Prediction of Gold ROI Based on LSTM model

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Abstract. The developed financial market system must develop the gold market and play an important role in the financial market. Like other financial markets, the gold market also faces the risk of price fluctuation. Although gold has the monetary attribute, its own value is stable, and it has the hedging function, the price of any commodity always fluctuates around its own value, and the market risk caused by gold price fluctuation is inevitable. At the same time, the gold market trading products are almost homogeneous, which determines that the price of gold in the domestic market and the domestic and foreign markets cannot deviate too much, and the existence of certain price differences between different markets will lead to arbitrage between markets. Therefore, it is necessary to forecast the gold yield. Based on this, this paper uses LSTM model to forecast the price yield of gold. The research results show that the price of gold will still fluctuate in the near future. This research has certain theoretical and practical significance for the application of LSTM model in the financial field.

Keywords: LSTM; Gold; Machine Learning.

1. Introduction

For a long time, gold has played an important role in the monetary system and has an important function of value scale. As one of the important assets in the financial market, the research and prediction of gold price fluctuation is very important [1]. In addition, gold returns have a significant impact on many financial activities around the world. This is because it is possible to develop a reliable predictive model to gain insight into the situation, behavior and dynamics of gold stocks, which could ultimately provide the opportunity to gain significant profits [2]. Therefore, in this work, the study decided to study the topic about gold in order to accurately predict the yield and movement of gold. Since it is an investment in the trading market, important for both personal asset investment and hedging, it makes sense to predict its price return.

Firstly, the motivation mainly comes from the importance of gold. Second, due to the complex and volatile world economic environment, gold because of its value preservation and appreciation function, asset allocation value is increasingly prominent. Affected by the epidemic, there was a massive shock in the financial market in 2020, but the gold market performed well spot gold prices rose from $1517.18/oz at the beginning of 2020 to about $1900 at the end of the year, an increase of about 25%. This rise was accompanied by the enthusiasm of gold investors to trade, with gold trading volume on the Shanghai Gold Exchange reaching a record high of 21.23 trillion yuan in 2020 by the end of November. However, a fact that should not be overlooked is that the road to the top of the gold price has not been a smooth one. After hitting an all-time high of $2,075.14 per ounce, gold experienced its biggest one-day drop of the year. This means that in a two-way long/short gold market, high volatility can bring increased risk if investors get the rhythm wrong [3]. Misjudgment of gold investments can lead not only to massive investment and financial losses, but also to potentially unprofitable mining projects for gold miners. Therefore, under the current situation where the uncertainty of the international situation has increased significantly and the financial market is caught in a wave of unconventional monetary policies, the study of gold market yields is undoubted of great practical significance to protect investors' assets, safeguard the healthy and stable development of the real economy and enhance the level of national financial security. It can be seen that it is particularly important to forecast the gold yield.

The topic of the study will be the gold yield and its particular analysis of high returns. The economic and financial health of the banking and investment markets is significantly influenced by

gold yields. Due to its extensive trading service, rapid capital settlement, simplicity of use, two-way trading, favorable trend, and strong value preservation features, among many other benefits, it is a popular choice among market participants for risk management and hedging. Gold, however, always makes investing riskier. Because the causes of these variations are so complex, a variety of things might affect the pattern.

For instance, real yields and the movement of the US dollar influence gold's movement, whereas nominal interest rates and inflation have an indirect impact on real yields, which in turn has an impact on gold. Be aware that gold prices may fluctuate erratically, which could result in substantial gains or, conversely, sizable investment and financial losses. Gold also has a huge impact on gold mining firms since expensive mining projects might become unprofitable if yields drop dramatically in the future. Therefore, it is crucial for financial investors and central banks to establish reasonable and efficient forecasting models that illustrate and reveal the trends in gold yields and their evolution mechanisms in order to reduce potential risks and help them make informed decisions for their investment policies.

