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Quantity and Price Indicator for Technical Analysis in the Stock Market

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The two things equity investors are most concerned with are: 1) stock picking - finding a good investment target, and 2) timing of purchase and sale. That said, these two things will be the main theme of this research. Although common technical indicators are being widely used by investors to determine time to enter market, these techniques have been used by too many, obtaining these information have been made relatively easy, thus making these references less valuable. In addition, past technical indicators did not take into consideration the relationship between stock prices and trading volume. Many researches have shown that using a single variable as the basis of investment is insufficient and unwise. In view of the above, this research will propose a new technical indicator that takes into consideration both stock price and trading volume at the same time, thus making it superior in terms of investment timing.   This research involves seven scenarios of the price-volume relationship, converts the daily transaction data of individual stocks into daily scores, then takes the scores and transforms those into short-term, as well as long-term moving averages. The crossing of the two averages will be used to predict the trend of the stock prices in the future, thus indicating the timing of investments. For example, when short-term moving average line breaks above the long-term moving average, it indicates a buy; when short-term moving average falls below the long-term moving average, it indicates a sell. Based on the empirical test results, the performance of the strategy discussed in this research was comparable with historical records, but involves less transactions while being easy to use. We can conclude from this that the new technique can provide investors a more valuable market reference.

1. Introduction

Technical analysis of stock trends is used to help investors with timing decisions, while the most frequently used technical indicators revolve around stock prices (Li, 2010; Wu, 2010; Guo, 2008; Lin, and Li, 2006), and only a few are based on trading volumes (Cambell et al., 1992). Blume et al. (1994) indicated that trading volume can reflect new information in a timely manner, and changes in trading volume can efficiently reveal market reaction to the information. Relevant studies have proven the importance of trading volume (Gao, 2008; Lai et al., 2008). In view of the researches done by the above mentioned scholars, it can be said that both changes in stock price and changes in trading volumes have significant impact on the stock market's movement and trends, and none can be left alone.

However, when looking at the commonly used technical indicators, it can be found that regardless of whether it is a price-based or a volume-based technical indicator, the stock price or the trading volume is the sole variable that is being considered. For this reason, movements in the stock price and trading volume cannot be measured simultaneously. The first and foremost objective of this research is to develop a bivariate technical indicator that takes into account both stock price and trading volume, and this technique would assist investors in making superior timing decisions for trades. We hereby name this technical indicator the Quantity and Price Indicator (QP).

This research takes stock's daily price and trading volume, and converts those into QP index values using the pre-determined conditions. Then, by calculating the QP Index, the long term exponential moving average (EMA) and short term EMA can be constructed, and crossings of the lines would serve as buying or selling signals. In order to test the QP Index proposed in this

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research, empirical research will be conducted in both stock markets in the United States and Taiwan, and the result will be compared against previous literatures. Section Two contains a detailed description of the QP Indicator in explaining how it takes into consideration both stock's closing price and trading volume. Empirical result of proposed technique is compared to previous researches in Section Three, while Section Four is the conclusion of this research.

2. Research Method

Both stock's price and trading volume are crucial factors that affect investment decisions. However, technical indicators in the past are not able to consider both trading volume and price at the same time. That said, this research proposes a new Quantity and Price Indicator (QP), which requires inputs from daily closing prices and trading volumes, then translates those into a daily QP Index value. Details of the calculation procedures are outlined in Section 2.1. After obtaining the QP Index value, the long term and short term QP Index moving averages can be constructed. Based on the property and moving averages, crossings of the two moving average lines would be seen as signals for buy or sell. Section 2.2 includes a detailed description of this theory. Steps for calculating the return on investment is listed in Section 2.3.

2.1 QP Indicator

Building on the basis of the Cumulative Price and Volume Scoring System designed by Hu (2009), QP Indicator uses stock's daily price and volume relationship and defines a set of rules to evaluate each stock based on the changes of the stock's closing price and trading volume from the previous day. Also taking into consideration previous research conclusion of increased possibility of price rebound or reversal following significant volume increases, the QP Indicator's decision

rule has included the factor of trading volume increases. With this, there would be a total of seven price-volume patterns, serving as the basis for evaluating each individual stock.

