Exchange rate forecast between Euro and US dollar based on recurrent neural network

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Abstract. In the global financial market, the euro and the US dollar are the two most important currencies. The euro is the official currency of EU member states and the second largest trading currency in the world. Its exchange rate is determined by market supply and demand. The US dollar is the world's largest trading currency, and its position in international trade and financial markets is irreplaceable. They play an important role in international trade, financial markets, and travel. It plays an important role in various aspects and has a profound impact on the global economy. The relative value of these two currencies is influenced by various factors, and predicting their exchange rate movements is of great significance for investors, economists, and policymakers. This paper introduces a method to predict the exchange rate between Euro and US dollar using recurrent neural network (RNN). By processing and analyzing historical exchange rate data, the RNN-based model is trained and used to predict future exchange rate changes. Our model shows high accuracy, which proves the predictive ability of RNN in this respect. Deep-learning-based forecasting models and their applications in finance have attracted considerable attention in recent research (Fischer and Krauss 2018; Huck 2019; Kim et al. 2019).

Keywords: neural network, financial markets, creating profits.

1. Introduction

The Euro and the dollar are the two most important currencies in global financial markets. The Euro US Dollar rate is one of the most important exchange rates in the world, making the analysis of its behavior fundamental for the global economy and for different decision-makers at both the public and private level. (Alejandro Parot, Kevin Michell, Werner D. Kristjanpoller) Predicting their exchange rate movements is important for investors, economists and policymakers. At Boniface P. Nowcasting of the Short-run Euro-Dollar Exchange Rate with Economic Fundamentals and Time-varying Paramet by Yemba Olusegun Michael Otunuga and Nabaneeta Biswas also emphasizes the importance of the euro and the dollar in financial markets. [1] The emerging market countries most vulnerable to a big shift in the dollar-euro exchange rate are those that rely on foreign exchange debt. And it can protect some financial institutions from the financial risk caused by the great change of the exchange rate of euro-us dollar. In this paper, we use the circular neural network (RNN) and BP neural network as the forecasting tools, forecast the exchange rate between Euro and United States dollar, import the data and train the data, find the problem and solve the error and redundant data and delete and correct it. Data our data consists of 130-month macroeconomic indicators for the US and eurozone economies, divided into five parts, including daily opening and closing prices and guesswork from various surveys.

Overall, the euro and the US dollar, as the two most important currencies in the world, play important roles in various aspects and have a profound impact on the global economy. Predicting their exchange rate movements is of great significance for investors, economists, and policymakers. Investor perspective: Investors usually need to decide whether to engage in foreign exchange trading based on changes in exchange rates. For example, if investors predict that the value of the euro will rise relative to the US dollar, they may choose to buy the euro and sell the US dollar. This behavior will further drive up the value of the euro, thereby creating profits. On the contrary, if investors predict that the value of the euro will decline, they may choose to sell the euro and buy the US dollar, which

will drive the value of the euro down and avoid potential losses. Therefore, accurate exchange rate predictions can help investors make wise investment decisions. From the perspective of economists and policymakers: Understanding the causes and impacts of exchange rate fluctuations is crucial for economists and policymakers.

For example, if policymakers predict that the value of the euro will rise, they may need to take measures to adjust domestic monetary policy to prevent excessive appreciation of their currency, which may have a negative impact on exports. In addition, understanding the reasons behind exchange rate fluctuations (such as macroeconomic factors or market sentiment) can also provide policymakers with a basis for adjusting economic policies. Studying the exchange rate between the euro and the US dollar can help these institutions better understand the reasons for exchange rate changes and take appropriate hedging strategies and risk management measures.[2]

