Emprirical Investigations into the effectiveness of Technical Analysis Techniques in Singapore Stock Market and America Stock Markets

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Summary

Technical Analysis is one of the many investment strategies that professional investors and amateur investors use to invest. It is considered to be simple to apply and easy to understand as opposed to statistical models and fundamental analysis which requires proper training to apply properly. In a working paper from National University of Singapore (Wong et al, 2002), it is discovered that technical analysis techniques such as moving averages and relative strength index are very effective in generating good returns from the stock market. However, in that particular working paper, only moving average and relative strength index are used and compared. In this paper, we seek to expand the number of technical analysis techniques which are objective in nature and attempt to compare their overall effectiveness in the context of Singapore stock market and American stock market. A new method of testing the effectiveness of the techniques will be proposed in this paper. A review of the original test statistics used in Wong et al (2002) will also be done.

Introduction

Maximizing the overall return from any investments has always been the main aim of investors regardless of their background, race and belief. This strong motivation results in a proliferation of techniques to maximize returns from investments. The stock market is one of the many investment instruments which people can purchase and well within the reach of amateur investors. The fantastic return for several periods of the stock markets make it extremely attractive for investors and speculators alike. This fervent interest in maximizing returns from stock market results in many academic research and working papers written on the various techniques of stock trading. The results from all these papers gave rise to the 2 main schools of investment, namely the technical analysis school and fundamental analysis school. During my specialization modules period, many of my lecturers have indicated that this school is either useful or useless. While they have demonstrated the theoretical reasons for their stands, there were no direct empirical investigations into the effectiveness of these techniques. In this paper, we will focus on evaluation of the technical analysis school.

Background leading to this paper

During the investment management module, the lecturer mentioned the use of technical analysis as a possible way of making money in the stock market or any form of market which are price dependent and subjected to massive market forces. While the efficient market hypothesis indicates that such strategies will not be able to produce any return above the
market, it is however disputable. This is because the market may not necessarily be efficient in a way for technical analysis to fail. However, I was not entirely convinced that we can beat the market. As the module went on, he demonstrated some of the more interesting technical analysis techniques which are not often seen in active use. However, as the module was too focused on the technical aspects of various instruments, we did not go in depth on the discussion of the technical analysis.

In the international finance module, the topic of technical analysis was again brought up as one of the many techniques that can be used to predict the market movements of futures, options and other financial instruments. He further elaborated on the topic by showing some trend lines and simple approaches on the estimation of prices. But the derivatives are usually traded by banks as opposed to individuals. Thus, it will be interesting to see whether individuals can make money by following simple technical analysis techniques.

The strategic financial planning module demonstrated the fundamental analysis approach to company valuations which leads to equity valuations. In the module, it show us the difficulties in estimating the value of a company by combing through huge amount of accounting data and estimating continuing values. However, this approach is time consuming and takes considerable skills and efforts in order to achieve an accurate result. This prompts me to search for an alternative way of predicting the prices of stocks of companies. In my search, I came across a working paper by Assoc Prof Wong of NUS economics department which investigates the usefulness of technical analysis in Singapore market. Based on this paper, I was inspired to do further research into the subject on other markets and also an expanded group of technical analysis techniques.

**Background of technical analysis**

Technical analysis uses certain price indicators of the stock market to facilitate the buy and sell decisions. The techniques require the user to look for patterns in the market which would either signal a buy or sell situation. There are even proponents of this school who advocate the use of market psychology to determine the buy and sell price. To facilitate an objective comparison of various techniques, only techniques which are widely established as good technical analysis techniques whose use does not over rely on the judgment of the user.

Before we can start using technical analysis in the stock market, it is important to note the various assumptions of the techniques.

1. Market Action Discounts Everything.
2. Prices Move in Trend.
3. History repeats itself

The first assumption implies that the stock market does not extract information from events other than itself. This assumption also implies that the price of the stock contains all the information that it needs to price itself. The second assumption implies that the movement in stock market tends to occur in sequence. Thus a lower closing price today is more likely to results in a lower closing price tomorrow, conversely, a higher price today will lead to a
higher price tomorrow. This assumption also implies that the ups and downs of the stock prices can be easily identified by observing the movement of the stock markets. The last assumption implies that the market repeats itself over and over again. This assumption also implies that the best way to maximize your return is to identify the stock that has the potential and highest probability to be the next Microsoft or Yahoo!.

While these assumptions often draw criticisms and are at odds with the efficient market hypothesis, the results from technical analysis seems to indicate that the assumptions are not necessarily wrong. According to Irwin (2008), many research have indicated that it is possible to generate positive returns through the use of technical analysis. Thus for this paper, we will accept the basic assumptions and not to go into in depth discussion about their accuracy and relevance.