QP Indicator is given a score of 3 when there is an increase to stock price while trading volume surges to 1.3 times of the 5-day moving average. The second scenario is when the stock price rises and trading volume shows an increase of 5% to 30% from the 5-day moving average, the QP Indicator is given a score of 2. The third scenario happens when the stock price moves up for two consecutive days but trading volume has fallen, the QP Indicator is given a score of 1.

The fourth rule applies when the stock price falls for two consecutive days while trading volume decreases, QP Indicator receives a score of -1. The fifth rule applies when there is downward movement accompanied by a 5% to 30% increase in trading volume to the 5-day moving average, the QP Indicator receives a score of -2. According to the sixth rule, the QP Indicator receives a score of -3 when the stock price falls and the trading volume surges to 1.3 times of the 5-day moving average. Finally, when closing price is unchanged or when none of the above scenario applies, the QP Indicator is given a score of 0. Using mathematical formulas, the seven situations on the QP Indicator proposed in this study can be expressed as below:

t : Trading day

Pt : Stock's closing price on day t

Qt : Stock's trading volume on day t

$Qma5$: Moving average on trading volume of the most recent 5 days

$ft(x)$: Score for QP Indicator on day t

$$ft(x) = \begin{cases} 3, \text{ if } Pt > Pt\text{-}1 \text{ and } Qt > Qma5*1.3 \\ 2, \text{ if } Pt > Pt\text{-}1 \text{ and } Qma5*1.3 > Qt \text{ and } Qt > Qma5*1.05 \\ 1, \text{ if } Pt > Pt\text{-}1 \text{ and } Pt\text{-}1 > Pt\text{-}2 \text{ and } Qt < Qt\text{-}1 \\ -1, \text{ if } Pt < Pt\text{-}1 \text{ and } Pt\text{-}1 < Pt\text{-}2 \text{ and } Qt < Qt\text{-}1 \\ -2, \text{ if } Pt < Pt\text{-}1 \text{ and } Qma5*1.3 > Qt \text{ and } Qt > Qma5*1.05 \\ -3, \text{ if } Pt < Pt\text{-}1 \text{ and } Qt > Qma5*1.3 \\ 0, f\ Pt = Pt\text{-}1 \quad \text{or otherwise} \end{cases} \quad (1)$$

Explanation of Method:

1. Consider individual stock's daily change in price and volume. When today's price (Pt) is higher than that of the day before (Pt - 1), and trading volume today (Qt) surges to 1.3 times of the 5-day moving average ($Qma5$).

2. When price today (Pt) is higher than that of the previous day (Pt - 1), and when trading volume today (Qt) is 5% to 30% more than that of the previous day (Qt - 1).

3. When price today (Pt) is higher than that of the previous day (Pt - 1), and when the price on the previous day (Pt - 1) is higher than that of the day before (Pt - 2), while trading volume for today (Qt) is less than that of the previous day (Qt - 1).

4. When price today (Pt) is lower than that of the previous day (Pt - 1), and price of the previous day (Pt - 1) is lower than that of the day before (Pt - 2), while trading volume for today (Qt) is less than that of the previous day (Qt - 1).

5. When the price today (Pt) is lower than that of the previous day (Pt - 1), and when the trading volume today (Qt) is higher than that of the previous day (Qt - 1) by 5% to 30%.

6. When the price today (Pt) is lower than that of the previous day (Pt - 1), and when the trading volume today (Qt) surges to 1.3 time of the 5-day moving average ($Qma5$).

7. When price today (Pt) is the same as that of the previous day (Pt - 1), or when none of the previous six scenarios applies.

