DATA-DRIVEN STUDY OF KENYA'S EXCHANGE RATE DYNAMICS

UNDERSTANDING THE FORCES SHAPING KENYA'S CURRENCY VALUATIONS

Overview

This presentation is divided into 5:

1. Business Understanding

2. Data Understanding

3. Data Analysis

4. Modeling

5. Conclusions and Recommendation

Business Understanding

- We used data from various sources specifically key macroeconomic indicators as well as other indicators such as the exchange rate(target variable), interest rates such as banking(deposit, lending, overdraft, savings), and central bank rates(T-bills, Cash Reserve, Inter-bank Rates).

- Due to the variation in timeline for the data sources, some daily, monthly, and yearly, we worked using averages and came up with 4 different data sets. Our primary one is the monthly dataset(with some repeat values), and also the yearly average(with no repeat values).

- For our initial analysis, we shall work with the monthly dataset and then proceed with the yearly average one especially for modelling

Objectives

1. To conduct exploratory data analysis (EDA) on the USD/KES exchange rate from 2003 to 2023, identifying major trends, seasonal patterns, and conducting time series decomposition.

2. To develop and compare time series forecasting models to predict exchange rate movements in 2024 and validate forecasts against actual 2024 data.

3. To apply supervised learning techniques to detect distinct volatility or trend regimes in USD/KES exchange rate data.

4. To determine the macroeconomic indicators with the greatest influence on exchange rate behavior.
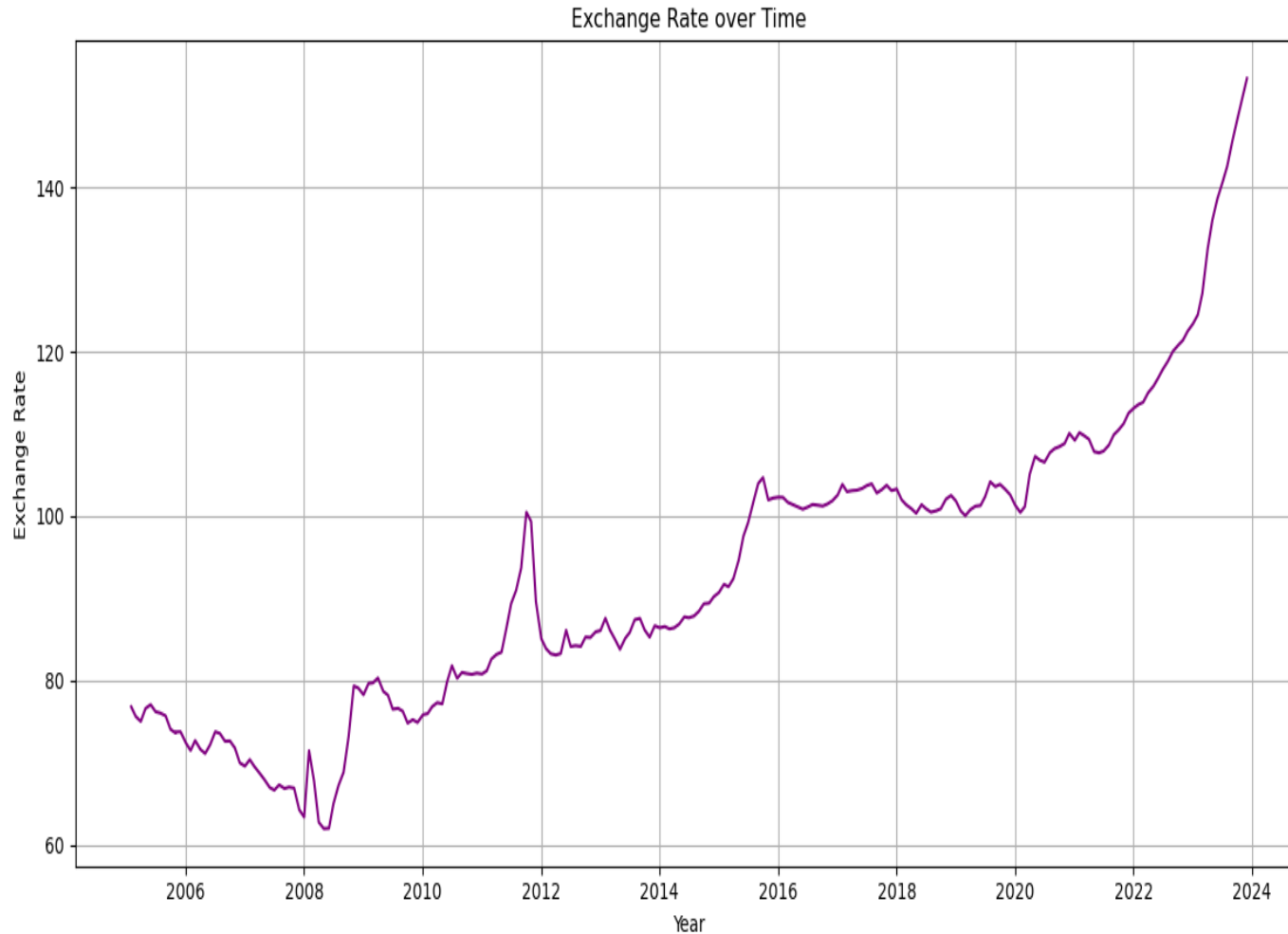
Methods

The methods used in the analysis are as follows:

1. Data Collection
2. Exploratory Data Analysis
3. Data Cleaning
4. Data visualization
5. Statistical Analysis - correlations
6. Modeling

# Data Understanding

Exchange Rate over Time

- From 2005 to 2008, the Kenyan Shilling steadily strengthened but weakened sharply during the 2008–2009 and 2011–2012 election-related tensions.

- A significant depreciation occurred from 2022 to 2024, likely due to increased government borrowing and looming debt repayments.