Technical Analysis Techniques

Accumulation/Distribution index

The accumulation/distribution index is the measure that is first proposed by Marc Chaikin which uses stock prices together with stock volume to detect trends. The divergence in the measure indicates either a long or a short situation. If the closing price is nearer to the high, it indicates that there are more people who are buying, and if the closing price is nearer to the low, it indicates that there are more selling. This provides useful information to signal the beginning or the end of a bull run. The formula for this techniques is given as below,

\[
ADI = \frac{\text{Close} - \text{Open}}{\text{High} - \text{Low}} \times \text{Volume} \quad (1)
\]

Where Close refers to the closing price, Open refers to the opening price, High refers to intra day high and Low refers to intra day low. The volume refers to volume of the stock traded. In the event that the opening price is not available, the following formula will be used,

\[
ADI = \frac{\text{Close} - \text{Low} - (\text{High} - \text{Close})}{\text{High} - \text{Low}} \times \text{Volume} \quad (2)
\]

To use of the accumulation/distribution index, we will need to examine whether there are more people buying in or selling out. If there are plenty of people who are buying, then it implies a recovery. Conversely, if there are plenty of people who are selling, then it signals a drop.

Average True Range

Average True Range is a technical analysis indicator proposed by J.Welles Wilder based on the trading ranges smoothed by an N-day exponential moving average.

The intra day trading range is simply high – low. The meaning of True Range is to extend the range by incorporating information from the previous day. The information that is
incorporated is the previous day closing range. Thus the formula for True Range is as follow,

\[ \text{TrueRange} = \max (\text{High}, \text{Close}_{\text{previous}}) - \max (\text{Low}, \text{Close}_{\text{previous}}) \]  

To obtain the Average True Range, a moving average is then constructed with a recommended period of 14 (Wilder, 1978). The Average True Range is designed to do 2 things, the first is to design a stop loss scenario and the other one is the use it to predict the turning point of stock market. The second purpose is achieved by observing the highest ATR which indicates the beginning of a upward trend.

**Bollinger bands**

Bollinger bands are developed by John Bollinger in 1980s as a form of control chart which indicates the upper and lower limits which the stock fluctuates between. The idea behind the bands is to construct a control chart which to compare the highs and lows in relative terms. Bollinger bands formulas are shown below,

\[ \text{MiddleBand} = 20\text{daysmovingaverage} \]  
\[ \text{UpperBand} = \text{MiddleBand} + 2 \times \text{StandardDev.} \]  
\[ \text{LowerBand} = \text{MiddleBand} - 2 \times \text{StandardDev.} \]

While there have much misuse of the Bollinger band as a form of signals tool, it is developed to understand how high or low the current prices were as compared with the past. Thus to apply this techniques, we require some form of measures to indicate the signals.

\[ \text{BandWidth} = \frac{(\text{UpperBollingerBand} - \text{LowerBollingerBand})}{\text{MiddleBollingerBand}} \]

The band width measure is use as sign of volatility. This measure is then used in conjunction with Relative Strength Index for predicting the next move in the stock market.

**Commodity Channel Index**

The commodity channel index is developed by Donald Lambert in 1990. It is a form of oscillator which is useful for the detection of cyclical trend. The formula (Wikipedia, 2008) for the calculation of the index is as below,

\[ CCI = \frac{1}{0.015} \frac{p_t - SMA(p_t)}{\sigma(p_t)} \]

It is similar to Bollinger charts in its construction. If the CCI is above 100, it indicates that the stock is now overbought. However, if the CCI is below -100, it indicates that the stock is now under bought. However, it does not by itself indicates whether the stock should be sold or purchased. Thus it is common for the index to used with other indicators. Bollinger, in his book, combined CCI with the use of RSI to determine the buy and sell signal.
Coppock indicator

Coppock indicator is a technical analysis tool which helps to identify the beginning of a bull run through the use of rate of change and moving average. It is developed by Edward Coppock and published in 1962. The original formula is designed for monthly data and is shown below,

\[ \text{Coppock} = WMA[10] \text{of} (ROC[14] + ROC[11]) \]  \hspace{1cm} (9)

However, to use the Coppock indicator for daily data, we have to change the period to 294 days and 231 day with a 210 day weighted moving average. The indicator is designed to only detect the reversal of trend for buy signal and not sell signal. To generate the sell signal, it is necessary to identify the combination of high price and low Coppock indicator value. This divergence in value indicates the beginning of a bear market.

Moving Average Convergence/Divergence

MACD is developed in the 1960s by Gerald Appel. The concept behind MACD is to find the difference between a fast exponential moving average and a slow exponential moving average. The points of intersection between the 2 exponential moving averages indicate the buy and sell signals depending on individual interpretation.

The formula (Wikipedia, 2008) suggested by Gerald Appel in 1960s are the 12 days and 26 days exponential moving averages difference which is formulated as below.

\[ MACD = EMA[12] \text{ of price} - EMA[26] \text{ of price} \]  \hspace{1cm} (10)

A trigger line is also constructed by the use of an additional 9 days exponential moving average on the MACD which is suggested by Gerald Appel. The formula (Wikipedia, 2008) is shown below,

\[ signal = EMA[9] \text{ of MACD} \]  \hspace{1cm} (11)

To determine the weight for use in MACD, the following formula (Wikipedia, 2008) is used to determine the weighting.

\[ \alpha = \frac{2}{N + 1} \]  \hspace{1cm} (12)
The above 3 formula forms the basis for MACD investment strategy. There are a few implementations of the above MACD with varying rules. The two implementations that will be used in this case are the pure MACD method and the MACD-signal method.

