Electronic Engineering and Informatics
G. Izat Rashed (Ed.)
© 2024 The Authors.
This article is published online with Open Access by IOS Press and distributed under the terms of the Creative Commons Attribution Non-Commercial License 4.0 (CC BY-NC 4.0).
doi:10.3233/ATDE240052

The Validity of Quantitative Technical Indicator Factors Based on Back Testing

Lingwei ZHANG[1], Xiaolei DING[2], Biyuan YANG[3]
College of Finance Zhejiang University of Finance & Economics, Hangzhou, China

Abstract. Technical indicator factors can quickly reflect the transformation of current market behavior. The application system in quantitative trading has become increasingly mature in recent years. Back testing is widely used in factor validity tests because of its validity. However, the current research on the effectiveness of technical indicator factors has ignored the adaptability to the model timing strategy, and the use of factors is not differentiated enough. How to carry out reasonable and effective factor validity research has become a difficult problem for many scholars to discuss. This paper first selected representative technical indicators as the research object and crawled the trading data of Chinese A-share listed companies through Python. It then calculated the sample data using computer databases such as Pandas and NumPy. Furthermore, this paper confirms the optimal interval of each factor with the method of back testing. On this basis, it tests the income distribution of each factor and the maximum pullback. It introduces the timing method of the simple moving average for comparison and discusses the feasibility of using a technical indicator strategy to conduct stock selection trading.

Keywords. technical indicator factors; quantification; back testing; Python; simple moving average

1. Introduction

Compared with fundamental indicator factors, technical indicator factors focus more on the use of stock prices, trading volumes, and other indicators in the market to reflect changes in market behavior [1]. In contrast, back testing is an empirical way to substitute trading strategies or models into historical data for reverse testing for cross-validation [2].

At present, the back testing research on factors mainly focuses on verifying the effectiveness of factor stock selection [3] while ignoring the adaptability of factors and timing strategies. Even if the factors with high stock selection effectiveness have low adaptability to the timing strategy in the model, the ability of the trading model to obtain excess returns and control the maximum back testing is difficult to be guaranteed. And among many technical index factors, some have strong stock selection ability, and some have an outstanding ability to make profits at the right time. However, many researchers have not accurately distinguished and applied these factors. Therefore, this paper will study the above issues, and further improve the application system of technical index

[1] Lingwei ZHANG, College of Finance Zhejiang University of Finance & Economics, e-mail: 1195494097@qq.com
[2] Corresponding Author: Xiaolei DING, College of Finance Zhejiang University of Finance & Economics, e-mail: klausding@zufe.edu.cn
[3] Biyuan YANG, College of Finance Zhejiang University of Finance & Economics, e-mail: 2495636430@qq.com

factors in the field of stock quantification. It will explore more effective stock quantification strategies based on technical index factors, providing a useful experience for more scholars to conduct in-depth research.

2. Sample Selection and Data Processing

2.1 Selection of Technical Indicators

Since technical indicators are a kind of indicators derived from historical market data such as stock price, trading volume, and turnover, and there are many types and quantities of technical indicators, it is necessary to use models to analyze different types of technical indicators. Technical indicators can be divided into price momentum, price reversal, trading volume, and price volume. Therefore, when building the model, this paper mainly takes the classical indicators of the four types as the research object of the factor validity test. MACD and MTM are price momentum indicators. KDJ and WR are price reversal indicators. VWAP and volume price correlation coefficient (hereinafter referred to as "CCOQAP") are price volume indicators, and the standard deviation of BIASVOL is trading volume indicators. The above indicators are defined in the following table (Table 1).

Table 1. Definitions of technical indicators selected in this document.

