THE ACCURACY OF SIMPLE TRADING RULES IN STOCK MARKETS

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Abstract

Previous researches on the S&P 500 Index using the most widely used method of technical analysis – Moving Averages are more or less appellative. Most of research results were obtained testing MA behaviour in weak-form efficiency markets, trying to find relationship between historical and future prices, to survey normal and abnormal returns. This paper compares Standard and Poor’s 500 (S&P 500) Index (US) to the 6 another indexes: NASDAQ Index (US), Nikkei 225 Index (Japan), CAC 40 Index (France), FTSE 100 Index (UK), SCEC Index (Shanghai), RTS Index (Russia) with the respect that the Technical Analysis methods can be less effective than it was thought until nowadays. For 14942 daily observations of S&P 500 and other tested Indexes, test results imply that Moving Average method is inadequate to predict the direction of prices’ movement. The method provides slightly different forecasting results than the real prices are. The results let make prerequisite for different lengths Moving Averages sustaining different systematic errors methods and the results accuracy can be characterized by deviation.

Keywords: Technical Analysis, Moving Average, Stock Price, MA Length, Forecast Accuracy, Systematic Error.

Introduction

The finance crisis of 2009 was the result of people belief that the ownership value rises and never decreases. Traders and investors use different methods trying to predict future stock prices and expect high returns. Technical analysis always posed an interesting question for the Moving Average method efficiency. Technical analysts argue that prices gradually adjust to new information. The moving average method (MA) is one of the most used methods of technical analysis. This method involves a comparison of the market prices or index with the long MA. Most of MA research results were obtained testing MA behaviour in weak-form efficiency markets, trying to find relationship between historical and future prices, to survey normal and abnormal returns. So the main point of this paper is to determine whether MA method is proper to predict stock prices in different stock markets, examine methods for trend forecast accuracy evaluation and assess relationship between MA length and error types (Mean Square Error, Mean Forecast Error and Mean Absolute Percentage Error). The first stage research has to accept or refuse such hypothesis as whether Moving Average method is appropriate to forecast stock prices and to find out the forecasting accuracy; which MA (short or long) provide more correct forecast results; whether MA behaviour is the same in different stock markets. In the second phase of varying degrees of accuracy (with a margin of error from 1 to 15 %) it can be seen how different lengths of Moving Average guess the price. The purpose of third phase is to evaluate errors. All boosted hypothesis can be refused while testing stock markets.

The organization of this paper is as follows. Section I provides a brief review of the relevant information. Section II describes the research data. Section III presents methodology and the Moving Average method. Section IV discusses the empirical results of this study. The last section contains a brief summary and conclusions.

Literature review

The moving average (MA) method is one of the most widely used methods of technical analysis. It includes different versions and levels of sophistication. The MA method is easy to use and apply in investment decision-making or empirical tests (BenZion et al., 2003.) Edwards and Magee (1992), Myers (1989), Pring (1993) describe technical analysis as a technique which uses the patterns of the price history of a financial instrument in order to provide indications on the future behaviour of prices.

Technical analysis consists of different methods with a common set of basic principles and is the main alternative to fundamental analysis which strives to assess the true value of financial instruments. Significant return from technical analysis, even in conjunction with valuation methods, trends to argue against the efficient market hypothesis. Consequently, there is a close link between validity of technical analysis and the inefficiency of the market (Caginalp & Balenovic, 2003).

Technical analysis history starts with the belief that the historical price information does not reflect new prices (Ellinger, 1955, republished in 1971; Lo, Mamaysky and Wang, 2000). In contrast BenZion et al.
(2003) observed that prices gradually adjust to new information. Cootner (1961) tested 45 NYSE stocks using weekly data for estimating moving average and found that the variance of the trading rules approximately 30% less than that of the “buy-and-hold” (B&H) strategy. Lo and MacKainly (1988, 1999) demonstrated for a weekly U.S. Stock indexes that historical prices may be used to forecast future returns to some degree. Seasonal effects in international developed equity markets were discovered by Cadsby and Ratner (1992) while Agrawal and Tandom (1994) and Agrawal and Rivoli (1989) identify seasonality in emerging markets.

