

Analysis of COVID-19 Impact on US and European Currency Exchange Rates

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Overview

The COVID-19 pandemic brought unprecedented economic disruption globally, impacting currency exchange rates between the United States and Europe. Using historical exchange rate data from January 2019 to November 2020, we analyzed how the pandemic influenced the EUR/USD currency pair. By leveraging ARIMA and GARCH models, we forecasted the exchange rates, calculated confidence intervals, and assessed the accuracy of our predictions. This report outlines the key findings and their implications.

Data Source and Scope of Analysis

Historical Exchange Rate Data:

- The exchange rate data for the EUR/USD currency pair was obtained using Yahoo Finance's API.

Dataset Coverage:

- The dataset spans from January 1, 2019, to November 6, 2020, including both the pre-pandemic period of 2019 and the pandemic affected period of 2020. This allows for comparative analysis of exchange rate behavior before and during the global COVID-19 pandemic.
- Including the COVID -19 shutdown period (March 15 – April 1, 2020) provides a focused view of how unprecedented mandatory economic disruptions impacted the EUR/USD exchange rate.

Data Quality and Consistency:

- To maintain data consistency, gaps and missing values in the dataset were addressed. Exchange rate values were limited to business days, as financial markets are closed on weekends and holidays.
- Residuals from ARIMA and GARCH models were filtered to exclude any non-finite values, ensuring the reliability and accuracy of the model outputs.

Dataset Limitations:

- The dataset for 2020 covers the period from January 1 to November 6, which may slightly skew results for the year as it excludes late-year developments, including end-of-year fiscal and monetary adjustments.
- Inflation data was unavailable, limiting the macroeconomic variables analyzed to GDP, unemployment rates, and interest rates. This constrains the explanatory power of the analysis regarding exchange rate dynamics.

Significance of Data Scope:

- By covering both stable and volatile economic periods, the dataset provides valuable insights into the impact of global macroeconomic disruptions on currency markets.
- The time-limited coverage of 2020 highlights the challenges of analyzing economic trends during periods of incomplete or rapidly changing data.

Analytical Models

1. ARIMA Model

- **Purpose:** Used for short-term forecasting of exchange rates, particularly capturing trends and seasonality in the time series data.
- **Functionality:**
 - Captures autoregressive and moving average components along with integration to address non-stationarity in the data.
 - Provides a predicted exchange rate for the next day based on historical data trends.
- **Strengths:**
 - Ideal for time-series data with clear linear dependencies.
 - Useful for understanding the underlying relationship between past and future values.

2. GARCH Model

- **Purpose:** Applied to the residuals from the ARIMA model to capture volatility and account for heteroskedasticity in the time series.
- **Functionality:**
 - Captures periods of high and low volatility in financial data.
 - Produces 95% confidence intervals, offering a range for anticipated fluctuations in exchange rates.
- **Significance:**
 - Especially relevant during periods of uncertainty, such as the COVID-19 pandemic, where market volatility was elevated.

3. MAPE (Mean Absolute Percentage Error)

- **Purpose:** Serves as a measure of forecast accuracy, evaluating how closely the model's predictions align with actual values.
- **Calculation:**
 - Expressed as a percentage, it provides a clear measure of error by comparing the size of absolute errors to actual values.
- **Importance:**
 - A lower MAPE value indicates higher predictive accuracy.
 - In this analysis, the MAPE values demonstrated the effectiveness of the ARIMA model in forecasting EUR/USD exchange rates.

Key Findings

1. Increased Volatility During the Pandemic

- **Analysis of volatility Across Periods:**
 - The GARCH model revealed a sharp increase in market volatility during 2020, with the most extreme levels recorded during the March 15 to April 1, 2020, shutdown period. This period saw a 95% confidence interval of $[-394.13, 394.13]$, compared to the narrower $[-22.46, 22.46]$ confidence interval for 2019.
 - The elevated volatility aligns with the onset of global lockdowns, which disrupted supply chains, decreased consumer demand, and destabilized financial markets. The wide GARCH intervals indicate significant uncertainty in investor sentiment during this time.
- **Implications for Investors:**
 - The extreme uncertainty highlights the importance of hedging strategies and diversification in portfolio management.
 - Forex traders would have faced challenges in predicting short-term movements, but increased price volatility created opportunities for arbitrage.