Indicator Name	Indicator Definition
MACD	The timing of buying and selling is studied and judged by the convergence and separation between the short-term index moving average and the long-term index moving average of the closing price.
MTM	The momentum of the price is measured by the difference between the price of the day and the price of N days ago.
KDJ	It is used to measure the position between the lowest price and the highest price of the current closing price in the past N days. The higher (lower) the value, the closer it is to the highest (lowest) price in the past N days. When the value is too high or too low, the price may reverse.
WR	It is used to measure the strength of the market and the state of overbought and oversold. It is generally believed that when WR<20, the market is overbought; When WR > 80, the market is oversold; When WR is between 20 and 80, it is more balanced.
VWAP	The weighted average of prices is calculated with the trading volume as the weight. If the current price crosses VWAP upward, buy; if the current price goes down through VWAP, it is sold.
Volume price correlation coefficient	Pearson correlation coefficient between the closing price of stock resumption and the daily turnover rate of stock in the past half month.
BIASVOL	The turnover version of the BIAS indicator. If BIASVOL6＞5, BIASVOL12＞7 and BIASVOL24＞11, a buying signal will be generated; If BIASVOL6＜-5, BIASVOL12＜-7 and BIASVOL24＜-11, a sell signal is generated.

2.2 Sample Data Processing

This paper takes all the stocks of listed companies of A-share before December 14, 2022, as the research object, and the research range is from January 1, 2010, to December 14, 2022. In this research interval, China's stock market has experienced many bull-bear transitions, almost covering all the trends of the stock market under different systematic

risks. The data in this paper is from Tencent Finance, and the data analysis software is Python.

In this paper, we first use the crawler to obtain the opening price, closing price, lowest price, and highest price of the stock. Then, we use the recovery factor to calculate the recovery price of the four indicators in turn. After obtaining the recovery price, this paper uses Pandas, NumPy, and other computer databases to calculate relevant technical indicators, including MACD indicators, WR indicators, KDJ indicators, VWAP, MTM indicators, volume price correlation coefficient indicators, and BIASVOL indicators, and takes these indicators as the research object of factor test. Then this paper divides these indicators into five equal parts, with an interval span of 0.2. It describes the income distribution of each major indicator in different intervals in the form of bar charts.

3. Back Testing

3.1 Distribution of Factor Income

Before building the model, use Python to back test the above indicators with the interval from January 1, 2010, to December 14, 2022. According to the stock selection frequency of ten stocks per week, we count the returns of each research object in different intervals and judge whether it is suitable for China's A-share market according to IC and IR rankings. This paper lists the income distribution map of MACD and KDJ indicators (Figure 1 and Figure 2) [4-6].

IC is the abbreviation of the Information Coefficient, which represents the correlation between the predicted value and realized value [7]. The larger the absolute value is, the better the prediction ability of the indicator is [8]. When IC>0.05, the indicator can be regarded as an effective indicator. IR is the abbreviation of Information Ratio, which refers to the ratio of the mean value of excess return to the standard deviation, representing the ability of indicators to obtain stable Alpha. When IR>0.5, the indicator has a strong ability to stably obtain excess returns.

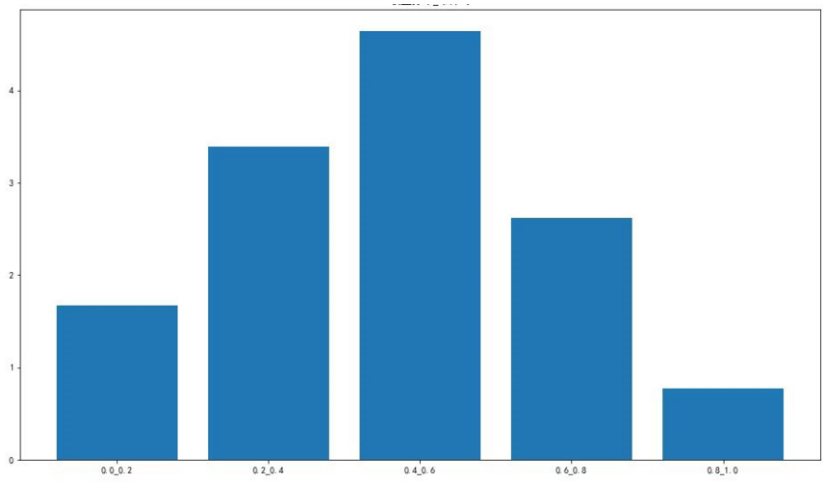

Figure 1. Income distribution map of MACD indicators.

