

Artificial Neural Networks and Conditional Heteroscedastic Models for Forecasting Exchange Rate

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1 Introduction

By definition, the exchange rate is the relative price of one currency in terms of another. In an open economy, exchange rates are one of the most important prices, because your level has a significant impact in relation to other macroeconomic variables, stock market prices, international trade contracts, tourism, imports, exports, inflation, etc. Contemporary economies adopt the floating exchange rates system, but this is a recent fact. According to [1], the study of exchange rate determination is a relatively new part of international economics, and that has a historical motivation.

This study aims to analyze the predictive performance of the artificial neural networks, and conditional heteroscedasticity models for exchange rates United States Dollar/Brazilian Real (USD/BRL), Euro/Brazilian Real (EUR/BRL), and Great Britain Pound/Brazilian Real (GBP/BRL).

2 Methodology

- The data were obtained from Brazilian Central Bank (BCB) database for the period between January 03, 2000 to December 31, 2020. In total are 5725 observations for each exchange rate. Statistical analyzes, as well as graphic representations, were built using R and Python programming languages.
- Artificial neural networks were developed, in principle, as mathematical models of the information processing capabilities of the biological brain [[2], [3]]. In this study were take into account two types of neural networks: multilayer perceptron (MLP) and Recurrent Neural Networks (RNN).
- In this study were take into account four generalized autoregressive conditional heteroscedasticity models: standard GARCH (sGARCH), integrated GARCH (IGARCH), exponential GARCH (EGARCH), the Glosten, Jagannathan and Runkle GARCH (GJR-GARCH), and the bayesian GARCH (bGARCH).
- The selection of most suitable model for the train and test sets was made through the mean absolute error (MAE) and root mean squared error (RMSE).

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3 Results

The Lagrange Multiplier (LM) test for autoregressive conditional heteroscedasticity indicates that log of results of the three series in analysis rejects the null hypothesis of no ARCH effects: USD/BRL (p-value 2.2e-16), EUR/BRL (p-value 2.2e-16), and GBP/BRL (p-value 2.2e-16). Among the proposed GARCH models, we selected those with the lowest value of Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC).

In Table 1, it is possible to observe the results of the MAE and the RMSE on the predictions of the test set of the models used in the study. The results indicate that the conditional heteroscedastic models have the lowest values on MAE and RMSE for the three exchange rates under analysis, obtaining a better predictive capacity than the artificial neural networks models considered. Future studies may consider other models, such as the Bayesian GARCH and the LSTM (Long short-term memory) - a variation of the RNN.

Table 1: Test set forecasting evaluation to USD/BRL, EUR/BRL and GBP/BRL.

	Model	RMSE	MAE	Exchange Rate
1	MLP	0.03	0.03	USD/BRL
2	RNN	0.03	0.02	USD/BRL
3	eGARCH (1,1)	0.014	0.013	USD/BRL
4	eGARCH (2,1)	0.014	0.013	USD/BRL
1	MLP	0.05	0.04	EUR/BRL
2	RNN	0.04	0.03	EUR/BRL
3	eGARCH	0.018	0.016	EUR/BRL
4	gjrGARCH	0.018	0.016	EUR/BRL
1	MLP	0.06	0.04	GBP/BRL
2	RNN	0.05	0.04	GBP/BRL
3	gjrGARCH	0.0175	0.0143	GBP/BRL

References

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