Portfolio Size and Profitability of Moving Average Timing Strategy – A cross country comparison

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Abstract

Using popular technical trading rule of moving averages, this study documents the profitability of technical analysis for equal weighted random portfolios from Australian (ASX) and New Zealand (NZX) Stock Markets. The findings confirm prior evidence on the profitability of technical analysis for portfolio trading in relatively illiquid financial markets that are part of small open economies. This study contributes to the technical analysis literature regarding the number of stocks in a portfolio (hereafter "portfolio size") that a trader must hold to outperform a passive benchmark strategy. Precisely, the findings suggest that an investor can consistently outperform buy and hold strategy return by applying MA timing strategy to a portfolio that contains 80 or more random stocks.

Keywords: Moving average timing strategy, Portfolio size, Random portfolios

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1. Introduction

Portfolio trading is one of the most commonly used trading strategy in stock markets around the world. Owing to its popularity and effectiveness, the use of portfolio trading strategy is also very common in technical analysis literature. Han, Yang, and Zhou (2013) reports profitability of moving average (MA) rule for volatility decile portfolios; results from their study show that MA timing strategy returns outperform buy and hold strategy returns with consistency. Ko, Lin, Su, and Chang (2014) find that application of MA timing strategy on portfolios sorted by book to market ratio generate excess returns over buy and hold strategy. The results from these studies are robust after adjusting for transaction cost, business cycle effect, and alternative lag lengths of MAs. Researchers also emphasize the role of information uncertainty in stock returns as an important factor for the profitability of technical trading rules (TTRs). In their study, (Chen, Su, & Lin, 2016) document that MA strategy excess returns from stocks that do not issue stock options are higher than the stocks that issue stock options, they argue that these results are outcome of greater price consistency produced by information uncertainty.

Prior studies use firm and stock characteristics like return volatility, book to market ratios, information uncertainty, trading volume and other characteristics to form portfolios. Although, earlier studies report profitability of TTRs for portfolio trading, none of these studies focuses on the portfolio size that an investor must hold to outperform buy and hold benchmark. This paper introduces a novel approach of portfolio formation with the objective of portfolio size that an investor must hold to outperform buy and hold benchmark using MA timing strategy. In finance literature, portfolio size and return relationship long been discuss in context of portfolio diversification since (Markowitz, 1952) present modern portfolio theory. To the best of our knowledge none of the empirical study in technical analysis literature explore the size of portfolio that an investor should hold to outperform a passive benchmark. Thus, this is the major contribution of this study in technical analysis literature. We select NZX and ASX as these two financial markets share common characteristic of being part of small open economies. Additionally, both of these markets are relatively illiquid as compared to rest of the financial markets around the world.

The novel portfolio formation approach used in this paper is based on random selection of individual stocks to form equal weighted portfolios of different size using all alive stocks from NZX and ASX during January,1994-December, 2014 period. We start with 2 stocks and go up to 100 stocks to form a random portfolio. Once a random portfolio of specific size is formed, we calculate its buy and hold return and 10-day MA price. For a given random portfolio, the investment strategy is to purchase or continue to hold the random portfolio on a day when previous trading day's price is more than its 10-day MA portfolio price, and to invest the money into risk-free asset if previous trading day's price is below 10-day MA portfolio price. Alike, other technical analysis studies we calculate the profitability of MA timing strategy for a random portfolio by comparing the return of 10-day MA timing random portfolio with the returns on the corresponding random portfolio under buy and hold strategy. We perform 10,000 repetitions of this process for every portfolio size to validate randomness in stock selection and report average results in our analysis.

We find that random portfolios start to produce statistically significant excess return over buy and hold strategy for a portfolio size of 60 and 80 stocks for NZX and ASX respectively. The excess returns and their statistical significance

increase monotonically with increase in portfolio size above 60 and 80 stocks for NZX and ASX respectively. This is very noteworthy finding as knowing portfolio size that can outperform benchmark return is very important for an investor and for an active fund manager. In addition to increase in excess return, standard deviation of excess return dampens monotonically with increase of portfolio size. The excess returns for a portfolio size of 100 stocks are large enough to cover average transaction cost of 15 basis points for both ASX and NZX.