Data Analysis

Banking Rates vs Exchange Rate

Bank Specific Interest Rates and Exchange Rate Over Time
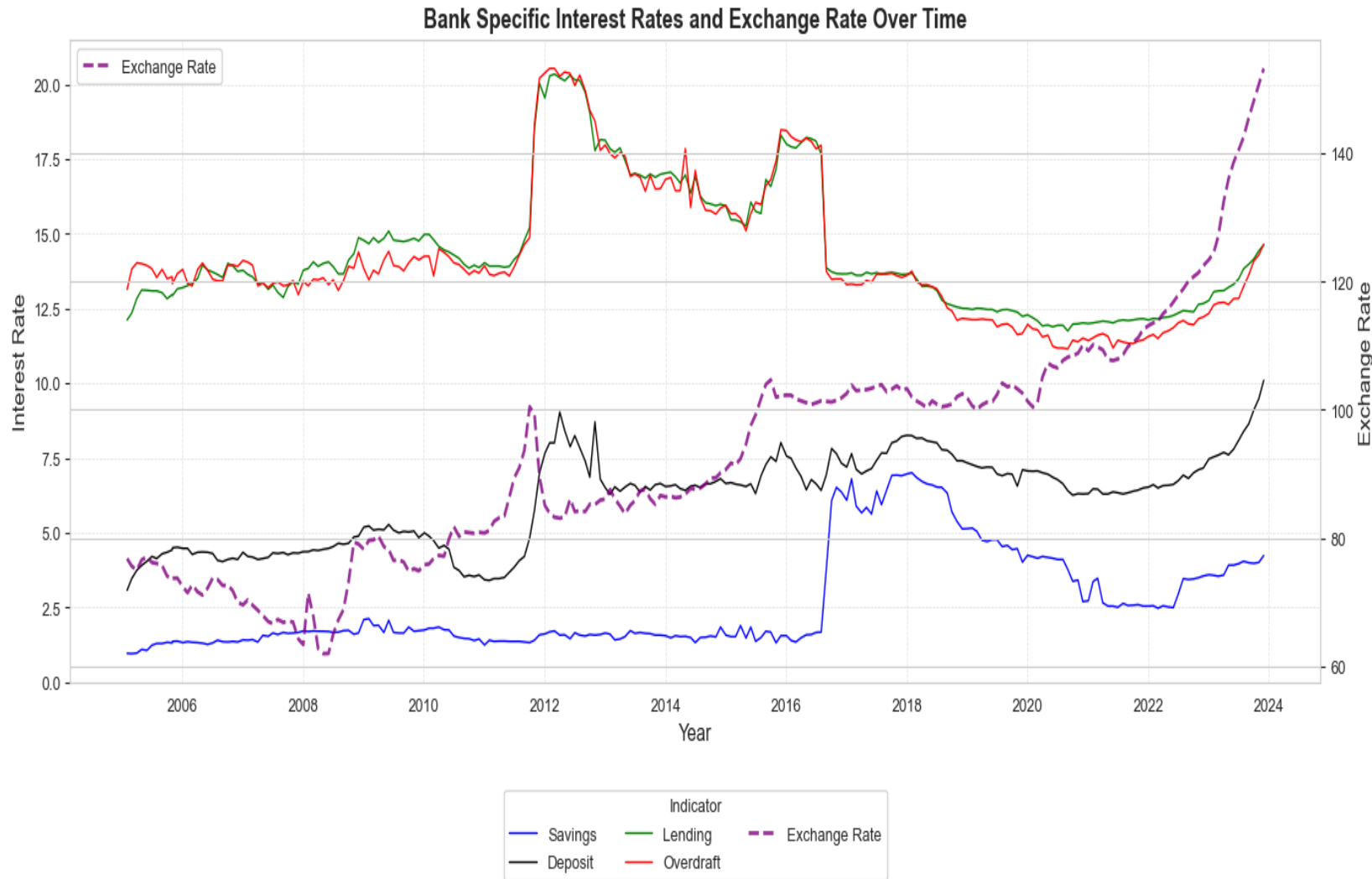
1. The deposit interast rate tends to follow closely the exchange rate, we can attribute this to the fact that money is weakening, less people are investing and as such due to the low demand for fixed deposits, banks are forced to increase the interest rate to attract more money.

2. Lending and Overdraft have very little effect on the exchange rate.

# Total Debt and Total Remittances vs Exchange rate

Total Remittances & Total Debt vs Exchange Rate Over Time
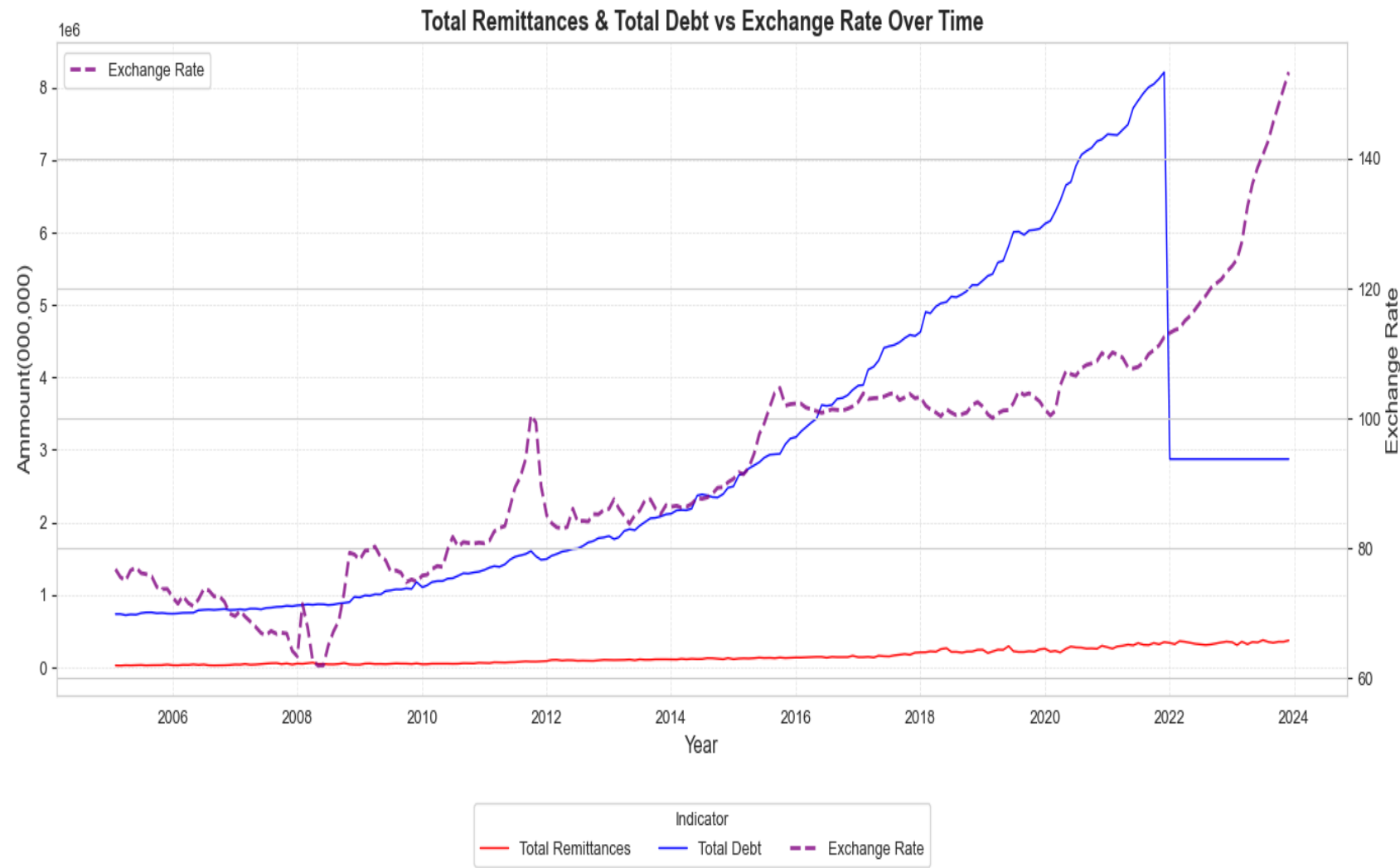
1. The plot evaluates how external support and national debt may influence currency strength or depreciation.

2. The country may have been using external debt to cushion the currency, however as soon as the repayment matured and Kenya made it the currency greatly weakened due to the currency outflow.

