Research on Policy configuration Scheme based on improved ARIMA Model

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Abstract. In this paper, we use the principle of different models to remove the trend from the stock time series and choose the SARIMA [1, 1, 1][0,1,0] 12 models to fit the stock price. The results show a good prediction performance. Then a ternary transaction strategy is proposed, accurately identifying value changes regarding cash as financial products (expected rate of return = 0%, cost = 0%), and establishes a ternary asset flow model. Combining the expected rate of return and volatility, we model the value of existing financial products. Based on the trend accuracy to evaluate the accuracy of stock price prediction, the SARIMA model shows high accuracy in the verification set, and the maximum root mean square error (RMSE) is 11. 5494. The final five-year return is 51973 times higher than the bank savings and fixed investment return.

Keywords: SARMI model; Curve fitting; Investment forecast; RMSE.

1. Introduction

Our society has witnessed the rise of quantitative trading. A distinguishing feature of quantitative trading funds compared to traditional partials is their stock price prediction and quantitative risk assessment based on a large amount of historical data [6]. The recent explosion of Bitcoin and the significant volatility of gold have also provided new investment opportunities for quantitative trading funds. Previous work has shown that traders primarily refer to P/E ratios and risk assessments before purchasing financial products in the market [7, 8]. They can adjust their trading strategies by analyzing these indicators. Thus, historical price and risk assessment data of stocks inform traders' portfolio-making, which helps develop adaptive trading solutions [9]. By leveraging this data, we can achieve a win-win situation of maximizing returns and controlling risk.

2. Establishment of ARMA model

2.1. Preliminary construction

ARMA model (English: Autoregressive moving average model, full name: Autoregressive sliding average model). It is an important method for studying time series and consists of a "mixture" of an autoregressive model (AR model) [1] and a moving average model (MA model). It is often used in market research to track data over time, such as Panel research.

$$X_t = c + \sum_{i=1}^{p} \varphi_i X_{t-i} + \varepsilon_t \tag{1}$$

The autoregressive model describes the relationship between current values and historical values. (Where: c is a constant term. It is assumed to have a mean equal to 0 and a standard deviation equal to the random error value and is assumed to be constant for any t.

$$X_t = \mu + \varepsilon_t + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i} \tag{2}$$

The moving average model describes the accumulation of errors in the autoregressive component. (Where μ is the mean of the series, θ_i θ_p are the parameters, and ε_t $\varepsilon_{t-1} \ldots \varepsilon_{t-q}$ are white noise)

$$X_t = c + \varepsilon_t + \sum_{i=1}^{p} \varphi_i X_{t-i} + \sum_{j=1}^{q} \theta_j \varepsilon_{t-j} \tag{3}$$

The ARMA (p, q) model contains p autoregressive terms and q moving average terms [2].

2.2. Differencing to Remove Trendiness

Differencing soothes out the mean of a time series by removing some of its various characteristics and therefore eliminates (or reduces) the trendiness of the time series [3].

$$y_t' = y_t - y_{t-1} \tag{4}$$

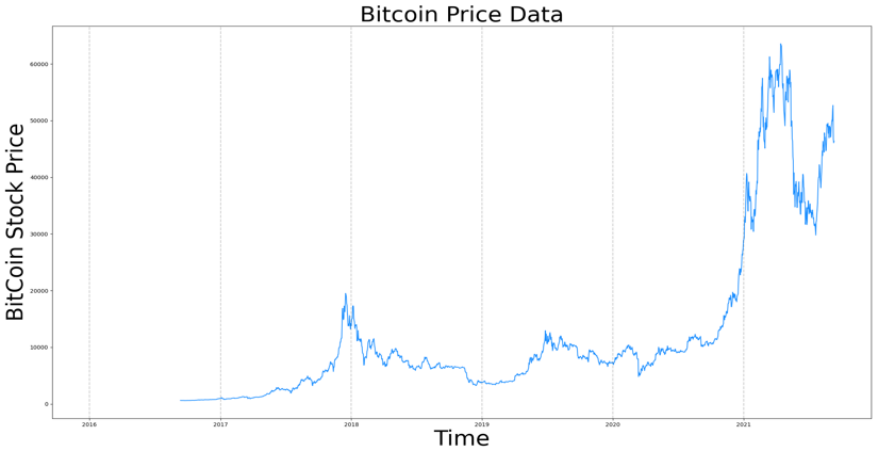

Figure. 1 Bitcoin share price time series chart.

