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New Technique for Stock Trend Analysis – Volume-weighted Squared Moving Average Convergence & Divergence

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In computational intelligence, Gerald Appel designed MACD, short for Moving Average Convergence / Divergence in the 1970s, a popular trading indicator used in the business data analysis of stock prices to predict future trends. While it is easy to read, MACD has two distinct disadvantages, the time lagging problem and the fake signals problem, resulting in delays in buying or selling signals and decisions. Besides, three parameters input are required for the calculation model, which is not user-friendly for new learners. This study proposes a new methodology – Volume Square-Weighted Moving Average Convergence & Divergence (VSWMACD). It aims to improve MACD performance and apply various evaluation tools to verify the enhancements. Five datasets with 200 stocks from Hong Kong Stock Market in each have been applied to the testing. The outcome shows that compared to MACD, the average Return On Investment of VSWMACD increased by around 15%, and the average Maximum Drawdown decreased by about 5%. VSWMACD is proven to reduce fake signals while earning a higher return with a lower risk than MACD. A better portfolio management can be formed.

Keywords—Computational Intelligence, Business analytics, Business informatics, Data information and knowledge

I. MOTIVATION & BACKGROUD INFORMATION

MACD displays the relationship between two moving averages of a stock's price. The difference between the 12-period exponential moving average (EMA) and the 26-period EMA forms the MACD line. A signal line, calculated by the 9-period EMA of the MACD line, is plotted on the MACD chart. Trading opportunities can be identified through signal line crossover. The buy signal is formed when MACD rises across the signal line, while the sell signal is formed when MACD drops across the signal line. EMA (12, 26, 9) is a medium-speed parameter setting proposed by G. Appel (1979), the creator of MACD. Investors may adjust the timeframe to meet their trading goals.

MACD formula:

$$\text{MACD} = \text{EMA1}_{t1} - \text{EMA2}_{t2} \quad (1)$$

$$\text{Signal line} = \text{EMA}_{t3} \text{ of MACD} \quad (2)$$

$$\text{EMA(n)} = \left(\text{Close}_{\text{today}} \times \left(\frac{\text{Smoothing}}{1+\text{n}}\right)\right) + \text{EMA}_{\text{yesterday}} \times \left(1 - \left(\frac{\text{Smoothing}}{1+\text{n}}\right)\right) \quad (3)$$

The first day of EMA is represented by SMA(n).
EMA1_{t1} = denote as short timeframe EMA
EMA2_{t2} = denote as long timeframe EMA

Despite the simplicity and straightforward interpretation of the indicator, MACD has two distinctive drawbacks to short timeframe EMA.

- Time lagging problem. When a longer period of EMA is applied in a short timeframe EMA, it takes time for MACD to react to the reversal, which causes delays in making buy or sell signals and decisions.
- Fake signals problem. Since some investors like taking a shorter period of EMA to apply in a short timeframe EMA, the result will be easily affected by noises like a sudden rise in stock price may result when the company announces surprise earnings. It is a temporary effect that may not be appropriate for predicting the future trend. Such a trading strategy would become very expensive if commissions are factored into the equation.

In Halilbegovic's paper (2016), using MACD signals to make investment decisions cannot guarantee consistent, considerable, and sustainable earnings. Therefore, having noticed that time lag and fake signals cause trade losses, an improved indicator based on the existing MACD model will be proposed.

II. EXISTING ALTERNATIVE & LIMITATIONS

An improved trading algorithm, Volume-weighted Moving Average (VWMA) is first executed in 1984. The exponential moving average (EMA) calculation in MACD involves only the closing price data. Differently, the Volume-weighted Moving Average (VWMA), suggested by the name, takes volume as a prediction factor in addition to the closing price data. Trading volume positively correlates with stock price volatility (Eric et al., 2009). Most of the time, when transaction volume increases, stock price increases.

VWMA formula:

$$\text{VWMA(n)} = \frac{\sum_{i=1}^{n} P_i V_i}{\sum_{i=1}^{n} V_i} \quad (4)$$

Given n = Time setting parameter
P = Closing price
V = Volume

Although volume is considered in VWMA (Price x Volume) in addition to the price data alone compared with EMA, where higher weightings are given to more recent price data and fewer weightings on past data. The time lagging problem remains since no heavier weightings are given to more

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recent volume data. Furthermore, since higher weighting is given to recent price data in VWMA, the chance of fake signals still exists as sudden news of the company may boost or lower the stock price in the short term.

To alleviate the time lagging and noise problems, overfitting (i.e., too many noises included) and underfitting (i.e., data are overly smoothed that are not up-to-date) should be avoided. Instead of applying VWMA to price data, where overfitting may occur, it is more suitable to use it for both price and volume factors. The solution details will be further discussed in Section III.

