Comprehensive Analysis of Exchange Rate Prediction: Influencing Factors, Methodologies, and Future Prospects

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- Keywords: Exchange Rate Prediction, Machine Learning Techniques, Deep Learning Techniques, Forecasting Limitations.
- Abstract: With the deepening of global economic integration and the increasing complexity of financial markets, exchange rate forecasting has become increasingly important in economics and finance research. Exchange rate fluctuations not only directly affect the international trade, but also profoundly impact investment decisions and the formulation of monetary policies. Accurate exchange rate forecasts provide valuable decision-making support for investors, policymakers, and enterprises, assisting them in managing market fluctuations and economic uncertainty more effectively. This paper reviews the current research status in exchange rate forecasting, focusing on the factors affecting exchange rates, forecasting methods based on machine learning and deep learning, and the limitations of existing technologies. First, this paper systematically introduces various economic factors that affect exchange rate fluctuations, including macroeconomic indicators, market sentiment, political events, and international trade. Secondly, this paper reviews existing exchange rate forecasting methods, including machine learning and deep learning techniques, as well as their performance in forecasting accuracy and data processing capabilities, as well as their advantages and limitations in practical applications. By deeply understanding the influencing factors and optimizing the forecasting methods, the reliability of exchange rate forecasting can be significantly improved, thereby providing more effective decision-making support for financial market participants and policymakers.

SCIENCE AND TECHNOLOGY PUBLICATIONS

1 INTRODUCTION

An important factor in global economic trade is the exchange rate, which is the value of one currency relative to another. The price of a domestic currency expressed in terms of a foreign currency is typically expressed as the exchange rate, which represents the relationship among the two currencies' exchange rates (Cai, 2023). As an important bridge between macroeconomics and microeconomics, the exchange rate is often used as an important reference indicator for evaluating the economic value of other countries. The strength of economic fundamentals between countries is the core factor in exchange rate changes (Li, 2023).

Fixed and variable exchange rates are the two primary categories of exchange rates. The market's supply and demand dynamics determine floating exchange rates, which fluctuate in response to sudden shifts in the overall state of the economy. This exchange rate mechanism has high flexibility and can be adjusted quickly to respond to dynamic changes in the economy. In contrast, fixed exchange rates are set by the government or central bank and maintained within a stable range through market intervention, thereby reducing the uncertainty caused by exchange rate fluctuations. In addition, there are other types of exchange rates, such as managed floating exchange rates and currency union exchange rates. Managed floating exchange rates combine the characteristics of market determination and central bank intervention, and maintain a certain degree of stability by adjusting exchange rate fluctuations. Currency union exchange rates refer to the use of a common currency by multiple countries or regions to attain a high level of economic integration and monetary policy coordination. These different exchange rate Changes in exchange rates also have a profound impact on all aspects of a country's economy. First, exchange rates directly affect the competitiveness of international

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trade. A rise in the value of the currency may result in higher export prices on the global market and a potential decline in exports; on the other hand, a fall in the value of the currency may make export items more competitive and encourage export expansion. Secondly, changes in exchange rates will also impact the returns of cross-border investments. When investors make international investments, exchange rate risk becomes an important consideration, and exchange rate fluctuations will directly affect their investment returns. In addition, the execution of national economic policy is significantly impacted by the stability of the currency rate. Turbulence in the financial market and economic uncertainty can result from exchange rate volatility.

Under the general trend of economic globalization, exchange rates are an important factor affecting international trade and financial investment. Scientific analysis of exchange rate fluctuations and reasonable prediction of exchange rate fluctuations have important theoretical research significance and practical application value. Effective exchange rate forecasting can not only help private investors adjust their investment strategies and diversify risks promptly, thereby optimizing investment returns but also provide a key risk management decision-making basis for multinational companies in international transactions, so that investors and companies can better cope with the challenges brought by exchange rate fluctuations and reduce potential financial risks (Wang et al., 2024).