The pure MACD has only 2 rules for trading.
1. If 12 periods EMA goes above 26 periods EMA, the rule is to buy.
2. If 12 periods EMA goes below 26 periods EMA, the rule is to sell.

The MACD-signal method has 2 rules for trading.
1. If MACD goes above signal line, the rule is to buy.
2. If MACD goes below signal line, the rule is to sell.

**Momentum**

Momentum or rate of change is another technical analysis indicator used to identify opportunity to buy and sell. It has the simplest formula among the indicators. The formula for momentum is as shown,

\[ \text{momentum} = \text{close}_{\text{today}} - \text{close}_{N \text{ days ago}} \]  

(13)

While the formula for rate of change is shown as below,

\[ \text{rate of change} = \frac{\text{close}_{\text{today}} - \text{close}_{N \text{ days ago}}}{\text{close}_{N \text{ days ago}}} \]  

(14)

To use the indicators to generate buy and sell signal, we use the following rules,

**Momentum rule/Rate of Change rule**
1. If the momentum/rate of change changes from zero to positive, then there is a buy signal.
2. If the momentum/rate of change changes from zero to negative, then there is a sell signal.

**Money Flow**

Money Flow is another technical analysis indicator which is similar in construct to the Relative Strength Index. It is an indicator which attempts to calculate the dollar value of the day and the index identifies the percentage of days where the money flow is positive and negative. To calculate money flow, we have to obtain the typical price first. The formula is shown below,
The money flow of the day is then calculated as below,

\[ \text{money flow} = \text{typical price} \times \text{volume} \]  

To use money flow to generate buy and sell signals, we will have to calculate the totals of the money flow over \( N \) days. Positive money flows are those days where the money flow is total for those days where the typical price is higher than the previous day's typical price, and negative money flow where below. If typical price is unchanged then that day is discarded. The money ratio is then generated using the formula below,

\[ \text{money ratio} = \frac{\text{positive money flow}}{\text{negative money flow}} \]

Using the money ratio, we then convert the ratio into an index (Money flow index),

\[ MFI = 100 - \frac{100}{1 + \text{money ratio}} \]

The Money flow index is then used as an oscillator. If the index value is greater then 80, the stock is over bought, while an index value lower than 20 indicates an under sold situation.

**Moving Average**

Moving average is one of the more popular technical analysis indicators. Its construct is simple and a 10 days simple moving average is shown as below,

\[ \text{SMA} = \frac{p_M + p_{M-1} + \cdots + p_{M-9}}{10} \]

The most common application of moving averages to the stock is by applying 2 different moving averages with different time period and use the intersections of the 2 moving averages to generate the buy and sell signals. This application is the same as moving average convergence/divergence techniques. The method of generating buy and sell signal in Wong et al (2002) uses simpler rules.

Rules for using MA to generate buy and sell signals (Wong et al, 2002)

1. If the close price moves above the moving average, buy signal generated.
2. If the close price moves below the moving average, sell signal generated.
In this paper, we will be using the rules as defined by Wong et al. (2002) so as to conduct a meaningful comparison in terms of techniques' effectiveness.

**Pivot Point**

Pivot point calculation uses information from the stock market to generate resistance and support levels. The formulas to calculate the various levels are shown below,

\[
PivotPoint = \frac{(High + Close + Low)}{3} \quad (20)
\]

\[
Resistance_1 = (2 \times Pivot) - Low \quad (21)
\]

\[
Resistance_2 = Pivot + (High - Low) \quad (22)
\]

\[
Resistance_3 = High + 2 \times (Pivot - Low) \quad (23)
\]

\[
Support_1 = (2 \times Pivot) - High \quad (24)
\]

\[
Support_2 = Pivot - (High - Low) \quad (25)
\]

\[
Support_3 = Low - 2 \times (High - Pivot) \quad (26)
\]

To use the pivot points for trading, it is necessary to understand which are the more important levels to note and use. For resistance and support levels 2 to 3, if the stock price actually moves above or under them, it indicates that the stock has been either over sold or under bought. In either situations, they are strong indicators which would suggest either an entry or exit position. The more common use of pivot point involves the use of pivot point with support level 1 and resistance level 1. If the opening price of the day is above the pivot point, then it is likely that the price will be above the pivot point until it hits resistance level 1. Conversely, if the opening price of the day is below the pivot point, then it is likely that the price will be below the pivot point until it hits the support level 1. Thus if the opening price is below pivot point, we will initiate a short sell until the price hits the support level 1 in which we will cover the short selling. If the opening price is above the pivot point, we will initiate a long buy until it hits the resistance level 1 in which we will sell the stocks away.

The pivot point method is unusual in the sense that it gives indication for buy and sell opportunities for both long and short position. Most of the other techniques do not incorporate short positions.

