



The Summary of Price Prediction Methods of Gold-related Financial Products

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Abstract. After the dismantling of the Bretton Woods System, the financial attributes of gold are gradually emerging, more and more gold-related financial products appear in the market in recent years, such as gold futures and so on. The price of gold-related financial products has reflected and influenced economic development and people's livelihood. So, the price prediction of gold-related financial products is important. The article will introduce the most advanced hybrid models for the prediction, such as SVM-D-Hurst-HLP and so on. Compared with traditional single models, these hybrid models have characteristics of a high accuracy rate. Meanwhile, they also have other problems, such as the high computing power requirement is high and complex operation. Although the present hybrid models have already had sufficient accuracy and strong adaptability, they will also exhibit large prediction deviations when faced with Extreme black swan events. And the large predicted cost has stopped the model from spreading and application. So, it will be one of the most important research directions that reduce the prediction deviation of extreme black swan events and the prediction cost of these hybrid models.

Keywords: Gold-related Financial, SVM-D-Hurst-HLR Model, DPformer Hybrid Model, MA-GRU Model.

1 Introduction

After the dismantling of the Bretton Woods System, the financial attributes of gold are gradually emerging, more and more gold-related financial products appear in the market in recent years, such as gold futures and so on [1, 2]. The price of gold-related financial products has reflected and influenced economic development and people's livelihood. So, the price prediction of gold-related financial products is important. The article will introduce the most advanced hybrid models for the prediction, such as SVM-D-Hurst-HLP and so on. Compared with traditional single models, these hybrid models have characteristics of a high accuracy rate [3, 4]. Meanwhile, they also have other problems, such as the high computing power requirement is high and complex operation. Although the present hybrid models have already had sufficient accuracy and strong adaptability, they will also exhibit large prediction deviations when faced with Extreme black swan events. And the large predicted cost has stopped the model

from spreading and application. So, it will be one of the most important research directions that reduce the prediction deviation of extreme black swan events and the prediction cost of these hybrid models. The article mainly introduces to make readers learn about and choose more convenient.

2 SVM-D-Hurst-HLR

The SVM-D-Hurst-HLR model is based on the EMD integrated model and combines other arithmetic [5]. This model uses Variational Mode Decomposition (VMD) to decompose the original gold price sequence. It could work out the problems that arise because of the boundary effect effectively. The Hurst exponent will become the rule for reconstructing judgment and prediction. The process of linear regression data, which is processed by SPCA and MCP as a sub-model, will suit the smooth attribute of a stable decomposed sequence. According to the different memories, the linear regression data will be component modeled according to components with different time period lengths. It will become a decomposition-assigned HLR model. In the last, it will get the model prediction result by using a hierarchical integration strategy. This hybrid model has easier operation for processing data and solves some problems which because by the boundary effect. The hierarchical integration strategy has solved overfitting to enhance the consistency of the prediction results. The considerations are more comprehensive. So, compared with single-factor prediction, the prediction accuracy gets enhanced obviously. And because these models are current models, they could avoid parameter tuning and lower computer power compared with other hybrid models. However, this model mainly uses a linear model. It is difficult that predict special things to appear and it needs to lot much time to train the model. Although it is also complex for some people, it is suitable for a person to predict.

3 KANsLTformer

The KANsLTformer model, which is based on the Transformer model and combines Long Short-Term Memory (LSTM)、Kolmogorov-Arnold Networks (KANs) and Temporal Convolutional Gated Linear Unit. The model is a hybrid model [6]. The LSTM model could make the hybrid capture long-term information. The TCGLU model could enhance the processing ability of the hybrid model for nonlinear data and avoid excessive feature smoothing. In the hybrid model, Multi-Layer Perceptrons(MLPs) of the Transformer are changed into KANs. The KANs could promote the feature representation of the hybrid model and make the model have a more effective complex processing capability. Compared with the Transformer model, the hybrid model has a stronger capability for complex data and enhances model interpretability. This model is nonlinear. As a multi-module type model, it also overcomes the shortcomings of a single model. Compared with the last hybrid model that appeared, this hybrid model could process more complex data and is especially good at processing data which have too many features. Meanwhile, it is considered high noise. So, it has a stronger capability of dealing with emergencies and is more suitable

for real situations. Because the data in the related article has a short time span. It needs to prove in the next step if it can deal with data over a longer time span. The data reading rate of this hybrid model is higher than other models. So, the quality of data will have a great influence on the last prediction. And this hybrid model has many modules, so using it will face many difficulties, such as large computer power, a complex parameter optimization problem and long training time and so on. These difficulties result in people or institutions that use the hybrid model bearing huge costs. After considering these characteristics of the hybrid model, this model is more suitable for professional institution than a person.

4 Dpformer

Dpformer is also based on the Transformer model, like the last one and it is combined with Shapley Additive exPlanations (SHAP) attribution method and prediction fusion method [7]. Different from other hybrid models, it analyzes all the data, whereas other models analyze only macroeconomic indicators. The prediction fusion method divides long-term influencing factors and short-term influencing factors and processes them at the same time. This makes the hybrid model not only consider the rules of the macro economy but also consider large-scale international events which happened in recent years to promise a higher accuracy rate in prediction. The SHAP attribution method could quantify many kinds of macroeconomic indicators, such as the S&P 500. In the last, use data that has been processed to train the Transformer model and get the last prediction. The main data that this hybrid model uses are macroeconomic indicators. So, compared with other hybrid models, it is easier to gain data that the hybrid model needs to process and it has stronger explanatory power. The ability to deal with emergencies is strong enough, and it is sensitive to policy responses. In the related article [3], it also has more stronger ability to predict events than other stronger models. However, as a medium-and long-term prediction model, the short-term prediction and ultra-short-term prediction are its shortcomings. And because of data, which are macroeconomic indicators, it leads to that it is not good at market dynamic capture and is slow in reacting to market capital change. Adding its complex algorithm and parameter adjustment, this hybrid model is good at predicting long-term macro-level gold-related financial prices of long term.