Interbank and Central Bank Interest rates vs Exchange rate

Central Bank & Inter-Bank Rates and Exchange Rate Over Time
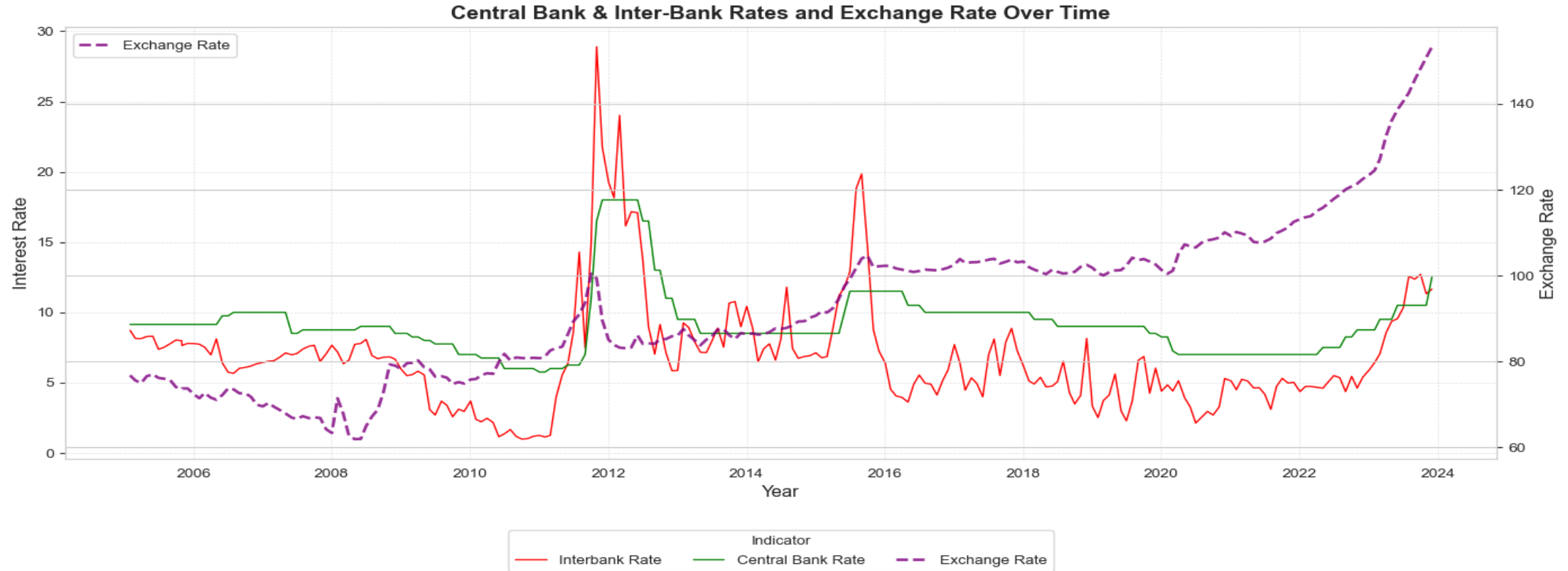
- This plot compares Central Bank Rate and Interbank Rate with the exchange rate over time, helping evaluate how monetary policy and market liquidity conditions influence currency value.

