

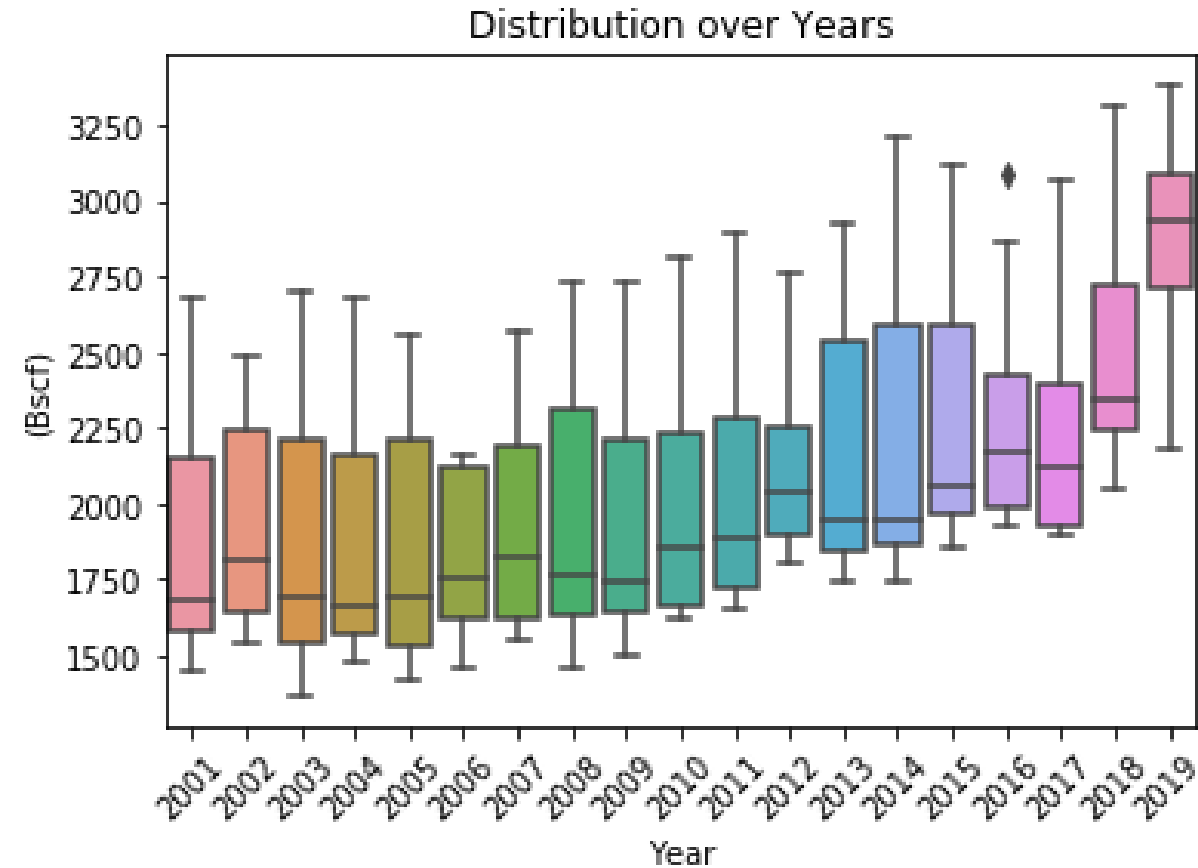
Analytics Methodology

1. Data Collection
2. Data Transformation/Exploration
 - Time Trend Analysis
 - Normality Analysis
 - Variable Correlations
3. Model building – Econometric Model
 - ARIMA
 - SARIMAX
4. Model building – Machine Learning Model
 - Regression
 - Random Forest