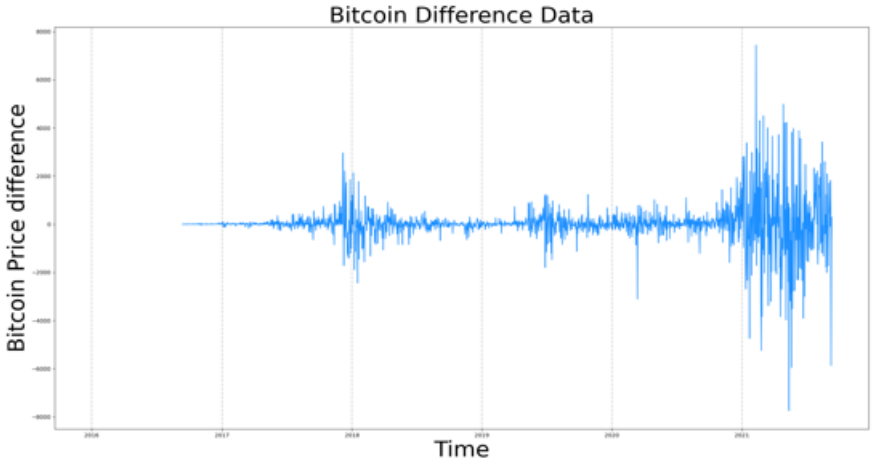

Figure. 2 Difference in Bitcoin share price.

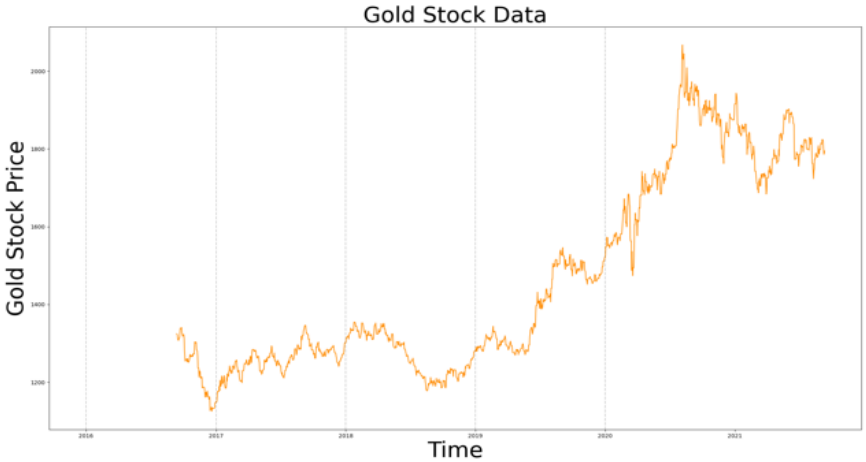

Figure. 3 Gold stock price time series chart.

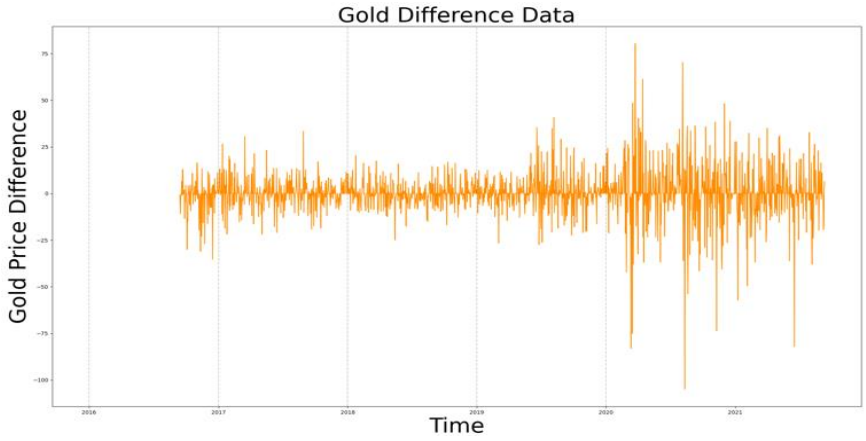

Figure. 4 Difference in gold share price.

The differential image conforms to the characteristics of a smooth time series.

When the data in a time series is affected by seasonal factors (e.g., time of year or time of the week), the series is said to be seasonal. Seasonality is always a known and fixed frequency. So seasonality and periodicity are eliminated. When the time series data has an irregular rising and falling frequency, it means that the series is cyclical. These fluctuations are often caused by economic activity and are related to the "business cycle." Periodic fluctuations usually last at least two years. Many time series contain trends, seasonality, and cyclicality [4].

a. ACF is the intercorrelation of a signal on itself at different points in time [5]. Informally, it is the similarity between two observations as a function of the time difference.