Treasury Bills (91-Day, 182-Days, 364-Days) Rate vs Exchange rate

Treasury Bill Rates and Exchange Rate Over Time
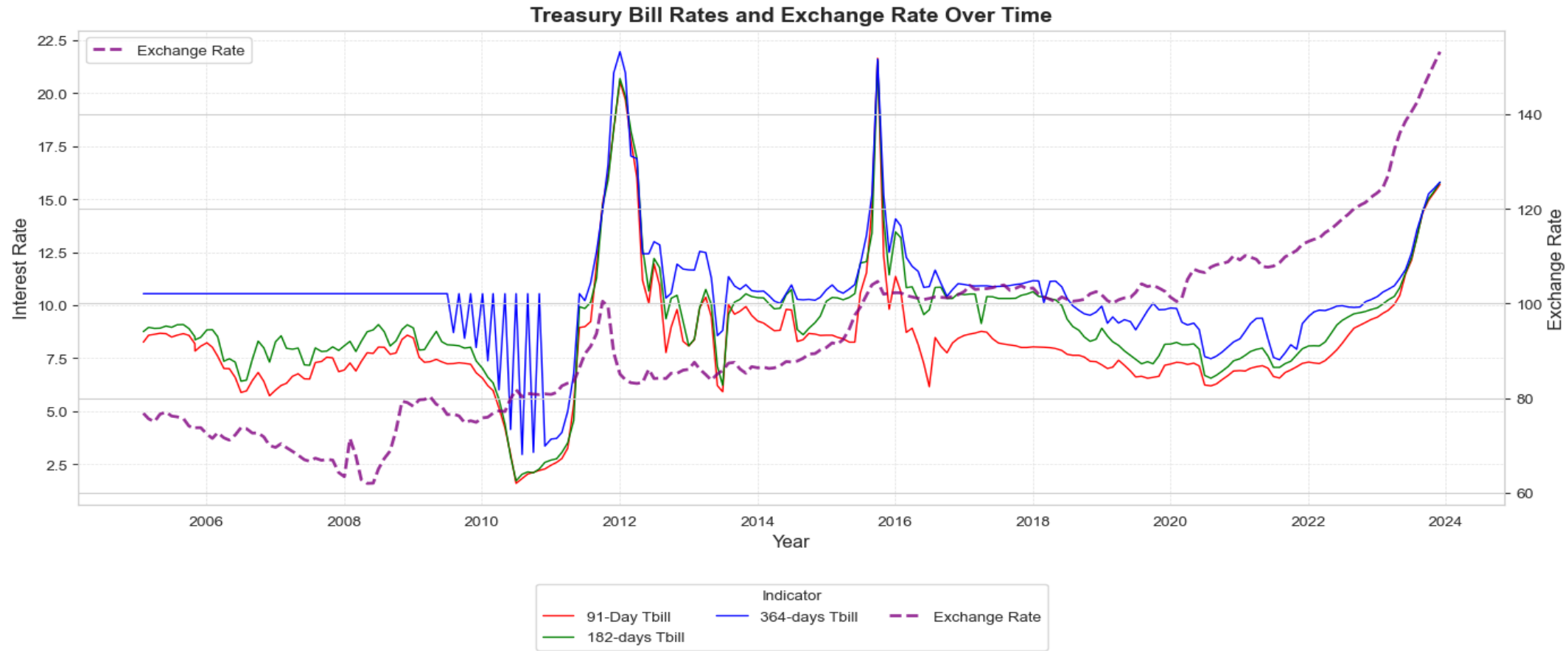
- This plot compares short-term government interest rates (T-bills) with the exchange rate to show how market interest rates may influence or react to currency movements, helping understand investor behavior and macroeconomic conditions.
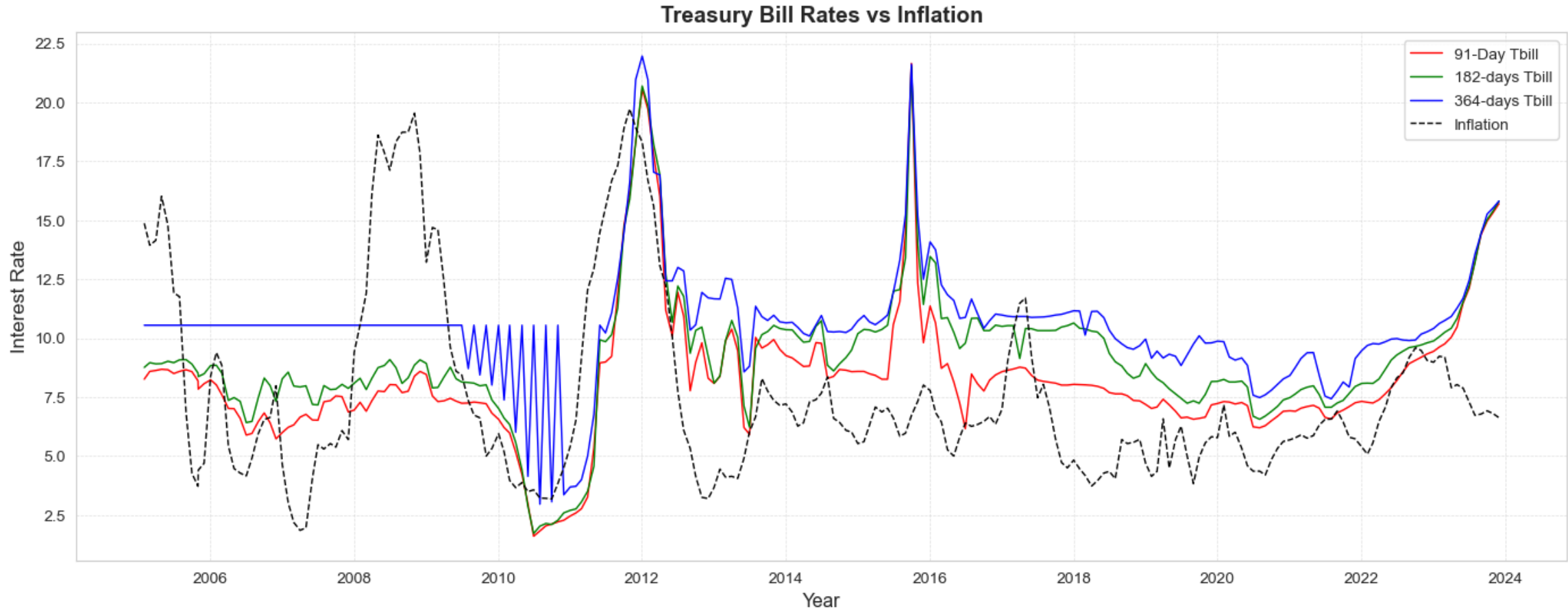
Inflation Rate vs Exchange rate
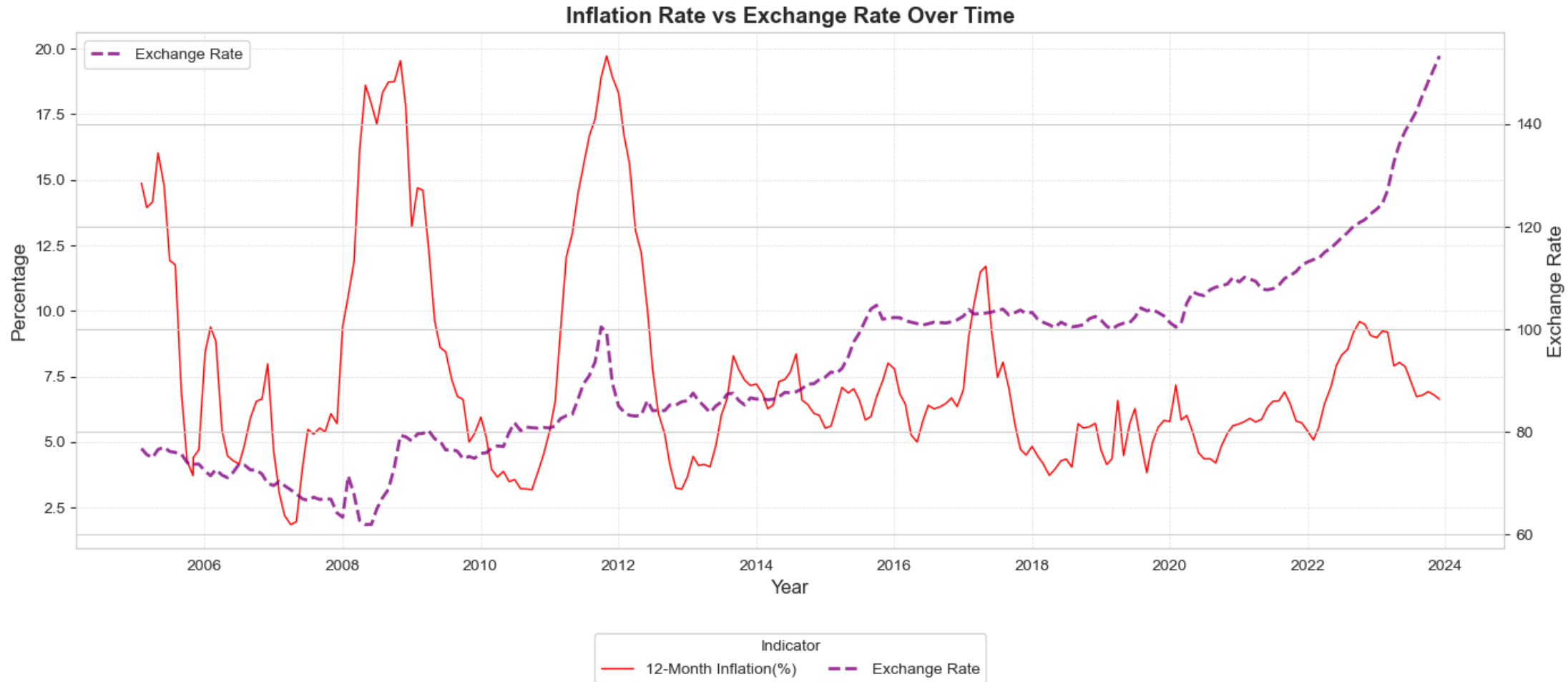
- Inflation has very little effect on exchange rate. However, significant similar spikes are seen around the election periods of 2012, 2017.

Treasury bills vs Inflation


Treasury Bill Rates vs Inflation

- Close relation ship between inflation and Treasury bills, and how they are used a fiscal tool to control the inflation rate. However, we see that the influences are not so significantly strong hence why treasury bills are used in conjunction with other methods to stabilize inflation.

