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Abstract

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Background

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2.3 Currency Exchange Rate Forecasting

2.3.1 Statistics Approach

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2.5 Critical Analysis¹⁰

Chapter 3

Methodology

This chapter presents the methodology used to achieve the project's objectives. It starts by describing the data collection process and analyzing the data collected, followed by an overview of the pre-processing techniques. The chapter then discusses the model building approach and the hyperparameter optimization strategy.

3.1 Data Collection

Data for this study were obtained from the Yahoo Finance platform using Python's `yfinance` package. The data collection process was designed to support three main aspects of the research: (i) the primary dataset, (ii) supplementary features for multivariate modeling, and (iii) datasets for benchmarking against previous studies.

QUESTION: 我该不该引用yfinance的官方文档?

3.1.1 Primary Dataset

The primary dataset consists of the USDEUR exchange rate with a daily frequency, spanning from December 1, 2003 to January 31, 2025.

QUESTION: 我是否应该提及具体的数据收集的脚本

3.1.2 Supplementary Features for Multivariate Models

To build a robust multivariate model, additional financial indicators were collected. The supplementary data include:

- Crude Oil (WTI Futures)
- Gold Futures
- FTSE 100 Index
- US Dollar Index (DXY)

These datasets cover the period from January 1, 2000 until the present day. When used, they are aligned based on the corresponding currency pair's time base.

3.1.3 Benchmarking Datasets

For comparative analysis with prior research, additional datasets were collected to ensure that the time series forecasting results are directly comparable. Two sets of benchmarking data were collected:

1. A multi-currency dataset covering the period from December 18, 2017 to January 27, 2023. This dataset includes exchange rates for EUR/USD, GBP/USD, AUD/USD, and NZD/USD. For USD/JPY data, the script inverts the closing prices to derive the JPY/USD rate[1].

2. A focused subset for the EUR/USD pair spanning from January 1, 2013 to January 1, 2018[2].

写的很难受, 该不该写Data Analysis? 总觉得不对劲

3.2 Data Analysis

Data analysis is a critical step in understanding the underlying quality, patterns, and characteristics of the dataset.

3.2.1 Data Quality Check

Ensuring high data quality is a critical first step before any analysis. In this stage, the following checks are performed:

- **Missing Values:** Confirm that there are no missing entries, or if there are, decide on an appropriate imputation method.
- **Outliers:** Identify any extreme values using statistical methods (this project used IQR), or if there are any, determine if they need to be removed or capped.
- **Duplicates:** Check for duplicate records to prevent bias in analysis.
- **Consistency and Integrity:** Ensure data types, ranges, and formats are consistent across the dataset.

Results: All datasets collected via yfinance contain no missing values or duplicates, and no outliers were detected using the Interquartile Range (IQR) method. Data types are consistent, with the ‘Date’ as an object and ‘Close’ as float64.

3.2.2 Exploratory Data Analysis

Exploratory Data Analysis (EDA) involves summarizing the main characteristics of the dataset using visual and quantitative methods. This project includes the following EDA techniques:

- **Summary Statistics:** Compute mean, median, variance, and other descriptive measures to understand data distribution.
- **Line Chart for Long-Term Trends:** Plot the USDEUR exchange rate over time to reveal long-term trends and identify potential anomalies. (See Figure 3.1.)
- **Rolling Statistics for Volatility Analysis:** Compute the rolling mean and standard deviation of the USDEUR exchange rate using a 30-day window to assess volatility changes over time. (See Figure 3.2.)