The rest of the paper is organized as follows: Section 2 presents data variables and their brief descriptive analysis. Section 3 presents detailed methodology for MA timing strategy using MA10 as trading signal and regression framework for determinants of MA timing strategy's profitability. Section 4 provides profitability evidence for MA10 timing strategy and analysis of MA10 timing strategy's profitability determinant. Finally, section 5 presents concluding remarks.

2. Data and descriptive statistics

This section present details of data variables and their descriptive statistics. We use daily data from New Zealand Stock Exchange (NZX) and Australian Securities Exchange (ASX) for the period from 03 January, 1994 to 30 December, 2016. All the data variables are extracted from Thomson Reuters DataStream. Daily data of total returns is used for 162 stocks from NZX and 1907 stocks from ASX, and Data Stream total return index for both NZX and ASX is used as a proxy for total market. Royal Bank of New Zealand (RBNZ) and Royal Bank of Australia 90-day bill rates are used as a proxy for risk free rate for NZX and ASX respectively. The daily return calculation for individual stocks and market indices is performed using following methods. Any daily return more than 300% is eliminated to avoid outlier bias.

$$R_{it} = \frac{Pt}{Pt-1} - 1 \qquad \textit{(Eq. I)}$$

Where;
R_{it} = *Return of stock/index at day t*
Pt = *price of stock at day t*
$Pt - 1$ = *Price of stock one trading day before day t*

2.1 Descriptive Statistics

Table I shows the descriptive statistics for data variables used in this study. Panel A and B presents annualized descriptive statistics for DataStream total market return, individual stock returns and risk-free rate returns for NZX and ASX respectively. Second column of panel A and B show annualized mean, standard deviation, minimum, maximum and Skewness of total market returns for NZX and ASX respectively. ASX DS-Market Index has relatively greater annualized mean return of 9.79% and annualized standard deviation of 15.31% as compared to NZX DS-Market index which has annual mean return of 8.26% and annualized standard deviation of 11.83%. Both market indices have negative skewness score which point towards data being negatively skewed. Third of Panel A and B present average results of individual stocks, like market index individual stocks' descriptive statistics also show higher return for ASX as compared to NZX. Average annualized mean of all 162 NZX stocks is 15.89% with standard

deviation of 47.85% whereas 1908 stocks of ASX have average mean of 31.10% and standard deviation of 89.30%. Greater standard deviation scores from individual stocks show that individual stocks are more risker as compared to market indices in both stock markets.

Last column of Panel A and B in table I presents descriptive statistics for risk-free rates. During the given data period from 03 January, 1994 to 30 December, 2016, 90-day T-bill rate of RBNZ has a mean of 5.303 with standard deviation of 2.25%, similarly 90-day dealer bill rate of RBA has a mean of 4.95% with standard deviation of 1.58%. These descriptive statistics clearly show that ASX present more return both on index and individual stock level as compared to NZX, on the contrary risk-free rate is higher for New Zealand market as compared to Australian market.

3. Methodology

This study uses (Han et al., 2013) methodology to capture the profitability of MA timing strategy in New Zealand and Australian equity markets. However, we introduce a novel approach of portfolio formation that is based on random stock selection strategy. Under random portfolio approach any number of random stocks are picked to form a portfolio i-e for a five stocks portfolio we pick five random stocks from total 165 stocks to form a portfolio of five stocks from NZX stocks, we repeat this procedure to form another portfolio of five randomly selected stocks. This approach is flexible and can be easily applied to a large number of random portfolios; this study uses 10,000 repetitions of such portfolios formation for strategy implementation. To observe the effect of portfolio size on profitability of MA timing strategy, we use 2, 3, 4, 5 ,10, 20, 40, 60, 80, and 100 stocks to form random portfolios. The portfolio returns are calculated using equal weighted method. The return for an equal weighted random portfolio under buy and hold strategy is calculated as under;

$$R_{xt} = \frac{R_{it}+R_{jt}+R_{kt}+ \ldots\ldots\ldots\ldots\ldots +R_{nt}}{n} \qquad \textit{(Eq. II)}$$

Where;
R_{xt} *= Return of equal weighted portfolio x at day t*
R_{it} *= Return of stock i at day t*
n = number of stocks in portfolio
t = A certain day

To apply MA rule, 10-day MA price is calculated using the return index of each portfolio. MA price formula is given as under;

$$x_{it,L} = \frac{P_{it-(L-1)}+P_{it-(L-2)}+ \ldots\ldots\ldots P_{it-1}+P_{it}}{L} \qquad \textit{(Eq. III)}$$