Imports and Exports vs Exchange Rate


Imports & Exports vs Exchange Rate Over Time
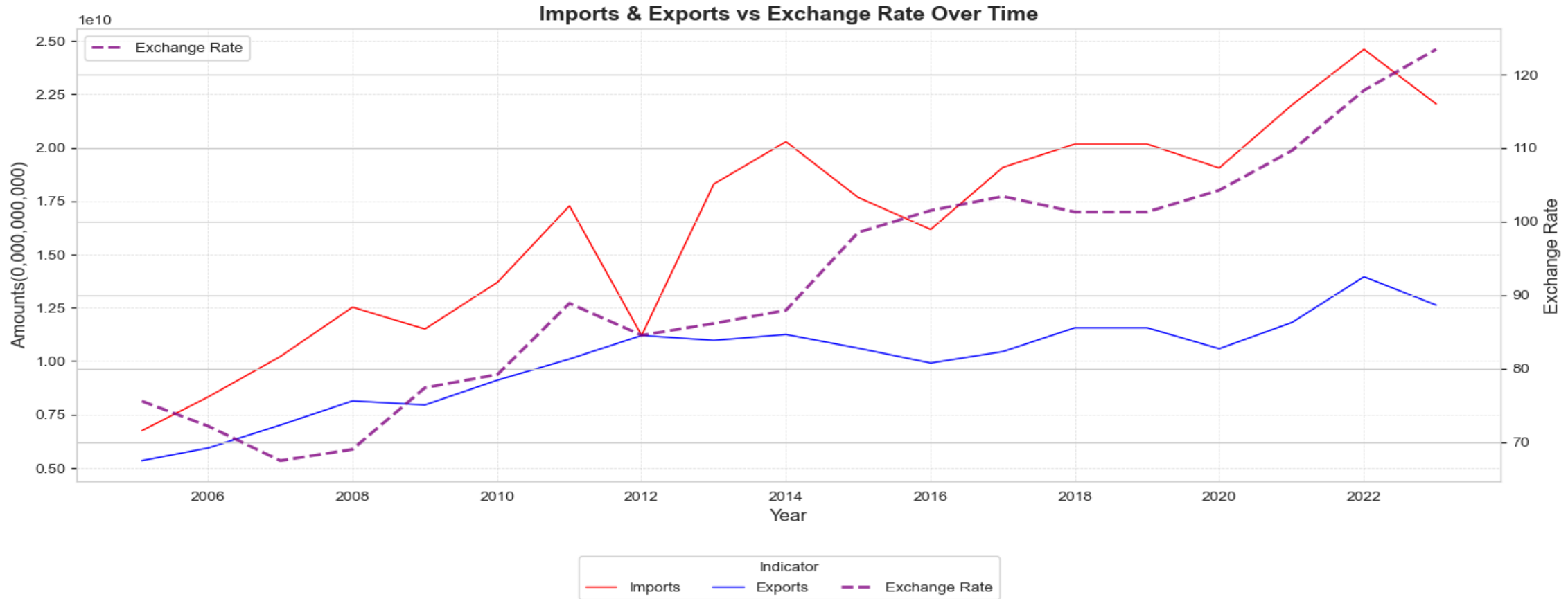
- The plot helps assess how trade performance especially trade imbalances may affect currency strength, showing whether higher imports or exports correspond with currency depreciation or appreciation.

Foreign Direct Investment and IBRD loans and IDA credits (DOD, current US$) vs Exchange rate
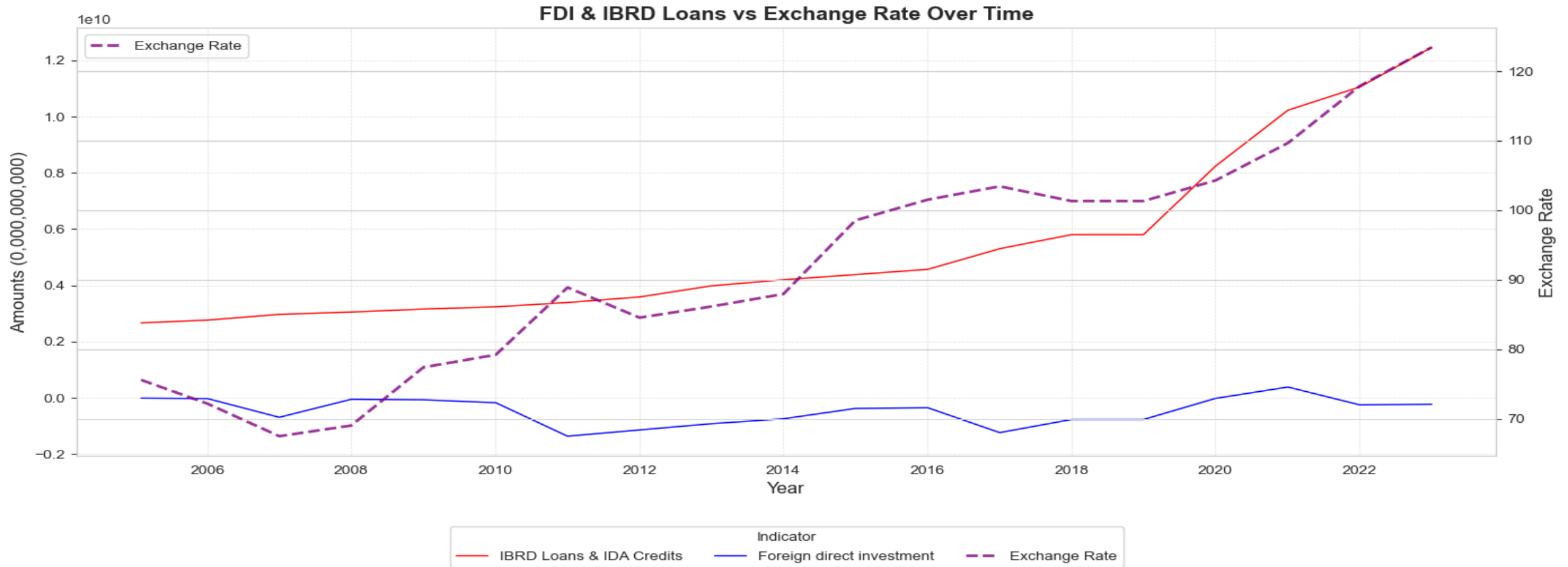

- Comparison of FDI and external loans (IBRD/IDA) with the exchange rate over time, offering insights into how capital inflows and external borrowing affect currency strength and economic confidence.