Nonlinear models started to be gradually used to the prediction problem of gold production time series as the quality of computer hardware increased quicker and faster and the research on neural networks evolved. Many academics have started utilizing LSTM models to simulate stock market projections in recent years, and some financial series forecasts using LSTM models have produced promising forecasting outcomes. LSTM models do, however, have some drawbacks. The fact that the LSTM model mainly relies on stepwise forecasting is a key drawback when attempting to predict time series. As a result, long-term forecasting using LSTM could not be successful.

LSTM forecasting model from traditional forecasting models and nonlinear forecasting model, to establish a more suitable gold futures price forecasting approach. As the research object, the study chooses the gold return from 2000 to 2020. First, the study normalizes the original gold return. Next, the study compares the models under various parameter settings. Finally, the study chooses the parameter model to find best fits the normalized value and report the forecasting findings. The outcomes show the model ‘s shortcomings in the analysis of gold returns.

For gold prediction results, a large number of studies focus on ARIMA or VAR models, and predict future prices based on past gold price trends. LSTM model is seldom used for prediction. Based on this, this paper chooses LSTM model to analyze the price trend of gold, and tries to find the price fluctuation rule of gold during and after the epidemic.

2. LSTM Model

Long Short-Term Memory (LSTM) was proposed by Hochreiter and Schmidhuber in 1997 [4]. The cell state is the key of LSTM. To protect and control the state of the memory cell, three control gates are placed in a memory cell, called input gate, forget gate and output gate. The structure of the LSTM memory cell is shown in the figure below. A horizontal line running across the top of the diagram from the input on the left to the output on the right is the state of the memory cell. The two layers in the figure 1 correspond to the input and output of the memory cell, and the first layer generates a vector, which is used to update the cell state. Details of the input gates, forgetting gates and output gates are as shown in figure 1.

In terms of forgetting Gate, when a message enters the network of LSTM, only the messages that meet the algorithm's certification can be not forgotten. It determines how much of the unit state of the previous moment can be retained until the current moment by substituting the input sum into the following equation.

In terms of input gate, the input gate determines how much of the input to the network at the current moment is kept in the memory cell state by sigmoid. Next, the layer generates a vector to update the memory cell state. Then, the obtained by the forgetting gate and the input gate are substituted, so that the current cell state and the long-term cell state can be combined to form a new cell state.

In terms of output gate, the output gate determines the LSTM output content. It first obtains an initial output through a sigmoid layer. Then it uses a layer to push the cell state values between -1 and 1. Finally, the output of the sigmoid layer and the layer are multiplied together to filter the cell states.