Time-varying Paramet. The importance of the euro and the US dollar in the financial market has also been repeatedly emphasized. If there is a significant change in the exchange rate between the US dollar and the euro, the most vulnerable emerging market countries are those that rely on foreign exchange debt. The Euro and the US dollar are among the most important currencies in global trade and investment. [3] These countries usually need to borrow foreign debt to finance their economic and social development. If the US dollar appreciates, the debt burden of emerging market countries will increase as they need more domestic currency to repay their external debts. This may lead to debt defaults, capital outflows, currency depreciation, and other issues, leading to economic crises and social unrest. On the other hand, if the euro depreciates, the debt burden of emerging market countries will be reduced, as they can repay their external debts with relatively less domestic currency. This may stimulate economic growth and investment, but it may also lead to inflation and other economic problems. Therefore, for emerging market countries that rely on foreign exchange debt, maintaining stable and predictable exchange rates is crucial. Policy makers need to closely monitor exchange rate fluctuations, take necessary measures to mitigate negative impacts, and ensure debt sustainability and financial stability. And it can protect some financial institutions from the financial risks caused by the significant changes in the exchange rate of the European and American dollars. This article uses recurrent neural networks (RNN) and BP neural networks as prediction tools to predict the exchange rate between the euro and the US dollar. The obtained data is imported and trained to identify problems and solve operational errors and excess data and deleted and corrected. Recurrent Neural Network (RNN) is a neural network structure used for processing sequence data, such as speech, natural language text, etc. RNN has memory ability and can store previous information for use in processing sequence data. The research and application based on recurrent neural networks are very extensive, including speech recognition, natural language processing, machine translation, and other fields. In terms of speech recognition, RNN is used to convert speech signals into text, improving the accuracy and speed of recognition. In natural language processing, RNN has been used for tasks such as text classification, sentiment analysis, and language modeling, demonstrating strong capabilities. In terms of machine translation, RNN has been used to translate sentences from one language into another, achieving good results. The structure of a recurrent neural network includes an input layer, a hidden layer, and an output layer. The hidden layer is a recurrent structure that can transmit previous states to the next time step. Common recurrent neural networks include Long Short-Term Memory Network (LSTM), Bidirectional Recurrent Neural Network (Bi RNN), Gated Recurrent Unit (GRU), etc. [4]

These network structures all have different characteristics and application scenarios, and suitable network structures can be selected based on specific tasks. The learning algorithms of recurrent neural networks include backpropagation algorithms and gradient vanishing problems, which require different techniques to solve. Among them, the most famous technique is to use weight sharing and gradient cropping to alleviate the problem of gradient vanishing. In addition, there are some new methods, such as Long Short-Term Memory Network (LSTM) and Gated Recurrent Unit (GRU), which can better solve the problem of gradient vanishing. In summary, research and applications based on recurrent neural networks are very extensive, with many advantages and applicable

scenarios. In the future, with the continuous development of technology, recurrent neural networks will be applied and developed in more fields. The prediction of the exchange rate between the euro and the US dollar based on recurrent neural networks (RNNs) is a complex problem that requires consideration of multiple factors. However, we can try using RNN to establish a prediction model to predict the exchange rate changes between the euro and the US dollar. Firstly, it is necessary to collect exchange rate data between the euro and the US dollar, including changes in exchange rates over a period of time and relevant macroeconomic data, such as GDP, inflation rates, interest rates, etc. These data can be obtained through financial market data providers. Secondly, it is necessary to preprocess, and feature engineer these data. Exchange rate data can be converted into logarithmic returns to better capture the trends and volatility of exchange rate changes. In addition, it is also necessary to convert macroeconomic data into features suitable for RNN processing, such as mean, standard deviation, etc. Then, RNN can be used to establish a prediction model. Exchange rate data and macroeconomic data can be used as inputs, and the output can be set to the exchange rate value of the next time step. When training the model, mean square error (MSE) or other loss functions suitable for regression problems can be used to evaluate the performance of the model. Finally, trained models can be used for prediction. You can input the exchange rate data and macroeconomic data before the current time step into the model to obtain the predicted exchange rate values for the next time step. It should be noted that exchange rate prediction based on RNN is only a preliminary attempt, and the actual prediction effect is influenced by various factors, including data quality, model complexity, market volatility, etc. Therefore, it is necessary to use the predicted results with caution and conduct sufficient posterior validation and risk control. Our data consists of 130-month macroeconomic indicators from the United States and eurozone economies, which are divided into five parts, including daily opening and closing prices, as well as speculative economic indicators from various surveys. Daily opening and closing prices: These price data can provide information about the real-time value and expectations of the market towards the euro and US dollar. By analyzing the trends and fluctuations of these data, we can understand the short-term views and emotions of the market towards the two currencies. Economic indicators: Economic indicators, such as the Consumer Price Index (CPI), Gross Domestic Product (GDP), unemployment rate, etc., usually have a significant impact on the exchange rate. [5]

