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Research Article

Predictive Analysis of Iraq's Development Road and Trade Balance Using Machine Learning

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ABSTRACT

This scholarly article examines the utilization of machine learning algorithms, with a particular emphasis on Random Forests, to forecast the trade balance of Iraq, which is a critical economic indicator anticipated to fluctuate as a consequence of the execution of the Development Road Project. By leveraging datasets sourced from the World Bank and the International Monetary Fund (IMF), vital economic indicators such as gross domestic product (GDP), export and import volumes, foreign direct investment (FDI), and public sector expenditure were utilized to construct a Random Forest classification model.

Keywords: Development Road ,Machine learning, Random Forest, BRI, Trade balance prediction, Iraq, Al-Faw Grand Port, Economic analysis

INTRODUCTION

Khoshnaw& Anwar ,2023 Their study addressed the clarification of the concept of the trade balance in general, which represents the state's ability to pay for imports of goods and services from foreign countries through exports, which indicates the state's competitive ability in international trade[1].

Saleh & Addai, 2020 dealt with Iraq's confrontation with structural imbalances in the trade balance, as the disparity in the trade balance is an indicator of a deeper imbalance, related to the structure of production, resulting from neglect of alternative sectors. This phenomenon is evident in the lack of sufficient diversification of exports[2]. In their research, Al-Karimawi and Obaida believe that revenues generated from oil represent the main component of the national budget and act as a major catalyst for economic endeavors[3].

Hasan, 2024 The researcher explains that the development path is an important initiative that aims to benefit from the strategic geographical location of the country and its multiple borders. This initiative aspires to create transport infrastructure linking the Persian Gulf to Turkey and promote cross-border trade and connectivity, not only between regional countries but also extending to countries across Asia, Europe and Africa [4].

Öztürk, 2024 The researcher focused The Faw Grand Port is expected to surpass the capacity of Dubai's 67-berth Jebel Ali Port, currently the largest port in the Middle East. The Faw Port development is expected to generate annual revenues of around US$4 billion and create at least 100,000 jobs[5]. (Yıldız ,2024) The researcher discussed the "Development Road" project that Turkey is planning in cooperation with Iraq as an alternative or complement to the "Belt and Road" initiative and the "Indian-Middle East-European Economic Corridor" (IMEC) project. Or an alternative to the Suez Cana [6].

Putri at.el, 2024 Their research analyzed Indonesia's trade balance using support vector machine (SVM) methodologies based on gross regional product (GRDP) and wholesale trade price index (IHPB). The polynomial kernel showed superior performance[7].

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Brabenec & Šuleř, 2020 their research examined trade balance fluctuations between the Czech Republic and China as the Czech Republic faces a growing trade deficit attributed to a significant rise in imports. This research uses artificial neural networks (ANNs) to forecast the trade balance and China[8].

2.RELATED WORK

1-In 2019, Batarseh et.al Their study using machine learning for economic forecasts.Multiple machine learning models were used, such as ARIMA, GBoosting, XGBoost, LightGBM, and K-Means Clustering. LightGBM achieved an accuracy of 88%, XGBoost achieved an accuracy of 69%.[9]

2- In 2022, Zhang et. al Their study analyzed the coefficients attributed to imports and exports, using the random forest algorithm with Gini index, accuracy, with MSE values of 0.095 for training, 0.188 for experimental training ,R^2 values of 0.924 for training and 0.849 for testing. [10]

3-In 2024, Kusumah et. al Their research seeks to assess the exchange rate fluctuations, inflationary pressures, and interest rate changes on Indonesia's trade balance using ordinary least squares (OLS) methodology. The results indicate that these economic variables account for 57.22% of the changes in the trade balance[11].

4-In 2020, Rowland et.al Their research addresses the application of multilayer perceptron (MLP) neural networks to predict the trade balance between the United States and China. the R^2 result exceeds 0.96 for imports and 0.97 for exports [12].

5- In 2020 Matskul et.al Their research examines the trade balance between Ukraine and the European Union using neural networks (ANNs) and time series analysis (such as ARIMA, ARIMAS, and Holt's linear trend model) .Holt's model showed error of 4.28%[13].

6- In 2024 Wang et.al Their study investigated Chinese investment, GDP growth, and port containers. Using multiple regression analysis techniques with AHP, the result for port containers was R^2 = 0.991507, MSE = 0.002975. For GDP: R^2 = 0.984568, MSE = 0.030559) [14].