2. Depreciation of the US Dollar

- **Key Observations:**
 - The ARIMA model consistently forecasted USD depreciation against the Euro during 2020. For instance, the ARIMA forecast for 2020 showed an exchange rate of 1.178079, significantly higher than the 2019 forecast of 1.110099.
 - Stimulus measures, such as aggressive interest rate cuts by the US Federal Reserve, contributed to a weaker USD as the real returns on US assets diminished.
 - The Euro maintained relative stability due to Europe's coordinated fiscal policies, which included significant recovery funds and containment measures.
- **Implications for International Trade:**
 - A weaker USD benefited European exporters, making their goods more competitive in the global market. However, US importers faced challenges due to the rising cost of European imports.

3. Economic Recovery Divergence Between the US and Europe

- **Key Insights:**
 - Exchange rate trends in late 2020 reflected the diverging recovery paths of the two economies.

- Europe's strong industrial output and proactive fiscal policies ensured quicker recovery. In contrast, the US faced prolonged economic uncertainty due to delayed stimulus negotiations and inconsistent public health measures.
- This divergence is reflected in the ARIMA model's higher forecast for 2020 and the narrower GARCH confidence interval for late 2020 compared to the shutdown period.

4. Impact of COVID-19 Shutdowns (March 15 – April 1, 2020):

- **Extreme Market Conditions:**

- During the initial shutdowns, the ARIMA model forecasted an exchange rate of 1.117751, with a GARCH confidence interval of [-394.13, 394.13]. The Mean Absolute Percentage Error (MAPE) increased to 1.33%, highlighting the challenges of forecasting during highly volatile periods.
- Market instability was fueled by rapid selloffs in equity markets, increased demand for low-risk assets, and policy uncertainty.

- **Investor Behavior:**

- Investors shifted toward safe-haven currencies like the USD during the early pandemic phase, causing short-term USD appreciation. However, sustained fiscal measures in the US led to longer-term depreciation against the Euro.

5. Predictive Accuracy of Models

- **ARIMA Model Performance:**

- The ARIMA model demonstrated strong predictive performance across all periods, with a MAPE of 0.73% for 2019, 0.41% for 2020, and 0.35% for 2019–2020 combined. The model's ability to adapt to shifting trends highlights its reliability for exchange rate forecasting.
- During the COVID-19 shutdowns, the MAPE rose to 1.33%, highlighting the challenges in modeling during extreme market conditions.

- **GARCH Model Insights:**

- The GARCH model effectively captured market uncertainty, with wider confidence intervals during high-volatility periods like the shutdown phase. For example, the GARCH interval for March 15 – April 1, 2020, was 17.5 times larger than that for 2019, underscoring the pandemic's disruptive impact.

6. Long-Term Trends (2019–2020 Combined)

- **Summary of Results:**

- The ARIMA model forecasted an exchange rate of 1.177321, reflecting the USD's depreciation trend over the two years.
- The GARCH confidence interval of [-16.18, 16.18] and MAPE of 0.35% indicate stable performance despite significant global economic disruptions.
- Long-term forecasts provide valuable insights for policymakers and investors looking to understand macroeconomic trends beyond short-term crises.

Results Breakdown:

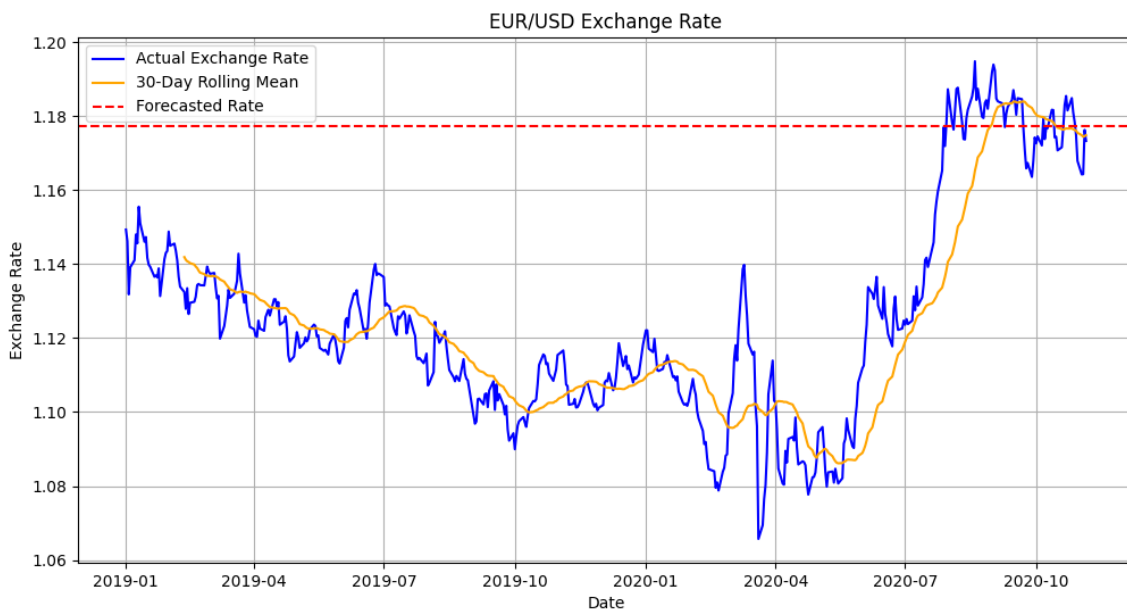
1. Results for 2019:

- **ARIMA Forecast:** 1.110099
- **Confidence Interval (GARCH):** [-22.46, 22.46]
- **MAPE:** 0.73%
 - **Implications:**
 - Narrow confidence intervals and low MAPE indicate a stable economic environment.
 - Minimal variance reflects investor confidence in both the US and European economies during the pre-pandemic period.

2. Results for 2020:

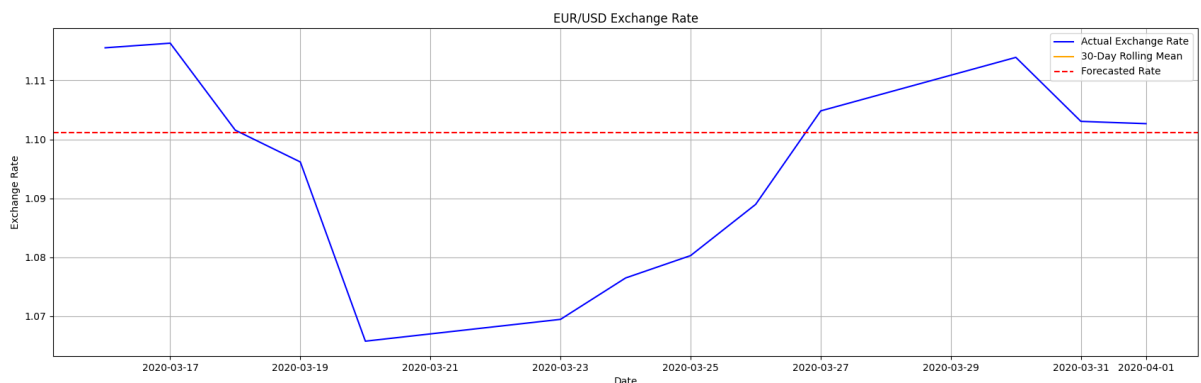
- **ARIMA Forecast:** 1.178079
- **Confidence Interval (GARCH):** [-24.08, 24.08]
- **MAPE:** 0.41%
 - **Implications:**
 - Wider confidence intervals and higher ARIMA forecast values indicate increased volatility and a weaker USD in the post-pandemic period.
 - The Federal Reserve's rate cuts and fiscal measures are evident in the depreciation.

3. Results for 2019–2020 Combined:



- **ARIMA Forecast:** 1.177321
- **Confidence Interval (GARCH):** [-16.18, 16.18]
- **MAPE:** 0.35%
 - **Implications:**
 - Combining data across two years smoothens the volatility but still captures significant economic divergence.
 - Demonstrates the long-term trend of a weakening dollar amidst the global economic impact of COVID-19.

4. Results for March 15 – April 1, 2020 (COVID-19 Shutdowns):



- **ARIMA Forecast:** 1.117751
- **Confidence Interval (GARCH):** [-394.13, 394.13]
- **MAPE:** 1.33%
 - **Implications:**
 - Exceptional market volatility, reflecting investor uncertainty during the early phases of lockdowns in the US and Europe.

Conclusion

The COVID-19 pandemic significantly impacted the EUR/USD exchange rate, with heightened volatility and a depreciating USD. The analysis demonstrates the critical connection between economic policies, market sentiment, and public health crises. Future studies could broaden these findings by including additional currency pairs and explore real-time forecasting methods.