

Trading strategy model of gold and bitcoin based on user investment income

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Abstract. Gold and bitcoin are the hottest investment products today. In this wave of investment, a large number of investors swarmed in, trying to obtain huge profits. Therefore, it is very important to establish mathematical models to help traders make decisions. In order to explore the best trading strategy to maximize revenue, we need to solve prediction problems to help carry out quantitative trading. Based on the time series given in the question, we use the LSTM long-term and short-term memory neural network model to build the network layer, and set the training time to predict the gold and bitcoin prices on the trading day. We use quantitative trading investment method, combined with turtle strategy and prediction data to obtain the daily transaction types of gold and bitcoin, and then combined with alpha hedging strategy and LB ladder rule to obtain the daily transaction quantity of both, and then combined with the Commission of each transaction to obtain the daily total account value model.

Keywords: LSTM Long Short-Term Memory neural network, quantitative trading.

1. Introduction

To maximize the total return on speculation, market traders often buy and sell assets with relatively high price volatility, two of which are gold and bitcoin. Commissions accompany each purchase and sale. While the epidemic and domestic economic policy changes have caused the normally stable price of gold to fluctuate, bitcoin has maintained its long-standing price movement.

The whole market remains in distance volatility due to the global epidemic. Gold, as a safe-haven asset, is driven by risk aversion on the one hand, but investors' demand for liquidity, on the other hand, makes them sell gold sharply, so gold prices are likely to continue this oscillating state. In this situation, more and more stockholders are choosing gold to improve their investment yields. Because bit has stable bookkeeping properties with value preservation, it is also called digital gold. With many companies fearing a declining dollar, bitcoin has become very popular, and many people are buying bitcoin to preserve their assets. Ease of circulation and preservation of the value of bitcoin is the most valuable aspect of bitcoin. Long Short-Term Memory Model. For these two popular investment products, this paper establishes a prediction model to calculate the daily account value model, which provides some support for relevant practitioners to calculate the return on investment.

2. The Establishment of Long Short Term Memory Model

After data pre-processing and making the model, we came up with prediction curves for bitcoin and gold. During this process, we divided the data into predicted and tested values for prediction, and then scored them with residual standard deviation (RMSE) and found that the predicted values were significantly better than the tested values, so we predicted all the data for the predicted values and came up with prediction curves. The implementation process is as figure1.

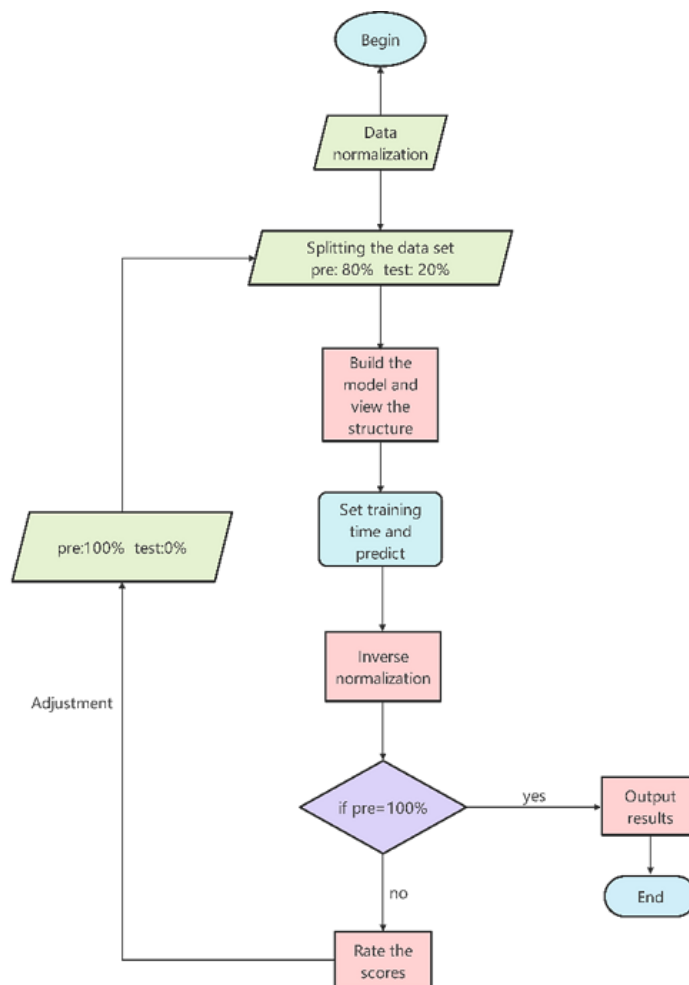


Figure1 Flow chart of the LSTM based prediction

After we made the LSTM model and check the structure, we built 943,000 network layers in total. Setting the training time, we were able to train all epochs in a short time. Then we substituted the data to get the prediction results. By recording some parameter changes during the training process, we were able to see that our loss parameter dropped very quickly and finally converged to a small value, indicating a good training effect, and the following figure shows the loss parameter. Loss parameter drop image is shown as figure2.