7- In 2024 Krulikowski et.al Their research examined the economic implications of China's Belt and Road Initiative on trade and GDP. Using gravity models, the models showed remarkable accuracy, as evidenced by R^2 value of 0.9945 [15].

8-In 2023 Wang and Li Their research examines the openness of Commercial urban areas in Liaoning Province, China, using a machine learning approach subjected to clustering through the K-means algorithm, and SVM. The accuracy of the SVM model was(91.67%) [16].

9-In 2021 Koffi Dumor et al Their study evaluated the trade implications of China's Belt and Road Initiative (BRI) by applying structural gravity models (SGMs) and artificial neural networks. ANNs showed accuracy (R2 = 0.96), And for SGMs (0.89) [17].

10-In 2021 De Stefano et. al Their study examined the impact infrastructure on bilateral trade among BRI countries using gravity model with regression analysis achieved accuracy (R2= 0.474) for the initial model and (R2=0.197) for the subsequent model[18].

3.PROBLEM STATEMENT

Previous studies did not accurately address forecasting the trade balance in Iraq and how it is affected when implementing development road. These studies lacked the use of the best techniques, as most of them used statistical models, and therefore machine learning and random forests were used to address this and to reach a high accuracy that previous studies had not achieved [19] and also The effectiveness of economic operations in Iraq is mostly based on the extraction and export of crude oil. With the launch of the "Development Road" project, there has become an urgent need for a comprehensive understanding of how this project affects the trade balance. Therefore, a comprehensive database of economic indicators was created and machine learning was applied to it

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4.METHODOLOGY

4.1 Data Collection

This research employed an extensive dataset meticulously assembled from credible sources, such as the World Bank and the International Monetary Fund (IMF). The dataset covers the economic and social factors of Iraq, containing 780 monthly records for the period from 1960 to December 2024. The main factors include GDP, trade balance, imports, exports, population growth, unemployment rates, foreign investment, and government spending, with the primary focus on the trade balance as a target variable that depends on certain economic factors.

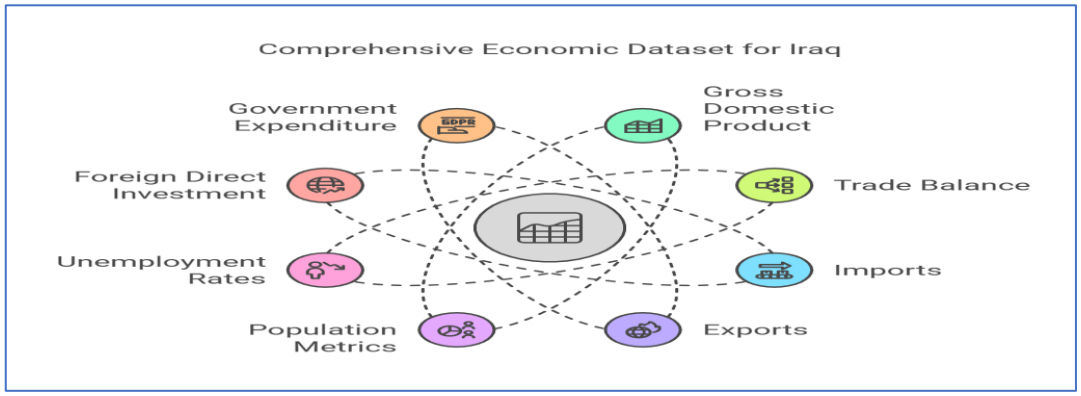

Figure.1 Data Collection

4.2 Data Preprocessing

Data processing was performed to prepare the data to build a predictive model of the trade balance, an economic factor that is expected to change after the implementation of the Development Road Project. Missing data were eliminated to maintain data quality, and the time dimension was ignored to focus on quantitative analysis. Correlation analysis was performed between variables. Numerical variables were standardized to ensure model performance.