This article summarizes the pertinent techniques in the field of exchange rate forecasting, reviews the findings of previous research, and assesses the benefits and drawbacks of various machine learning and deep learning algorithms in exchange rate forecasting. These efforts are motivated by the recognition of the critical role that exchange rate forecasting plays in the global economy and the significant influence it has on international trade, investment choices, and financial market stability. The factors influencing the exchange rate are first introduced in this article, which also provides an overview of the current methods for forecasting exchange rates from the perspectives of deep learning and machine learning. Finally, the limitations of these methods are discussed, along with potential directions for future research. By means of an extensive examination from many angles, it seeks to offer a thorough comprehension of the domain of exchange

2 EXCHANGE RATE FACTORS

Generally speaking, exchange rate fluctuations are mainly affected by the size of foreign exchange reserves (Li, 2021), inflation rate (Liu, 2020), political situation (Miao, 2022), money supply (Wang & Meng, 2019), interest rate (Yin, 2018), and global economic conditions.

First and foremost, a nation's foreign exchange reserves are a vital and necessary instrument for controlling its economy and achieving both internal and external balance. The economies of different nations are entwined and readily impacted by the economic activity of other nations in the setting of global economic integration (Li, 2021). Therefore, foreign exchange reserves have become an important means of regulating the balance of payments. A larger level of reserves can improve the economy's resilience to risks and encourage the steady and healthy growth of the economy by assisting in managing global capital flows and economic shocks as well as preserving exchange rate stability. Second, the rate of inflation is a crucial metric for gauging the extent of price growth over a given time frame, which has an immediate impact on the real worth and buying power of a nation's currency. More specifically, rising inflation will cause domestic prices to rise (Liu, 2020), making domestic goods more expensive in the international market, thereby weakening the competitiveness of export goods. At the same time, inflation will also stimulate import demand because foreign goods are relatively cheap, leading to a widening trade deficit. In addition, inflation will change the market's expectations of future economic trends, weaken the confidence of investors and trading partners in the local currency, and thus lead to the depreciation of the local currency. The next factor is the political situation (Miao, 2022). Political instability or uncertainty will reduce investors' confidence in a country and reduce their demand for the country's currency, leading to capital outflow and triggering exchange rate depreciation. On the contrary, a stable political environment can enhance investors' trust in the national economy, attract more foreign investment, increase demand for the local currency, and thus support exchange rate stability. A stable political situation provides a more reliable foundation for economic growth and helps maintain the international credibility and value of the currency. Then there is the money supply. The entire quantity of money that is available for use in a nation's economy throughout a specific time period is referred to as the money supply. Changes in a nation's central bank's monetary policy are typically closely linked to

changes in the money supply. The quantity of money in the market rises when a central bank implements an accommodating monetary policy, such as cutting interest rates or injecting significant sums of money. The excess amount of money may cause the money circulating in the market to exceed the actual demand of the economy, leading to inflation, which in turn drives up prices. The real purchasing power of local currency decreases as inflation rises and the same amount of money can buy fewer goods and services, ultimately leading to a decline in the currency exchange rate (Wang & Meng, 2019). Next is the interest rate. Economist John Maynard Keynes proposed the exchange rate parity theory, which states that the difference in interest rates is equivalent to the rate at which the exchange rate of two countries changes. In the event of a disparity in interest rates between two nations, money tends to go toward the one with the higher rate in order to maximize profits. Due to the profit-seeking nature of funds, it will lead to a rise in the country's currency's demand with high interest rates, thereby driving its currency to appreciate. A nation with low interest rates experiences a decline in demand for its currency at the same time, which results in currency depreciation. Consequently, the currency of the nation with lower interest rates tends to weaken while the currency of the nation with higher interest rates tends to strengthen in the near run (Yin, 2018). Finally, the global economic situation. Global economic growth or recession will affect international trade and investment flows. When the economy is strong, trade and investment activities in various countries will generally increase, and the demand for currency will rise. Strong economic performance will generally attract the interest of foreign investors, promote capital inflows, and enhance the demand for a country's currency, thereby increasing the exchange rate. On the other hand, trade and investment activity often decline during a recession, which lowers the demand for money in a nation and lowers the value of the currency.