Unemployment Rate vs Exchange Rate
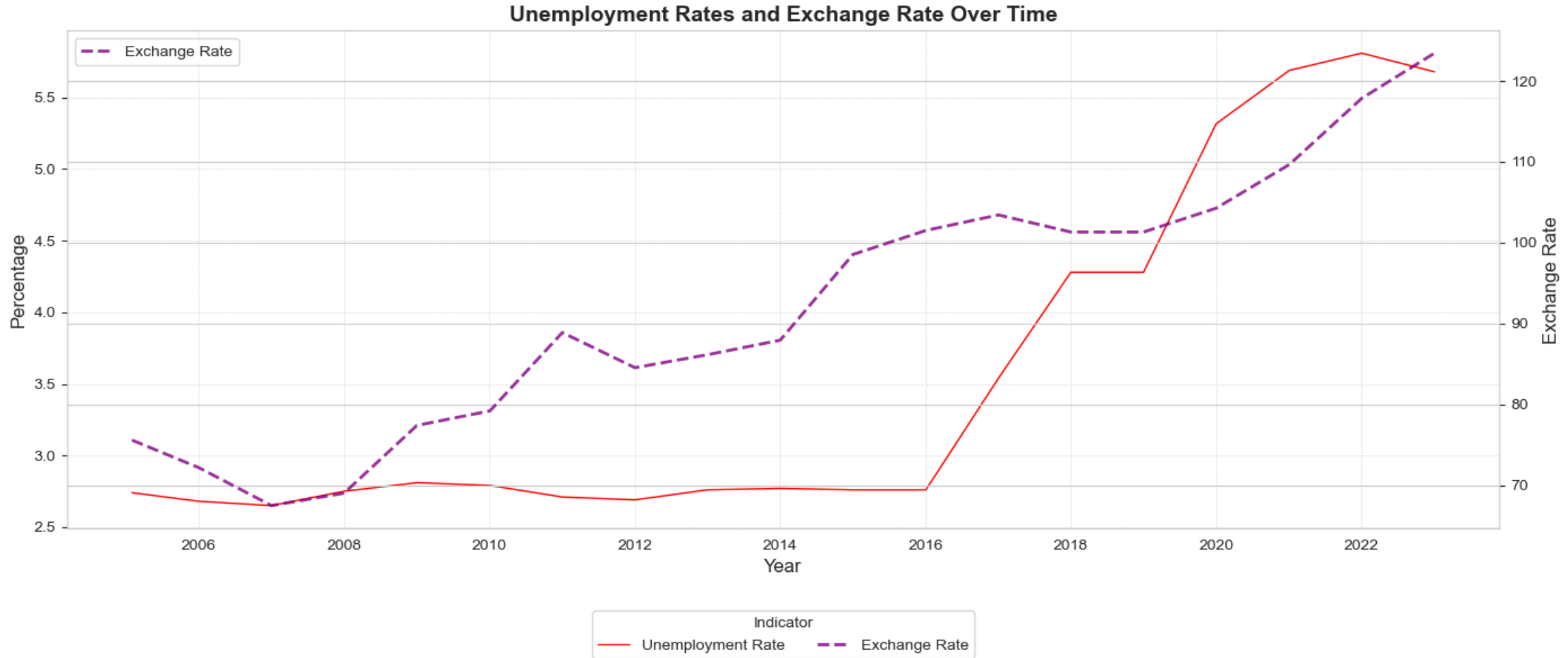
- The highlights between labor market conditions and currency value, showing how domestic economic performance can influence the exchange rate.