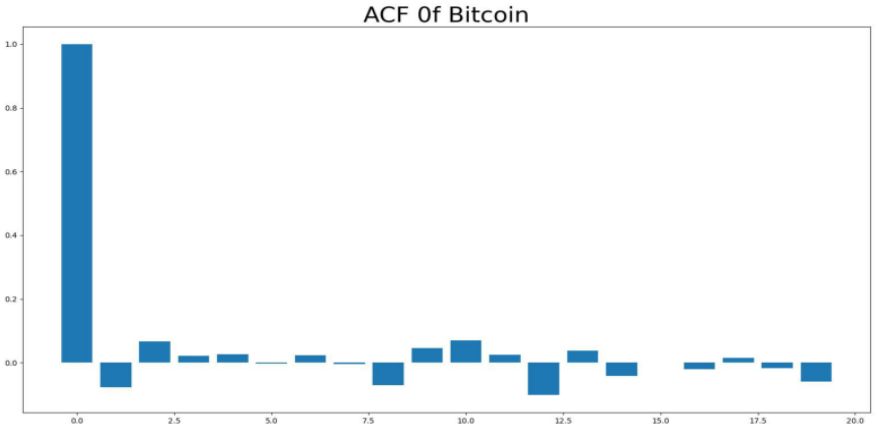

Figure. 5 The ACF analysis towards the Bitcoin.

The bar chart above indicates that the difference of Bitcoin has seasonality with the period time interval of 10 days.

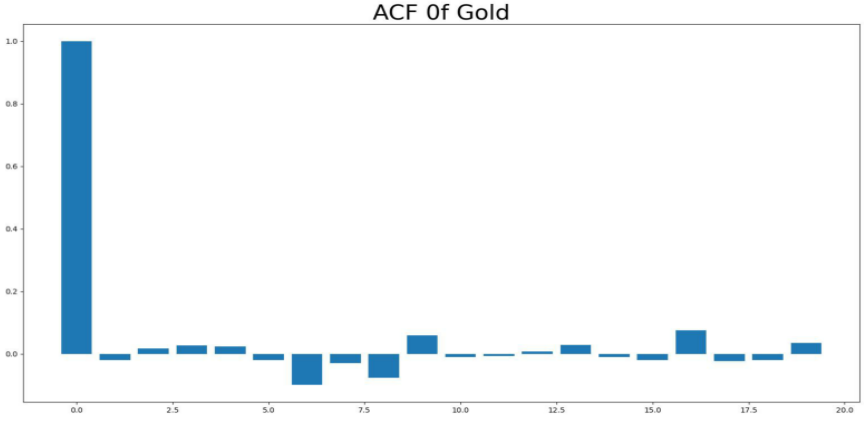

Figure. 6 The ACF analysis towards the gold.

The bar chart above indicates that the difference of gold has seasonality with the period time interval of 8 days.

b. PACF: with a delay of k, this is the correlation between the values of sequences k time intervals apart, taking into account the values between the intervals.

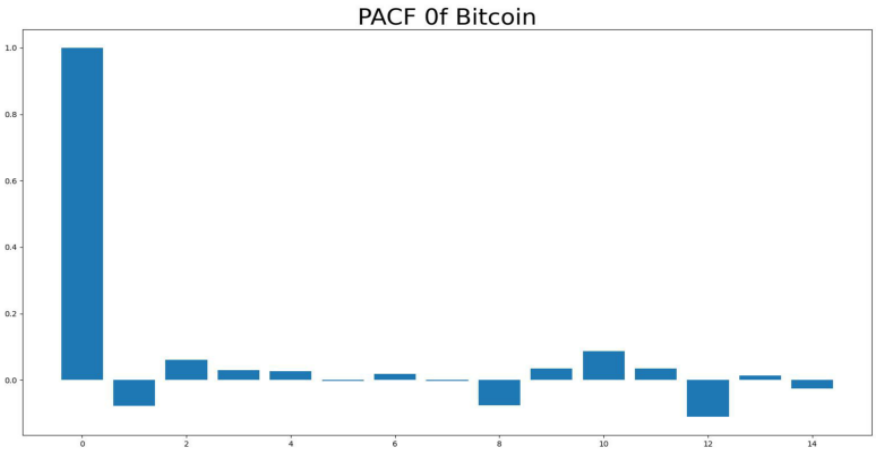

Figure. 7 The ACF analysis towards the gold.