2.2 Long term and short term moving averages based on QP Indicator

With the calculation method described above, each individual stock has a daily score that ranges between 3 and -3. Then based on the property of moving averages, the short term moving average ($Avgx$) and long term moving average ($Avgy$) are constructed respectively based on each stock's daily score. When the short term x-day moving average line crosses the y-day moving average line from below while the value of the x-day moving average line is lower than 0, then it signals for buy (also called the Golden Crossover). On the other hand, when the x-day moving average line crosses the the y-day moving average line from above while the value is bigger than 0.5, then it signals for sell (Death Cross). Below are the definitions and formulas for the short term and long term moving averages:

Avg : Moving average

x, y : x and y each stands for the number of days for the short term and long term moving average

ft : Value of the QP Indicator on day t

$$Avg_x = (\textstyle\sum_{i=1}^{x} f_i)/x , \quad (2)$$

$$i = t - x, t - x + 1, t - x + 2, \ldots, t - 1,$$

Buy and sell signals from the cross up or cross down of short term and long term moving average lines as follows:

Golden Cross: $Avg_x > Avg_y$, and $Avg_x < 0$ (3)

Death Cross: $Avg_x < Avg_y$, and $Avg_x > 0.5$ (4)

2.3 Measuring return on investment

The return on investment for each trade (R) is calculated by subtracting the closing price on the purchase day (BC) from closing price on the selling day (SC), then dividing that by the closing price on the purchase day (BC), and multiply that by 100%. The calculation is explain as below:

SC : Closing price on the selling day

BC : Closing price on the purchase day

R : Sum of return on investment

Ri : Return on investment of each stock on one trade

i : Each trade

n : Number of trades

$$Ri = \frac{SCi - BCi}{BCi} * 100 \% \quad (5)$$

Adding up the return on investment for each trade yields the sum of return on investment for each individual stock.

$$R = \sum_{i=0}^{n} Ri \quad (6)$$

3. Analysis of empirical results

To prove the validity of the technique proposed herein, the research will compare itself against various previous literatures (Chang et al., 2011; Chang, Fan & Liu, 2009; Giles, Lawrence & Tsoi, 2001; Mallick, Lee & Ong, 2008), of which all of the academics involved have proposed new methodologies to predict buy and sell points. The comparison will be made in the context of a total of six U.S. stocks while taking into consideration of three different market trends, being upward, flat and downward markets. The stocks selected for the empirical studies in the previous literatures also included U.S. and Taiwanese stocks. U.S. stocks include Apple Inc. (AAPL), The Boeing Company (BA) and Verizon Communications Inc. (VZ), which each represents for upward, sideways, downward market trends respectively.

The time interval also follows that of the previous literature. Training period for the U.S. stocks was between January 2, 2008 to December 30, 2008, while the testing period was between January 2, 2009 to June 30, 2009.

At the same time, since the new indicator utilizes the concept of moving averages, the collection of data used for purpose of comparison would have to be pushed to earlier to avoid interference to the calculation of x-day and y-day moving averages. That said, the actual testing data would have to be adjusted backward to the appropriate date; for example, for a 10-day long term moving average, testing data would have to be adjusted backward for 9 days.

3.1 Results for the training interval

This research translates each stock's daily changes in price and trading volume into daily scores. The scores ranges between 3 and -3, and then are transformed into x-day short term and y-day long term moving average lines. Through the crossing of the two moving average lines, buy and sell opportunities are being identified. Below, (x, y) will be used to represent value of a combination of short term and long term moving averages.

Based on the return on investment from the trainning results, the best days combination for Apple Inc. was (6,14), representing the buy/sell point at MA6 > MA14 which is the Golden Cross, and MA6 < MA14 is the Death Cross. The best days combinations are (6,12) for The Boeing Company, (5,10) for Verizon Communications Inc., (6,10) for AU Optronics Corporation, (6,13) for EPISTAR, and (5,9) for United Microelectronics Corporation respectively.