**Relative Strength Index**

The relative strength index is the other common measure used in technical analysis. It is first developed by J. Welles Wilder in 1978 in his book *New Concepts in Technical Trading Systems*. The index attempts to measure how much of the stock is being sold and thus
whether the stock is oversold or undersold. The method is slightly more complicated than MACD but it is still relatively simple.

The method first calculates the upward change (denoted by U) and the downward change (denoted by D)

Let \( \text{Change} = \text{Close(today)} - \text{Close(yesterday)} \)

1. If \( \text{Change} > 0 \) then \( D = 0 \) and \( U = \text{Change} \)
2. If \( \text{Change} < 0 \) then \( D = \text{Change} \) and \( U = 0 \)
3. If \( \text{Change} = 0 \) then \( D = 0 \) and \( U = 0 \)

After we have calculated the values of U and D, we will then calculated the average U and D through the use of exponential moving average. After we have calculated the moving averages, we then calculate the relative strength by using the formula given below,

\[
RS = \frac{EMA[N] \text{ of } U}{EMA[N] \text{ of } D} \tag{27}
\]

The relative strength index is then calculated using the formula below.

\[
RSI = 100 - 100 \times \frac{1}{1 + RS} \tag{28}
\]

The suggested smoothing period is 27 days which using formula (27) will yield a smoothing period of 14. The rules to using the RSI are much simpler than MACD. If the RSI goes above the upper limit, then the stock is undersold and over bought. Conversely, if the RSI goes below the lower limit, then the stock is oversold and under bought. To summarize the implementation, below is the rule table for implementation.

Rule for RSI:
1. If \( RSI > \text{upper limits} \), sell the stock.
2. If \( RSI < \text{lower limits} \), buy the stock.
3. If lower limits < \( RSI < \text{upper limits} \), hold the stock.

With RSI, we have reached the end of our brief discussion of technical analysis techniques. As in Wong et al (2002), we will now move towards our selections of stocks from the various stock exchanges to ensure we obtain a representative portfolio of stocks on which we can apply the techniques and test whether the returns are significantly different from the market and which technique is the most effective.

**Data**

Due to the limitations of resource on the part of the author, the data for the various stock markets will be obtained from Yahoo! Finance section which is freely available for download as a csv file.
However it must be noted that the data set may not be complete in part due to missing information. This is especially the case for volume of stocks traded. This missing data will restrict the number of usable techniques which rely on the presence of volume to function properly. In the light of such problems, and to maximize the amount of data which is available for use, technical analysis techniques which rely on the use of stock volume will not be used in this case. It must be noted that most of the technical analysis techniques rely more heavily on the prices than volume.

Below we will discuss the stocks that we have selected in terms of their background. The stocks are selected from American Stock exchanges and also Singapore Stock Exchanges. A total of 12 stocks from 4 different fields are selected from each stock exchange. The 4 fields selected are namely, finance, manufacturing, commodities and transport.

**Stocks**

<table>
<thead>
<tr>
<th>Name of the company</th>
<th>Field</th>
<th>Stock exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great Eastern Holdings Ltd</td>
<td>Finance</td>
<td>Singapore Stock Exchange</td>
</tr>
<tr>
<td>Hong Leong Finance</td>
<td>Finance</td>
<td>Singapore Stock Exchange</td>
</tr>
<tr>
<td>DBS Group Holding Ltd</td>
<td>Finance</td>
<td>Singapore Stock Exchange</td>
</tr>
<tr>
<td>Asia Pacific Breweries</td>
<td>Manufacturing</td>
<td>Singapore Stock Exchange</td>
</tr>
<tr>
<td>Adampak Ltd</td>
<td>Manufacturing</td>
<td>Singapore Stock Exchange</td>
</tr>
<tr>
<td>Creative Technology Ltd</td>
<td>Manufacturing</td>
<td>Singapore Stock Exchange</td>
</tr>
<tr>
<td>Asia Power Corp Ltd</td>
<td>Commodities</td>
<td>Singapore Stock Exchange</td>
</tr>
<tr>
<td>City Spring infrastructure</td>
<td>Commodities</td>
<td>Singapore Stock Exchange</td>
</tr>
<tr>
<td>SP Ausnet</td>
<td>Commodities</td>
<td>Singapore Stock Exchange</td>
</tr>
<tr>
<td>Poh Tiong Choon Logistics</td>
<td>Transport and Logistics</td>
<td>Singapore Stock Exchange</td>
</tr>
<tr>
<td>Neptune Orient Lines</td>
<td>Transport and Logistics</td>
<td>Singapore Stock Exchange</td>
</tr>
<tr>
<td>Chuan Hup Holdings Limited</td>
<td>Transport and Logistics</td>
<td>Singapore Stock Exchange</td>
</tr>
<tr>
<td>Manulife Financial Corporation</td>
<td>Finance</td>
<td>American Stock Exchanges</td>
</tr>
<tr>
<td>Citigroup Inc.</td>
<td>Finance</td>
<td>American Stock Exchanges</td>
</tr>
<tr>
<td>JPMorgan Chase &amp; Co.</td>
<td>Finance</td>
<td>American Stock Exchanges</td>
</tr>
<tr>
<td>Apple Inc.</td>
<td>Manufacturing</td>
<td>American Stock Exchanges</td>
</tr>
<tr>
<td>Diageo plc</td>
<td>Manufacturing</td>
<td>American Stock Exchanges</td>
</tr>
<tr>
<td>Tupperware Brands Corporation</td>
<td>Manufacturing</td>
<td>American Stock Exchanges</td>
</tr>
<tr>
<td>Aquila Inc.</td>
<td>Commodities</td>
<td>American Stock Exchanges</td>
</tr>
<tr>
<td>NRG Energy Inc.</td>
<td>Commodities</td>
<td>American Stock Exchanges</td>
</tr>
<tr>
<td>Mirant Corporation</td>
<td>Commodities</td>
<td>American Stock Exchanges</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>FedEx Corporation</td>
<td>Transport and Logistics</td>
<td>American Stock Exchanges</td>
</tr>
<tr>
<td>United Parcel Services Ltd</td>
<td>Transport and Logistics</td>
<td>American Stock Exchanges</td>
</tr>
<tr>
<td>Excel Maritime Carriers Ltd</td>
<td>Transport and Logistics</td>
<td>American Stock Exchanges</td>
</tr>
</tbody>
</table>