Cross Correlation for all the variables
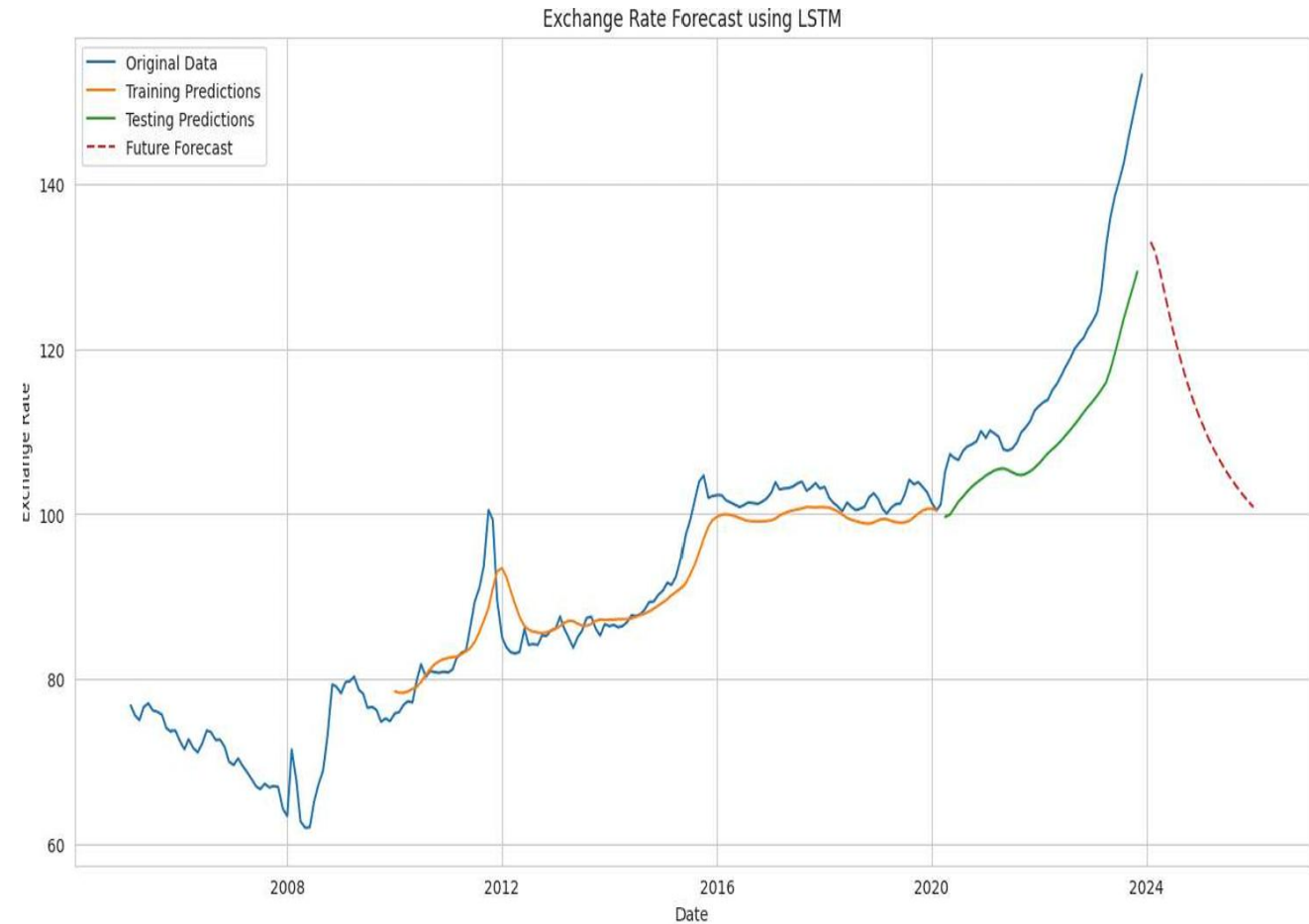

Correlation Heatmap; for dfmonthly Variables
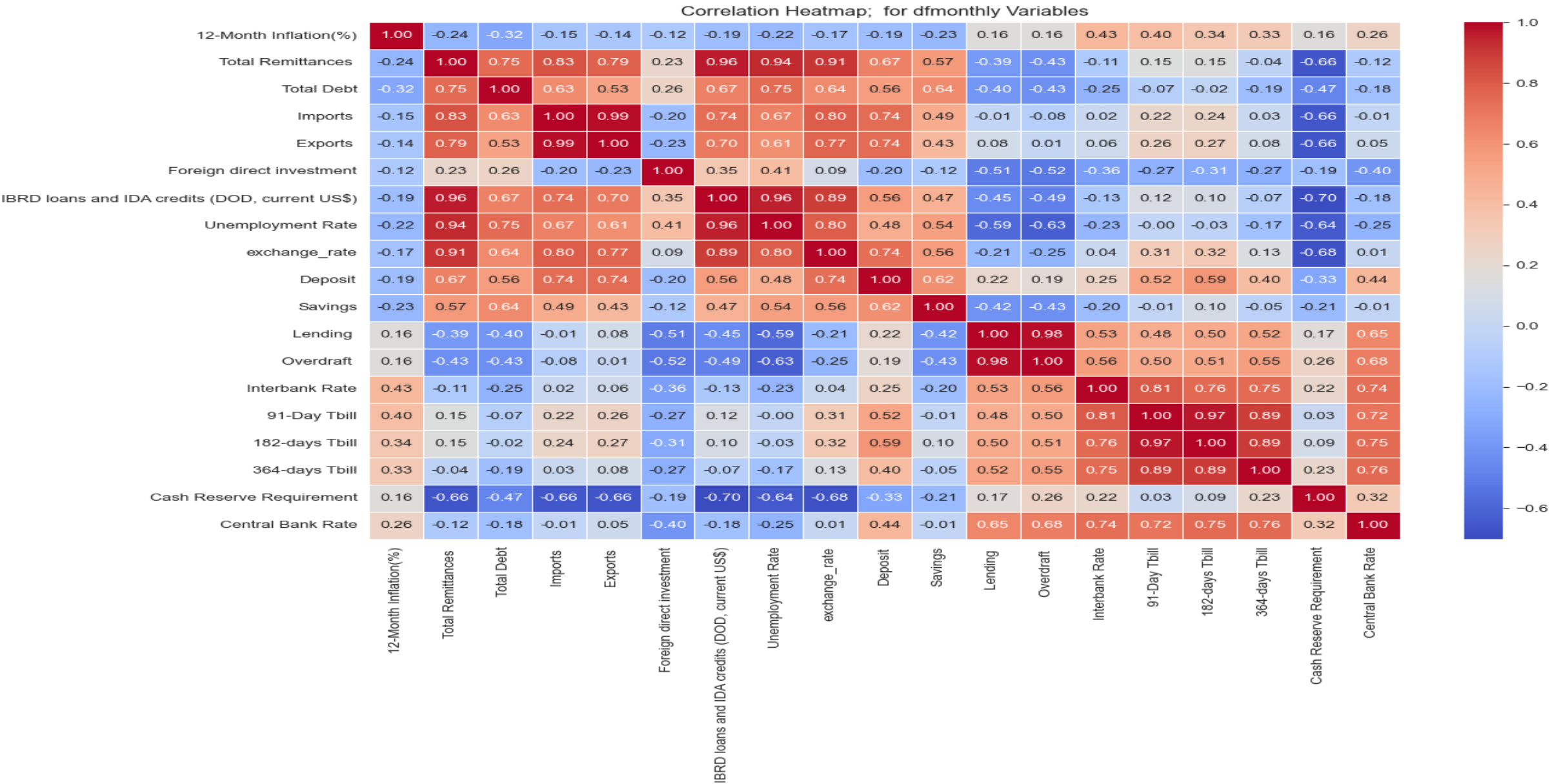
Modeling

LSTM Model
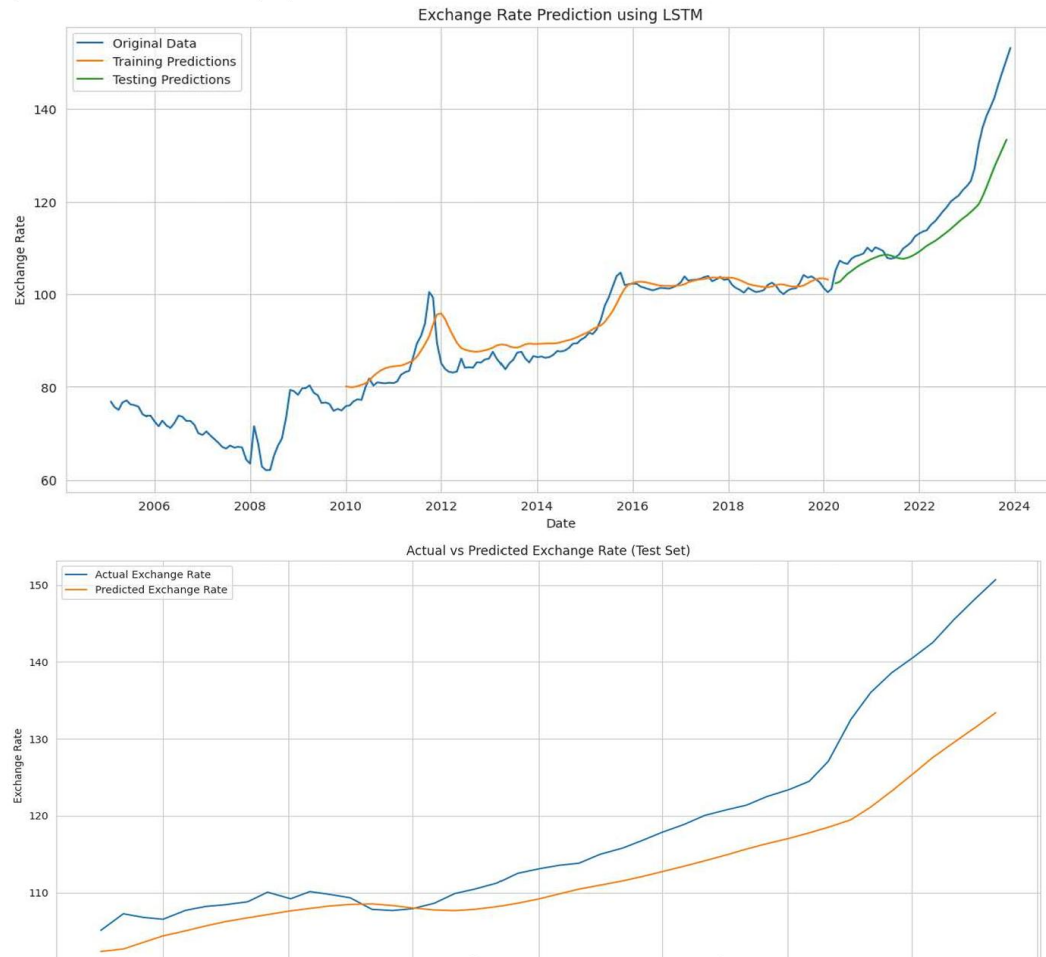
1. The LSTM model captures the overall trend of the USD/KES exchange rate well but underestimates the sharp rise in recent years.
2. Training predictions closely follow historical data, while test predictions lag behind actual values during the 2022–2023 surge.
3. This suggests the model struggles with sudden, steep changes in the exchange rate.