3.2 Empirical results for the testing interval

U.S. Stocks selected for the empirical study include Apple Inc., The Boeing Company, and Verizon Communications Inc. According to the training data, the term combination for Apple Inc. would be (6,14). Looking at the short term and long term moving average lines of Apple Inc. (see Figure 1), and the actual buy / sell points during the testing period (please refer to Figure 2), a Golden Cross appeared on January 23, 2009. On the same date, the stock would be purchased at a price of $88.36. This holding would be sold on the Death Cross that happened on February 25, 2009 at $96.46, resulting in a gain of 9.17%. The second purchase would be on March 6, 2009 at $85.30, and then would be sold on April 17, 2009 at $123.42, resulting in a 44.69% gain. The third transaction would happen on June 23, 2009 at $134.01, and then would be sold on June 30, 2009 at $142.43 with a gain of 6.28%.
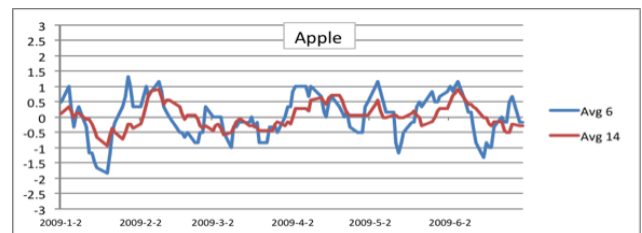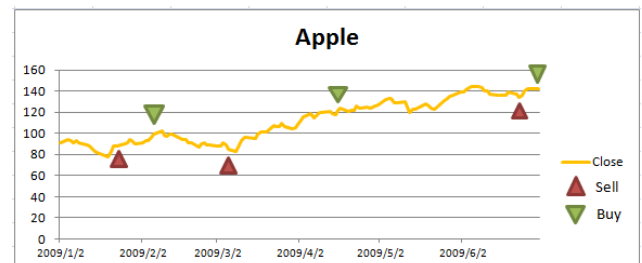

Figure 1: QP moving average lines for Apple Inc.

Figure 2: Buy and sell points for Apple Inc.

Table 1: Transaction records on Apple Inc.

Item	Date of Purchase	Purchase Price	Date of Sell	Selling Price	Rate of Return (%)
1	2009/1/23	88.36	2009/2/5	96.46	9.17
2	2009/3/6	85.3	2009/4/17	123.42	44.69
3	2009/6/23	134.01	2009/6/30	142.43	6.28
Total					60.14

Three trades were conducted during the empirical testing period, and the rate of return for the trades were 9.17%, 44.69% and 6.28% respectively, for a total return of 60.14%. The average rate of return per transaction would be 20.05%.

According to the training data, the term combination for The Boeing Company would be (6,12). The short term and long term moving average lines for the second stock, being The Boeing Company, as well as the actual buy/sell points during the testing period are shown in Figure 3 and 4. Because the QP Indicator's short term moving average line crossed up through the long term moving average line on January 22, 2009, a purchase for BA would be made on the same day at a price of $42.26. This purchase would then be sold on February 9, 2009 at a price of $42.80, yielding a return of 1.28%. The second transaction would happen on March 3, 2009 at a purchase price of $29.36, and would then be sold on May 6, 2009 for a return of 50.54%. The same principal for trading applies for VZ.
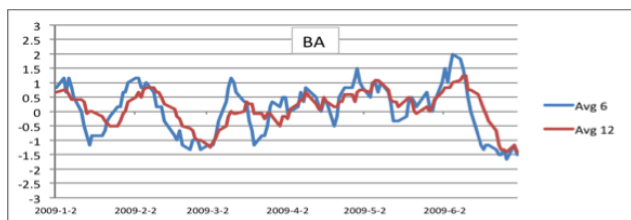

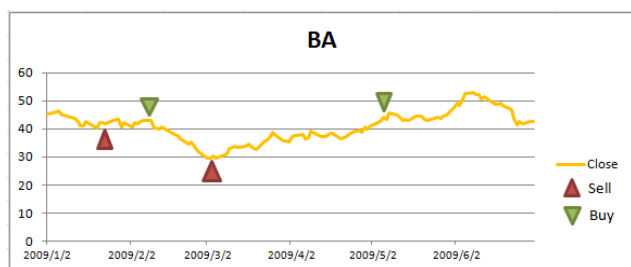Figure 3: QP moving average lines for The Boeing Company

Figure 4: Buy and sell points for The Boeing Company

Table 2: Transaction records on The Boeing Company

Item	Date of Purchase	Purchase Price	Date of Sell	Selling Price	Rate of Return (%)
1	2009/1/22	42.26	2009/2/9	42.8	1.28
2	2009/3/3	29.36	2009/5/6	44.2	50.54
Total					51.82