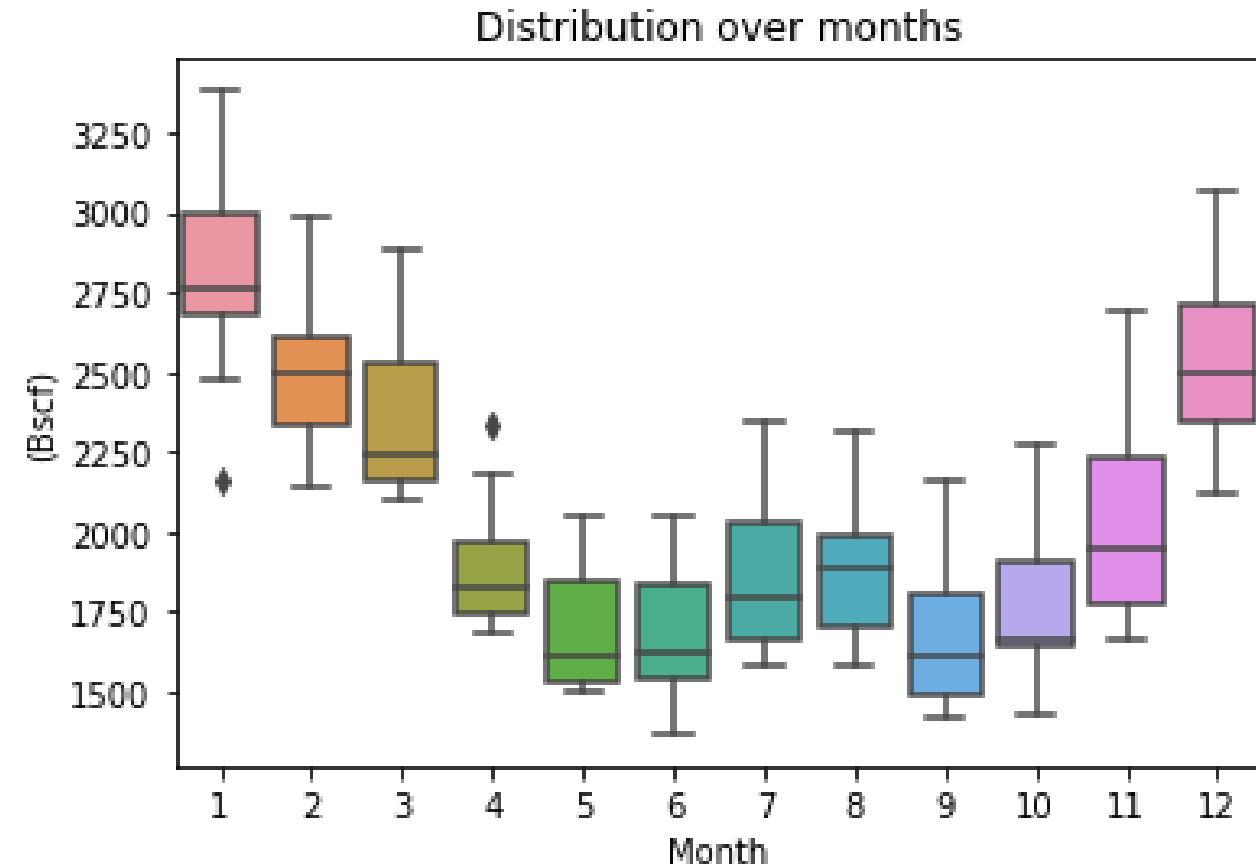
Data Collection

- Natural Gas Consumption and Prices
 - Source <https://www.eia.gov/>
 - Method: API
 - Range: daily value for 15 years from 01/01/2001 – 01/07/2019
- S&P Information:
 - Source: <https://finance.yahoo.com>
 - Method: API call using module fix_yahoo_finance
 - Range: daily value for 15 years from 01/01/2001 – 01/07/2019.
 - Data include: Ticker, Date, Close, and Volume.
- Economics Stats:
 - Source: Federal Reserve Economic Data <https://fred.stlouisfed.org/>
 - Method: direct download.
 - Range: quarterly value for 20 years from 01/03/2004 – 01/07/2019.
 - Data include: CPI, GDP, GDP_Change, and Household income