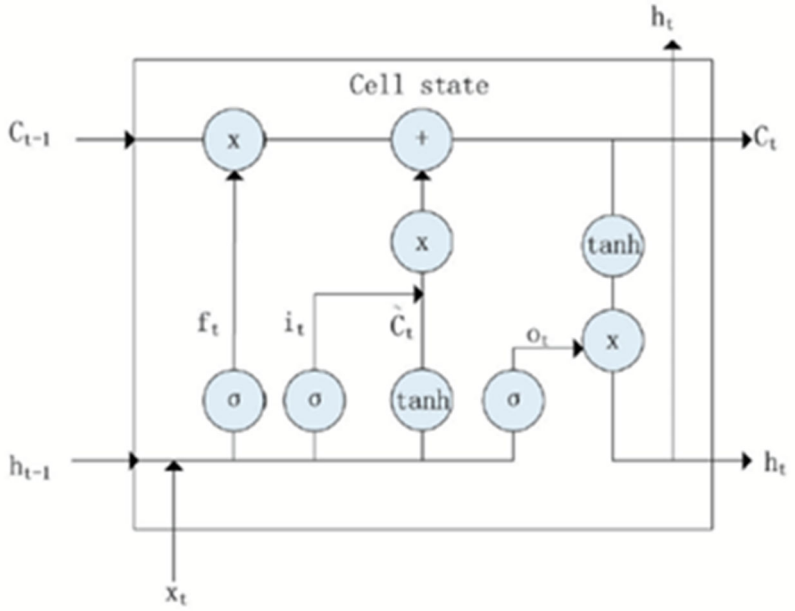

Fig. 1 Cell state in LSTM

To measure the effectiveness of the model in predicting gold yields. Mean absolute error (MAE), Mean Absolute Scaled Error (MASE) and Root Mean Square Error (RMSE) are selected as the forecast error indicators, where the smaller the value of these three performance indicators, the closer the forecast value is to the actual value, and the smaller the forecast error is.

$$\text{MSE} = \frac{1}{n}\sum_{t=1}^{n}(y_t - \hat{y_t})^2 \quad (1)$$

$$\text{RMSE} = \sqrt{\frac{1}{n}\sum_{t=1}^{n}(y_t - \hat{y_t})^2} \quad (2)$$

$$\text{MAE} = \frac{1}{\text{n}}\sum_{\text{i=1}}^{\text{n}}\left|\hat{y_i} - y_i\right| \quad (3)$$

Here y_t is the actual observed value, ŷt is the predicted value, and n is the number of prediction periods. The model with the lowest value obtained according to the above formula should be used as the most suitable model.

Neural networks, such as LSTM, are excellent at managing numerous variables, which makes them valuable for tackling time series forecasting problems. Traditional linear models struggle to solve multivariate or multi-input problems. The original data collection must first be transformed into time series prediction-ready data. In order for the LSTM model to predict stock returns at the moment the study want (t) from stock data and returns at the previous moment, the data also be adjusted when it is used. This includes normalizing the variables, both input and output values, and converting the dataset into a supervised learning problem (t-1).

The closing gold price in USD used in this study is information gathered by Yahoo! Finance (a website providing financial data and comments). It is more reasonable to forecast the rate of return in the gold price for only one day—a relatively short term that guarantees that the results predicted by the model and the author used the LSTM model is valid—rather than next year or even a longer period because the gold price and its return rate is highly affected by the long-term global economic and political circumstances. Therefore, using the two models indicated above, this study predicts the rate of return in gold price on May 1, 2020, and then evaluates its predictions against actual facts.

The next stage is to visualize the data, which enables a more understandable picture of the data. The price of gold fluctuated significantly from 2000 and 2020, as shown in the figure 2, showing both a growth and a reduction. It enables us to see the fluctuation of gold in a single image [5-7].

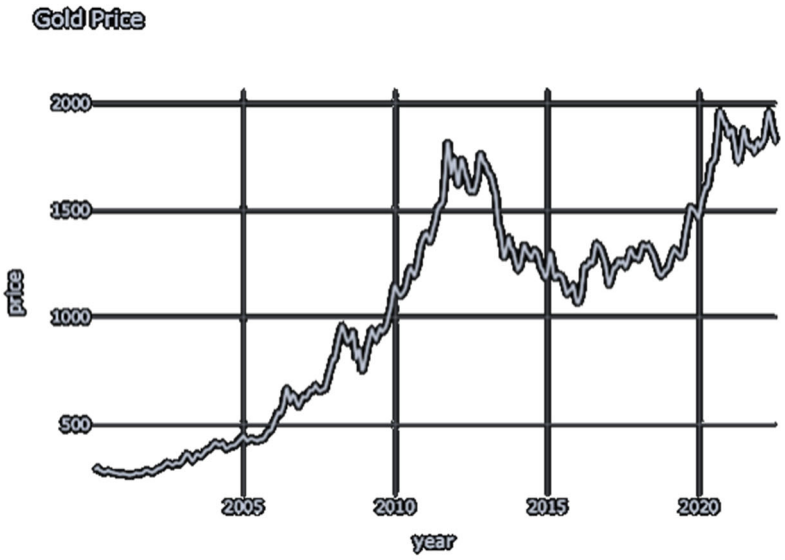

Fig. 2 Gold price from January 4th 2000 to July 11th 2020

The LSTM model is built next, and for prediction, the study employs a three-layer LSTM model. In order to forecast gold returns, the study first employed a three-layer LSTM model to determine the real yield using the function to use the data's gold price [8,9]. Then, in order to forecast the return on May 1st, 2020, the study used the return determined from the data of April 30th, 2020.The value of the prediction is 0.00019669.