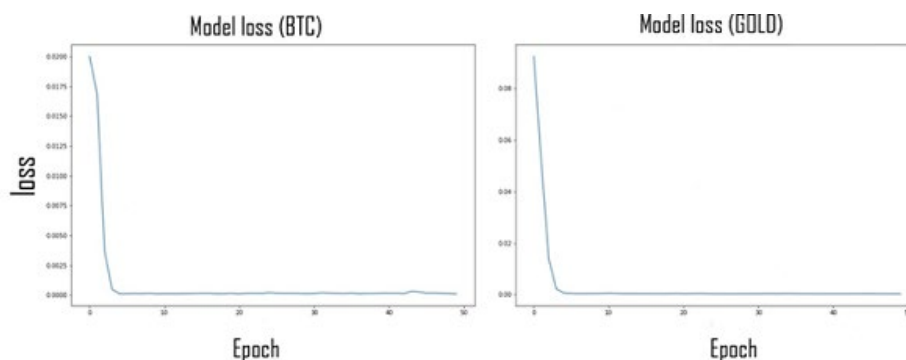


Figure2 Loss parameter drop image

The figure3 shows the image of the resulting prediction data. The first 80% of the data for each investment commodity is the predicted value prediction data, and the last 20% is the test value prediction data. Then, we apply the root mean square error (RSME) scoring method to further verify the stability of the predicted value prediction data, after calculation, the pre score:343.36 while the test score:2587.80. The pre score is lower than the test, so we can adjust the prediction ratio to 100% to get the forecast results for gold and bitcoin, which follows the figure4 shows[1].