By analyzing the trends and differences in these indicators, we can understand the relative performance of two economies and predict the long-term trend of exchange rates. Survey data: Various survey data, such as consumer confidence index and business confidence index, can also provide clues about future exchange rate trends. These data reflect the expectations and emotions of market participants and experts and may have a significant impact on short-term fluctuations in exchange rates. When analyzing these data, we can use statistical methods such as time series analysis, regression analysis, etc. to reveal the relationships between the data and predict the trend of exchange rates. In addition, machine learning methods and deep learning methods can also provide more accurate and timely prediction results. [6]

Finally, it should be noted that predicting exchange rates is a complex task that requires comprehensive consideration of various factors, including economy, politics, market sentiment, etc. Therefore, even with advanced data analysis and prediction models, we still need to treat the prediction results with caution and make adjustments according to the actual situation.

2. Methods

2.1. Data

The data used in this study are the daily exchange rates between Euro and US dollar for the past ten years. The data are presented as a one-dimensional array. In general, the following steps are required: data initialization: the process of assigning an initial value to a variable or data structure after it has been created or allocated memory. Data Initialization is an important step in ensuring that

a variable or data structure has a known initial state before starting to use it. First Clean the workspace, screen and close the window.

2.2. Data processing methods

In order to improve the performance and accuracy of the model, we first reduce the dimension of the data. Data dimensionality reduction aims to reduce computational complexity while preserving as much as possible the characteristics of the original data.

The specific steps of dimensionality reduction usually include the following main steps:

Data pre-processing: this includes data normalization or standardization to ensure that data with different characteristics are within similar scales. Feature selection: Based on the relevance, importance, or other indicators of a feature, select the feature that best represents the original data. Feature extraction: using dimension reduction algorithm, the original data is mapped to a lower dimension feature space, usually through linear transformation or nonlinear mapping to achieve. Evaluation of dimensionality reduction: through the evaluation of indicators, such as the proportion of retained information, model performance, etc., to evaluate the quality and effect of dimensionality reduction data.

For this prediction, we used the BP Mental Network, a deep learning network that includes multiple layers and draws inspiration from the structure of the human brain, which the researchers studied. By changing the weights that connect them, a neural network composed of several interconnected neurons can strengthen or reduce the models between various neural networks. The neural network can set the training parameters to stop running and output data after reaching the target or the number of times limit, and the output components are arranged in a new feature map.[7] In the training phase, the learnable weights of the filter are updated to optimize the performance of the network in a given task. The number of filters usually depends on the number of different features to be extracted, and the strength and diversity of filters are key factors in determining the ability and accuracy of web learning. [8] Since the filter weights are shared at all input locations, there are fewer parameters to learn, which improves the generalization ability of the network. Our model also uses recurrent neural network (RNN). RNN is a powerful tool for modeling time series data. It has excellent performance in dealing with time series data, such as exchange rate change. We used the model's accuracy in training and running time as indicators. The accuracy reflects the accuracy of the model prediction, while the running time reflects the efficiency of the model. We set the maximum number of times to 100 set the completion error within 0.01. [9]

Simulation testing of data is a common method for evaluating and validating the performance of data processing algorithms or models. It can help us simulate and predict the data behavior in practical applications and verify the validity and robustness of the processing method. Evaluate performance: set performance metrics to ensure good performance when used. Other applicable evaluation indicators can be selected according to specific problems. When evaluating performance, methods such as cross-validation, division of training set and test set are often used to evaluate the effectiveness of algorithms or models more comprehensively. Drawing: can be used to generate various types of diagrams, including line charts, scatter plots, histograms, pie charts, and so on. We set the X-axis as the forecast sample and the Y-axis as the Shanghai Price to show the difference between the real value and the forecast value more intuitively.

