MINES Saint-Étienne

Une école de l'IMT

Advanced Time Series Analysis and Forecasting of Financial Data

TP noté (30% de la note finale)

Objective

The goal of this practical session is to analyze and model the time series behavior of Euro/USD and Gold/USD exchange rates using several appropriate time series models like AR, ARMA, ARCH, and GARCH models. You will evaluate and forecast future observations with confidence intervals and study the heteroscedasticity in financial time series data.

Instructions

1 Data Import and Preliminary Analysis

1. **Import Data:**
   - Using Yahoo.finance, and the command "getsymbols", import the Euro/USD and Gold/USD daily exchange rates from 1 January 2022 to 31 August 2024.
   - Convert the data into a time series object in R.
2. **Plot the Data:**
   - Plot both time series.
   - Add titles, axis labels, and gridlines.
3. **Descriptive Analysis:**
   - Compute and interpret summary statistics (mean, median, variance, skewness, kurtosis) for both series.
   - Analyze any apparent trends, seasonality, or volatility visually.
4. **Stationarity Check:**
   - Apply two statistical tests to study the stationarity of both series.
   - If non-stationary, apply transformations (differencing) until the series are stationary.

2 Modeling and Analysis

1. **Autoregressive and Moving Average Models:**
   - Plot the ACF and PACF of the stationary series.
   - Determine the appropriate AR or MA model order for each series using AIC/BIC criteria.
   - Fit AR and ARMA models to the series.
2. **Residual Analysis:**
   - Perform residual diagnostics (plot residuals, ACF of residuals, Ljung-Box test) to ensure the model fits well.
3. **Heteroscedasticity Testing:**
   - Apply the Engle's ARCH test on the residuals to check for heteroscedasticity.
   - Interpret the results and discuss the presence of volatility clustering.

3 ARCH and GARCH Models

1. **Fitting ARCH Models:**
   - Fit an ARCH(1) model to the residuals of the ARMA model for both series.
   - Analyze and interpret the coefficients. Check if the model captures the volatility correctly.
2. **Fitting GARCH Models:**
   - Fit a GARCH(1,1) model to the series.
   - Compare the AIC/BIC values of the GARCH model with the ARCH model to assess improvement.
3. **Model Validation:**
   - Plot the fitted values against the observed values.
   - Check the residuals of the GARCH model for any remaining autocorrelation using the Ljung-Box test.

4 Forecasting

1. **Point Forecasts:**
   - Use the best-fitting model to forecast the next 20 observations for both series.
   - Plot the forecasts along with 95% confidence intervals.
2. **Forecast Evaluation 1:**
   - Compare the forecasted values to the actual observations.
   - Compute the Mean Squared Error (MSE) and Mean Absolute Percentage Error (MAPE) of the forecasts.
3. **Scenario Analysis:**
   - Simulate different scenarios by varying the model parameters (e.g., increase in volatility) and observe the impact on forecasts.
4. **Forecasting Evaluation 2:**
   - Without passing through ARCH model, forecast these 20 observation using the ARMA or ARIMA models found above.
   - Plot it on the same graph with the previous observation
5. **Analyse, Comments the forecasting results obtained**