in asset allocation (Zhu and Zhou, 2009). Faber (2007) demonstrates that technical analysis enhances risk-adjusted return across several asset classes, especially the foreign exchange (forex) markets. While Gehrig and Menkhoff (2006) suggest that technical analysis is equally essential as fundamental analysis for forex traders. Most recent evidence discovered by Neely *et al.* (2013) on the value of technical analysis in predicting market risk-premium.

2.1. Trend-Following Strategy

The trend-following strategy is the popular investment style among CTAs, managed futures hedge funds, specific macro traders, and systematic quantitative investors for many decades (Ostgaard, 2008) Trend-following can be defined as buying (long) when price has been rising and selling (short) when price has been falling, with the foundation that price trends will likely to continue. In other words, go long when the underlying trend is positive, while short or cash-out when underlying trend is negative. The long and short signals can be generated using a variation of tools, for instance price breakouts and MA crossovers to determine price trend, whether for broad market indices or individual securities.

Several recent studies have found trend-following strategies to be profitable. Faber (2007) finds that using trend-following as a technical allocation strategy in market-timing can generate a portfolio with enhanced return (equity-level of returns) and greatly reduce risk (bond-level of volatility) comparing to the buy-and-hold strategy. As trend-following strategies are commonly based on rules, losers (losses) are cut short mechanically while winners (gains) are left to run. In which this is commonly contrary to investors' natural instincts. Several others examples of trend-following effectiveness are studied in equity markets (Wilcox and Crittenden, 2009) and commodity futures market (Hurst *et al.*, 2010; Szakmary *et al.*, 2010).

Brock *et al.* (1992) has studied the moving-average crossover system using MA (1,50; 1,150; 5,150; 1,200, and 2,200 days with 0 and 1% bands) and trading range breakout (using 50, 150 and 200 periods with 0 and 1% bands) across the sample period of 1897—1986 on the Dow Jones Industrial Average (DJIA), without adjusting transaction cost. They found that Long (Short) positions across the conditional MA trading rules generated higher (lower) average return consistently than the unconditional MA average returns. Other studies show consistent result when applied the same trading rule on stock index (Coutts and Cheng, 2000; Parisi and Vasquez, 2000; Qi and Wu, 2006); Gunasekarage and Power (2001) and foreign currency (LeBaron, 1999).

In short, the main purpose of MA is to determine or identify changes in new trend, or to identify the completion of an existing (old) trend. MA is used to “smoothen” market noise and facilitates in determining of a new trend. Also, the MA lags behind current market price. Shorter MA has little lags and it follows the market price closely but sensitive; longer MA is less sensitive and lags behind more than shorter MA. Thus, it would be stimulating to compare shorter and longer MA depending on its predictive power.

3. Research Methodology

3.1. Research Framework

This study examines the effectiveness of modified MA crossover trading systems as a better investment strategy than the conventional simple buy-and-hold and the original MA crossover strategy in enhancing investment performance, measured by trading performance analysis, which are the strategy's total net gain, risk-adjusted return (Sharpe ratio), skewness of return, and kurtosis. Particularly, the Modified moving-average crossover trading strategy with additional trading rules such as entry rule, exit rule, holding rule, and stop-loss rule are added onto the Original moving-average crossover trading strategy is studied. In addition, the variation and combination of short-MA and long-MA periods are tested to observe its strategy performance.

Trading strategies is a set of technical trading rules that enhances market-timing accuracy in decision making and improvement in investment return. The strategy performance is the net percentage gained or loss after an investor liquidates all holding position.

3.2. Simple Moving Average (SMA)

Computing the averages of recent prices is most likely the most common way for smoothing prices and filtering out “noise” or insignificant market fluctuation and movement. The MA is applied as a technical trading rule in developing the MA crossover trading system applied in this study. According to the MA is the simplest and most renowned smoothing technique of time-series analysis.

Moving average, MA (n) = Sum of n closing price / n

Where n = the number of time periods in moving average

3.3. Original Moving-Average Crossover Strategy

The original MA crossover rule is purely based on only entry point and exit point from the MA crossover of short-period MA and long-period MA. There is no stop-loss rule for cutting losses.

3.3.1. Entry Point

Entry point is the open (Buy/Long) position when entry signal is shown at the signal day's closing price.

Enter when $\text{Price}_{\text{current}} > \text{MA}_{\text{short}} > \text{MA}_{\text{long}}$.