Xgboost Model

Full Model: Actual vs Predicted Exchange Rate

XGBoost Exchange Rate Forecast: 2024-2025
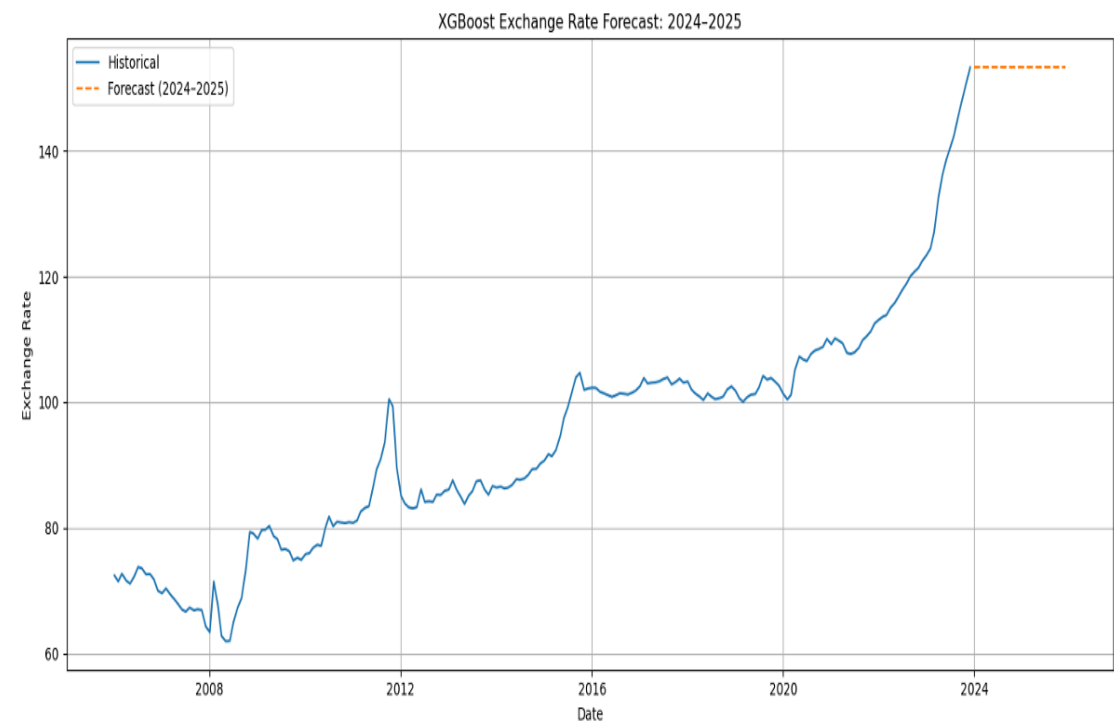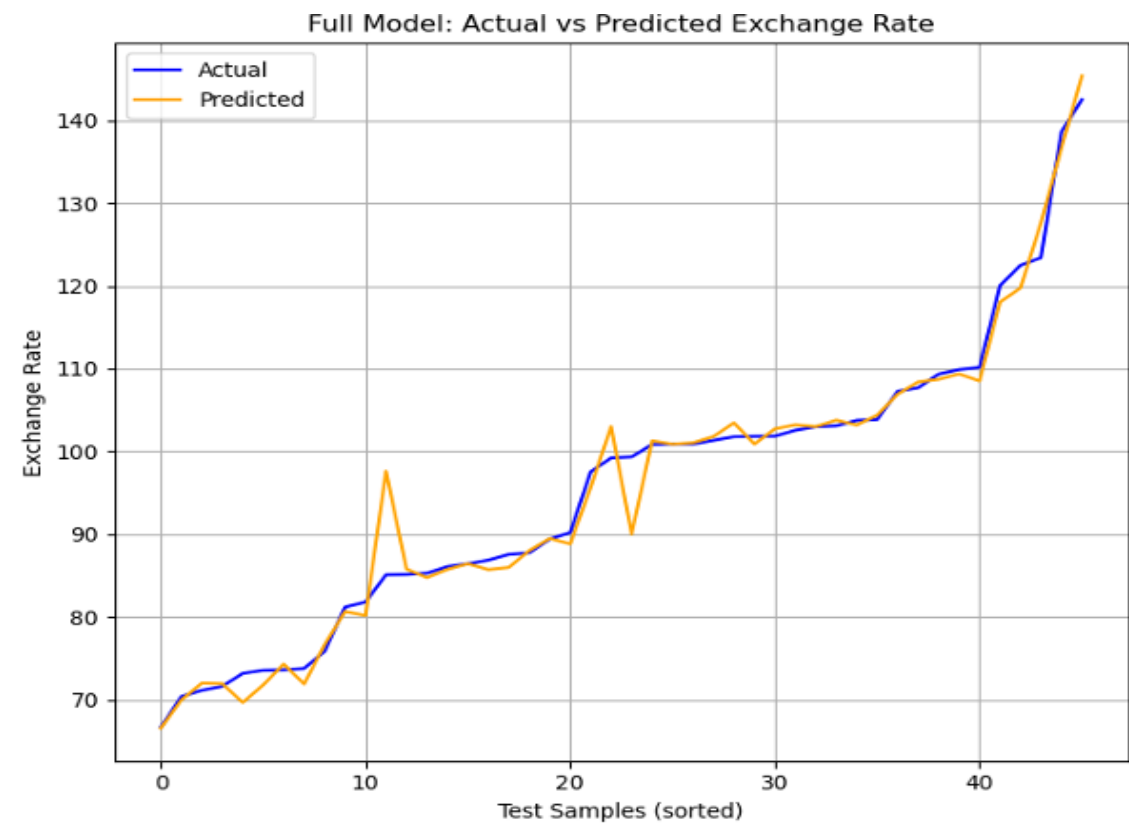
Summary of all used models

Model Metric	ARIMA	EXPONENTIAL SMOOTHING	PROPHET	MOVING AVERAGE	LSTM	XG BOOST
RMSE	22.360	1.644	2.614	20.572	6.051	2.737
MSE	486.684	2.703	6.830	423.223	36.612	7.490
MAE	17.491	1.002	2.007	17.893	4.503	1.538
MAPE	14.040	1.149%	2.200%	12.455%	3.540%	1.620%
R² Score	-1.766	0.992	0.979	-3.510	0.768	0.974

Conclusion

<u>Features</u>

From our exploratory analysis, we came to the conclusion that the following features have the most influence on/are influenced by the exchange rate;

a. Imports & Exports

b. IBRD Loans & IDA Credits

c. Unemployment

d. Bank Deposit Rate

e. Savings

f. Total Debt

g. Total Remittances

For a future and ongoing analysis after this one, these would be the key features to consider in the analysis.

Conclusion

Models

- From the below table, we can see very mixed reactions from the metrics and forecasted values;

Model Date	ARIMA	EXPONENTIAL SMOOTHING	PROPHET	MOVING AVERAGE	LSTM	XG BOOST	ACTUAL (CLOSING)
Dec – 2023		155.13	144.60	154.95			154.09
Jan – 2024	254.87	157.01	147.06	155.44	141.23		159.69
Feb – 2024	356.63	158.90	147.06	155.47	141.32		151.84
Mar – 2024	458.53	160.78	148.29	155.60	140.67		137.35
Apr – 2024	560.56	162.67	148.54	155.56	139.72		131.57
May – 2024	662.72	164.55	148.36	155.54	138.69		131.69
Jun – 2024	765.02	166.44	169.22	155.40	137.67		129.36
July – 2024	867.45	168.32	151.92	155.39	136.70		129.87
Aug – 2024	970.02	170.21	152.06	155.37	135.80		129.32
Sep – 2024	1072.71	172.09	171.16	155.27	134.95		129.20
Oct – 2024	1175.55	173.98	154.02	155.14	134.16		129.20
Nov – 2024	1278.51	175.86	156.24	154.96	133.42		129.40
Dec – 2024	1381.61		173.63		132.72		129.36

Recommendation

- Integrate continuous EDA and decomposition tools into the national financial reporting system to monitor seasonal or structural shifts in currency dynamics.

- Adopt the best-performing forecasting model (e.g., Exponential Smoothing or ARIMA) for regular use by financial institutions and central bank analysts to enhance forecasting precision.

- Use machine learning–based regime detection to inform risk-adjusted investment strategies and enhance the timing of monetary policy interventions.

- Prioritize identified key indicators (e.g., inflation, interest rates) in macroeconomic policy targeting, exchange rate management, and central bank communications.

The end!