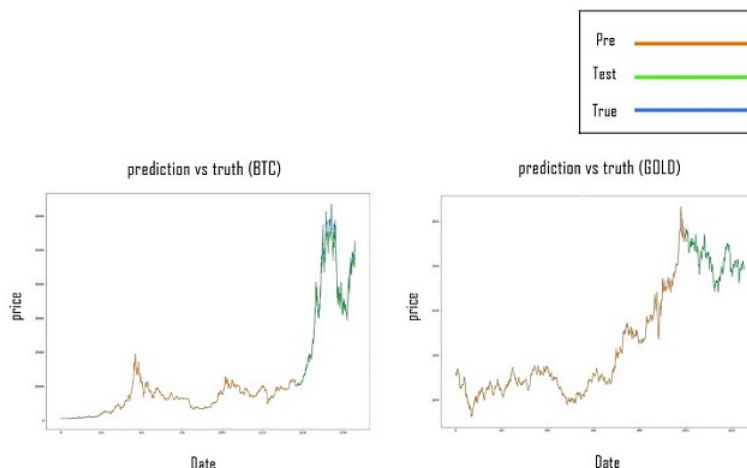


Figure3 Prediction comparison chart with predicted and tested values

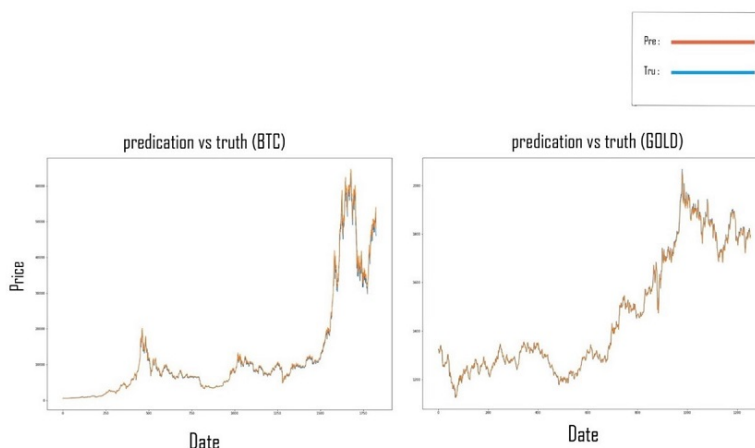


Figure4 Gold and Bitcoin Forecast Results

3. LSTM Forecasting-Highest Return model

3.1 The Establishment of LSTM Forecasting-Highest Return model

Quantitative trading[2] is a computer-aided tool that uses a programming development language to write programs that analyze, judge, and help provide decisions with a fixed logic. Complete quantitative trading should include the input of data, processing of trading strategies, backtesting, and analysis of data, display of return results, giving trading judgments, and finally automated or manual way to complete the trading. The selection of data has a significant impact on the quantitative trading strategy. Currently, there are a large number of stocks in the stock market, and it is especially important to select which stock and which period of stock data to use, so the back-testing analysis of the data and thus the optimization of the trading strategy is an important aspect. The following figure5 shows the development process of the quantitative trading system.

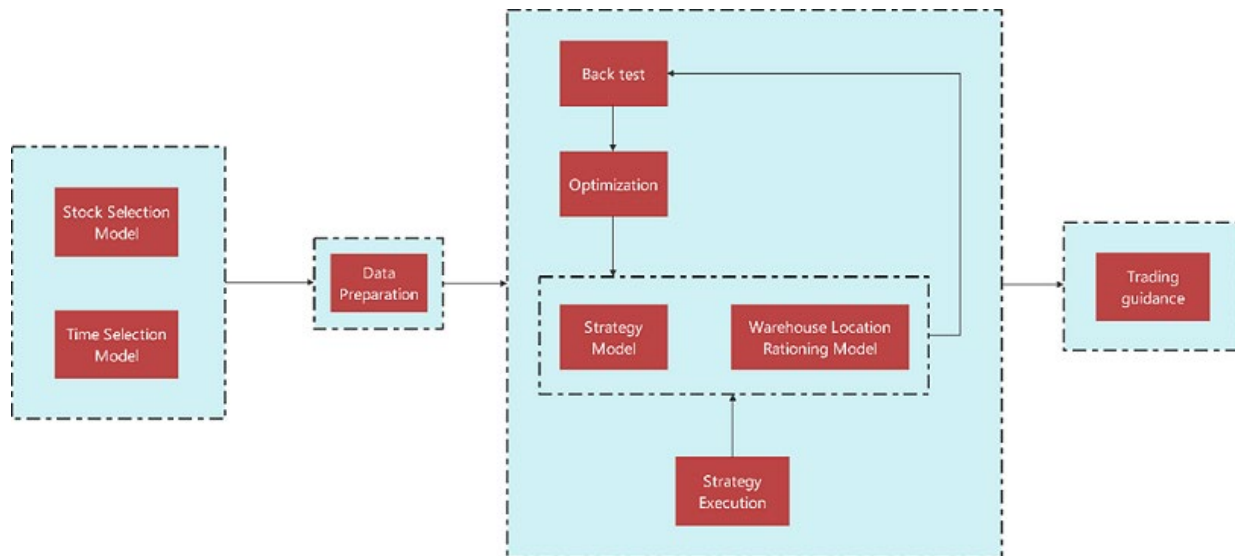


Figure5 Quantitative trading system development process

3.2 Turtle-Alpha Quantitative Trading

Turtle trading[3] is a complete, mechanical trading idea that can systematically complete the entire trading process. It includes a series of trading strategies such as what to buy and sell, position size, when to buy and sell, when to exit, etc. It is a trend trading strategy.

The turtle trading method divides the position opening capital into several small parts according to a certain ratio. Each position opening position and position addition size are related to the volatility amount ATR, which is the average amplitude of the maximum intra-day index fluctuation, determined by the highest and lowest prices of the day and the closing price of the previous trading day. For this question, quantitative trading can be divided into two parts. The first part is to determine whether a trade is necessary, and the second part is to determine the amount of the trading.

3.2.1 Sea turtle trading

For turtle trading, it is a complete, mechanical trading idea that can systematically complete the entire trading process. It includes a series of trading strategies such as what to buy and sell, position size, when to buy and sell, when to exit, etc. It is a trend trading strategy.