Brock et al. (1992) reviewed the literature and concluded that most of simple trading rules have found no statistical validity. They test the hypothesis of the moving average trading rule that consists of a buy signal when the price moves above a particular moving average and a sell signal when the price crosses below the average. Using the data set of the Dow Jones average for several decades, they found almost no net gain for using either the buy or the sell signal. Scientifically testing all three day reversal patterns discussed in Morris (1992), on a 265,000 day data set of daily open, close, high, low for each of the S&P 500 stocks for a five year period, they found significant predictive power. However, a recent study by Blume et al. (1994) explores technical analysis as a component of agents’ learning process. They focused only on the information role of volume and conclude that sequences of volume and price can be informative and argue that traders who use information contained in the market statistics attain a competitive advantage. Hudson, Dempsey and Keasey (1996) employ 60 years of daily returns from the Financial Times 30 Index on the London International Stock Exchange. They conclude that long-term B&H strategies exclude the possibility of abnormal returns. Ito (1999) used the same trading technical system as Brock et al. (1992) testing 6 national equity markets. The obtained results suggested that the profit fairly compensates the risk of trading rules. Taylor (2000) reviewed 6 indexes using daily data. The technical trading system he has selected was short and long moving averages. He realized that differences of mean returns between buy and sell positions were mainly positive. Coutts & Cheung (2000) conclude that all tested trading rules generate buy or sell signals which mean returns are significantly higher or lower than unconditional mean returns. Skouras (2001) analyzed Dow Jones industrial Average stock market and found that time-varying estimated rules outperformed various fixed moving average rules employed by Brock et al. (1992) as well as the B&H strategy. When the market is bullish or bearish, technical trading rules perform better or worse than trading strategies based on some time-series models. Authors who have tested trading rules on developed markets outside the US generally also find that the profits generated do not offset transaction costs (Marshall et al. 2009). Caginalp, G., Balenovich, D. (2003) state that to technical analysts the failures are not surprising.

Data description

The technical sample trading rules can be calculated at different data frequencies (Table 1).

<table>
<thead>
<tr>
<th>Period</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>From</td>
<td>To</td>
</tr>
<tr>
<td>S&amp;P 500</td>
<td>1950.01.03</td>
</tr>
<tr>
<td>NASDAQ</td>
<td>1971.02.05</td>
</tr>
<tr>
<td>Nikkei 225</td>
<td>1984.01.04</td>
</tr>
<tr>
<td>CAC 40</td>
<td>1990.03.01</td>
</tr>
<tr>
<td>FTSE 100</td>
<td>1984.04.02</td>
</tr>
<tr>
<td>SCEC</td>
<td>2000.01.04</td>
</tr>
<tr>
<td>RTS</td>
<td>2007.10.18</td>
</tr>
</tbody>
</table>

In this research we use daily data and our sample includes stock market close prices of 7 indexes: US - S&P 500 and NASDAQ; Europe - FTSE 100, CAC 40, RTS; Asia - Nikkei 225 and Shanghai Composite. The indexes were tested in national currency. Information on local daily prices was found on the stock market’s respective web sites. We source data for different periods, because we have tested all indexes since they had been appeared until the 22nd of May, 2009 because these indicate the first daily data which is available. Japan market is most risky and this proposition is based on standard deviation – 6420.46 while US markets S&P 500 and NASDAQ are the least risky – respectively 443.88 and 955.89. The daily data of
indicated periods provide a sufficient number of daily observations to allow for the formation review and investigation of the technical sample trading rules.

**Methodology**

The Technical Analysis is characterized by a large number of rules and indicators committed to identify and explain the regularity of historical prices dynamics. Such type of the relationship can be used to forecast future prices trends. The time for transactions and best prices can be also set using forecasting methods in Technical Analysis.

This paper is focused on the one of Technical Analysis indicators - simple moving average (SMA) rule and the possibility to use this method for prices and their trends forecasting was tested. The methodology disassociates from particular buy-and-sell strategies and specific rules applications.

The research was conducted in three mains stages. The first stage was to determine whether it is appropriate to use Moving Average method for the market price trend forecast. The second stage of this research was to appoint how different length Moving Averages can predict the future prices with a margin of error of 1 to 15%. The third stage was to estimate bias.

A1. For the hypotheses validation or refutation the first stage of the research was resolved into 3 levels. In order to determine whether it is appropriate to use the MA indicator for the prices trend forecast S&P 500 (US Stock market) Index was tested. Moving averages indicators were calculated using S&P 500 Index close prices:

\[
MA = \frac{\sum_{i=1}^{n} Y_t}{n}
\]  

where \( \sum_{i=1}^{n} Y_t \) is the sum of the prices for the time period \( n \). As well it was valuated whether the real prices trends match the forecasts of prices trends and the percentage of prediction was justified.

A2. In order to determine whether some Moving Average lengths usage for the prices trend prediction is superior to other, MA indicator was tested 499 times testing different MA length: \( n = 2, 3, 4, 5, ..., 500 \).

A3. In order to appoint whether in different stock markets research results differ A1 and A2 researches were made additionally in 6 stock markets using 6 indexes daily close prices data (see Table 3).