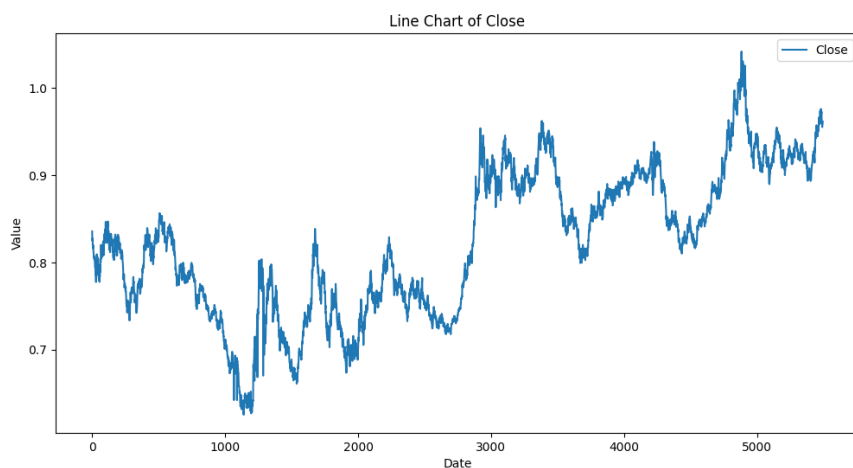


图 3.1: Line Chart of the USDEUR Exchange Rate (The Primary Dataset)

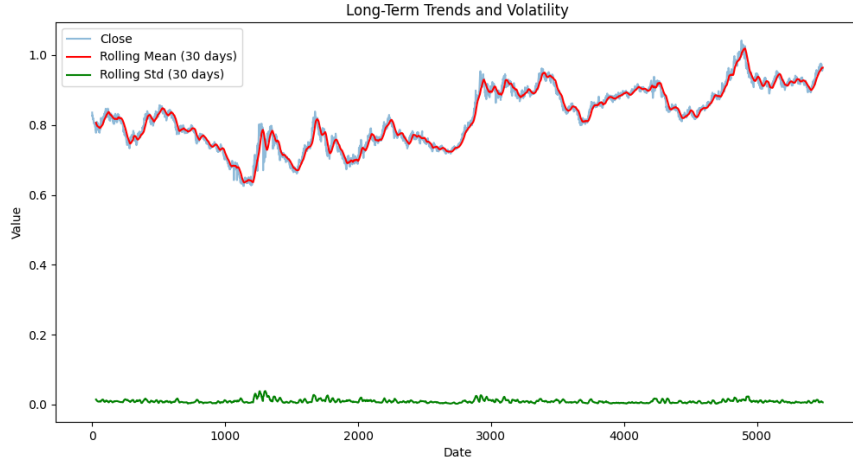


图 3.2: Rolling Mean and Standard Deviation of the USDEUR Exchange Rate (The Primary Dataset))

For the primary dataset, its summary statistics indicate that the mean exchange rate is approximately 0.823 with a standard deviation of 0.084, which reflects moderate variability. The line charts visually confirms this stability, which highlights long-term fluctuations without evident anomalies.

3.2.3 Stationarity Testing

Stationarity testing is an important process in time series analysis. A stationary time series has statistical properties that do not change over time.

3.2.3.1 Augmented Dickey-Fuller Test

The Augmented Dickey-Fuller (ADF) test operates under the following principles:

- **Null Hypothesis (H_0):** The time series has a unit root (non-stationary).

- **Alternative Hypothesis (H_1):** The time series is stationary.

3.2.3.2 KPSS Test

The KPSS test operates under these principles:

- **Null Hypothesis (H_0):** The time series is stationary around a deterministic trend (level stationary).
- **Alternative Hypothesis (H_1):** The time series is non-stationary.

Results: Both the ADF and KPSS tests indicate that there are more than 99% confidence that the primary dataset is non-stationary. This suggests that further differencing is required to achieve stationarity.

3.3 Data Pre-processing

3.3.1 Data Splitting using Windows

3.3.2 Data Scaling and Normalization

3.3.3 Sequence Transformation

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3.6.6 Simulated Annealing

3.6.7 Reinforcement Learning

Chapter 4

Evaluation Methods

4.1 Classification Metrics

4.2 Regression Metrics

4.3 Ablation Experiments

Chapter 5

Development

Chapter 6

Results and Discussion

Chapter 7

Conclusion

7.1 Achievements

7.2 Limitations

7.3 Future Work

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