The turtle trading method divides the position opening capital into smaller parts according to a certain percentage. Each position opening position and position addition size is related to the volatility volume ATR, which is the average amplitude of the maximum intra-day index fluctuation, determined by the highest and lowest prices of the day and the closing price of the previous trading day.

$$TR = \text{Max}(H - L, H - PDC, PDC - L) \quad (1)$$

$$ATR = \frac{TR}{n} \quad (2)$$

PDC is the previous day's closing price, H is the day's highest price, and L is the day's minimum price. PDN is the previous day's n value, and ATR is the average value of TR over n days.

Using the n value to reflect the value fluctuation[4] amount DV:

$$DV = n \times C \quad (3)$$

C is the value per point of the contract, where the amount of value represented by each point is the price represented by each index point.

Number of contracts per open trade UNIT is determined by dividing 1% of total assets by DV. A is total account assets

$$Unit = \frac{1\%A}{DV} \quad (4)$$

3.2.2 The improvements

In order to avoid that the revenue from the transaction is less than the commission charged, we intend to set PAK (Predicted and Known).

$$PAK = \frac{PP}{PDC} \times ATR \quad (5)$$

Where PP is the price of the day predicted earlier and PDC[5] is the actual price of the previous day. ATR is the ATR for Turtle Trading.

For the 'buy low, sell high' idea, according to the principle of price and actual distribution, the use of PR (Price Real) to reflect the price of the day high or low

$$PR = \frac{PDC}{R} \times Unit \quad (6)$$

R is the actual price

$$R = \frac{\sum_{i=1}^n PDC}{n} \quad (7)$$

Finally, we get BS(Buy Sell)

$$BS = PR + PAK \quad (8)$$

From this, a BS scatter plot can be obtained from the data. BS scatter plot of GOLD is shown as figure6. BS scatter plot of BTC is shown as figure7.