The bar chart above indicates that the difference of Bitcoin has seasonality with the period time interval of 10 days.

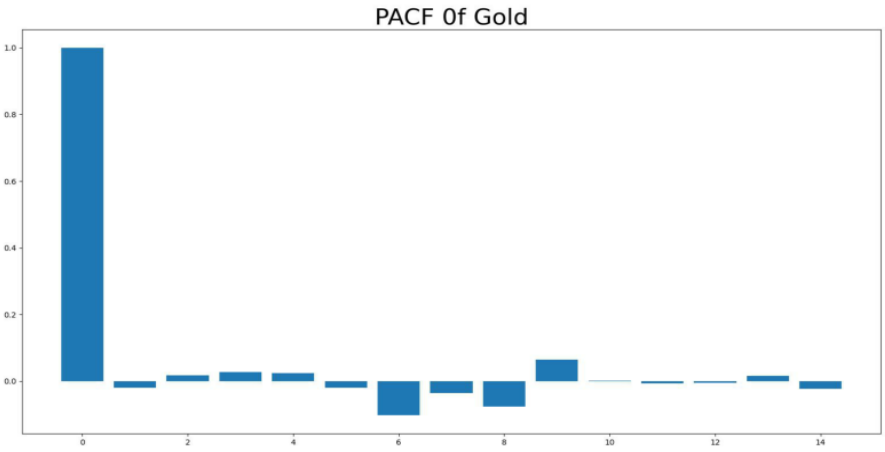

Figure. 8 The ACF analysis towards the gold.

The bar chart above indicates that the difference of gold has seasonality with the period time interval of 9 days.

c. Seasonal decomposing:

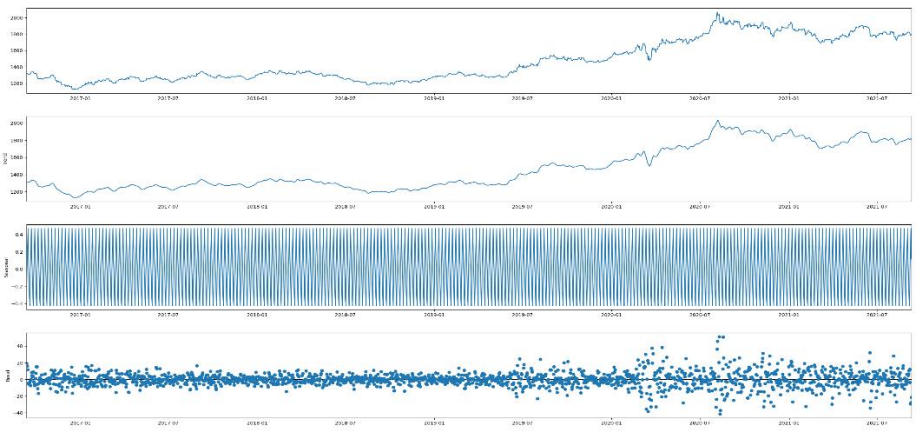

Figure. 9 Seasonality verification (decomposing method).

3. Sarima Model

The seasonal part of the model consists of terms similar to the non-seasonal components of the model but involves backshifts of the seasonal period. For instance, an ARIMA (1, 1, 1) (1, 1, 1)4 model (without a constant) is for quarterly data (m = 4), and can be written as

$$(1-\phi_1 B)\left(1-\Phi_i B^4\right)(1-B)\left(1-B^4\right)y_t = (1+\theta_1 B)\left(i+\Theta_1 B^4\right) \tag{5}$$

The additional seasonal terms are multiplied by the non-seasonal terms:



Figure. 10 Bitcoin Stock Price Forecast.



Figure. 11 Gold Stock Price Forecast Chart.

It uses mean absolute error to evaluate how precise our prediction model is.

$$\frac{1}{n}\sum_{i=1}^{n}\sqrt{\frac{Y_{pre}-Y_{true}}{Y_{true}}} \tag{6}$$

The result is that the mean absolute percent error of Bitcoin and Gold are 0.0275 and 0.0043, respectively, which shows our prediction model predicts precisely even under huge fluctuations.

