# Research On Quantitative Transaction Auxiliary Evaluation System Based on ARIMA And EWM

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**Abstract:** With the innovation of computer technology and the progress of financial engineering theory, mathematical finance and quantitative trading strategies have become a hot field of research. This article mainly focuses on using the predicted data obtained from the time series model and establishing evaluation models to provide transaction decisions that maximize returns. ARIMA models, entropy, and TOPSIS methods are used to find solutions. We have built ARIMA models based on the given daily price data of Bitcoin and gold, providing predicted data for subsequent analysis. We obtained some basic indicators from the predicted and actual historical data, respectively. We also used the entropy weight method for empowerment to construct the secondary indicators further. By using these metrics, scoring was performed using the TOPSIS model.

## 1. Introduction

Market traders purchase and sell volatile assets frequently to maximize their total return. Moreover, as a specific commission will be charged for every action of purchase and sale, traders have to take the trading cost into consideration of revenue. Two typical assets are gold and Bitcoin.[1] Bitcoin (BTC), the native asset of the Bitcoin Blockchain, is the world's first digital currency without a central bank or administrator.[2] Ever since the foundation of Mt.Gox, the first Bitcoin Exchange, Bitcoin has aroused wider attention and has become a heated topic in the financial world for its huge fluctuations in prices.[3] Bitcoins had gone through sharp declines when experiencing hacker attacks, the Bear Market and the COVID-19, and risks like that. However, when China announced the Blockchain technique as its national strategic need, Bitcoins' value soared dramatically.[4] Take the COVID-19, for instance. Bitcoins lost half of their value in 48 hours and recovered to their full value in one month. As an acknowledged anti-risk asset, the gold price may not perform unexpected acts during the peaceful time. However, its price will rise sharply when encountered with sudden risks like the 2008 financial crisis and the 2010 European debt crisis.[5]

Due to these features of various assets mentioned above, traders need to deploy their portfolio investments of cash, Bitcoins, and old to gain revenue.[6] To meet the needs of traders with limited information, it is necessary to develop a model based on the past stream of daily prices to date, which offers reliable and calculable results on the determination of buying, holding, or selling traders' assets in their portfolio each day.

## 2. Financial Data Prediction Model Based on ARIMA

ARIMA is a statistical analysis model that uses time-series data of a variable to understand better the data set or predict future trends.[7] With the data stream, we can determine the relation that describes transitions of the variables by time. After putting the variable of time into the equation, we complete the prediction process, which is also the essence of many predictive models. However, the ARIMA model utilizes regressive auto item, moving average item, and integration item synthetically to analyze disturbance terms. It takes the past and present values and the deviation of the predictor

variable into account, which effectively enhances forecast precision. For time series models, it is necessary to test the stationary of time series so that the possibility of spurious regression can be lessened. Therefore, the difference should be implemented to non-stationary data, which depends on applying the ARIMA model.[8]

Based on the principles of the ARIMA model and the past flow of daily gold prices by date, we establish our ARIMA (p,d,q) model. In the model below, L stands for the lag operator.

$$\left(1 - \sum_{i=1}^{p} \emptyset_i L^i\right)(1 - L)^d X_t = \left(1 + \sum_{i=1}^{q} \theta_i L^i\right)\varepsilon_t, d \in Z, d > 0 \tag{1}$$

By examining the original series through the ADF test, we find that the initial gold price time series data is unstable, leading to the existence of unit root. The ACF and PACF test results prove to be double trailing, and we may try to find the appropriate lag order. We comprehensively work out the concrete answer regarding indicators including AIC and goodness of fit: p=2, q=2. So, the gold model is ARIMA (2,1,2) (no constant terms).

With ARIMA (2,1,2) model discussed before, the predictive sequence FITTED_GOLD can be computed. The fitting diagram of FITTED_GOLD, GOLD and RESIDUAL demonstrates that the fitting result is satisfying.
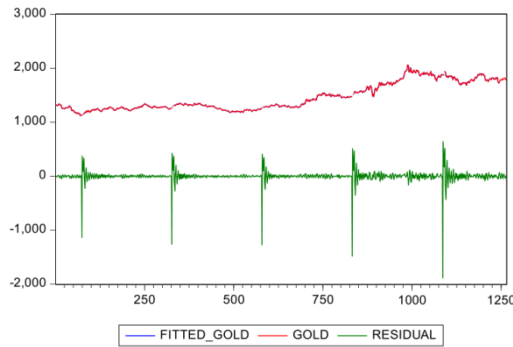


Figure. 1 Fitting diagram of FITTED_GOLD, GOLD, and RESIDUAL

As the operational process of the Bitcoin price model is consistent with the gold price model, we display the results. Since the ACF and PACF tests are double-order truncation, we make various forms attempts and consider all indices synthetically to decide the lag order. According to our calculation results, p=2, q=1. So the bitcoin model is ARIMA (2,1,1).