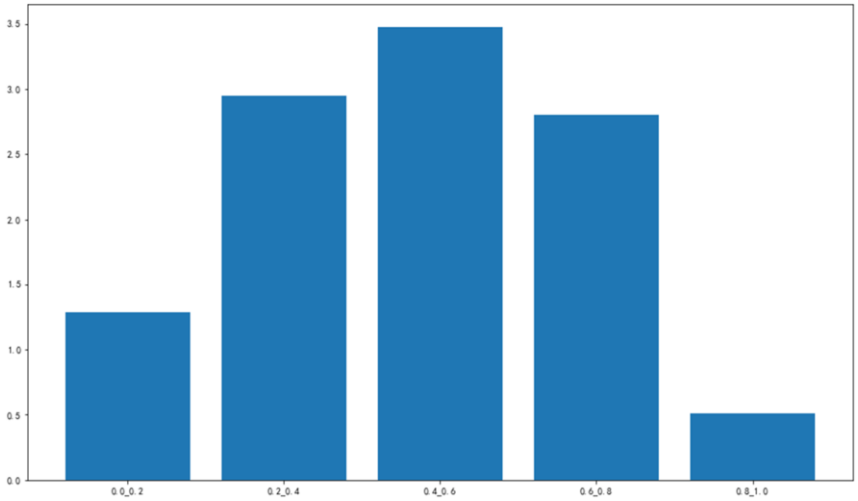

Figure 2. Income distribution map of KDJ indicators.

It can be seen from the income distribution map of the seven indicators that MACD indicators and KDJ indicators show a normal distribution, with the largest income in the range of 0.4-0.6. However, the returns of MTM indicators, volume price correlation coefficient, and BIASVOL decrease with the increase of the range, showing a right bias trend. WR has the largest return in the 0.6-0.8 range, showing a left bias trend. The VWAP index gains the most in the 0-0.2 range, but the distribution trend is not obvious.

According to the IC and IR of each technical indicator (Table 2), this paper finds that MACD, MTM, KDJ, VWAP, volume price correlation coefficient, and BIASVOL have positive IC values. Among them, the IC values of MTM and BIASVOL are >0.05, which can be used as effective factors and have good stock forecasting ability. In terms of IR, MTM, volume price correlation coefficient, and BIASVOL index have a strong ability to obtain excess returns.

Table 2. IC and IR of technical indicators.

Factor	IC	IR
MACD	0.0372	0.3159
MTM	0.0695	0.5381
KDJ	0.0406	0.2886
WR	-0.0267	-0.3467
VWAP	0.0203	0.1220
Volume price correlation coefficient	0.0479	0.5975
BIASVOL	0.0749	0.5754

3.2 Factor Validity Test

In this paper, according to the income distribution chart of indicators, all factors are limited to their optimal intervals. The model is used to calculate the annualized income and maximum rollback generated by each factor in the optimal interval.

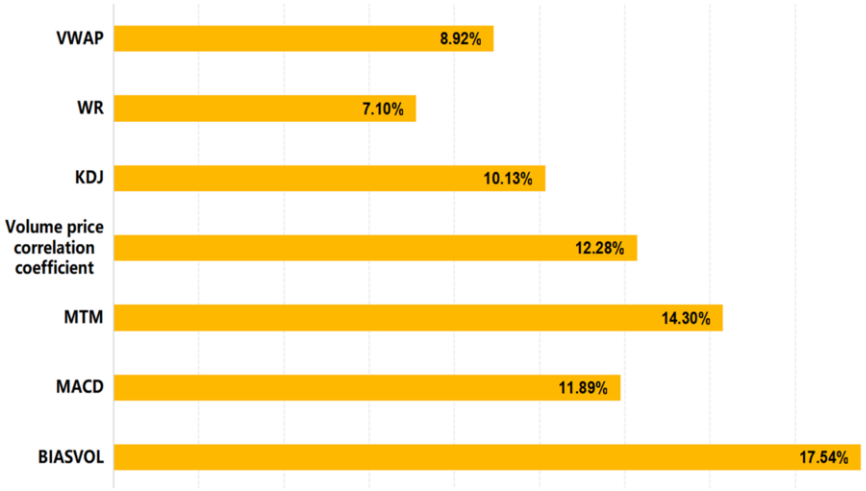

Figure 3. Comparison of annualized returns of major factors within the optimal range.