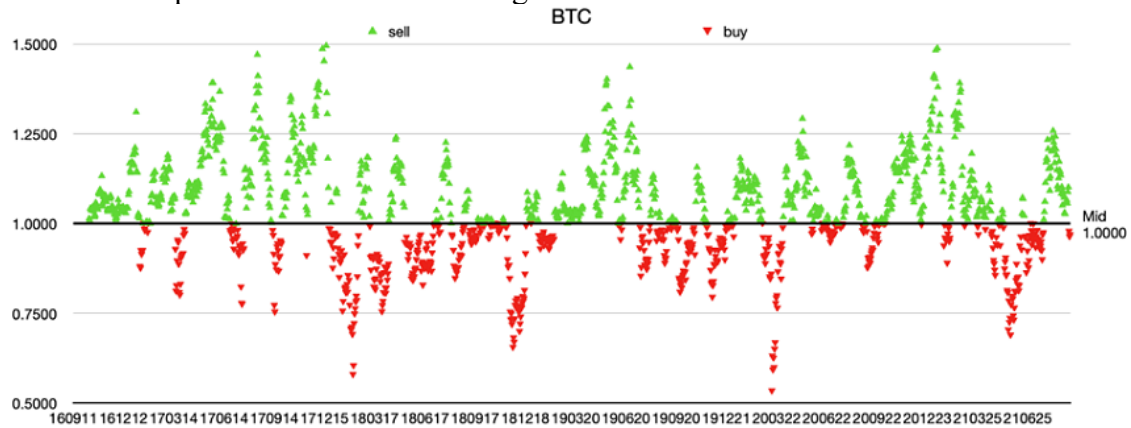


Figure6 BS scatter plot of GOLD

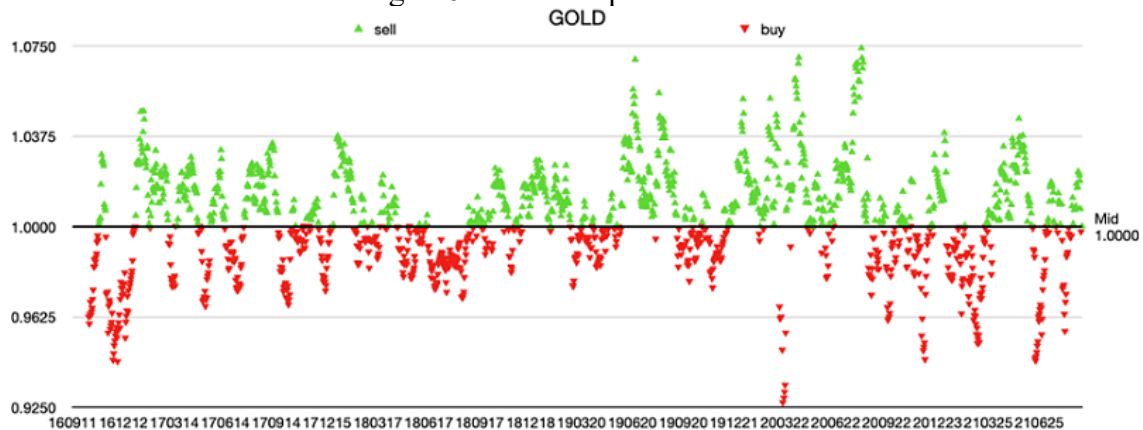


Figure7 BS scatter plot of BTC

In both charts, the red part corresponds to a time when the price is 'cheap' and the green part corresponds to a time when the price is 'expensive'. Because both charts have a midline, the midline means that the current price of gold or bitcoin is the same as its real value, and when the BS is less than 1[6] then its price is less than its real value, and their prices will eventually approach or even exceed the midline. Therefore it is best to buy when the BS is less than 1.

3.3 Alpha Hedging

For Alpha strategies, starting with the CAPM model, assuming that the market is equilibrium, the expected excess return of the asset is then determined by the market return excess return and risk exposure. This is shown in the following equation[7].

$$E(r_p) = r_f + \beta_p(r_m - r_f) \quad (9)$$

where r_m is the market portfolio and r_f is the risk-free rate of return.

According to the CAPM model, the expected return of the portfolio consists of two parts, one is the risk-free rate of return r_f and the other is the risky rate of return.

However, the CAPM model represents the market in equilibrium, but the market is not always in equilibrium, and individual stocks will always earn returns that exceed the level of the market benchmark, i.e., there is always an α term at the right end of the CAPM model.

To solve this problem, in 1968, the American economist Michael Jensen proposed the Jensen index to describe this α , so also known as α index. The calculation is shown as follows:

$$\alpha_p = r_p - [r_f + \beta_p(r_m - r_f)] \quad (10)$$

Therefore, the return of the portfolio can be rewritten as follows

$$r_p = \alpha + \beta_p(r_m - r_f) \quad (11)$$

The return of the portfolio can be split into α return and β return. The formula for calculating β is as follows

$$\beta = \frac{\text{COV}(r_p, r_m)}{\sigma_p \sigma_m} \quad (12)$$

β is determined by the market, is systematic risk, and is not related to the investor's management ability, but only to the portfolio's relationship to the market. When the market as a whole falls, the return corresponding to β also falls with it (assuming positive beta).

To further achieve quantitative precision in trading, we introduce the LB (Labber Rule) ladder rule[8].

Buy one unit (e.g. 1% of the position) if the current price is higher than the highest price in the last 20 days.

Add a position: If the price has risen by a certain percentage (e.g. 1% of the position) from the previous buy, add one unit to the position.

$$LB = \frac{\alpha_p \cdot PP}{PDC} \quad (13)$$

On the basis of this, we introduce our model.

$$\text{Num} = \frac{LB \cdot r_p}{\beta} \quad (14)$$

3.4 The Suolution of LSTM Forecasting-Highest Return model

Finally:

$$PR = \left(\frac{PDC}{R} \times \frac{1\%A \cdot n}{TR} + \frac{P}{PDC} \times ATR \right) \times \frac{LB \times (\alpha + \beta_p(r_m - r_f))}{\frac{\text{cov}(r_p, r_m)}{\sigma_p \cdot \sigma_m}} \quad (15)$$

Where PR greater than 0 means buy and less than 0 means sell. According to the formula, the daily transaction amount PRgn for gold and PRbn for bitcoin can be derived respectively

Combine the daily transaction amount^[8]with the commission, gold and bitcoin prices to get the total daily account value[9].

$$VALUE_n = \sum_{i=1}^n |PR_{gi}| \cdot \alpha_{gold} + \sum_{i=1}^n |PR_{Bi}| \cdot \alpha_{bitcoin} + g \cdot PDC_g + b \cdot PDC_b + D \quad (16)$$

VALUEN is the total value of the account on day n. g is the amount of gold in the account, b is the amount of bitcoins in the account, and D is the amount of dollars in the account. Bringing this data into the formula for calculation: the following figure8 is obtained.