No entry when $\text{MA}_{\text{short}} > \text{Price}_{\text{current}} > \text{MA}_{\text{long}}$ or $\text{MA}_{\text{short}} > \text{MA}_{\text{long}} > \text{Price}_{\text{current}}$.

3.3.2. Exit Point

Exit point is the close (Sell/Liquidate) position when exit signal is shown at the signal day's closing price.

Exit when $\text{Price}_{\text{current}} < \text{MA}_{\text{short}} < \text{MA}_{\text{long}}$.

No exit when $\text{MA}_{\text{short}} < \text{Price}_{\text{current}} < \text{MA}_{\text{long}}$ or $\text{MA}_{\text{short}} < \text{MA}_{\text{long}} < \text{Price}_{\text{current}}$.

3.4. Modified Moving-Average Crossover Strategy

The modified MA crossover rule is based on the original MA crossover rule (entry rule and exit rule) with some additional trading rules and criteria added with the intention to enhance its trading performance. The additional trading rules and criteria such as stop-loss rule, minimum holding period, no entry on narrow-range day, entry on white candlestick day, etc.

3.4.1. Entry Point

Here, the entry point is based on the original MA crossover strategy. Entry signal occurs when MA_{short} crosses MA_{long} from below, and the latest price is above both of such MA lines, therefore entry trade is made.

In additional to the original MA crossover strategy, the entry-point rule needs to satisfy the conditions described below:

Condition #1: The trading day must be a white candlestick (i.e., Closing price is higher than Opening price). If trading day is a black candlestick even if the original MA crossover rule is satisfied, no trade will be taken, I will wait until next buy signal occurs.

Condition #2: No entry is made if signal day is a narrow-range day or doji (i.e. the real body of candlestick is so narrow that it consist only of a horizontal line, in order words very thin range between the opening and closing price).

In other words, enter when $\text{Price}_{\text{current}}$ (is a white candle only, not narrow-range day or black candle) $> \text{MA}_{\text{short}} > \text{MA}_{\text{long}}$.

No entry when $\text{Price}_{\text{current}}$ is a black candle or narrow-range day or $\text{MA}_{\text{short}} > \text{Price}_{\text{current}} > \text{MA}_{\text{long}}$ or $\text{MA}_{\text{short}} > \text{MA}_{\text{long}} > \text{Price}_{\text{current}}$.

Exception: Gaps. A price gap is a blank or empty area on the chart that shows the low price above the prior day's high, or high price below the prior day's low. There are no specific criteria for trading on gaps.

3.4.2. Exit Point

Here, the exit point can be based on either three (3) conditions: (1) the original MA crossover strategy, (2) when price goes below stop-loss level, (3) when price is less than MA_{short} and MA_{long} for more than 10 days upon entry day, but above stop-loss level. When sell signal occurs, exit price would be on signal day's closing price.

Condition #1: For exit based on original MA crossover strategy, exit signal occurs when MA_{short} crosses MA_{long} from above, and the latest price is below both of such MA lines, thus exit trade is taken. In short, exit when $\text{Price}_{\text{current}} < \text{MA}_{\text{short}} < \text{MA}_{\text{long}}$.

No exit when $\text{MA}_{\text{short}} < \text{Price}_{\text{current}} < \text{MA}_{\text{long}}$ or $\text{MA}_{\text{short}} < \text{MA}_{\text{long}} < \text{Price}_{\text{current}}$.

Condition #2: For exit based on stop-loss, exit signal occurs when the current price goes below stop-loss level. Exit will be made on signal day when closing price is below stop-loss level. In other words, exit when $\text{Price}_{\text{current}} < \text{Stop-loss level}$.

Condition #3: Upon entry, there would be possibilities where sell signal in Condition #1 may occur or if price is less than MA_{short} and/or MA_{long} within or during 10 days after entry day, I will hold it for ten (10) consecutive trading period. Here I denote holding for $T + 10$.

If within $T + 10$, price goes below stop-loss level, I will follow Condition #2.

Otherwise, if on $T + 11$ (the eleventh trading period after entry day), I will follow strategy rule stated in Condition #1 on exiting the trade. In other words, if sell signal still exist on $T + 11$ (Condition #1: $\text{Price}_{\text{current}} < \text{MA}_{\text{short}} < \text{MA}_{\text{long}}$), I will exit the trade on $T + 11$ closing price. However, if the price on $T + 11$ do not fulfill Condition #1, I will hold the position until the next exit signal is generated following Condition #1 or Condition #2.