Data Exploration – Time Trend Analysis



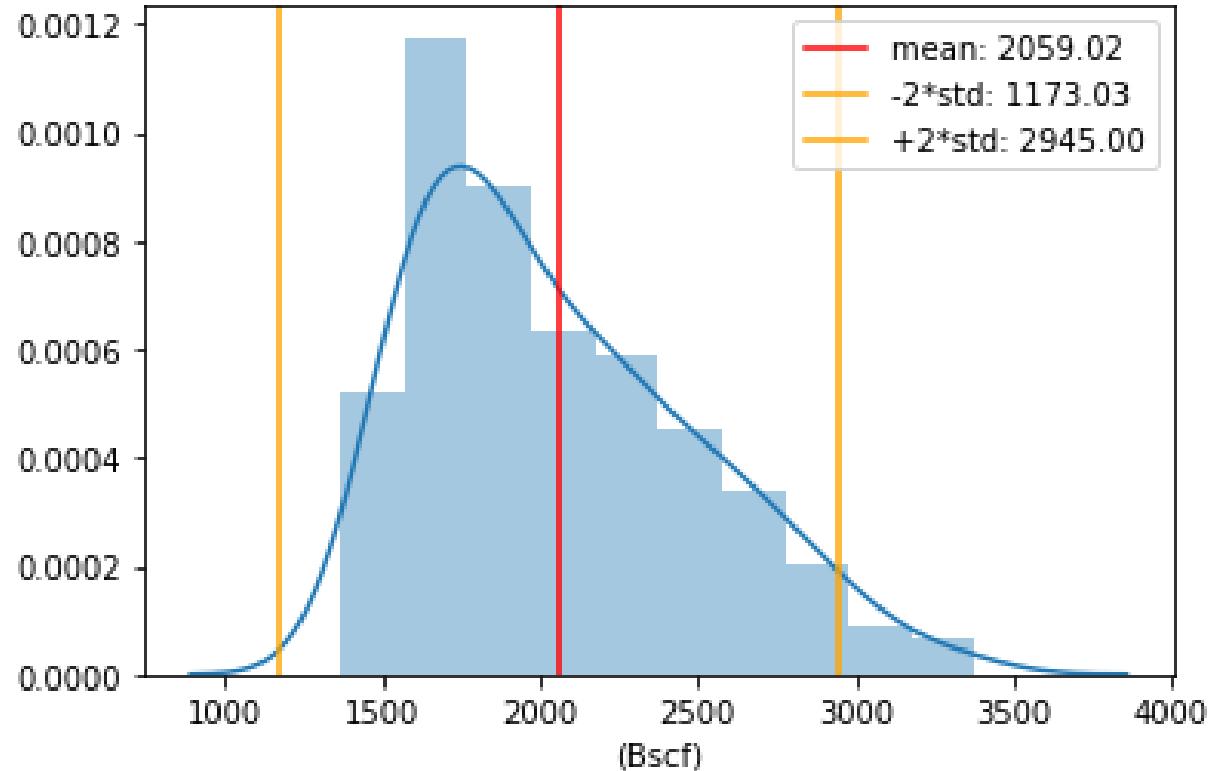
Consumption has been increasing over the years