Table 1: Table showing the various stocks that are used in this paper and their fields and countries.

**Review of the tests conducted in Wong et al (2002)**

In Wong et al. (2002), the choice of data is extracted from the daily close of the Singapore's Straits Times Index from 1\(^{st}\) January 1974 to 31\(^{st}\) December 1994. The author explicitly mentioned about the avoidance of the Asian Financial Turmoil which started in 1997. This act of avoidance puts the ability of Technical analysis in times of high volatility in doubt.

The methods that are used in the paper are as follow,

1. 5 days simple moving average
2. 3-5 days dual moving averages
3. 4-9-18 day triple moving averages
4. 5 day t-ratio moving averages
5. 6 period RSI method with cross over

The return from the stock market is calculated using the formula below,

\[ r_t = \ln \left( \frac{S_t}{S_{t-1}} \right) \quad (29) \]

where \( S_t \) is the closing price for day \( t \). The methods is then tested using a normal hypothesis test with one sided bound for both the buy signal and sell signal. After getting the one sided results, the paper then combined both test statistics to form a 2 sample t-test. This hypothesis is then done for 3 period which is defined by the Wong et al.

The original testing method is not robust in testing for the true effectiveness of the various techniques for several reasons. The original statistics used in the paper (Wong, 2002) assumes that the average return is zero which may not necessary be true. The methodology also did not state whether the methods are compared against a particular method or against one another. This results in ambiguity when one method is stated to be more effective than the others. To remedy this ambiguity in comparison, there are 2 approaches that can be adopted. The first method is to use multiple comparison tests and the other method is to use Analysis of Variance (ANOVA). In this paper, the author proposed to use both the ANOVA methodology and multiple comparison tests which can yield useful insights into interaction effects.
Experimental Approach: ANOVA

Analysis of variance is a technique which attempts to differentiate whether the mean response from a group is significantly from the rest. It is similar in nature to multiple comparisons test. The ANOVA model in this case is a 2-factors ANOVA model which is described as below,

\[ Y_{ij} = A_a + B_b + AB_{ab} + e_{ab} \quad (30) \]

where,

A is the first factor with a levels
B is the second factor with b levels
AB is the interaction factor with ab levels
e is the error term which is assume to be Normal(0, \( \sigma^2 \))

To partition the variance up for analysis, the sum of square for each factor is calculated and partitioned. Below is the table showing how the variance is split among the various factors.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Square</th>
<th>Degrees of freedom</th>
<th>Mean Square</th>
<th>Expected Mean Square</th>
<th>( F_0 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>( SS_A )</td>
<td>a-1</td>
<td>( MS_A )</td>
<td>( \sigma^2 + \frac{b\sum A^2}{a-1} )</td>
<td>( \frac{SS_A}{MS_A} )</td>
</tr>
<tr>
<td>B</td>
<td>( SS_B )</td>
<td>b-1</td>
<td>( MS_B )</td>
<td>( \sigma^2 + \frac{a\sum B^2}{b-1} )</td>
<td>( \frac{SS_B}{MS_B} )</td>
</tr>
<tr>
<td>AB</td>
<td>( SS_{AB} )</td>
<td>(a-1)(b-1)</td>
<td>( MS_{AB} )</td>
<td>( \sigma^2 + \frac{n\sum AB^2}{(a-1)(b-1)} )</td>
<td>( \frac{SS_{AB}}{MS_{AB}} )</td>
</tr>
<tr>
<td>Error</td>
<td>( SS_E )</td>
<td>ab(n-1)</td>
<td>( MS_E )</td>
<td>( \sigma^2 )</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>( SS_T )</td>
<td>abn-1</td>
<td>( MS_T )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: ANOVA formula table