III. DESIGN/METHODOLOGY/IMPLEMENTATION

A. Formation of VSWMACD

Step 1: Construct Volume-weighted Squared Moving Average (VSWMA)

$$\text{Volume} - \text{weighted Squared WMA(n)} = \frac{\sum_{i=1}^{n} W_i{}^2 \times V_i \times P_i}{\sum_{i=1}^{n} W_i{}^2 \times V_i} \quad (5)$$

Step 2: Construct Volume-weighted Squared Moving Average Convergence & Divergence (VSWMACD)

$$\text{EMA(n)} = \left(\text{Close}_{\text{today}} \times \left(\frac{\text{Smoothing}}{1+\text{n}}\right)\right) + \text{EMA}_{\text{yesterday}} \times \left(1 - \left(\frac{\text{Smoothing}}{1+\text{n}}\right)\right)$$

$$\text{VSWMACD} = \text{VSWMA}_t - \text{EMA}_t \quad (6)$$

$$\text{Signal line} = \text{EMA}_{t1} \text{ of VSWMACD} \quad (7)$$

Given that two ts are the same timeframe, while t1 is another timeframe. The first day of EMA is represented by SMA(n).

B. Concept differences with MACD and VSWMACD

The new indicator, VSWMACD, substitutes short timeframe EMA with long timeframe VSWMA. Here, MACD and VSWMACD are sharing the same idea, while VSWMACD replaces the two EMA formulas with two VWMA formulas. Compared to MACD, the volume factor is applied. Besides, the input of three timeframe parameters is required in MACD, while VSWMACD requires two. It is more user-friendly for investors to tune the parameters. Finally, VSWMA can perform smoothing without interpreting many noises, which is better than EMA. Fake signals reduce when there is a crossover in the indicator as a trend is conformed.

IV. EVALAUATION AND RESULTS

VSWMACD is proven to be business informatics that is able to capture more return and avoid loss in different trends by reducing fake signals compared to MACD. The data information and knowledge derived from the new computational technique are summarized below. 5 datasets, with 200 stocks each, are tested and visualized against the indicators and parameter sets at different speeds. The selected stocks are the most active 1000 stocks in Hong Kong Stock Market in 2021. When comparing the average Return On Investment (ROI) in 5 datasets, VSWMACD obtains a higher return than MACD in all speed parameter sets with positive values in all data sets, while MACD records a negative return in the fast parameter set 6,19,6. Results are shown in Table I.

TABLE I. Average ROI/MDD with different Parameter set

Indicator	Average ROI/MDD with different Parameter set		
	Fast *(6,19,6) / (19,6)*	***Medium*** *(12,26,9) / (26,9)*	***Slow*** *(19,39,9) / (39,9)*
MACD	-3.37% / 47.12%	3.37% / 43.67%	8.75% / 40.83%
VSWMACD	19.54% / 39.35%	21.02% / 38.28%	23.54% / 36.65%

For Average Return On Investment (ROI), VSWMACD got a positive ROI in all three parameter sets, while MACD got a negative return in the fast-speed parameter. The best VSWMACD is the slow-speed parameter set, with a 23.545% return. Followed by the medium-speed parameter set (21.019% return) and the fast-speed parameter set (19.540% return). The results indicate that VSWMACD has a higher ability to capture the increase in stock price than MACD, hence gaining higher investment returns.

For Average Maximum Drawdown (MDD), VSWMACD has a lower Maximum Drawdown than MACD, with the slow parameter set at the least (36.651%). VSWMACD in the fast-speed, medium-speed, and slow-speed got a Maximum Drawdown of less than 40%, while MACD in all parameter sets suffered from a more than 40% Maximum Drawdown. The results indicate that VSWMACD has a higher ability to capture the decrease in stock price than MACD, hence avoiding losses in investment.

- Multiple stocks investment strategy
  It is suggested to use the Slow parameter set (39,9) for VSWMACD, with the highest return and lowest risk among all speed parameter sets.
- Individual stocks investment strategy
  An adaptive test should be carried out to find the best indicator with the best speed parameter sets on the historical data of a specific stock.

V. CONCLUSION

Based on the testing results, by reducing fake signals, VSWMACD can capture more return and minimize investment risk in a great volatility market compared to MACD. Besides, VSWMACD is able to gain a return or minimize the loss in different trends (uptrend, downtrend, cyclical trend). It is suggested to take the Slow speed parameter set to obtain a higher return in multiple stocks investment, while an adaptive test should be carried out to adapt to different stock patterns. For testing limitations, the optimized parameter set is only applicable in Hong Kong Stock Market, and day trading is not tested in this paper. Overall, the new data analytics model applied in VSWMACD has great potential for further development in the business analytics area.

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