3 EXCHANGE RATE FORECASTING METHODS

3.1 Machine Learning Methods

Computer systems may learn from data and become better versions of themselves thanks to a process called machine learning. It is a part of artificial intelligence that uses scientific methods such as

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statistics, algorithms, and computers to identify patterns in data to make predictions or decisions. Specifically, machine learning methods can automatically learn and identify patterns from large amounts of data without the need for humans to write complex rules. At the same time, it can continuously improve its predictive capabilities and adapt to changes in new data, that is, the machine learning model can Historical data is used for forecasting and handles various forecasting tasks such as classification, regression, and clustering to provide insights into future trends. Compared with artificial learning, machine learning has significant advantages in automation, processing of complex data, predictive capabilities, and adaptability. It can improve the performance and efficiency of the system by learning from data and self-improvement, adapting to modern data-driven application scenarios. Therefore, many scholars use machine learning to study and analyze exchange rate changes.

The theory of support vector machines was first put forth by Vapnik (1995). Regression and classification issues can be handled by support vector machines. Compared with neural network theory, this model is based on statistical principles, emphasizes minimizing structural risks, and has stronger generalization ability. This method can better handle the prediction problem of exchange rate out of sample, is suitable for solving nonlinear problems, and is also suitable for small sample data sets (Zhao, 2021). A novel approach based on the blockchain framework and XGBoost was put out by Shahbazi and Byun (2022) to increase the system's security and transparency. Filters and coefficient weights are used in the construction of its prediction process, and the XGBoost algorithm exhibits the highest accuracy in the test. Fu et al. (2019) proposed two optimized support vector machine (SVR) models based on phase space reconstruction of historical exchange rate data to predict four typical RMB exchange rates. The SVR parameters are adjusted by balancing global and local optimization. The model has good results in horizontal prediction accuracy, directional prediction accuracy, and statistical accuracy.

3.2 Deep Learning Methods

Deep learning focuses on using neural networks (especially deep neural networks) for data processing and pattern recognition. Through brain-like simulation, it automatically pulls features and makes predictions or classifications from massive amounts of data. Typically, deep learning models have several layers of processing units, with each layer pulling out more advanced characteristics from the one above it. Its advantages are the ability to process unstructured data, efficient pattern recognition, strong generalization and adaptability, and simplified modeling. An increasing number of academics have turned to deep learning techniques in order to estimate exchange rates in recent years. Although these studies have adopted a variety of different methods, deep learning is still the most widely used in exchange rate forecasting.

Liu et al. (2024) suggested combining the LASSO and LSTM models to identify the variables influencing exchange rate pricing and provide logical justifications. A novel LASSO-BiLSTM integrated learning technique for variables influencing exchange rate prices was put out by them. Compared with traditional models such as ELM, KELM, LSTM, and SVR, LASSO-BiLSTM performs better than other models and shows good results in time series prediction. Windsor and Cao (2022) developed an algorithm model based on the multimodal fusion MF-LSTM model to predict the USD/CNY exchange rate. Paying attention to market indicators and investor sentiment builds a deep coupling model. This method shows that it is effective in integrating multimodal fusion algorithms into financial time series prediction. Liu et al. (2023) proposed a hybrid model CNN-STLSTM-AM to predict the exchange rate's closing price, in which CNN extracts data features, STLSTM improves the prediction accuracy and combines the attention mechanism (AM) to optimize the feature weights. Empirical evaluations demonstrate that the CNN-STLSTM-AM model surpasses other techniques, including as CNN, SVR, LSTM, CNN-LSTM, GRU-LSTM, and CNN-LSTM-AM, in terms of prediction accuracy. Wang et al. (2021) suggested a CNN-TLSTM model to estimate the closing price of the USD/RMB exchange rate on the following trading day in order to quickly grasp the changeable exchange rate information. In order to prevent overfitting, it enhances the input gate structure of the LSTM and extracts features using CNN. The experimental findings demonstrate the effectiveness of the CNN-TLSTM model in forecasting the USD/RMB exchange rate's closing price for the following trading day. Combining the views of investors and investment organizations, Chen et al. (2021) creatively presented a dual-objective optimization measurement model for portfolio exchange prediction analysis. The deep learning model offers more precise forecasts than the conventional exchange rate prediction method, and the NSGA-II-based model further improves portfolio selection. It has better prediction accuracy than

traditional models and can effectively help investors make good investment decisions.