3.4.3. Stop-Loss

A stop-loss is a level or an order to Exit (Sell) a security at a specified price with an intention to limit a loss and preserve capital.

3.5. Hypothesis Development

Brock *et al.* (1992) have found that all 26 technical trading rules on DJIA (90 years data, 1894-1984) outperformed benchmark significantly. And later studies, LeBaron (1999), Maillet and Michel (2000) and Szakmary *et al.* (2010) also show result that is consistent where MA crossover trading rule produce higher return when compared to the simple buy-and-hold strategy.

Faber (2007) applying trend-following strategy for technical allocation in market-timing produced improve return (equity-level of returns) and significantly reduce risk (bond-level of volatility) benchmarking against the simple buy-and-hold strategy.

Covering 24,000+ securities across 22 years, showing empirical results that trend-following strategy on stocks offer positive mathematical expectancy in the long-term. Trend-following strategies also show above-average performance in the intermediate horizons in the commodity futures market (Hurst *et al.*, 2010; Szakmary *et al.*, 2010). Whereas using similar rules in investigating the US equity market, Shynkevich (2012) shows that technical trading strategies cannot outperform the simple buy-and-hold strategy. Based on the above discussion the following hypothesis is developed. Tapa *et al.* (2016) stated that majority combinations of short-MA and long-MA of the modified MA crossover strategy outperform market benchmark with higher risk-adjusted return H1: The modified MA crossover trading strategy performs higher or better than the original MA crossover trading strategy.

3.6. Data and Collection Method

The data series used in this study is the daily closing price of FBMKLCI index from first trading day in 2000 to the last trading day in 2014, a collection of 15-years of daily trading data, inclusive of open, high, low, close price of the FBMKLCI, to back-test the original and modified MA crossover trading strategy.

Secondary data on FBMKLCI historical daily prices is collected from the ChartNexus charting software. The calculation of the moving-average is set in the software algorithm. When the entry signal is generated, entry date, entry price, stop-loss level are recorded. When the exit signal is generated, exit date and exit price are recorded. A round-trip of an entry and an exit of the same position are considered as one trade.

4. Results and Findings

Table-1. Trading performance analysis for the MA_{short} 10-period original MA crossover strategy.

Strategy Type	MA	MA	MA	MA
	(10,20)	(10,50)	(10,100)	(10,200)
Total No. of Trades	63	29	17	13
% of Winning Trades	48%	59%	47%	54%
% of Losing Trades	52%	41%	53%	46%
Avg. Profit per trade (%)	6.34%	10.38%	19.24%	19.35%
Avg. Loss per trade (%)	-2.10%	-3.35%	-2.08%	-3.19%
Min. Loss	-0.08%	-0.42%	-0.11%	-0.31%
Max. Loss	-7.49%	-6.79%	-7.56%	-9.62%
Min. Gain	0.29%	0.67%	0.99%	1.64%
Max. Gain	32.10%	42.93%	40.43%	48.73%
Reward-to Risk Ratio	3.01	3.10	9.23	6.07
Total Strategy Return	189.28%	222.46%	225.60%	166.44%
Geometric Mean Return	1.70%	4.12%	6.08%	7.83%
Standard Deviation	6.97%	11.91%	12.98%	17.12%
Sharpe Ratio	0.24	0.35	0.47	0.46

All of the MA_{short} 10-period original MA crossover also generates higher total strategy return, higher risk-adjusted return and higher reward-to-risk ratio as compared to the simple buy-and-hold strategy (Table 1). All modified MA crossover strategy with MA_{short} 10-period crossover here is positively skewed to the right. MA (10,20) and (10,50) are leptokurtic; while MA (10,100) and (10,200) are platykurtic. Here, the MA (10,20) has lower return than MA (10,50) and (10,100). This is due to 10-period MA is closer to 20-period MA relative to longer 50-period and 100-period MA, generated frequent unprofitable crossover signals. This phenomenon happens as when the smoothing effect of the two close or near periods of MA (e.g., here 10-period and 20-period) would reduce the price gap (distance) of its MA lines.