Two trades were conducted during the empirical testing period, and the rate of return for the trades are 1.28% and 50.54% respectively, for a cumulative return of 51.82%. The average rate of return per transaction would be 25.91%.
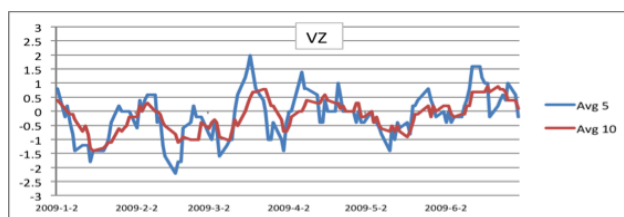

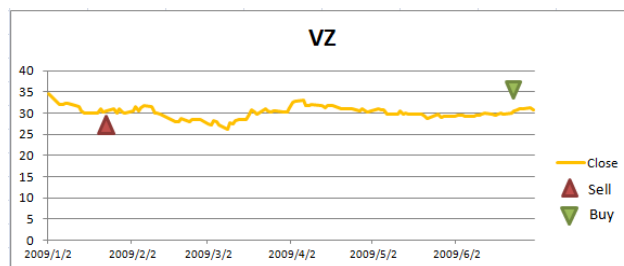Figure 5: QP moving average lines for Verizon Communications Inc.

Figure 6: Buy and sell points for Verizon Communications Inc.

Table 3: Transaction records on Verizon Communications Inc.

Item	Date of Purchase	Purchase Price	Date of Sell	Selling Price	Rate of Return (%)
1	2009/1/22	30.16	2009/6/24	30.8	2.12
Total					2.12

3.3 Comparison with previous literatures

A total of six stocks were being selected as subjects for this research, three of which were U.S. stocks. The study utilized the new technical indicator that is proposed by this report.

During the testing period, twelve transactions were being conducted. The average rate of return for the six stocks was 38.02%. Chang e al. (2011) conducted a total of 54 trades with a average return of 38.22%. The table below is a comparison between the results of this research and previous literatures.

Table 4: Rate of return and number of trades for individual stocks

Literature	Stock	APPL	BA	VZ	Cumulative Average
Giles et al. (2001)	Rate of Return (%)	8.02	-20.42	13.42	0.34
	No. of trades	2	2	4	
Mallick et al. (2008)	Rate of Return (%)	10.2	15.38	12.94	12.84
	No. of trades	10	14	8	
Chang et al. (2009)	Rate of Return (%)	12.97	17.5	**27.72**	19.40
	No. of trades	23	20	11	
Chang et al. (2011)	Rate of Return (%)	**61.28**	38.03	15.36	**38.22**
	No. of trades	13	11	4	
This research	Rate of Return (%)	60.14	**51.82**	2.12	38.02
	No. of trades	3	2	1	

Out of all the stocks, Apple and Boeing were the best performing ones, with each of them ending up with a return of over 50 percent. The average rate of return of all the stocks was 38.02%, which was slightly lower than the 38.22% in previous literatures. However, the number of transactions for the previous literature was fifty two times, which is a lot higher than that the twenty eight trades for this research. When taken into account transaction costs, return from this research would be higher than that of the literature.

From the empirical test, it could be proven that although return from this research is slightly lower than that of the literature, but the average rate of return per trade would be significantly higher. That said, if transaction cost is a constraining factor that needs to be taken into consideration, this research results in a lower fee. With this in mind, the QP Indicator that is proposed in this study would be of value to investors.

4. Conclusion and recommendation

This research proposes a new QP Indicator as a technical indicator that not only takes into consideration changes in stock prices, but also emphasizes on the value of monitoring trading volume. This new method employs the property of moving averages to calculate short term and long term moving average lines, and utilizes the relationship between these lines to identify the best timing for trades. Through comparison with previous literatures, this new method is seen to be able to generate gains for stocks in upward, sideways, and downward trends. Although the cumulative return on investment is less than 0.5% shy of that from literature, the number of trades is limited to twelve times, which is less than the fifty four times required to generate the higher return from the previous study. This decreased number of transactions avoids the case of frequent trading signals, as well as the transaction costs (or transaction taxes) that are triggered by

the excessive trading that would erode on gains. Taking the related costs into consideration, the performance of the method proposed by this research would exceed the return of previous studies. Other than that, this new indicator would be applicable to the U.S. markets.