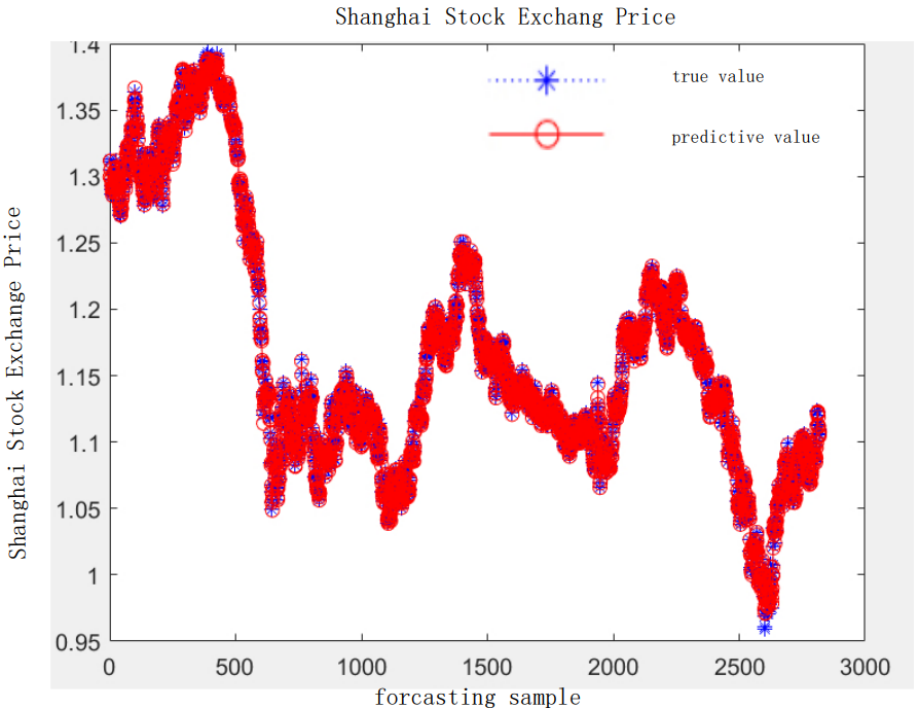


Figure 1. The real value and test value of the exchange rate, generate a line chart to visually and intuitively display price fluctuations.

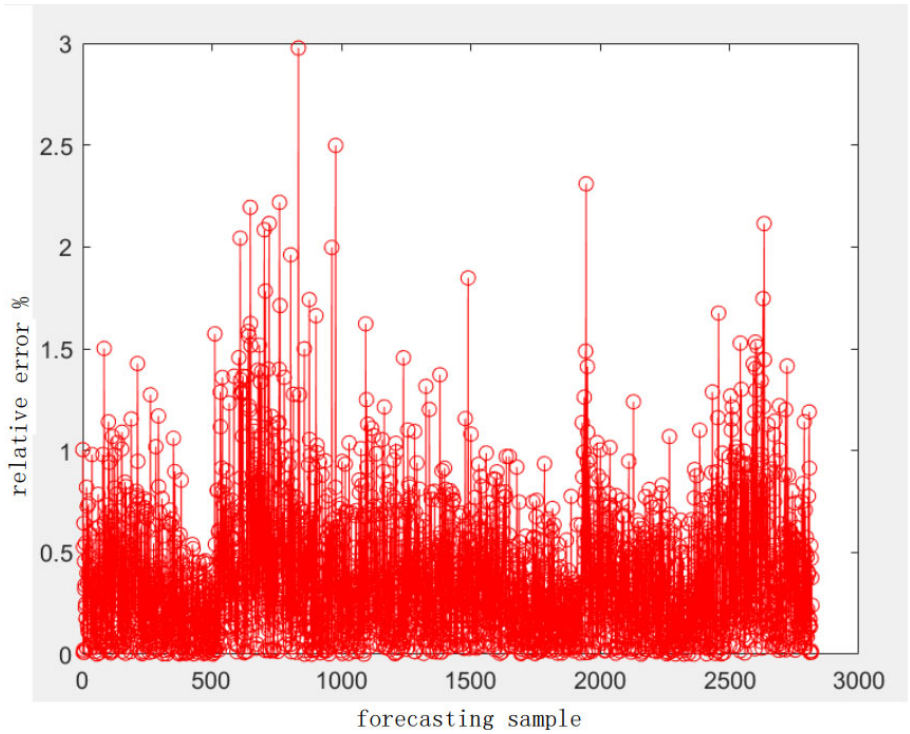


Figure 2. Relative error between predicted and true values, show the difference between the real value and the forecast value more intuitively.