From Figure 3, this paper finds that BIASVOL, a technical indicator of trading volume, has achieved an annualized return of 17.54% in the 12-year back testing interval. In contrast, MTM, volume price correlation coefficient, MACD, and KDJ indicators can all achieve an annualized return of more than 10%, which can be used as a signal indicator for the stock market to go long, while WR indicator does not have relatively high annualized returns. Furthermore, the maximum pullback of 7 indicators is measured.

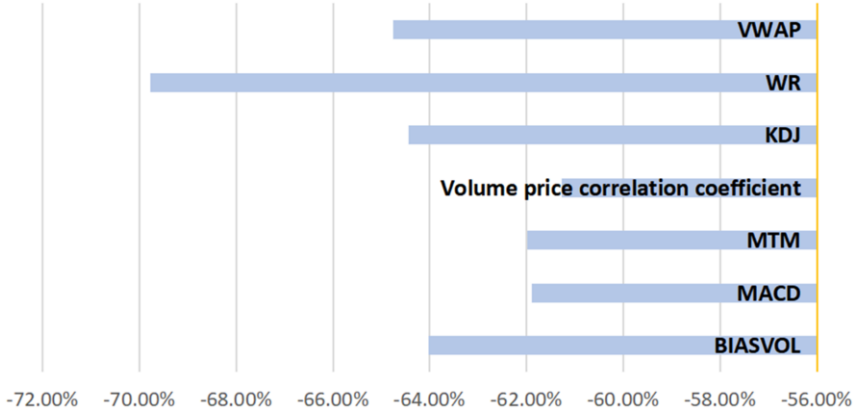

Figure 4. Comparison of maximum rollback of major factors in the optimal interval.

From Figure 4, this paper finds that the maximum rollback rate of these seven indicators is basically within the range of 60% to 70%, and the maximum pullback rate of the WR indicator ranks first. This shows that the WR indicator is not suitable for stock selection strategy in China's A-share market. The volume price correlation coefficient, MACD, and MTM indicators can make the back testing effect maintain a high annualized rate of return while controlling the maximum rollback rate at a low level. Then this paper adds a simple moving average timing strategy to observe the effect of its factors under timing conditions.

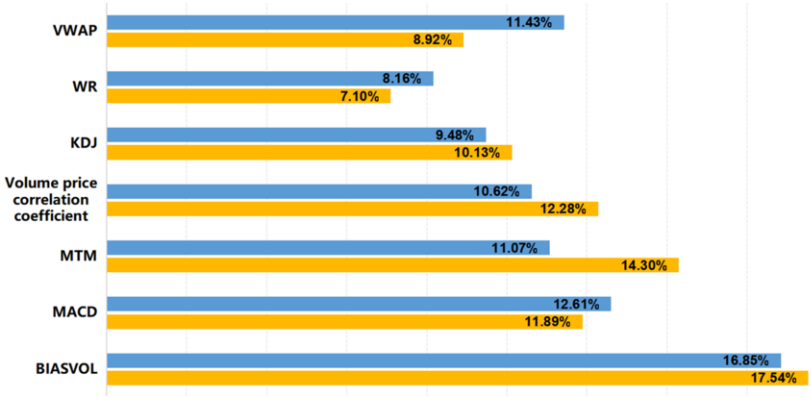

Figure 5. Comparison of timed annualized returns of major factors in the optimal interval.

From Figure 5, this paper finds that the returns of most factors will shrink under the condition of timing, but the annualized returns of MACD indicators and VWAP indicators will increase rather than decrease. This shows that MACD indicators and VWAP indicators are more suitable for use in combination with timing trading strategies. Furthermore, the maximum pullback of 7 indicators under timing conditions is measured.