The idea behind ANOVA is similar to linear regression. However, linear regression assumes that the factors are normally distributed and continuous in nature. In the case of ANOVA, it caters for the categorical variables which need not fulfill the normality assumption. Thus ANOVA can be viewed as a linear regression model with categorical variables. However, just plainly applying ANOVA does not indicate whether the mean return are different between the methods. In order to obtain the results for that, we will have to apply mean difference testing in ANOVA. There are many different ways to test for the mean. In this case, a multiple comparison test is done via the use of REGWQ test (Ryan (1960, 1959), Einot and Gabriel (1975), and Welsch (1977) ) to understand whether there are differences in the means. The test is not as well known as Duncan or SNK test but it is considered to be better than either one.
Methodology of application of techniques

To start measuring the effectiveness of each technique, it is necessary to calculate the return in a way which is easily comparable. As used in Wong et al. (2002), we will use the difference in logarithm of the stock price as the return which is defined as equation 29. As the various techniques have very similar structure of buy and sell signal, we will apply these rules in order to test the techniques properly.

Stock purchase and sales rule.

1. If a buy signal is seen and
   1. the previous signal is sell, the model set the buy price and set position to neutral if the buy price is lower than the sell price.
   2. the previous signal is buy, the model does nothing.
   3. The previous signal is nothing, the model set the buy price and set position to long.
2. If a sell signal is seen,
   1. the previous signal is buy, the model will set the sell price and set position to neutral if the sell price is greater than the buy price.
   2. The previous signal is sell, the model does nothing.
   3. The previous signal is nothing, the model will set the sell price and set position to short.

This purchase and sales rules allow for both long and short position which is quite close to the technical analysts' use of the models and techniques. However, some of the techniques have their pre-defined rules, which we will be following closely in this case. To further simulate the real world of stock trading, we will incorporate a 1% commission fee which is similar to the fees that are charges for transactions in stock market. The rationale behind the imposition of the 1% commission fee is that it is likely that any simple techniques would be able to pick up small amount of gains which adds up in the long run. Thus the implementation of the trading fee will prevent any such gains which is technically impossible in the real world. The 1% commission will be imposed on both buy orders and sell orders. While it is noted that most brokerage no longer trade with percentage commission, the 1% commission serves an additional role of ensuring that the techniques are robust and good in generating returns that exceed 1%.

A general algorithm for each technique will be implemented in a form which automates the process of generating the return. The methods which are implemented are MACD, MA, Momentum and RSI. The choice to use these 4 methods only is due to the nature of these indicators. They have very well defined trading rule which you can apply easily without any fear of subjectivity. At the same time, there are many variations to the techniques which allow us to seek the most optimum version.

In this paper, we will vary the traditional values that are used in these techniques. Thus before we can actually perform the ANOVA, we will first examine the most suitable values to be
used in the techniques. By varying the values, we will also be able to examine how the parameters of the model affect the results strongly. To achieve this, a simple regression will be performed to measure the effect of length of time period on the return. This preliminary analysis will also determine whether the techniques are suitable for further analysis as well as obtaining the optimum values for further analysis.

The data will be the data extracted from the past 1500 days of the stock market starting 19 May 2008 so that the measured return can be compared between the stocks carefully. There is also the credit crunch fallout during this period which adds credibility of the models should they manage to perform above expectations.

Results

<table>
<thead>
<tr>
<th>Model type</th>
<th>Control factor</th>
<th>Period 1 Value</th>
<th>Period 2 Value</th>
<th>P value</th>
<th>P Value 2</th>
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<th>Adj R-square</th>
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<td>0.00620</td>
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<td>0.00730</td>
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<tr>
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<td>0.00010</td>
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</table>

Table 3: Parameter estimates and the relevant regression diagnostics.

From the various models readings from table 3, it is noted that there are mixed signals in terms of the effect of time period on the model. In some cases, time period value is negative which indicates that shorter period are better while there are others which indicates that a longer time period will be better. It is also noted that for most of the models, the R-square values are very small. The only exceptions are the MACD models.
For the MACD models, the second time period is always negative in value which implies that a shorter second time period will be more advantageous for the return. This is slightly contradicting as the original model has a relatively longer period 2 than period 1. It is also noted that the explanatory power of the MACD models are very much higher than the other models indicating that the second time period is very powerful in determining the return rate of the MACD models. It is suggested that the second time period is a form of trigger for the first period and thus if the period is too far behind. The MACD model fails to work.