A neural network called an LSTM takes dependencies between observations in a time series into account. As a result, forecasting uses them frequently. The major factor that makes LSTMs effective with erratic time series is their innate capacity to react swiftly to sudden changes in trend. For instance, an ARIMA model might not have been able to respond as rapidly to the unexpected decline in the price of gold. These days, RNN and LSTM are both commonly used. In the 1980s and 1990s, LSTM and RNN were created, and they made a comeback in 2014. They evolved over the subsequent years into a method for resolving sequence learning, or seq2seq, which produced tremendous advancements in speech-to-text recognition and the capabilities of Siri, Cortana, Google Voice Assistant, and Alexa. Let's not forget machine translation, which includes translating texts into various languages, as well as neural network machine translation, which also translates text into images, images into text, and captions for videos, among other things. Most of the time, RNN, LSTM, and their derivatives are processed sequentially. The horizontal arrows indicate that before entering the current processing cell, long-term information must pass successively through each cell. This indicates that it is easily corruptible by multiplying it by a large number of decimal multiples of zero. The issue with vanishing gradients is brought on by this.

Due to this, the LSTM model, which is now regarded as a rescuer, developed in a similar manner to the ResNet model in order to prevent cells and recall longer time steps (the LSTM solves the gradient problem because it avoids endless concatenation of multiplications and instead multiplies as it adds, which is similar to ResNet itself). As a result, LSTM could solve various gradient vanishing issues. This does not entirely cure the issue, as the preceding graphic shows. This path now has add-ons and ignores the branches related to it, making it more difficult. Without a doubt, LSTM, GRU (Gated Recurrent Uni, an LSTM derivative), and its derivatives are capable of remembering a lot of longer-term data. However, they are only capable of recalling sequences of 100 magnitudes, not 1000 or more.

Another issue is that it puts a lot of strain on the hardware to train them. A lot of resources are needed even when we don't need to train these networks quickly. Similar to running these models locally, running them in the cloud likewise uses a lot of resources. Because they require storage bandwidth-bound processing, which is the worst nightmare for hardware designers and ultimately limits the usability of neural network solutions, LSTMs are challenging to train. In order to execute

in each sequential time step, LSTM needs 4 linear layers per unit (MLP layers). To the point where they can't use many computational units, linear layers need a lot of storage bandwidth. Usually, this is because the system doesn't have enough storage bandwidth to support the computational units. Adding more computing units is also simple, but increasing storage bandwidth is more difficult Hence, hardware acceleration is not a good fit for LSTM and its variations [10].

3. Conclusion

For thousands of years, no other substance has had such a profound impact on human politics, ec onomics, culture and society as gold. Gold market traditionally is a complete financial market syste m in the indispensable sub-
market, it and the currency market, foreign exchange market, capital market and insurance market t o promote each other, and each play a unique function. The study in this article tests the applicability of the LSTM model while also making predictions about the return on gold. The significance of the article's research is to test the predict ability of the LSTM model for the prediction of objects over long time periods, even if the applied objects have high volatility. At the same time, the rate of return on gold has been an important indicator for judging the performance of the global economy. This paper takes gold as sample data, and forecasts the price trend of gold based on LSTM model. Consistent with the conclusions of others, gold prices will still fluctuate in the near future. This study has certain theoretical and practical significance for understanding the price fluctuation law of gold and the risk of financial market. The limitation of the article is that the study was conducted under ideal conditions and the results may be affected if a black swan event occurs.

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