3. Result

3.1. Data processing results

After processing the source dataset, we obtained the dimensionality reduced data. These data retain the main characteristics of the original data, but greatly reduce the dimensionality of the data, thereby

improving the training efficiency of the model. The RNN model exhibits high accuracy on the training set. Within 3000 samples, the relative error did not exceed 3% and was mostly controlled within 1% of the internal test set. Our model also showed high accuracy, proving its good generalization ability. Firstly, investors can predict future changes in the exchange rate of the European and American dollars without causing indiscriminate inflows and outflows of funds. It can also prevent Eurozone investors from showing a preference for their own currency, leading to strong cross sectoral preferences.

According to the report, the results of data processing indicate that the data after dimensionality reduction retains the main characteristics of the original data, while reducing the dimensions of the data and improving the training efficiency of the model. The RNN model showed high accuracy on both the training and testing sets, indicating that it has good generalization ability. [10] Investors can use this model to predict future changes in the exchange rate of the European and American dollars, without causing indiscriminate inflows and outflows of funds, nor will it lead to Eurozone investors showing a preference for their own currency, leading to strong cross departmental preferences. This can provide important decision-making support for investors, reduce investment risks, and improve investment returns. In summary, this model has high accuracy and generalization ability, which can provide important decision support for investors and has important practical application value.

4. Discussion

Our research shows that the RNN model has high accuracy in predicting the exchange rate between the euro and the US dollar. The training time of the model is also within an acceptable range, proving the effectiveness and feasibility of this method.

However, our research still has some limitations. Firstly, our model mainly relies on past data for prediction, while in actual financial markets, changes in exchange rates may be influenced by many unpredictable factors. Secondly, although our model exhibits high accuracy, there is still a certain error rate, which may lead to inaccurate prediction results in certain situations.

Overall, our research provides a new RNN based method for predicting euro and US dollar exchange rates, which has important practical significance for understanding and predicting exchange rate fluctuations.

5. Conclusion

Understanding the movement of the euro-dollar exchange rate can help companies and investors predict the impact of exchange rate fluctuations on trade and investment, so as to make appropriate strategies and decisions.

For multinational enterprises and financial institutions, the foreign exchange risk caused by exchange rate fluctuations is an important consideration.

The exchange rate between euro and US dollar has important reference value for macroeconomic policy making. Governments and central banks can adjust monetary policy by focusing on exchange rate movements to boost economic growth, control inflation, or maintain international competitiveness.

For individual investors, understanding the trend of the exchange rate between the euro and the US dollar can help them choose suitable investment targets and develop an optimized investment portfolio. Exchange rate fluctuations can bring investment opportunities, but also accompanied by risks, so it is very important for investors to accurately predict the exchange rate trend.

Studying the exchange rate between euro and US dollar can help analyze the pattern of international trade and economic relations. Exchange rate changes directly affect the cost and competitiveness of imports and exports, and then have a profound impact on international trade and economic growth.

Exchange rates are also closely linked to global financial markets. Movements in commodity prices, stocks, bonds and other asset prices are often linked to exchange rate fluctuations, so it is important for investors and financial market participants to understand the euro-dollar exchange rate.

The stability and predictability of exchange rates are important for global financial markets and economic stability. The government and central bank intervene in the exchange rate market to maintain the stability of the exchange rate and prevent the occurrence of violent fluctuations and crises.

Finally, studying the exchange rate between the euro and the United States dollar also helps to deepen the understanding of the international financial system and currency markets. Exchange rate is one of the most important prices in the currency market, and understanding its formation mechanism and influencing factors is helpful to better grasp the global financial landscape and opportunities.

Authors Contribution

All the authors contributed equally and their names were listed in alphabetical order.

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