Drastic intra-year consumption variations

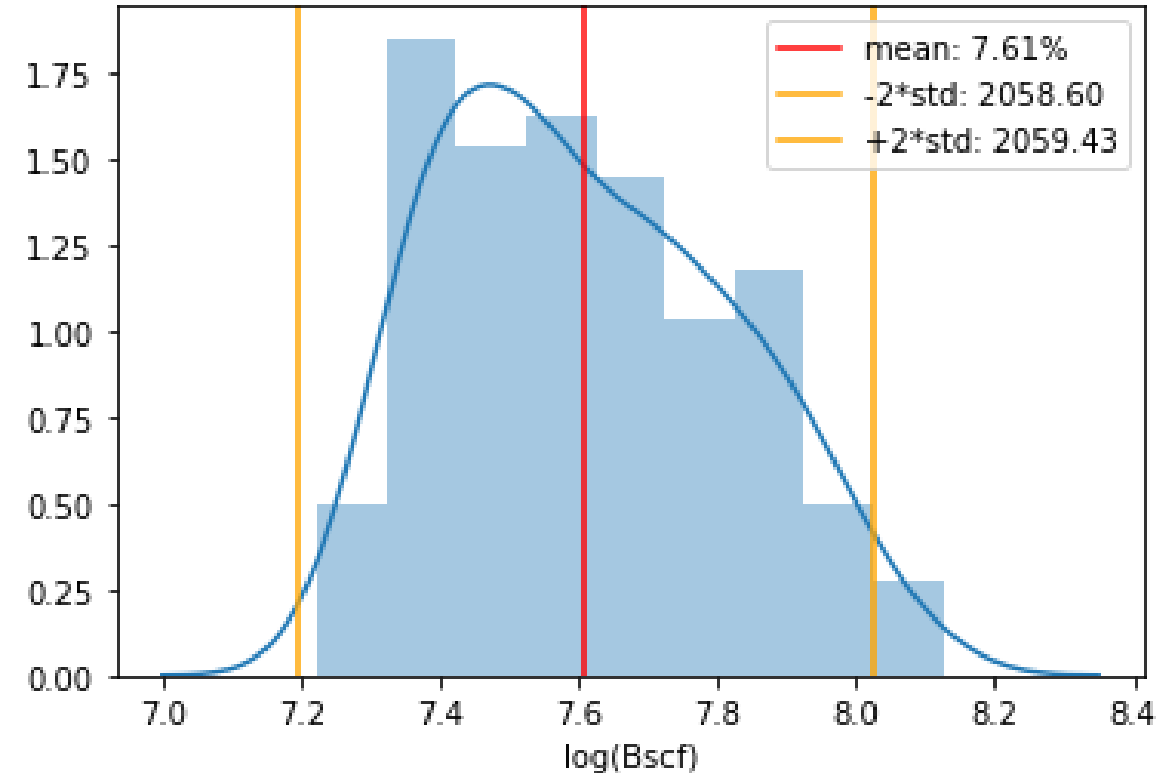
Data Exploration – Normality Analysis

Total Consumption Normality Analysis



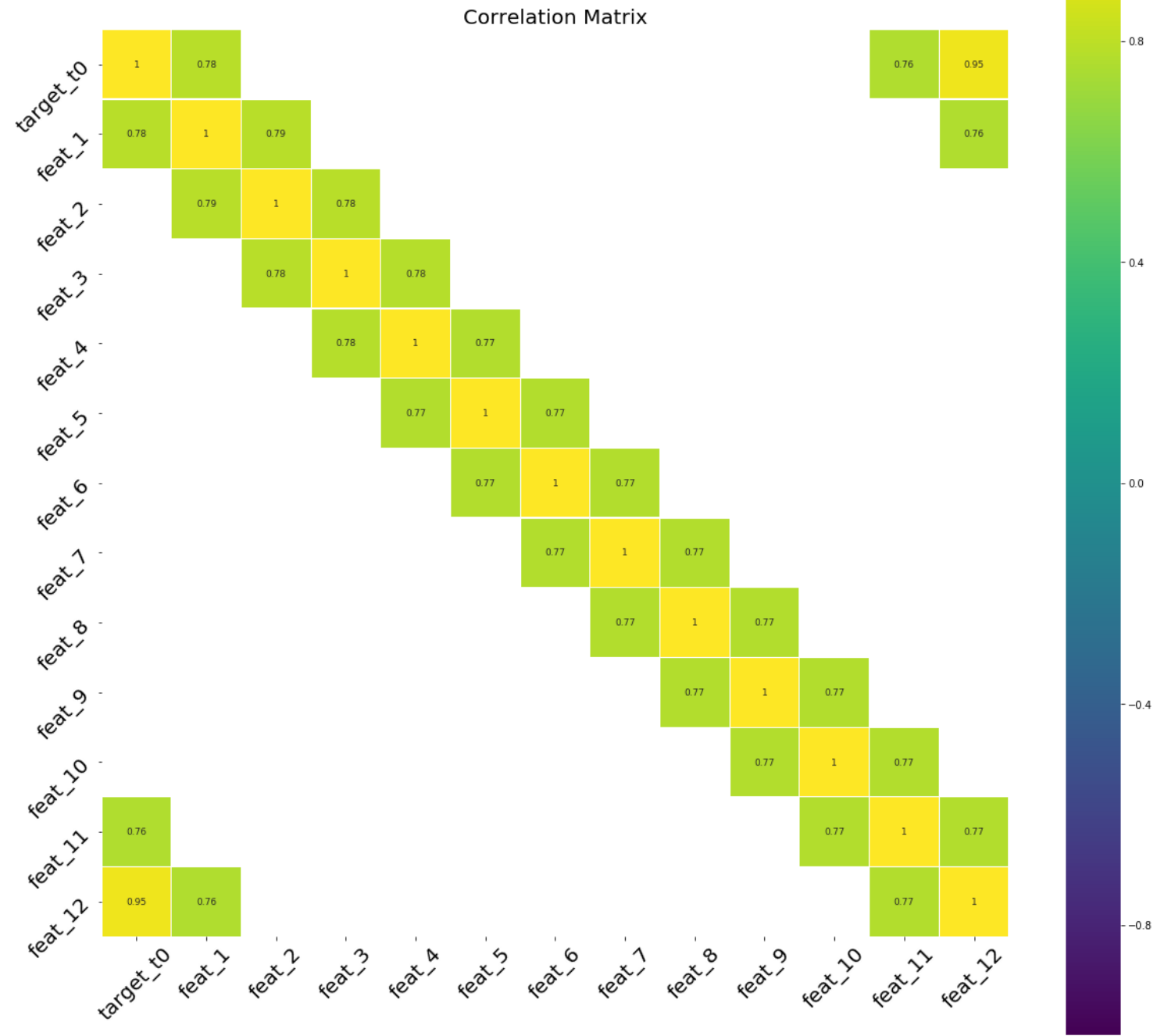
Normality Test: Shapiro Test
 $p = 1.2 \times 10^{-7}$