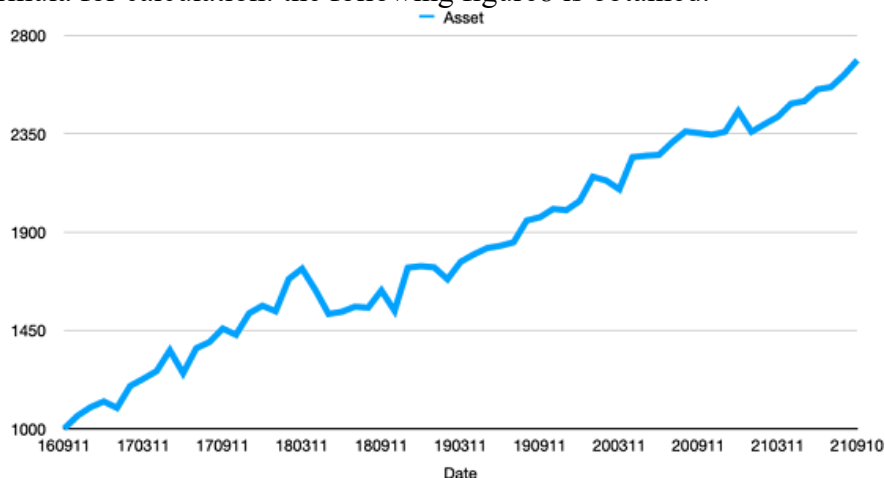


Figure8 The trade of total value

After five years, our account has risen from \$1,000 to \$2,685.84, for a total gain of 168.58%. And the gains have risen almost continuously and do not fluctuate with the price of gold or bitcoin, so our plan is working[10].

4. Conclusion

In this paper, an investment and trading mathematical model based on gold and Bitcoin is established to help traders make decisions. Firstly, based on the time series trend, we use long and short term memory neural network model to build the network layer, and set the training time to predict the gold and bitcoin prices on the trading day. Next, quantitative trading and investment method is adopted to obtain the daily trading types of gold and Bitcoin by combining turtle strategy and forecast data, and then the daily trading quantities of both are obtained by combining Alpha hedging strategy and LB ladder rule, and the daily total account value model is obtained by combining the commission of each transaction. This paper establishes a prediction model to calculate the daily account value model, which provides some support for relevant practitioners to calculate the return on investment.

References

- [1] Zhang N,Fang JW,Zhao Yuxuan. Bitcoin price prediction based on LSTM mixture model[J]. Computer Science,2021,48(S2):39-45.
- [2] Nash Kathryn,Trott Verity,Allen William,Iordache Catalina,Raats Tim,Afilipoaie Adelaida. Transnationalisation revisited through the Netflix Original: An analysis of investment strategies in Europe[J]. Convergence: The International Journal of Research into New Media Technologies,2022,28(1).
- [3] Wnuczak Paweł. Profitability of investment strategies developed on the basis of buy and sell recommendations[J]. Journal of Economics and Management,2021,43(1).
- [4] e Qixiang,Ma Yutong. Classification study of commodity futures risk premiums under different trading strategies[J]. Journal of Management Engineering,2019,33(03):52-60.DOI:10.13587/j.cnki.jieem.2019.03.007.
- [5] Sin, Jing. Quantitative trading strategy of A-shares based on KNN algorithm[J]. Bohai Rim Economic Outlook,2020(01):153.DOI:10.16457/j.cnki.hbhjllw.2020.01.105.
- [6] Huang, W.L.. Research on investment portfolio optimization based on multi-objective evolutionary algorithm [D]. Harbin University of Commerce, 2020. doi:10.27787/d.cnki.ghrbs.2020.000514.
- [7] Yongqi Zhang,Haiying Shi. Research on Quantitative Investment Strategy based on Empirical Analysis of Shanghai A-share Market Data[C]//.Proceedings of 2nd International Conference on Advances in

Social Sciences and Sustainable Development (ASSSD 2021),2021:188-192.DOI:10.26914/c.cnkihy.2021.005777.

- [8] Reza Gharoie Ahangar,Asma Salman. Investment Strategies in Emerging New Trends in Finance[M].IntechOpen:2021-04-14.
- [9] Shaokang Zhang, Zizhan Wei. Analysis of Trading Strategy based on LSTM[J]. International Core Journal of Engineering,2022,8(8).
- [10] Shi Yukun,Chen Ding,Guo Biao,Xu Yaofei,Yan Cheng. The information content of CDS implied volatility and associated trading strategies[J]. International Review of Financial Analysis,2022,83.