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Model} & \text{Country} & \text{Stock Type} & \text{Mean Period 1} & \text{Mean Period 2} \\
\hline
\text{RSI} & \text{SG} & \text{COM} & 18 & \text{SG} \\
& \text{SG} & \text{FIN} & 20.95 & \text{SG} \\
& \text{SG} & \text{MFC} & 21.81 & \text{SG} \\
& \text{SG} & \text{TNL} & 24.7 & \text{US} \\
& \text{US} & \text{COM} & 26.41 & \text{US} \\
& \text{US} & \text{FIN} & 40.56 & \text{US} \\
& \text{US} & \text{MFC} & 16.78 & \text{US} \\
& \text{US} & \text{TNL} & 20.06 & \text{SG} \\
& \text{SG} & 22.23 & 27.12 & \text{US} \\
\hline
\text{MA} & \text{SG} & \text{COM} & 62.5 & \text{SG} \\
& \text{SG} & \text{FIN} & 57 & \text{SG} \\
& \text{SG} & \text{MFC} & 73.97 & \text{SG} \\
& \text{SG} & \text{TNL} & 75.17 & \text{US} \\
& \text{US} & \text{COM} & 65.28 & \text{US} \\
& \text{US} & \text{FIN} & 65 & \text{US} \\
& \text{US} & \text{MFC} & 65 & \text{US} \\
& \text{US} & \text{TNL} & 65.26 & \text{SG} \\
& \text{SG} & 69.8 & 65.17 & \text{US} \\
\hline
\text{MACD} & \text{SG} & \text{COM} & 30 & 55 \\
& \text{SG} & \text{MFC} & 30 & 50 \\
& \text{US} & \text{COM} & 27.5 & 50 \\
& \text{US} & \text{TNL} & 30 & 60 \\
& \text{SG} & 30 & 53.75 & \text{US} \\
& \text{US} & 28.33 & 53.33 & \text{SG} \\
\hline
\text{Momentum} & \text{SG} & \text{COM} & 69 & 69 \\
& \text{SG} & \text{FIN} & 69.05 & 69 \\
& \text{SG} & \text{MFC} & 66.32 & 66 \\
& \text{SG} & \text{TNL} & 62.4 & 62 \\
& \text{US} & \text{COM} & 57.38 & 57 \\
& \text{US} & \text{FIN} & 85 & 85 \\
& \text{US} & \text{MFC} & 51.75 & 51 \\
& \text{US} & \text{TNL} & 48.75 & 48 \\
& \text{SG} & 65.93 & 54.22 & \text{US} \\
\hline
\end{array}
\]

Table 4: Mean values for time period 1 and time period 2.

The means values for time period as shown in table 4 indicates a huge variation in terms of time period which are suitable for the analysis in the later stage. The important highlight is that the MACD model did not produce positive returns for some of the industry. This observation indicates that the MACD model is not suitable for further analysis and thus shall be excluded. The optimum values are extracted based on the mean values by the country.
For RSI models, the result for US is quite similar to the original suggested 27 days which indicates that the proposed RSI model parameter is actually quite accurate. The optimum Singapore RSI parameter is 22 days. The MA models for Singapore and US indicate parameter values which are very large. This is in strong contradiction to the original proposed 3 days, 5 days and 10 days MA parameter. While we cannot offer any explanation for this strange behavior, further investigations will be done in the later stage to observe the behavior of the model. The same abnormal observation is observed in the case of MACD. The parameters that MACD uses are much larger than the original ones proposed. Momentum models also use much larger parameter estimates than what was originally proposed.

Preliminary Conclusions

From the various regression models, it is quite obvious that the length of the time period do have some effects on the return. The mean value of time periods are also measured and the most suitable ones are then selected. The failure of MACD models are rather unexpected and deserves a closer examination to understand its failure. The various parameters for the models do not coincide with those that are originally proposed. Thus, to ensure that the experiment in the later stage is representative, there will be 2 set of parameters. The first set of parameters are those which are the originally proposed ones, the second set being those which we have obtained from the above calculations. This will ensure that we have a good comparison of the various parameters.

ANOVA and REGWQ test

As described earlier, we will be using the ANOVA and REGWQ tests to determine which models produced returns that are different from the rest. Below is the result for type 1 sum of squares.

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Type I SS</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODEL</td>
<td>2</td>
<td>22.45685908</td>
<td>11.22842954</td>
<td>3.31</td>
<td>0.0413</td>
</tr>
<tr>
<td>FIELD</td>
<td>3</td>
<td>5.68339169</td>
<td>1.89446390</td>
<td>0.56</td>
<td>0.6442</td>
</tr>
<tr>
<td>MODEL*FIELD</td>
<td>6</td>
<td>5.98374058</td>
<td>0.99729010</td>
<td>0.29</td>
<td>0.9385</td>
</tr>
<tr>
<td>STOCK_EXCHANGE</td>
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<td>29.74781205</td>
<td>29.74781205</td>
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<td>0.0040</td>
</tr>
<tr>
<td>MODEL*STOCK_EXCHANGE</td>
<td>2</td>
<td>19.53201046</td>
<td>9.76600523</td>
<td>2.88</td>
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<tr>
<td>FIELD*STOCK_EXCHANGE</td>
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<td>28.63260428</td>
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<td>14.36633467</td>
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<td>0.71</td>
<td>0.6463</td>
</tr>
</tbody>
</table>

Table 5: Table showing the amount of variations accounted for by each source.

The table 5 shows that the stock exchange and the model used are the highest 2 explanatory factors in the model. Thus the above results confirmed the fact that the model does have an influence on the stocks. The stock market is also important as the best models will also not function well in a market which is plain bad. Below are the results of the Ryan-Einot-Gabriel-Welsch Multiple Range Test for the various factors in terms of return.
Means with the same letter are not significantly different.