The advantage of the QP Indicator would be its ease of understanding and execution. Only simple calculations are required to identify superior buying and selling opportunities. Also, different combinations of short term and long term moving averages would allow investors the flexibility to choose between suitable parameters for short term, medium term, and long term investments.

References

[Beaver 1970] Beaver, W., Kettler, P., & Scholes, M., *The association between market determined and accounting determined risk measures.*, In Psychological Review, 35, 654-682, 1970.

[Blume 1994] Blume, L., Easley, D., & O'Hara, M., *Market statistics and technical analysis: The role of volume.*, Journal of Finance, 49(1), 153-181, 1994.

[Bondt 1985] Bondt, W. F. M. D., & Thaler, R., *Does the stock market overreact?*, Journal of Finance, 40(3), 793-805, 1985.

[Chang 2009] Chang, P. C., Fan, C. Y., & Liu, C. H., *Integrating a piecewise linear representation method and a neural network model for stock trading points prediction.*, Applications and Reviews, 39(1), 80-92, 2009.

[Chang 2011] Chang, P. C., Liao, T. W., Lin, J. J., & Fan, C. Y., *A dynamic threshold decision system for stock trading signal detection.*, Applied Soft Computing, 11(5), 3998-4010, 2011.

[Conrad 1988] Conrad, J., & Kaul, G., *Time-Variation in Expected Returns.*, Journal of Business, 61, 409-425, 1988.

[Edwards 1992] Edwards, R. D., & Magee, J., *Technical analysis of stock trends.*, Boston: J. Magee Inc., 1992.

[Gao 2008] Gao, S. X., *Price-Volume Relationship: Is Volume a Leading Indicator of Price Discovery*., Feng Chia University Department of Finance, 2008.

[Gervais 2001] Gervais, S., Kaniel, R., & Mingelgrin, D. H., *The High-Volume Return Premium.*, The Journal of Finance, 56(3), 877-919, 2001.

[Giles 2001] Giles, C. L., Lawrence, S., & Tsoi, A. C., *Noisy time series prediction using recurrent neural networks and grammatical Inference.*, Machine Learning, 44(1-2), 161-183, 2001.

[Guo] Kuo, H. Y., *The Empirical Study of Technical Analysis in China Stock Market.*, Unpublished master's thesis, Ling Tung University of Science and Technology, 2008.

[Hu 2009] Hu, L. Y., *The 100 methods to invest on stock market, Economic Daily News.*, Taipei, 2009.

[Lai 2008] Lai, Y. C., Chang, C. M., Liao, M. L., Huang, C. L., *The Study on the Price-Volume Relationship of Taiwan Stock Index, Taiwan Stock Index Futures, and MSCI Taiwan Stock Index Futures: The Application of GARCH Model.*, Journal of Chinese Economic Research, 6(2), 18-34, 2008.

[Li 2010] Li, G., *The significance of technical analysis in the stock market.*, The management & technology of the small and medium enterprises, 2010(8A), 73-74, 2010.

[Lin 2006] Lin, J. X. and Li, S. H., *Profitability of technical indicators Quote decline in non-linear relationship.*, Taiwan Academy of Management Journal, 2006.

[Mallick 2008] Mallick, D., Lee, V. C., & Ong, Y. S., *An empirical study of Genetic Programming generated trading rules in computerized stock trading service system.*, Service Systems and Service Management, 2008 International Conference on 1-6, 2008.

[McInish 1991] McInish, T. H., & Wood, R. A., *Hourly Returns, Volume, Trade Size, and Number of Trades.*, Journal of Financial Research, 14(4), 303-315, 1991.

[Pruitt 1998] Pruitt, S. W., & White, R. E., *The CRISMA trading system：Who says technical analysis can't beat the market?*, The Journal of Portfolio Management, 14, 55-58, 1998.

[Wu 2001] Wu, T. A., & Gau, Y. F., *Relation between volatility and volume.*, Unpublished master's thesis, National Chi Nan University, 2001.

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