B. The second stage was to determine what the average value of prices forecast reliability is estimating a different precision level. S&P 500 Index was tested for this purpose calculating the separate lengths of Moving Average (2-500) and the percentage of all forecasted series level with the bias of 1, 2, 5, 10 and 15%.

C. The third stage of the research helped to determine the bias of Moving Average method usage. Mean Square Error (MSE). Forasmuch any error is being raised with the square, so this way highlights the significant error values. This feature is quite significant because forecasting methods with approximations of bias are frequently more suitable than the method which gives not only negligible errors but significant.

\[
MSE = \frac{\sum (F_t - Y_t)^2}{n}
\]  

Mean Forecast Error (MFE). Very often it is very important to estimate whether the forecast method has a systematic error id est the present forecast value is always major (or minor) than time series value. In this case the mean forecast error is being used. If the systematic bias does not exist the MFE value will be equal zero. If the forecast value is signally negative the forecast method overestimates trend series. If the systematic bias is signally positive the forecast method generates major values then time series.

\[
MFE = \sum (F_t - Y_t)
\]  

The Mean Absolute Percentage Error (MAPE) is useful when assessing the forecast error an important factor is the estimated value. MAPE estimates the size of bias comparing with time series values. This fact is very important when the times series value is quite large.

\[
MAPE = \frac{1}{n} \sum \left| \frac{F_t - Y_t}{Y_t} \right|
\]  

This stage of the research assessed the relationship among MA lengths and mentioned bias types. All 499 Moving averages were tested using 7 Indexes daily data identifying the relationship.

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Empirical results

A. All three hypotheses boosted in the study beginning were refused and the following findings were made.

A1. The usage of Simple Moving Average for the stock market prices trend forecasting is not reasonable and valid. The trend forecast accuracy level fluctuates from 45.63% in NASDAQ market to 52.53% in SSE market. No one of the successful trend forecasted values averages exceeds 49.00% level. The prediction accuracy is not sufficient for the successful forecast of stock prices trend transformation (Table 2).

Table 2. Trend Forecast Accuracy (%)

<table>
<thead>
<tr>
<th></th>
<th>CAC40</th>
<th>NASDAQ</th>
<th>RTS</th>
<th>NIKKEI 225</th>
<th>FTSE</th>
<th>SCEC</th>
<th>S&amp;P 500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min value</td>
<td>47.53</td>
<td>42.61</td>
<td>42.98</td>
<td>47.18</td>
<td>47.90</td>
<td>44.33</td>
<td>46.15</td>
</tr>
<tr>
<td>Max value</td>
<td>50.93</td>
<td>45.63</td>
<td>48.13</td>
<td>50.55</td>
<td>50.47</td>
<td>52.53</td>
<td>48.57</td>
</tr>
<tr>
<td>Average value</td>
<td>48.27</td>
<td>44.92</td>
<td>44.19</td>
<td>47.77</td>
<td>48.63</td>
<td>46.34</td>
<td>47.50</td>
</tr>
</tbody>
</table>

A2. This paper researched whether some Moving Average lengths are superior to other assessing them using forecast accuracy estimation method. The study claims that superior Moving Average lengths do not exist because the stock prices trend forecast accuracy level of all Moving average lengths is approximately the same. However it was noticed during the research that MA length has some influence on the trend forecast accuracy: the longer Moving Average provides the lower trend forecast accuracy level. But this tendency may be valid only in some separate markets.

A3. These study findings were confirmed in all tested markets so significant results margins were not found.

B. The usage of the Moving Average method for stock market close prices forecast delivered slightly different results. For example, the Fig. 1 shows S&P 500 Index forecasting results using Moving Average method. It represents the relationship between the successful prices forecast number with the error of 0, 1, 2, 5, 10 and 15% and Moving Average length.

Figure 1. The S&P 500 Index forecasts

The example illustrates that the usage of Moving Average method for price forecasting in absolute terms provides better results than the usage of this method just for the stock prices trend forecast. The shorter Moving Average can forecast more accurate price value. So the investors or researchers can select desirable bias level. It should be noted that in separate markets Moving Average method provides different results (Fig. 2).
In assessing, the average prediction accuracy values can be assumed that significant prediction accuracy of the MA method is only available with 10 or more percent of acceptable error level, and only in predicting the S&P 500 and the Nikkei Index and SCEC Index changes. In other markets, forecasting results are much worse, even with a 15% margin of error.