<table>
<thead>
<tr>
<th>REGWQ Grouping</th>
<th>Mean</th>
<th>N</th>
<th>MODEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.1046</td>
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<td>MO</td>
</tr>
<tr>
<td>A</td>
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<td></td>
</tr>
<tr>
<td>A</td>
<td>0.0996</td>
<td>23</td>
<td>RS</td>
</tr>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>-0.8081</td>
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</tr>
</tbody>
</table>

Table 6: REGWQ Test results for Model

Means with the same letter are not significantly different.

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<th>FIELD</th>
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</thead>
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<td>A</td>
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<td></td>
</tr>
<tr>
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<td>30</td>
<td>MFC</td>
</tr>
<tr>
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<tr>
<td>A</td>
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<td></td>
</tr>
<tr>
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<td>-0.7890</td>
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<td>COM</td>
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</tbody>
</table>

Table 7: REGWQ Test results for Field

Means with the same letter are not significantly different.

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<th>STOCK_EXCHANGE</th>
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</thead>
<tbody>
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<td>0.0540</td>
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<td>US</td>
</tr>
</tbody>
</table>

B  -0.9054   57   SG

Table 8: REGWQ Test results for Stock market

From table 6 to 8, we can observe that the return by field and model do not differ significantly. The only difference that is observed is stock market. Thus from this, we can conclude that the stock market itself is the main factor behind the return. It is worth mentioning that RSI and Momentum models produced reasonable amount of gain as compared to Moving average models.
Conclusions and Discussion

The above ANOVA indicated the importance of the stock market as opposed to the model in determining the stock return. It seems that from the result the application of the various models does not seem to beat the market and their gains are mainly the results of the market. This would imply that regardless of the model that is adopted, so long as the market does well, any techniques will do well. Thus the usefulness of the models is highly diminished and that any gains from the market can be attributed to the movement of the market. However, it must be noted that both momentum models and RSI models produced positive gains while moving average models produced negative gains.

The surprising result came from the preliminary results which indicates that longer time period are preferred as compared to the original values. In fact, most of the selected values are much higher then what is commonly recommended. This interesting find indicates the possibility that the models are outdated and require new updates to make them relevant to the current market.

The failure of the moving average convergence/divergence models indicate that the model may not be a sensible choice at all given its abysmal results. It is equally likely that the model is too specific to a particular field or stock exchange to be useful in generating return. The model also requires more parameters than the others. While there are no results in this paper that explains the phenomenon, from the values extracted from the regression results, there is a strong indication that the period 2 parameter is not useful as its presence strongly affects the return for the model in the negative manner. Thus, if we could reduce the value of the second parameter, it will converge as the moving average model. The second problem of the moving average convergence/divergence model is that the presence of the period 2 parameter could cause an unwanted effect on the return by creating unnecessary signals which encourage rapid trading. With rapid trading, the compounding effect of the trading charges will accumulate and wipe out the earnings. This is perhaps the main reason for the failure of the moving average convergence/divergence model.

Relative strength index models and momentum models are the better performers. The momentum model uses time lag values which are by far greater than those recommended in the references. This is likely to be due to the rapid fluctuations in the short term. This rapid fluctuation makes any momentum models which depend on short term spikes to be unreliable in determining buy and sell signals. Thus the regression models in the preliminary analysis indicated a value above 60 which would have allowed for the market prices to clear. These new values for the parameters reflect the change in the market as compared to the past. These differences should imply that the momentum model requires some updating and optimization of parameters before it can be used.

Relative strength index model is particularly interesting in terms of its return and the selected parameters. The return is positive which is expected for such a model. What is unexpected of the model is that the model uses the default trading rules and it did very well compared to the other models. The return is still impressive given the volatile market which the model is
experimented on. This shows that the model is relative robust compared to the other models. The other interesting point to note is that the selected parameter is close to the original model parameter which is proposed many years ago. The other point to note is that from table 4, most of the values for RSI models are near the original proposed values. Thus, it is likely that the RSI model is very robust and relatively accurate compared to the rest.

While the models themselves do not generate a lot of return by itself, their overall performance is admirable. However, it is likely that the return is more due to the market than the models themselves. Thus the effectiveness of these models in generating above average returns are questionable and their overall usefulness is not verifiable in this case.

**Limitations of the research**

In this paper, there were only 24 stocks that were chosen from 4 fields and 2 stock exchanges. Thus whether the sample is representative is questionable, although the author has tried to ensure that these stocks are representative of the stock market. The period of time used in the analysis contains a boom and a bust period. Thus, it may be possible that these macroeconomic factors are influencing the performance.

The trading algorithm may not be entire complete in the sense that there might be customized algorithm for each model that will enhance their overall return. The other problem is that the algorithmic trading portion may not be as effective as the human trading version which might bring about better returns as human are able to react better to the buy and sell signals.

**Recommendation**

It is recommended that technical analysis be tested with more data and more variety of techniques. Better optimization of parameters are also recommended to search for the best parameters for each model.

**Bibliography**


The Free E-Book of Technical Analysis, Wallstreetcourier.