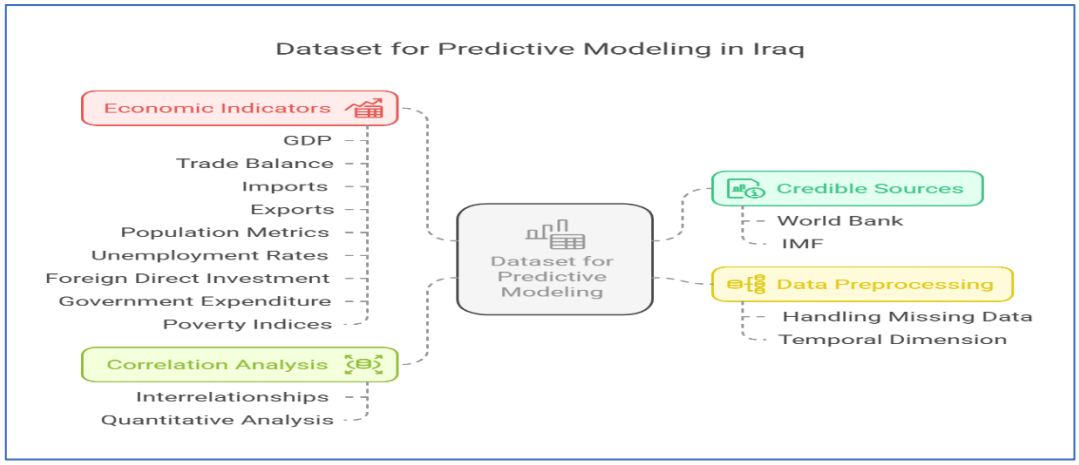

Figure.2 Data Preprocessing

4.3 Machine Learning classification

To predict the trade balance of Iraq, this research relied on the binary classification methodology, where the trade balance was divided into two groups: positive (indicating a surplus), meaning that exports are more than imports, and negative (indicating a deficit). This classification was based on the trade balance exceeding zero. The research used the random forest algorithm for its ability to manage and analyze non-linear relationships, and its flexibility against overfitting, as it has proven its ability to distinguish the factors that affect the trade balance.

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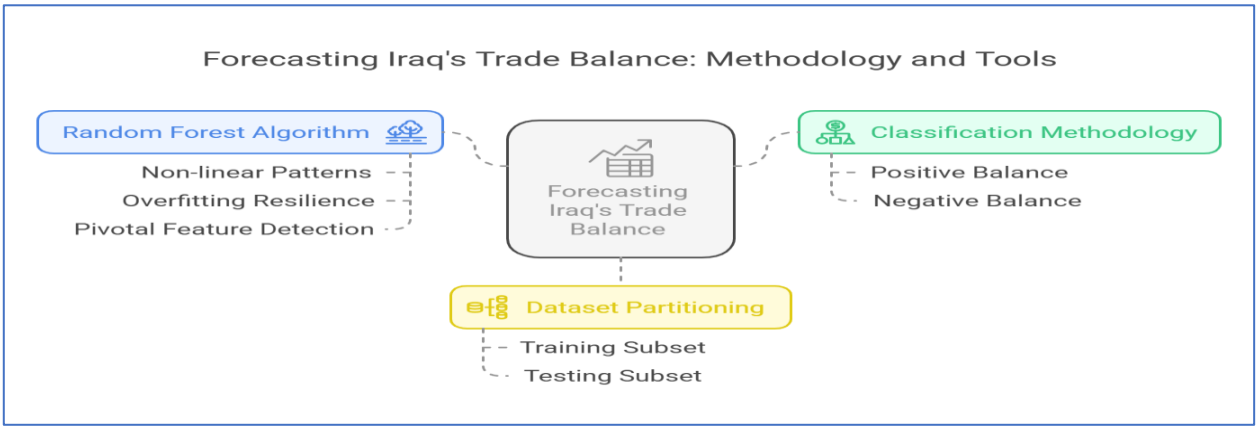

Figure.3 model selection

4.4 Training and Evaluation

Training Process

The dataset was selected as training (80%) and testing (20%) to accurately evaluate the model performance. The training set was used to fit the model, while the testing set was used to evaluate its predictive accuracy and extract classification metrics. The Random Forest algorithm was used to classify Iraq's trade balance into two groups: surplus (positive trade balance) or deficit (negative trade balance).

Evaluation Metrics:

Classification Model: The quality of the model was evaluated by applying various criteria, including accuracy, in addition to a full classification report containing precision, recall and F1 score, to ensure the model's efficiency in classifying the Iraqi trade balance with high accuracy.

5. RESULTS

5.1 Model Result

The random forest algorithm is applied to classify the trade balance into two groups: surplus (exports are more than imports) or deficit (exports are less than imports). The classification process utilizes historical economic datasets. Through the examination of trends and fluctuations in these variables, the model forecasts the trade balance condition for the coming years. Such predictions empower policymakers to refine economic strategizing and resource distribution. Fig.4 shows the forecast of Iraq's trade balance for future years and by months.