Table-2. Trading performance analysis for the MA_{short} 20-period, 50-period, and 100-period original MA crossover strategy

Strategy Type	MA (20,50)	MA (20,100)	MA (20,200)	MA (50,100)	MA (50,200)	MA (100,200)
Total No. of Trades	27	17	13	14	9	9
% of Winning Trades	63%	65%	62%	64%	67%	67%
% of Losing Trades	37%	35%	38%	36%	33%	33%
Avg. Profit per trade (%)	10.23%	13.02%	15.24%	16.13%	18.59%	18.88%
Avg. Loss per trade (%)	-0.92%	-4.57%	-3.10%	-7.34%	-4.72%	-4.91%
Min. Loss	-1.60%	-2.19%	-0.06%	-0.30%	-1.66%	-2.3%
Max. Loss	-6.77%	-6.92%	-7.93%	-16.03%	-10.21%	-10.21%
Min. Gain	0.06%	0.22%	0.68%	0.43%	0.80%	2.22%
Max. Gain	39.90%	58.88%	48.94%	60.99%	38.36%	37.33%
Reward-to Risk Ratio	2.61	2.85	4.92	2.20	3.94	3.85
Total Strategy Return	221.65%	161.10%	148.48%	136.04%	130.08%	132.90%
Geometric Mean Return	4.42%	5.81%	7.25%	6.33%	9.70%	9.85%
Standard Deviation	11.68%	16.47%	15.71%	19.42%	17.06%	16.88%
Sharpe Ratio	0.38	0.35	0.46	0.33	0.57	0.58

Table 2 shows the original MA crossover strategy for the MA_{short} of 20-period, 50-period, and 100-period. All of them have also generated higher total strategy return, higher risk-adjusted return, and higher reward-to-risk ratio than the simple buy-and-hold strategy. Here, only MA (50,200) and (100,200) are close to symmetrically distributed. While the others are positively skewed to the right. MA (20,100), (20,200), and (50,100) are leptokurtic, whereas MA (20,50), (50,200), and (100,200) are platykurtic.

Based on the result when two long-period MA crossovers are used, the total strategy return drops significantly. The total strategy return starts to drop significantly from MA (20,100) onwards. As two longer-period MA crossovers are used, the total strategy return drops further, even though the Sharpe ratio is still high. This is due to the fact that as increase in period (longer period) used for MA smoothing, the variability of price movement and the slope (steepness) of the MA line would decrease (go flat). And therefore, the frequency of trading and signal generated are greatly reduced, so does the opportunity for profit is reduced as well.

Table-3. Trading performance analysis for the MA_{short} 10-period Modified MA crossover strategy.

Strategy Type	MA (10,20)	MA (10,50)	MA (10,100)	MA (10,200)
Total No. of Trades	59	17	18	15
% of Winning Trades	47%	47%	56%	40%
% of Losing Trades	53%	53%	44%	60%
Avg. Profit per trade (%)	5.90%	17.09%	14.94%	14.06%
Avg. Loss per trade (%)	-1.42%	-1.46%	-1.40%	-2.00%
Min. Loss	-0.19%	-0.52%	-0.22%	-0.59%
Max. Loss	-5.63%	-2.86%	-3.35%	-4.28%
Min. Gain	0.19%	1.92%	0.72%	1.64%
Max. Gain	32.10%	42.93%	40.43%	36.67%
Reward-to Risk Ratio	4.16	11.70	10.65	7.05
Total Strategy Return	134.10%	192.36%	237.28%	78.62%
Geometric Mean Return	1.45%	6.51%	6.99%	3.94%
Standard Deviation of Return	6.11%	13.88%	13.21%	11.01%
Sharpe Ratio	0.24	0.47	0.53	0.36

All of the modified MA crossover strategies for MA_{short} 10-period have generated higher total strategy return, higher risk-adjusted strategy returns, and higher reward-to-risk ratio, except for MA (10,200) underperformed, as compared to the simple buy-and-hold strategy (Table 3). Here, all are positively skewed, and are leptokurtic; except for MA (1,200) platykurtic.

Given that the MA (1,200) is the lowest performance among all other MA_{short} 1-period, because the MA smoothing effect for 200-period reduces trading opportunity and number of trades; in addition, with a MA_{short} of 10-period reduces the trading signal further. Therefore, MA (10,200) underperformed.

Table-4. Trading performance analysis for the MA_{short} 20-period, 50-period, and 100-period Modified MA crossover strategy.