Through implanting data series to the model ARIMA (2,1,1), the predictive sequence FITTED_BP can be computed. We commit that the fitting result is admissible.
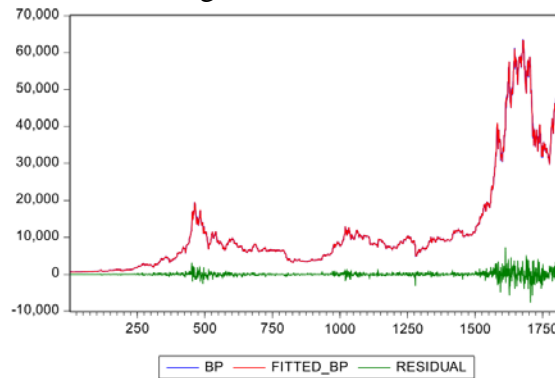


Figure. 2 Fitting diagram of BP, FITTED_BP, and RESIDUAL

## 3. Market Situation Judgment Model Based on Entropy Weight Method

To offer trading strategies for daily operation, we built an evaluation system by combining the predictions from the ARIMA model and historical information. We took the marketing features of

bitcoin and gold into consideration when choosing indices since bitcoin has a bigger price fluctuation and more free trading time while gold has a relatively strong risk resistance and more smooth price fluctuations. We refer to the existing literature, adopt the expert research method (Delphi method), and select indicators obtained through the actual data.

First, we create rising-rate indices for different periods using present data.
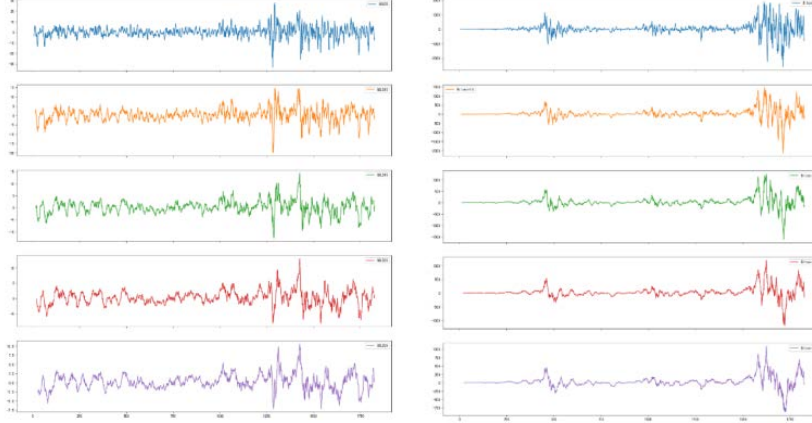


Figure. 3 Average of Bitcoin and gold's rise over time

From the chart above, we can conclude that bitcoin investment fits better for short-to-medium-term investing strategies since it has a more violent fluctuation than gold. Taking the index $Rise5$ can help us better seize violent fluctuation in the short term. Since gold has the features of a more robust risk-resistant performance and more stable short-term fluctuations, we choose $Rise10$ as the index for the construction of other indices.

As we chose the index $Rise5$ for bitcoin and $Rise10$ for gold in the former article, we are choosing the five-day bias ratio and ten-day bias ratio as parallel indices to correspond with the two assets.

$$\text{Rate}_{\text{Bias}_n} = \frac{P_{\text{present}} - P_{\text{average}_n}}{P_{\text{average}_n}} \tag{2}$$

Meanwhile, to better monitor the change of prices, we select indices in common use on assets markets-the ROC index, which separately cite $ROC_5$ and $ROC_{10}$ to score and evaluate bitcoin and gold.

$$ROC_n = \frac{P_i - P_{i-n}}{P_{i-n}} \tag{3}$$

Besides, whether the market is trade-welcoming or not also influences traders' judgment and preferences for the assets, since which we decide to cite Gold Index and Bitcoin Index to judge whether the market is trade-welcoming. We can get the two indices' precise numbers by constructing a small scoring model with the three indices of increase ratio, bias ratio, and ROC. The weight of these indices directly decides the importance of the indices, which influences the final outputs of the comprehensive performance of trading actions. Since the current common empowerment methods include subjective and objective empowerment methods and as former indices have already used expert research methods,[9] we are using the entropy weight method from the objective empowerment method to decide the weight used for scoring, which satisfies the "rational investors assumption."[10]