Where;
t = a certain trading day
L= lag length (10 days)
Pi = Price of stock i

MA rule is used to make investment decision, to invest in the market or invest in risk free securities. Buy signals are captured on the cross-over of last day stock price index and last ten days MA index; i-e if last day's stock price index

is higher than last ten days MA index, MA rule emit a buy signal otherwise MA rule emit a signal to invest in risk free security. The trading strategy is based on the notion that; if yesterday stock price (*Pt*) is greater than last ten days MA index (*X it, L*), the investor is in the market and earn market prevailing returns otherwise invest in treasury securities and earn risk free rate. Mathematically, this trading strategy can be stated as;

$$R_{it,L} = \begin{cases} Rjt & if \quad P_{jt-1} > X_{jt-1,L} \\ rft & otherwise \end{cases} \qquad (Eq.\ IV)$$

Where;
$R_{it,L}$ *= Return of a security/portfolio using MA strategy at day t*
P_{jt-1} *= Index price of stock/portfolio i one trading day before day t*
$X_{jt-1,L}$ *= MA price of stock/portfolio/index j one trading day before day t*
T *= a certain trading day*
rft *= Risk free rate at day t*

The excess returns are denoted by MAP, this is expressed as difference of MA timing strategy return and buy and hold return. It is expressed as;

$$MAP_{it,L} = R_{it,L} - R_{it} \qquad (Eq.\ V)$$

Where;
$MAP_{it,L}$ *= Excess return of MA timing strategy for stock/portfolio i day t*
$R_{it,L}$ *= MA return for stock/portfolio/index i at day t using lag length L*
R_{it} *= Buy and hold return for stock/portfolio/index at day t*

In addition to return calculations, we also calculate standard deviation, skewness, and Sharpe ratios for all portfolios to make results comprehensive and more easily comparable to each other.

4. Empirical Results

This section presents empirical results and their analysis, first we present profitability evidence for random portfolios of varying portfolio size.

4.1. Profitability of MA timing strategy in ASX and NZX

We test the profitability of MA timing strategy using random portfolios of different size ranging from 2 stocks to 100 stocks. We run 10,000 independent draws for each portfolio size and calculate mean, standard deviation, Sharpe and Skewness of each draw separately. Table II shows results of random portfolios formed using stocks from ASX. We show average results of all statistics calculated using results from 10,000 independent draws of each portfolio size. Panel A, B and C present summary statistics for buy and hold strategy return, MA10 strategy return and excess return for MA10 strategy over buy and hold strategy respectively. Results from table II show excess returns for MA strategy are negative and statistically significant until a random portfolio have 40 or less stocks, this shows MA strategy does produce enough return to outperform buy and hold strategy for a portfolio of 40 or less stocks. MA strategy start

producing positive returns when a random portfolio has 60 or more stocks yet it produces statistically significant positive returns only when random portfolio consists of 80 or more stocks. Standard deviation of excess returns also decreases monotonically with increase in portfolio size, ranging from 40.68% to 12.65% for 2 stocks and 100 stocks portfolios respectively.

Risk adjusted return represented by Sharpe measure produces negative score until a random portfolio has 80 or less stocks, nevertheless a random portfolio of 100 stocks produces positive risk adjusted returns. Similarly, Skewness score show a negative portfolio return tilt of excess return until a random portfolio has 20 or less stocks. Panel C of table II also show number of transactions that signifies the profitable opportunities for each portfolio size, results show a monotonic increase in number of profitable opportunities with increasing number of stock in a portfolio. Finally, we check whether excess profit withstand when we account of transaction cost, positive and monotonically increasing BETC for random portfolios of 40 stocks and more show strategy produces enough excess return to be profitable in presence of modest transaction cost. For a random portfolio of 80 stocks, strategy produces enough profit to cover BETC of 12.60 basis points.