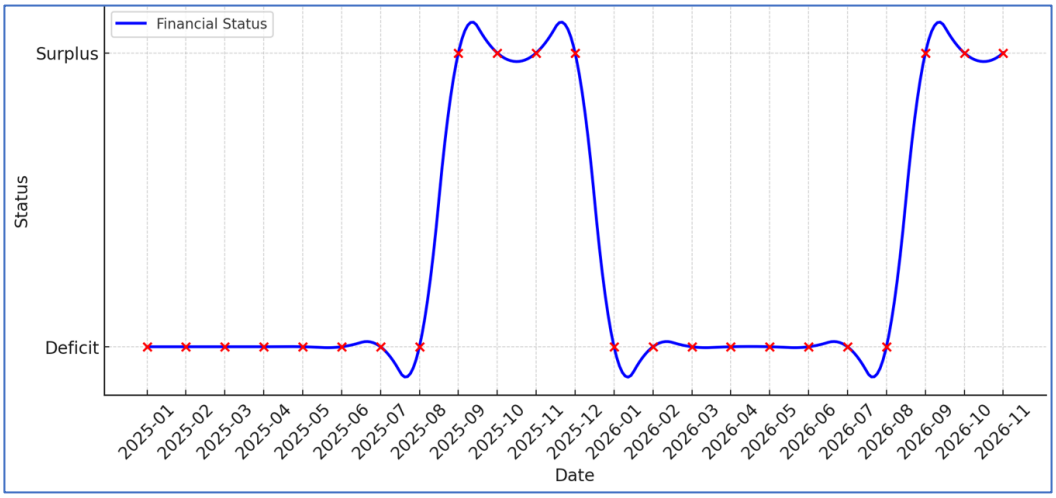

Fig.4 forecast trade balance

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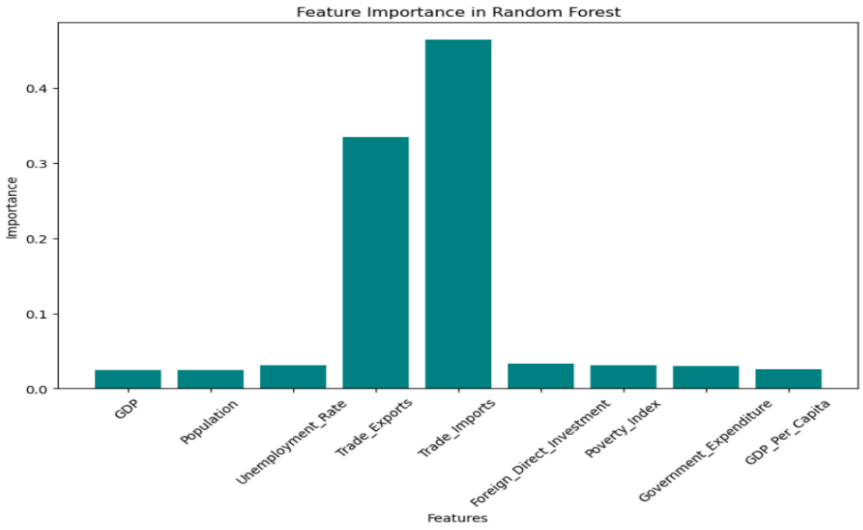

Fig.5 Feature Importance

The findings indicated that the attributes related to exports and imports exert the most significant influence on the trade balance. The findings are illustrated through a bar chart(Fig.5 that delineates the significance of each attribute, thereby offering a visual instrument for comprehending the fundamental dynamics.

5.2 Performance Evaluation

The efficacy of the Random Forest classification algorithm was scrutinized utilizing the testing dataset. The Random Forest model was evaluated through essential metrics including accuracy, precision, recall, and F1-score.

Evaluation Metrics: The algorithm performance quantified is as follows,

Accuracy: %97

Recall: %95

Precision: %96

6. CONCLUSION AND DISCUSSION

The use of random forests has proven successful and effective in fuzzy, few and unavailable data in countries suffering from a lack of studies and scientific research such as Iraq in the trade balance, which will improve after the completion of the development road project. Therefore, the proposed model has been successful in predicting the deficit or surplus of the trade balance with a high accuracy rate up to 97% using machine learning techniques and the random forest algorithm, as it has provided high accuracy for decision-making in a practical and scalable manneras the results in the above paper showed. The results and accuracy processed by the proposed model can be observed, as we note that the accuracy of the trade balance has surpassed other models in our proposed model with high accuracy. Future work will focus on adding infrastructure indicators and evaluating their impact on economic measures And also , add an stack for the purposes of storing and updating the most recent data, ensuring the model retains precision and flexibility in response to evolving circumstances. The analytical framework created in this study can also be applied to different Environments.

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