For the first step, since we cannot directly compare indices for their different unit, we have to normalize all the data and transfer all the calculations into data measured with the same unit.

$$x_{ij} = \frac{x_{ij} - \text{m}\ (x_j)}{\text{m}\ (x_j) - \text{m}\ (x_j)} \tag{4}$$

For the second step, calculate the feature gravity matrix, which will be convenient for scoring and weight-calculating in the latter steps.

$$P_{ij} = \frac{x_{ij}}{\sum_1^n x_{ij}} (j = 1,2,\dots,m) \tag{5}$$

For the third step, calculate the entropy value of all the indices.

$$e_j = -k * \sum_1^n P_{ij} * \log(P_{ij}), k = 1/\ln(n) \tag{6}$$

For the fourth step, calculate the difference coefficient and decide the weight for indices.

$$g_j = 1 - e_j \tag{7}$$

Finally, calculate the score by multiplying the weight and share.
To conclude, we get weight for these indices:

$$\begin{cases} Increase\ rate : 0.208 \\ Bias\ ratio : 0.372 \\ ROC_{10} : 0.419 \end{cases} \tag{8}$$

By analyzing the scatter diagrams of the Gold Index and Bitcoin Index, we can find that the average value of the two indices is approximately 0.546 and 0.5, from which we can determine that when the gold index is greater than 0.54, the market is undergoing a good performance and when the number is lower than 0.54, the market is on a bear market. In the same way, when the bitcoin index is greater than 0.5, the bitcoin market is undergoing a good performance, and when the number is lower than 0.5, the market is on a bear market.

Table 1. Standard of distinguishing markets

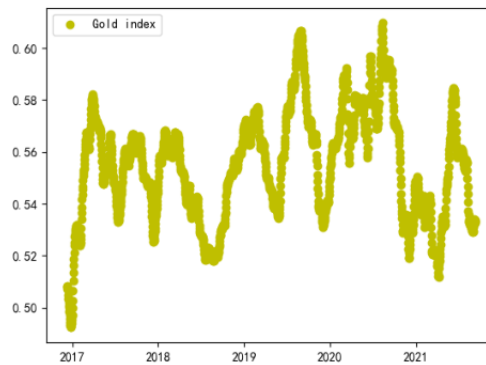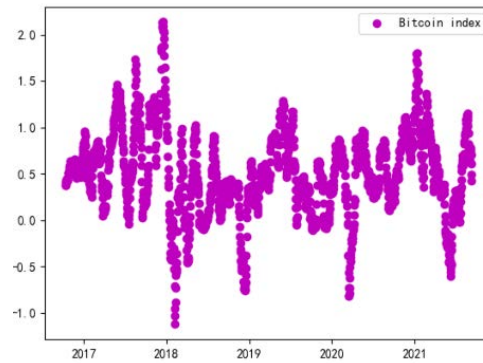| Market & Index | Gold Index | Bitcoin Index |
|---|---|---|
| Cow Market | >0.546 | >0.5 |
| Bear Market | <0.546 | <0.5 |



Figure. 4 Gold Index

Figure. 5 Bitcoin Index

By this scoring model, we can judge the fitting degree of the model by showing the market's performance during different periods by diagrams and comparing them with actual data. Due to the stability of the price of gold, we choose 90 days as a circulation to decide whether the market is a cow one or not. As for bitcoin, the great fluctuation in short periods leads to a 30-day circle to decide whether it is a cow market or not.

By analyzing the line chart that shows the performance of the market, we can see the high similarity between the judgment upon cow/bear market and the trend of the actual price, from which we can determine that the model to judge whether the market is good or not is successful.

## 4. Conclusion

By comparing the predicted data from the ARIMA model and the actual data, we can define the validity of our prediction. By combining the two types of basic data, we can construct the secondary indices multiplied by a specific weight calculated by the entropy method to build the marketing model. Specific scoring methods supported by the TOPSIS algorithm shall then be supplied to the output to determine our trading strategy. Nowadays, the global capital market has been undergoing violent changes with the influence of COVID-19. With disastrous concussion on the economic development of various countries, the capital market cannot help being affected—the US. Stock. The leader of the capital market, together with its followers, is facing valuation bubbles on the verge of fragmentation. With the uprise of the US. The historically-high-risky financial situation, bonds, and inflation are head above the water.

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