Table III presents the results for random portfolios from NZX. Panel A, B and C present summary statistics for buy and hold strategy return, MA10 strategy return and excess return for MA10 strategy over buy and hold strategy respectively. Excess return presented in panel C show MA10 strategy produces statistically negative excess return over buy and hold strategy until a random portfolio has 5 or less stocks. Although, strategy starts to produce positive excess returns when portfolio size reaches 40 or more stocks but statistically strong excess returns are only observed when a portfolio has 80 or more stocks. Standard deviation of excess returns decreases monotonically with increase in portfolio size ranging from 30.66% to 7.08% for 2 stocks portfolio and 100 stocks portfolio respectively. Risk adjusted returns presented by Sharpe measure also show positive returns for 100 stocks portfolio. Negative skewness scores for smaller portfolios show a negative tilt in excess returns whereas positive skewness scores for larger portfolios show shift in excess return from negative to positive.

Last two columns of panel C show number of transactions and BETC for a specific portfolio size. Number of transactions increase monotonically with increase in portfolio size, this shows presence of greater profitable opportunities when a portfolio has larger number of stocks. Double digit BETC for 80 or more stocks portfolios show these portfolios produces enough excess returns to cover double digit transaction costs.

The results from table II and III show MA timing strategy can produce consistent and statistically significant excess returns for a portfolio size of 80 or more random stocks. Additionally, risk adjusted excess returns produced by these random portfolios are also positive and excess returns are robust when transaction cost is considered. This is a very noteworthy finding because of three reasons; first, knowing portfolio size is very important for an investor because an investor can make proper allocation of funds given his/her financing constraints. Second, random selection of stocks allow investor to select diverse set of stocks without sticking to some specific characteristics like firm size, firm type (growth or value), return volatility etc. Finally, and most importantly no empirical work in technical analysis literature present such finding about portfolio size and profitability of technical analysis.

5. Conclusion

In this paper, we document the profitability of MA timing strategy using 10-day MA rule for random portfolios from NZX and ASX stock markets. Random portfolios are formed using a novel portfolio formation approach that is based on random selection of stocks every time we form a portfolio. The objective of this approach is to find portfolio size that an investor should hold to outperform a passive benchmark by applying MA timing strategy. We find that MA timing successfully outperform buy and hold strategy when a portfolio is formed using 60 or more random stocks in case of NZX and 80 or more random stocks in case of ASX. Random portfolios generate enough excess returns to cover an average transaction cost of 15 basis points when portfolio size reaches 100 random stocks for both stock markets. This is a very important finding as knowing portfolio size that can outperform passive benchmark is very crucial for an active investor.

Overall, this paper provides an important finding about portfolio size and profitability of MA timing strategy. Portfolio formation approach used in the study can be further extended into more liquid and relatively more connected financial markets. Further, an extension into other securities like mutual funds can also provide exciting new findings.

Appendix

Table I – Descriptive Statistics for Data variables			
Panel A -			
Statistic	NZX DS-Market	Individual stocks	90-day T-bill
Mean	8.26	15.89	5.303
Standard Deviation	11.83	47.85	2.252
Min	-31.15	-98.51	1.68
Max	24.96	300	10.15
Skewness	-0.63	0.61	0.082
Panel B – ASX			
Statistic	ASX DS-Market	Individual stocks	90-day Dealer-bill
Mean	9.79	31.10	4.95
Standard Deviation	15.31	89.30	1.58
Min	-21.56	-100	1.71
Max	15.46	300	8.64
Skewness	-0.33	2.76	-0.13
Note: Table I presents annualized descriptive statistics for NZX and ASX DataStream-market index returns, individual stocks' average returns and risk-free returns.			

Table II - Descriptive statistics for equal weighted random portfolio returns from ASX

	Panel A				*Panel B*				*Panel C*					
	Buy and hold				MA 10				MAP					
No. of stocks	Grand Mean	Grand SD	Grand Sharpe	Grand Skew	Grand Mean	Grand SD	Grand Sharpe	Grand Skew	Grand Mean	Grand SD	Grand Sharpe	Grand Skew	Grand NT	Grand BETC
2	10.19	68.68	0.11	0.61	-24.17***	34.88	-17.45	0.65	-36.11***	40.68	-9.42	-0.65	138	-72.36
3	11.08	62.71	0.12	0.60	-24.39***	34.21	-12.64	0.50	-36.55***	39.95	-7.31	-0.79	212	-71.82
4	11.77	58.39	0.14	0.60	-23.64***	34.30	-11.18	0.53	-35.78***	39.43	-6.14	-0.79	280	-68.61
5	12.15	54.00	0.15	0.58	-19.08***	32.31	-26.23	0.55	-31.49***	36.78	-13.68	-0.81	354	-61.24
10	12.75	42.87	0.19	0.49	-9.85***	27.19	-9.56	0.41	-22.32***	30.04	-5.45	-0.69	642	-42.78
20	12.87***	32.23	0.25	0.29	0.65***	21.55	-12.54	0.37	-11.96***	23.06	-7.63	-0.38	925	-22.35
40	12.88***	23.88	0.33	-0.02	9.83****	16.35	-1.05	0.32	-2.78***	17.25	-1.16	0.31	1007	-5.68
60	12.89***	20.31	0.39	-0.27	14.19***	13.84	0.29	0.29	1.53	14.80	-0.23	0.86	976	3.93
80	12.91***	18.36	0.44	-0.48	16.83***	12.39	0.91	0.27	4.16***	13.49	-0.11	1.31	940	10.39
100	12.92***	17.07	0.46	-0.65	18.64***	11.41	1.20	0.25	5.97***	12.65	0.08	1.67	908	15.32