Strategy Type	MA	MA	MA	MA	MA	MA
	(20,50)	(20,100)	(20,200)	(50,100)	(50,200)	(100,200)
Total No. of Trades	23	13	11	9	9	10
% of Winning Trades	48%	69%	45%	44%	44%	60%
% of Losing Trades	52%	31%	55%	56%	56%	40%
Avg. Profit per trade (%)	13.73%	15.41%	18.75%	20.36%	18.73%	16.92%
Avg. Loss per trade (%)	-1.50%	-1.73%	-1.28%	-0.4%	-2.78%	-1.82%
Min. Loss	-0.52%	-0.56%	-0.06%	-0.30%	-0.76%	-0.76%
Max. Loss	-3.69%	-2.99%	-3.78%	-1.57%	-8.35%	-3.01%
Min. Gain	0.58%	1.96%	0.68%	2.99%	0.80%	2.22%
Max. Gain	39.90%	58.88%	48.94%	60.99%	38.36%	37.33%
Reward-to Risk Ratio	9.18	8.89	14.65	21.65	6.74	9.30
Total Strategy Return	220.85%	208.43%	107.04%	86.96%	65.51%	127.32%
Geometric Mean Return	5.20%	9.05%	6.85%	7.20%	5.76%	8.56%
Standard Deviation	12.04%	17.44%	16.44%	20.10%	16.53%	15.06%
Sharpe Ratio	0.43	0.52	0.42	0.36	0.35	0.57

Table 4 shows mixed results for the modified MA crossover strategy. MA (20,50) and (20,100) produce higher total strategy return and higher risk-adjusted return. MA (20,200), (50,100), and (50,200) underperform, while MA (100,200) performance is slightly above than the simple buy-and-hold strategy. The underperformance is due to the stop-loss rule that closed out trades when price went below the stop-loss level. This could occur due to the following reasons: (1) stop-loss level that is too near the entry price that could not withstand a higher volatility in price movement, thus trades sometimes can be closed out too soon; (2) a whipsaw (price move in the opposite direction rapidly, and recovers back to its original trend).

Here, all MA crossovers are positively skewed to the right. MA (20,50), (50,200), and (100,200) are platykurtic, while MA (20,100), (20,200), (50,100) are leptokurtic.

Table 5. Comparison of trading performance analysis for the MA_{short} 10-period between the original and modified MA crossover strategy.

Strategy Type		MA	MA	MA	MA
		(10,20)	(10,50)	(10,100)	(10,200)
Total No. of Trades	Original	63	29	17	13
	Modified	59	17	18	15
% of Winning Trades	Original	48%	59%	47%	54%
	Modified	47%	47%	56%	40%
% of Losing Trades	Original	52%	41%	53%	46%
	Modified	53%	53%	44%	60%
Avg. Profit per trade (%)	Original	6.34%	10.38%	19.24%	19.35%
	Modified	5.90%	17.09%	14.94%	14.06%
Avg. Loss per trade (%)	Original	-2.10%	-3.35%	-2.08%	-3.19%
	Modified	-1.42%	-1.46%	-1.40%	-2.00%
Min. Loss	Original	-0.08%	-0.42%	-0.11%	-0.31%
	Modified	-0.19%	-0.52%	-0.22%	-0.59%
Max. Loss	Original	-7.49%	-6.79%	-7.56%	-9.62%
	Modified	-5.63%	-2.86%	-3.35%	-4.28%
Min. Gain	Original	0.29%	0.67%	0.99%	1.64%
	Modified	0.19%	1.92%	0.72%	1.64%
Max. Gain	Original	32.10%	42.93%	40.43%	48.73%
	Modified	32.10%	42.93%	40.43%	36.67%
Reward-to Risk Ratio	Original	3.01	3.10	9.23	6.07
	Modifie	4.16	11.70	10.65	7.05
Total Strategy Return	Original	189.28%	222.46%	225.60%	166.44%
	Modified	134.10%	192.36%	237.28%	78.62%
Geometric Mean Return	Original	1.70%	4.12%	6.08%	7.83%
	Modified	1.45%	6.51%	6.99%	3.94%
Standard Deviation	Original	6.97%	11.91%	12.98%	17.12%
	Modified	6.11%	13.88%	13.21%	11.01%
Sharpe Ratio	Original	0.24	0.35	0.47	0.46
	Modified	0.24	0.47	0.53	0.36

The MA_{short} of 10-period for modified strategy underperform the original strategy, except for MA (10,100). The minimum loss per trade for modified strategy is lower than the original strategy.