4. Construction of value calculation model

4.1. Value Computing

Value theory formula: Bitcoin/Gold:

$$\begin{aligned} \rho_{\text{bitcoin/gold}} &= \beta * (1+R) / Var * Gauss(0,1) \\ R &= \left(Yt+1'-Yt\right)/Yt - Cost_{\text{bitcoin/gold}} \end{aligned} \tag{7}$$

To model the potential risk, we use Gauss(0,1) IID as a risk term that can generate a random investing risk rate and combine with the volatility of stocks represented by the Var(Standard deviation). The value of cash is a constant number 0.1 since it has no trading cost and its risk is absolutely 0.

4.2. Trading Strategy

The above value theory model did not show great performance in the experiment. We believe that the differential process contains volatility and that the introduction of variance leads to correlation disturbances. The modified value theory we eventually used is shown below.

$$\rho = \beta * R \tag{8}$$

This paper proposes an advanced quantitative trading strategy based on fixed value theory. The strategy includes calculating the value of the SARIMA forecasts at each moment in time, ranking the two assets with relatively low values in order of magnitude, and converting all of them into the highest valued assets.

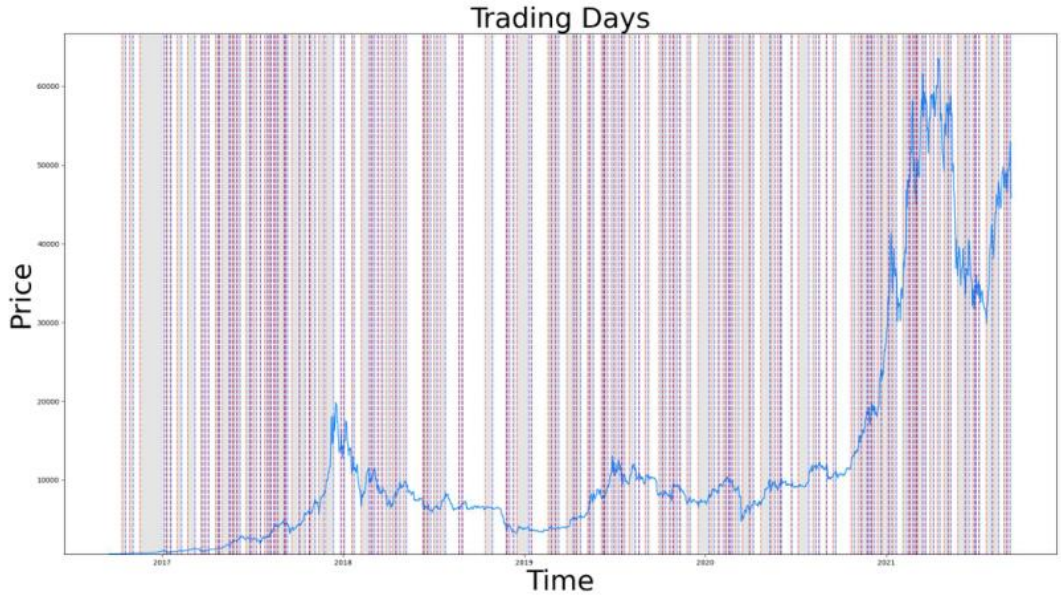

Figure. 12 Whole Transaction History



Figure. 13 Transaction History between Sep. 2017 and Feb. 2018.

Red is the buy record in the chart above, and blue is the selling record. The green area represents the position holding period. As we can see, at the end of 2016, 2018, 2019, and the middle of 2020, our model buys a more enormous amount of Bitcoins, which makes 50,000 times of wealth growth. Our model feels two coming peaks of Bitcoin and Gold and buys them in advance.

5. Conclusions

Under the guidance of equity value investment theory, the quantitative trading model usually evaluates the value and risk of each product. Because the analysis of stock return and stock volatility has received widespread attention, modeling analysis. Therefore, this paper uses the difference model to remove the trend from the stock time series. Moreover, choose SARIMA [1, 1, and 1] [0, 1, and 0] 12 models to fit the stock price, and the result shows a good prediction performance. The value change is accurately identified by regarding cash as a financial product (expected rate of return = 0%, expense = 0%), and a ternary asset flow model is established. Combining the expected rate of return and volatility, we model the value of existing financial products. By allocating funds on a pro-rata basis, we can maximize the return on our portfolio and minimize risk. Furthermore, based on the model in the literature, a "trend accuracy" is proposed to evaluate the accuracy of stock price forecasting. SARIMA model shows high accuracy in the verification set, and the maximum root mean square error (RMSE) is 11. The results show that the cost/income of the model is 54.83%, and the total number of transactions is 91, which shows that our model can balance transaction costs and actual returns.

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