5 MA-GRU Model

The MA-GRU hybrid model is based on the GRU model and combines a multi-head attention mechanism and a skip connection algorithm. The multi-head attention mechanism and skip connection could help the hybrid model enhance the capability of capturing key information. The GRU model divides the characters of data that it is processing into four floors (low, medium, high, and comprehensive). To gain a more reasonable processing way, the features of the high floor are processed with a multi-head attention mechanism. And combine with the features of the first floor to predict and output on the fourth floor. This hybrid model uses the Adam optimizer to train and

verify related data [8]. This hybrid model has a wider range. It could not only predict gold-related financials and also predict the price of other precious metals, such as platinum. Compared with other hybrid models, this model has simpler operation. The main data that the hybrid model processes is historical data and it is good at processing data which have time series characteristics. However, this hybrid model could not process external noise factors, so the quality and scale of data will seriously influence the accuracy of the prediction. Compared to other hybrid models which is in this article, it has less prediction cost and it is suitable for a person to predict. But a person who predicts with this model needs to consider complex external factors to simply analyze the accuracy rate of the prediction.

6 XGBoost Hybrid Model

The XGBoost hybrid model is based on the XGBoost algorithm and combines with VMD, Whale Optimization Algorithm (WOA), and Complete Ensemble Empirical Mode Decomposition with Adaptive Noise (CEEMAN) [9]. The VMD is the first floor of decomposing data. It decomposes the original into many Variational Mode Functions (VMF) and one Residual Component (RES) to process nonlinear data validly. The CEEDMAN of this hybrid model is the second decomposing floor; it decomposes the RES after processing. This way could solve the problems because of model complexity and noise interference. WOA is an algorithm that could be used for parameter adjustment and search for the best parameter of XGBoost. It could solve the problem of low prediction accuracy because of the default parameters of the XGBoost algorithm. This hybrid model has two dual decomposition technologies. So this model has could strong capability of processing features of related data and the data feature utilization rate is high. Compared with other hybrid models in this appear, the WOA makes it easier to parameterize and the model's complexity rate is lower. It has clearer logic and a lower construction cost. But this model mainly processes data of historical data. It could not consider the influence of extreme events. And it has high computational complexity and leads the more runtime cost than other models. So, it could not do real-time prediction. These characteristics of this hybrid model make it difficult that be used by professional institutions and people who predict related prices for real-time monitoring

7 RRF Hybrid Model

The RRF hybrid model is based on the Random Forest model and combined with many kinds of manual feature engineering and automatic feature engineering [10]. This hybrid model mainly processes data of au8888 and au9999, and so on. The first step is screening data features using Mean Decrease Impurity (MDI) and Mean Decrease Accuracy, and a combined Pearson correlation coefficient by a human to retain the features that could influence prediction and delete some features which is not important for prediction. The MDI in the first step is responsible for feature evaluation and the MDA is responsible for selecting important features for prediction. Then, it will select

and combine features after first selecting using an automatic feature engineering tool and reference the Pearson correlation coefficient. In the last, the hybrid model will process the data after processing and predict the price of gold-related financial products using by Random Forest model. This hybrid model has much higher prediction accuracy than a single Random Forest model. Combined with other hybrid models, which are introduced in this article, it has stronger subjective initiative because of manual feature engineering. And it will make the hybrid model adapt to complex environments better. The automatic feature engineering tool could avoid excessive reliance on experience because of manual feature engineering. However, it does not mean that automatic feature engineering could solve all problems because of manual feature engineering. So, using this hybrid model needs the one who use to have enough experience with prediction and sharp intuition for complex situations. It will increase the time cost for users. And the automatic feature engineering needs much computer power and there are requirements for hardware configuration. The model's dynamic capability of this model is poor. So, it will influence prediction accuracy if not adjusted on time. It will be more convenient that predict related prices by using this hybrid model if you have enough prediction experience and professional knowledge about computers.

8 Challenges and Prospects

Currently, hybrid prediction models with high accuracy have the characteristics of high computing power requirements, high demands for data quality and complex operations, and this leads to high prediction costs. Most of these models work better for large institutions like national agencies, but they are not very practical for individuals. What's more, there's still no model on the market that can properly tackle the prediction deviations caused by black swan events; this seriously affects the accuracy of model prediction results and people's confidence in those results. Looking ahead, the prediction costs for gold prices—such as the operational difficulty of using the models themselves and the prediction deviations from data quality and quantity—will directly affect how the models are applied and promoted. Meanwhile, as the international situation grows more complex today, the prediction deviation caused by black swan events will also become one of the important evaluation criteria for gold price prediction models. This directly has a major impact on the public's trust in the models. So, reducing the prediction costs of gold-related financial products and improving the models' adaptability to complex environments will become one of the main research directions in the future.

9 Conclusion

After the dismantling of the Bretton Woods System, the financial attributes of gold have gradually emerged, and more and more gold-related financial products have appeared on the market. The prices of these gold-related financial products directly reflect and influence the state of economic development, so predicting their prices is becoming

more and more important. This paper draws on multiple articles to introduce a range of internationally advanced models for predicting the prices of gold-related financial products (e.g., SVM-D-Hurst-HLR model, KANsLTformer model, DPformer hybrid model, MA-GRU model, XGBoost hybrid model, RRF model) and analyzes the characteristics of each one. This makes it easier for readers to choose well; readers can also use multiple models at the same time and compare them with each other to boost prediction accuracy.

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