Table-6. Comparison of trading performance analysis for the MA_{short} 20-period, 50-period, and 100-period between the original and modified MA crossover strategy

Strategy Type		MA	MA	MA	MA	MA	MA
		(20,50)	(20,100)	(20,200)	(50,100)	(50,200)	(100,200)
Total No. of Trades	Original	27	17	13	14	9	9
	Modified	23	13	11	9	9	10
% of Winning Trades	Original	63%	65%	62%	64%	67%	67%
	Modified	48%	69%	45%	44%	44%	60%
% of Losing Trades	Original	37%	35%	38%	36%	33%	33%
	Modified	52%	31%	55%	56%	56%	40%
Avg. Profit per trade (%)	Original	10.23%	13.02%	15.24%	16.13%	18.59%	18.88%
	Modified	13.73%	15.41%	18.75%	20.36%	18.73%	16.92%
Avg. Loss per trade (%)	Original	-0.92%	-4.57%	-3.10%	-7.34%	-4.72%	-4.91%
	Modified	-1.50%	-1.73%	-1.28%	-0.94%	-2.78%	-1.82%
Min. Loss	Original	-1.60%	-2.19%	-0.06%	-0.30%	-1.66%	-2.23%
	Modified	-0.52%	-0.56%	-0.06%	-0.30%	-0.76%	-0.76%
Max. Loss	Original	-6.77%	-6.92%	-7.93%	-16.03%	-10.21%	-10.21%
	Modified	-3.69%	-2.99%	-3.78%	-1.57%	-8.35%	-3.01%
Min. Gain	Original	0.06%	0.22%	0.68%	0.43%	0.80%	2.22%
	Modified	0.58%	1.96%	0.68%	2.99%	0.80%	2.22%
Max. Gain	Original	39.90%	58.88%	48.94%	60.99%	38.36%	37.33%
	Modified	39.90%	58.88%	48.94%	60.99%	38.36%	37.33%
Reward-to Risk Ratio	Original	2.61	2.85	4.92	2.20	3.94	3.85
	Modified	9.18	8.89	14.65	21.65	6.74	9.30
Total Strategy Return	Original	221.65%	161.10%	148.48%	136.04%	130.08%	132.90%
	Modified	220.85%	208.43%	107.04%	86.96%	65.51%	127.32%
Geometric Mean Return	Original	4.42%	5.81%	7.25%	6.33%	9.70%	9.85%
	Modified	5.20%	9.05%	6.85%	7.20%	5.76%	8.56%
Standard Deviation	Original	11.68%	16.47%	15.71%	19.42%	17.06%	16.88%
	Modified	12.04%	17.44%	16.44%	20.10%	16.53%	15.06%
Sharpe Ratio	Original	0.38	0.35	0.46	0.33	0.57	0.58
	Modified	0.43	0.52	0.42	0.36	0.35	0.57

The modified MA (20,200), (50,100), (50,200), and (100,200) underperform the original strategy. Only modified MA (20,50) and (20,100) outperform the original strategy. The outperformance and underperformance due to the stricter additional trading rule that reduces trading signals, and thus lower number of trades. Especially the additional rule for entry buy signal (entry on white candle crossover, no entry on dark candle or narrow-ranged day), that has significantly filtered out and reduce the signal for buying opportunities when the original strategy shows. Whereas the 10-day holding rule has reduces number of trades especially during market sideways when sell signal is generated less than 10 trading periods. Also, this has increased the return on average per trade, and increase in the return volatility, especially when stop-loss is triggered below original sell signal strategy. The stop-loss rule has limited the downside loss as the maximum drawdown in the modified strategy is lesser than the original strategy, given the same amount of maximum gain.

5. Conclusion

Modified MA crossover strategy improve the strategy effectiveness with generate better strategy return, lower distribution of return variability and lesser trade than the original MA crossover strategy, mainly due to the additional trading rule applied to the original strategy; however, some modified MA crossover strategy show lower strategy return. The modified MA crossover strategy show mixed result. The additional rule for the modified MA crossover strategy do not show consistent result across all period of MA crossover, i.e., some outperform the original MA crossover strategy while some underperform. Among the modified MA crossover strategy that outperform are MA (10,100), (20,50) and (20,100); these show higher risk-adjusted return and as compared to the original MA crossover strategy, which signifies higher return with lower return variability. Contrary to the opinion of efficient market theorem stating that usage of historical prices and volume in technical analysis unable to outperform market benchmark, however, in this study, we have affirmed past researches that supports the proposition of employing trend-following strategies in enhancing investment returns.

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