C. The evaluation of the relationship between Moving Average length, MSE, MFE and MAPE bias was made.

C1. For specific time series separate Moving Average lengths differ by forecast accuracy level. This demonstrates MSE values. In particular markets this indicator provides lower or higher bias level. The average value of MSE in Nikkei 225 stock market is only 6.6626 (Table 3). It means that the difference between real and forecasted prices is not significant and the lowest among all tested Indexes. Contrarily MSE of SCEC Index forecasted values are characterized by large swings – from 942308.8207 till 133386543.2826. Although the market is not very risky (st. deviation is 3302.2776) comparing with other markets. The forecasted values are unvalued and overvalued worst in this market. Wherewith the MA longer, ipso facto Mean Square Error value is higher. This tendency dominates in all markets. So it means that the longer Moving Average generates more inaccurate value \( F_t \). Moving Average length has influence on MSE values from 96.33% (CAC 40) till 99.90% (NASDAQ).

Table 3. Statistical Error Estimates and Successful Forecast Ratio

<table>
<thead>
<tr>
<th></th>
<th>CAC40</th>
<th>NASDAQ</th>
<th>RTS</th>
<th>NIKKEI 225</th>
<th>FTSE</th>
<th>SCEC</th>
<th>S&amp;P 500</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSE</td>
<td>99.90%</td>
<td>96.33%</td>
<td>99.34%</td>
<td>99.82%</td>
<td>99.51%</td>
<td>99.80%</td>
<td>99.63%</td>
</tr>
<tr>
<td>MFE</td>
<td>-99.53%</td>
<td>-86.50%</td>
<td>-98.64%</td>
<td>-94.62%</td>
<td>-99.55%</td>
<td>96.67%</td>
<td>-99.53%</td>
</tr>
<tr>
<td>MAPE</td>
<td>99.33%</td>
<td>99.45%</td>
<td>92.26%</td>
<td>98.83%</td>
<td>99.02%</td>
<td>99.33%</td>
<td>95.55%</td>
</tr>
<tr>
<td>Mean Square Error (MSE) evaluation</td>
<td>308073.1579</td>
<td>71897.4896</td>
<td>249255.6201</td>
<td>6.6626</td>
<td>169648.4561</td>
<td>11496576.5650</td>
<td>4028.1015</td>
</tr>
<tr>
<td></td>
<td>214012.1568</td>
<td>44591.5902</td>
<td>156777.2788</td>
<td>4.1886</td>
<td>109742.4647</td>
<td>1004292.9821</td>
<td>2671.1267</td>
</tr>
<tr>
<td>Min</td>
<td>3359.7926</td>
<td>830.4858</td>
<td>1590.6361</td>
<td>0.1080</td>
<td>2922.3989</td>
<td>9642308.8207</td>
<td>57.8769</td>
</tr>
<tr>
<td>Max</td>
<td>712584.4353</td>
<td>147952.2135</td>
<td>501431.6931</td>
<td>14.3779</td>
<td>379259.5275</td>
<td>13386543.2826</td>
<td>8950.7291</td>
</tr>
<tr>
<td>Mean Forecast Error (MFE) evaluation</td>
<td>-47.7383</td>
<td>-22.4560</td>
<td>-43.0339</td>
<td>0.0325</td>
<td>-69.3814</td>
<td>-31.7481</td>
<td>-8.2061</td>
</tr>
<tr>
<td></td>
<td>35.6131</td>
<td>14.3807</td>
<td>33.7585</td>
<td>0.0162</td>
<td>44.2034</td>
<td>28.4945</td>
<td>5.3371</td>
</tr>
<tr>
<td>Min</td>
<td>-120.7753</td>
<td>-50.0346</td>
<td>-92.5964</td>
<td>0.0002</td>
<td>-153.5735</td>
<td>-117.7126</td>
<td>-18.4122</td>
</tr>
<tr>
<td>Max</td>
<td>-0.4248</td>
<td>-0.2473</td>
<td>-1.2614</td>
<td>0.0509</td>
<td>-0.7700</td>
<td>-0.7369</td>
<td>-0.0874</td>
</tr>
<tr>
<td>Mean Absolute Percentage Error (MAPE) evaluation</td>
<td>0.1051</td>
<td>0.1378</td>
<td>0.3590</td>
<td>0.1159</td>
<td>0.0761</td>
<td>0.1678</td>
<td>0.0634</td>
</tr>
<tr>
<td></td>
<td>0.0474</td>
<td>0.0603</td>
<td>0.1652</td>
<td>0.0470</td>
<td>0.0294</td>
<td>0.0562</td>
<td>0.0407</td>
</tr>
<tr>
<td>Min</td>
<td>0.0114</td>
<td>0.0097</td>
<td>0.0205</td>
<td>0.0130</td>
<td>0.0089</td>
<td>0.0552</td>
<td>0.0003</td>
</tr>
<tr>
<td>Max</td>
<td>0.5104</td>
<td>0.2311</td>
<td>0.5864</td>
<td>0.1869</td>
<td>0.1181</td>
<td>0.2576</td>
<td>0.1139</td>
</tr>
<tr>
<td>Successful Forecast Ratio</td>
<td>0.47%</td>
<td>0.82%</td>
<td>2.89%</td>
<td>0.29%</td>
<td>0.28%</td>
<td>17.91%</td>
<td>17.89%</td>
</tr>
</tbody>
</table>
C2. Trying to determine whether the selected forecast method – Sample Moving Average – has a systematic bias the Mean Forecasting Error was evaluated. Inasmuch the MSE value of Nikkei 225 Index forecast is 0.0509 and is nearby 0, and then the systematic bias does not exist. There are some negative average values of MSE in tested markets: CAC (-47.7383), FTSE (-69.3814) which indicate that in French and UK stock markets the forecasted stock prices values are being overvalued. It comes to a conclusion that in all markets except Nikkei 225 high systematic errors exist trying to predict the stock prices using Moving average method. This method is linked to provide overvalued forecasted prices. The longer Moving average influences MFE lower value. This regularity is valid for all markets except Nikkei 225.Moving method usage in Japanese stock market (Nikkei 225) provides the lowest values of MFE. Moving Average length is a consequence of 96.67 % MFE values. \( F_t \) forecast value is higher than the real price \( Y_t \) is on this day in Japanese markets and conversely in all another markets the forecasted value \( F_t \) is lower than the real price \( Y_t \).