Note: Table II Panel A reports average statistics of equal weighted random portfolios (EWRP) for buy and hold strategy returns, Panel B present MA10 strategy returns and Panel C presents excess returns for MA10 strategy over buy and hold strategy. Statistics for number of transaction and BETC is also included in last two columns of Panel C. Here, Grand Mean equals mean of all EWRP means, Grand SD is average of standard deviations of all EWRP standard deviations, Grand Sharpe is average of all EWRP Sharpe scores, Grand skewness is average of all EWRP portfolio Skewness scores. Grand NT is average of number of transaction for all EWRP, Grand BETC is average BETC for all EWRP portfolios. *** and ** represent significance level at 1% and 5% respectively.

Table III - Descriptive statistics for equal weighted random portfolio returns from NZX

	Panel A				*Panel B*				*Panel C*					
No. of stocks	Buy and hold				MA 10				MAP					
	Grand Mean	Grand SD	Grand Sharpe	Grand Skew	Grand Mean	Grand SD	Grand Sharpe	Grand Skew	Grand Mean	Grand SD	Grand Sharpe	Grand Skew	Grand NT	Grand BETC
2	7.29	36.96	0.14	0.24	-7.37	24.25	-0.36	0.012	-13.69***	30.66	-0.68	-0.22	281	-7.95
3	7.44	33.87	0.14	0.17	-6.35	22.79	-0.33	-0.06	-13.23***	28.13	-0.69	-0.29	416	-1.28
4	7.65**	31.46	0.14	0.12	-4.65	21.40	-0.29	-0.05	-11.32***	25.93	-0.68	-0.28	512	-0.55
5	7.77**	29.22	0.14	0.06	-3.22	20.14	-0.27	-0.05	-9.90**	23.93	-0.68	-0.28	603	-0.25
10	7.81***	22.87	0.15	-0.02	1.18	15.82	-0.14	-0.01	-5.94	17.53	-0.67	-0.22	864	-4.09
20	7.73**	17.02	0.17	-0.07	5.64***	11.75	0.09	0.07	-1.89	12.39	-0.58	0.06	969	-2.59
40	7.71***	12.87	0.20	-0.16	9.28***	8.81	0.48	0.22	1.70	9.33	-0.38	0.49	943	4.32
60	7.75***	11.13	0.22	-0.27	11.17***	7.54	0.79	0.29	3.55**	8.13	-0.21	0.83	908	9.11
80	7.74***	10.17	0.24	-0.38	12.38***	6.82	1.04	0.32	4.77***	7.49	-0.07	1.09	877	12.60
100	7.72***	9.55	0.25	-0.47	13.16***	6.35	1.24	0.33	5.57***	7.08	0.03	1.29	852	15.11

Note: Table III Panel A reports average statistics of equal weighted random portfolios (EWRP) for buy and hold strategy returns, Panel B present MA10 strategy returns and Panel C presents excess returns for MA10 strategy over buy and hold strategy. Statistics for number of transaction and BETC is also included in last two columns of Panel C. Here, Grand Mean equals mean of all EWRP means, Grand SD is average of standard deviations of all EWRP standard deviations, Grand Sharpe is average of all EWRP Sharpe scores, Grand skewness is average of all EWRP portfolio Skewness scores. Grand NT is average of number of transaction for all EWRP, Grand BETC is average BETC for all EWRP portfolios. *** and ** represent significance level at 1% and 5% respectively.

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