4 EXISTING LIMITATIONS AND FUTURE CHALLENGES

Existing studies have conducted a relatively complete and comprehensive analysis of exchange rate forecasting, but there are still certain limitations. First, there are many factors that affect exchange rates. Medium- and long-term exchange rates are more affected by fundamental factors, including fiscal policy, government intervention measures, inflation, international trade, etc., and there is a high degree of uncertainty in the medium and long term. Many factors that affect exchange rates, such as emergencies and political changes, lack highfrequency data or reliable real-time information and are difficult to measure effectively, which makes it more difficult to establish an accurate forecasting model (Yin, 2018). Second, exchange rate changes may have complex nonlinear patterns, and data may fluctuate greatly. This volatility makes the model learning less effective and will be affected by more unstable data, thereby affecting the accuracy of the forecast. In addition, there may be time delays in the release of economic data and market indicators, and these delays may affect the timeliness of exchange rate forecasts. Delayed data may not reflect the latest market changes in a timely manner, making the model's forecast results unable to accurately reflect the current economic situation.

The following adjustments may be made in the future in light of the aforementioned restrictions. First, in-depth research on fundamental factors such as fiscal policy, government intervention measures, inflation, and international trade, and develop a forecasting model that can comprehensively consider the impact of these factors. Minimize the impact of potential uncertainties on medium- and long-term exchange rate forecasts. In addition, develop more advanced data collection tools to capture and integrate more high-frequency, real-time economic and market data, including information on emergencies and political changes, to ensure that the model can obtain and process the latest economic and market data in a timely manner. Then promotes the openness, transparency and standardization of economic data, reduces the impact of economic data delays on exchange rate forecasts, and better conducts data analysis and model development. Finally, more models can be used for integration, and more complex

deep learning and multi-model integrated learning methods can be used to reduce forecast bias and further increase the stability and accuracy of forecasts.

5 CONCLUSIONS

This paper deeply explores the key elements of exchange rate forecasting, including its basic concepts, influencing factors, types, two different exchange rate forecasting methods and their current limitations, and looks forward to future development trends. Exchange rate forecasting is not only of great significance to international financial markets, strategic decisions of multinational companies and global economic stability, but also affects the decision-making process of investors and policymakers. The substance of this article begins with an explanation of the fundamental idea of an exchange rate, which is the rate at which one currency is exchanged for another. Exchange rates come in two flavors: fixed exchange rates and fluctuating exchange rates. Then, by reviewing the factors affecting exchange rates, this paper reveals how factors such as foreign exchange reserves, inflation rate, political situation, money supply and interest rate interact and affect exchange rate fluctuations. Additionally, this article highlights the accomplishments and benefits of previous research in the subject of exchange rate forecasting and discusses the use and development of deep learning and machine learning techniques in this area. The shortcomings of the current exchange rate forecasting techniques are also highlighted in this research, including high uncertainty in exchange rate influencing factors, large fluctuations in data, delays in data and lack of timeliness. Therefore, although advanced forecasting technologies have made important progress in improving forecasting accuracy, these limitations still need to be overcome. Finally, this paper points out that in the future, the researchers should execute in-depth research on economic fundamentals and develop forecasting models that can comprehensively consider the impact of these factors. Secondly, the researchers should improve the effectiveness of data collection and promote the openness and transparency of economic data to ensure that the model can obtain and process the latest economic and market data in a timely manner, to continuously optimize the performance of the model and provide more reliable forecasting results in a complex and changing economic environment, thereby further enhancing its application value in global economic decision-making.

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