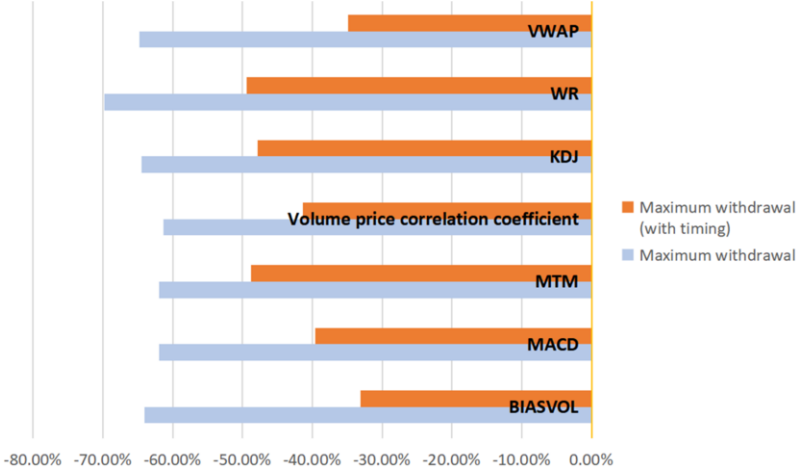

Figure 6. Comparison of maximum withdrawal of each major factor in the optimal interval.

From Figure 6, under the condition of timing, VWAP indicators can greatly reduce the maximum pullback and effectively reduce the losses of investors. At the same time, it is worth mentioning that although the yield of the BIASVOL indicator decreases under the condition of timing, its maximum rollback can be reduced to half of the original level under the condition of timing, and the optimization effect is more significant.

4. Conclusion

By comparing the results of back testing, the following conclusions are drawn in this paper:

First, the effectiveness of the WR indicator is low, whether in terms of the ability to obtain excess returns or the ability to control the maximum rollback.

Second, MACD, MTM, KDJ, and volume price correlation coefficient indicators have a good ability to obtain excess returns and control maximum pullback but have poor adaptability to timing strategies. They are more suitable for building stock selection models.

Third, VWAP indicators and BIASVOL indicators have a better ability to obtain excess returns and control the maximum rollback. They are more adaptable to timing strategies, which is more suitable for the construction of timing trading models.

References

[1] Y. Shynkevich T. M. McGinnity S. A. Coleman A. Belatreche and Y. Li “Forecasting price movements using technical indicators: Investigating the impact of varying input window length” Neurocomputing vol. 264, 2017, pp. 71-88.

[2] H. Yang, C. Wang, and Y. Zhao, “The Cross-section of Expected Stock Returns: Evidence from Chinese A-share Market,” 2012 Fifth International Conference on Business Intelligence and Financial Engineering, 2012, pp. 303-307.

[3] Y. Shi, “Analysis of Multi-factor Stock Market Choice Portfolio Model Based on Regression,” 2021 5th Annual International Conference on Data Science and Business Analytics (ICDSBA), 2021, pp. 1-5.

[4] S. M. Ahmed, "Quantification of investor emotion in financial news by analyzing the stock price reaction," 2017 International Conference on Information and Communication Technologies (ICICT), 2017, pp. 119-123.

[5] Isha, S. Dixit, M. K. Ahirwar, D. Sakethnath and M. Rakha, "Stock Prediction by Analyzing the Past Market Trend," 2021 9th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO), 2021, pp. 1-4.

[6] P. V. Chandrika, K. Visalakshmi and K. Sakthi Srinivasan, "Application of Hidden Markov Models in Stock Trading," 2020 6th International Conference on Advanced Computing and Communication Systems (ICACCS), 2020, pp. 1144-1147.

[7] L. Jidong and Z. Ran, “Dynamic Weighting Multi-Factor Stock Selection Strategy Based on XGboost Machine Learning Algorithm,” 2018 IEEE International Conference of Safety Produce Informatization (IICSPI), 2018, pp. 868-872.

[8] Y. Zheng, W. Nai and Y. Ren, “Multi-Factor Quantitative Stock and Transaction Timing Selection Model Based on Information Coefficient Mean Value Scoring,” 2021 IEEE 4th Advanced Information Management, Communicates, Electronic and Automation Control Conference (IMCEC), 2021, pp. 1991-1996.