C3. Since the time series values are quite high, the MAPE was assessed. This method highlights a part of systematic error comparing with the whole time series. The significant segment – 35.90% meanly – exists in RTS stock market using Moving Average method. The MAPE values in other markets swing among 6.34% and 16.78%. The longer average of MA influences the higher the average absolute relative error MAPE. This trend is confirmed in all markets, only the degree of precision varies from 92.26% to 99.83%.

C4. Trying to determine the percentage ratio between “successful” forecast number and the sample it was proved that Sample Moving Average method stands only predicting values of some particular markets and this ratio is quite low. The successful forecast values number with the error 0.0000 was the highest in Shanghai Composite stock market and S&P 500 stock market. The higher successful forecast number is the highest in S&P 500 market (17.89 %) and SCEC market (17.91 %). In the other markets the ratio sings between 0.29 % (Nikkei 225 Index) and 2.89 % (RTS Index). In CAC 40, NASDAQ, Nikkei 225 and FTSE 100 stock markets this ration does not reach even 1 %. So the study results imply that Moving Average method can generate significant forecast value errors and deviations from real prices and is not successful in price movement trend generation.

**Discussion and conclusion**

This paper examines the Moving Average method usage in different stock market and its forecast accuracy. Previous research on S&P 500 did not tested trend forecast accuracy.

The Moving Average method is a type of Technical Analysis. For market indexes it involves the comparison of short (1 day or index by itself) and long moving averages.

The data in this research consist of daily closing prices of 7 indexes: Standard and Poor’s 500 (S&P 500) Index (US) to the 6 another indexes: NASDAQ Index (US), Nikkei 225 Index (Japan), CAC 40 Index (France), FTSE 100 Index (UK), SCEC Index (Shanghai), RTS Index (Russia). Transaction costs and investment strategies are not involved into this study.

Starting with trend forecast accuracy the findings of this paper suggest that MA method is not useful trying to predict the price movement trend. There are no exceptional MA lengths which can provide more accurate results – more than 49 % meanly. For specific time series separate Moving Average lengths differ by forecast accuracy level. The forecast values are unvalued and overvalued worst in SCEC market Wherewith the MA longer, ipso facto Mean Square Error value is higher. This tendency dominates in all markets. The longer Moving average influences MFE lower value. This regularity is valid for all markets except Nikkei 225.Moving method usage in Japanese stock market (Nikkei 225) provides the lowest values of MFE. The longer average of MA influences the higher the average absolute relative error MAPE.

The successful forecast values number with the error 0.0000 was the highest in Shanghai Composite stock market and S&P 500 stock market. The higher successful forecast number is the highest in S&P 500 market (17.89 %) and SCEC market (17.91 %).

Accomplished research shows that MA method can not predict the price movement trends. The method provides slightly different forecasting results than the real prices are. The results let make prerequisite for different lengths Moving averages sustaining different systematic errors methods and the results accuracy can be characterized by deviation. So the study results imply that Moving Average method can generate significant forecast value errors and deviations from real prices and is not successful in price movement trend generation.
References