log(Total Consumption) Normality Analysis



Normality Test: Shapiro Test
 $p = 9.4 \times 10^{-5}$

Data Exploration – Correlation Matrix



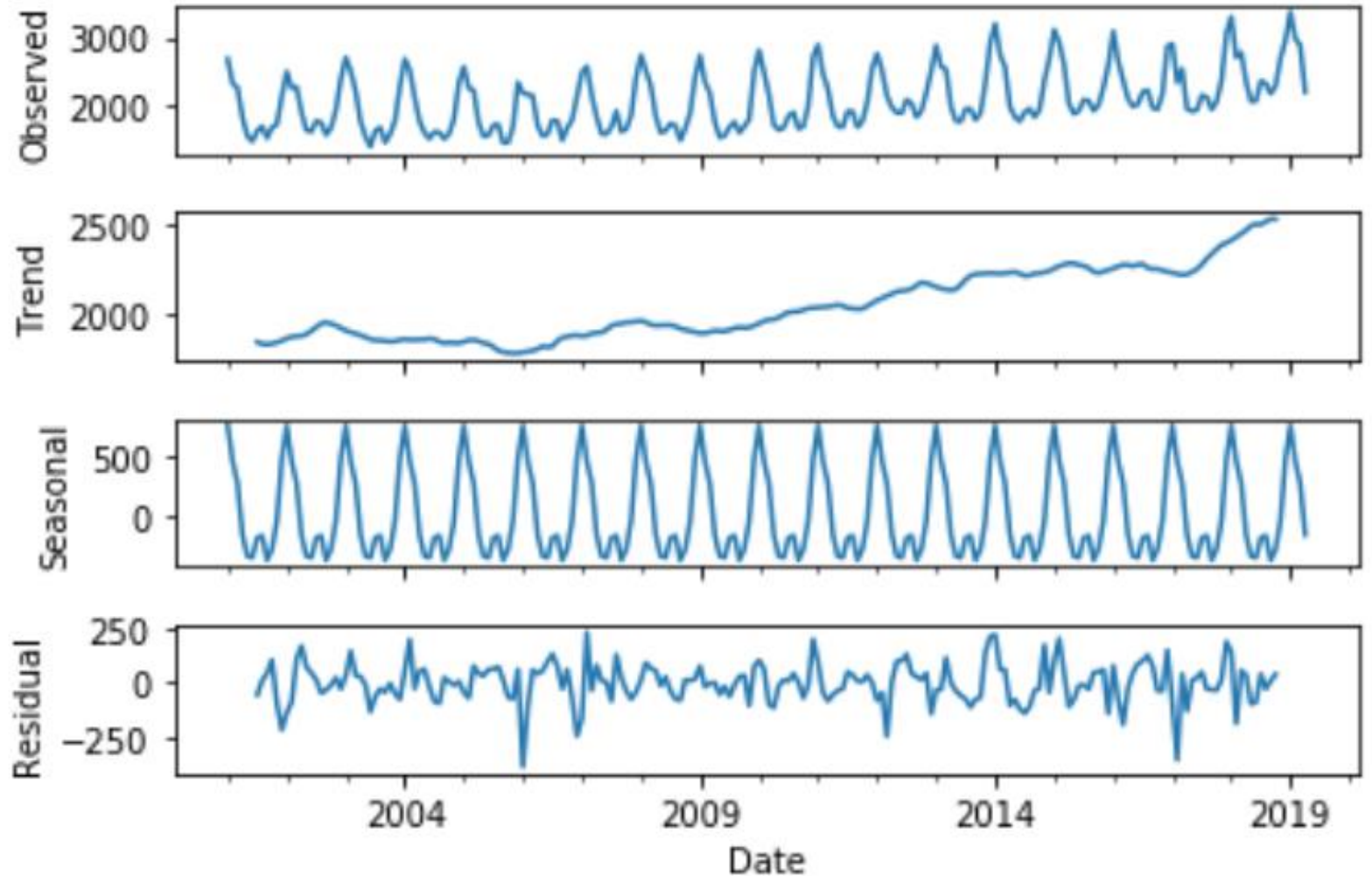
Econometric Model – ARIMA

Autoregressive Formula:

$$Y_t = \alpha + \epsilon_t + \phi_1 \epsilon_{t-1} + \phi_2 \epsilon_{t-2} + \dots + \phi_q \epsilon_{t-q}$$

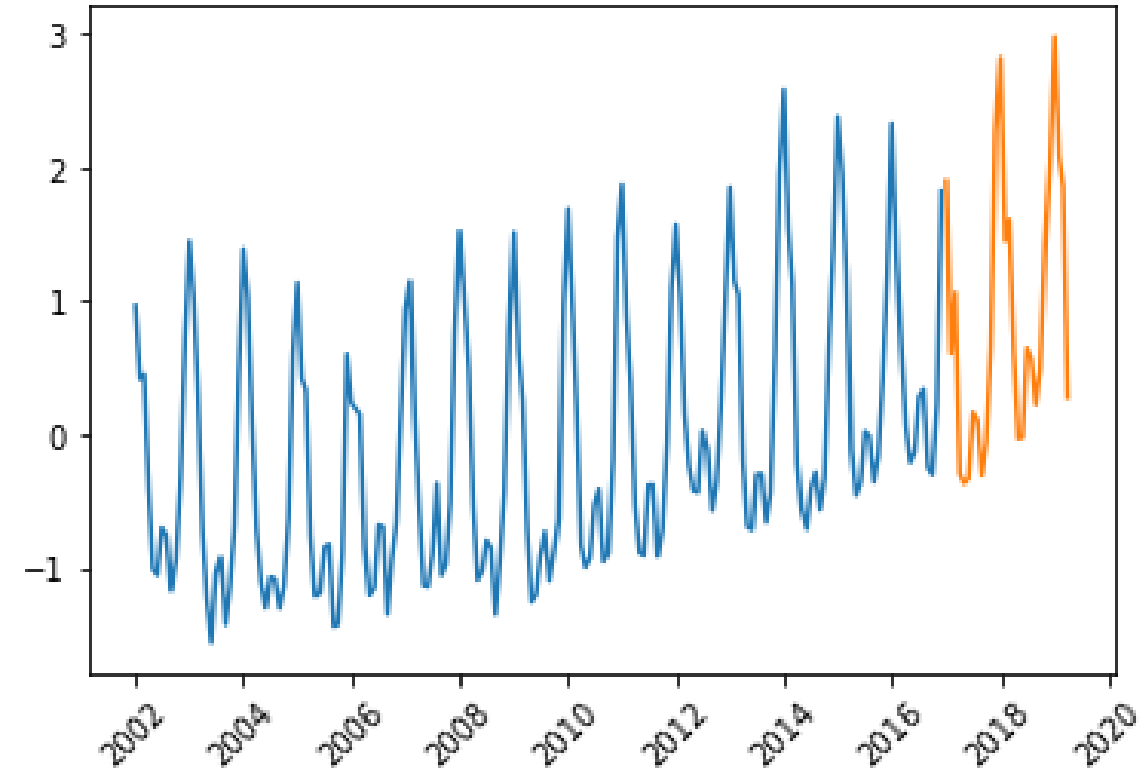
Moving Average Formula:

$$Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \dots + \beta_p Y_{t-p} + \epsilon_t$$

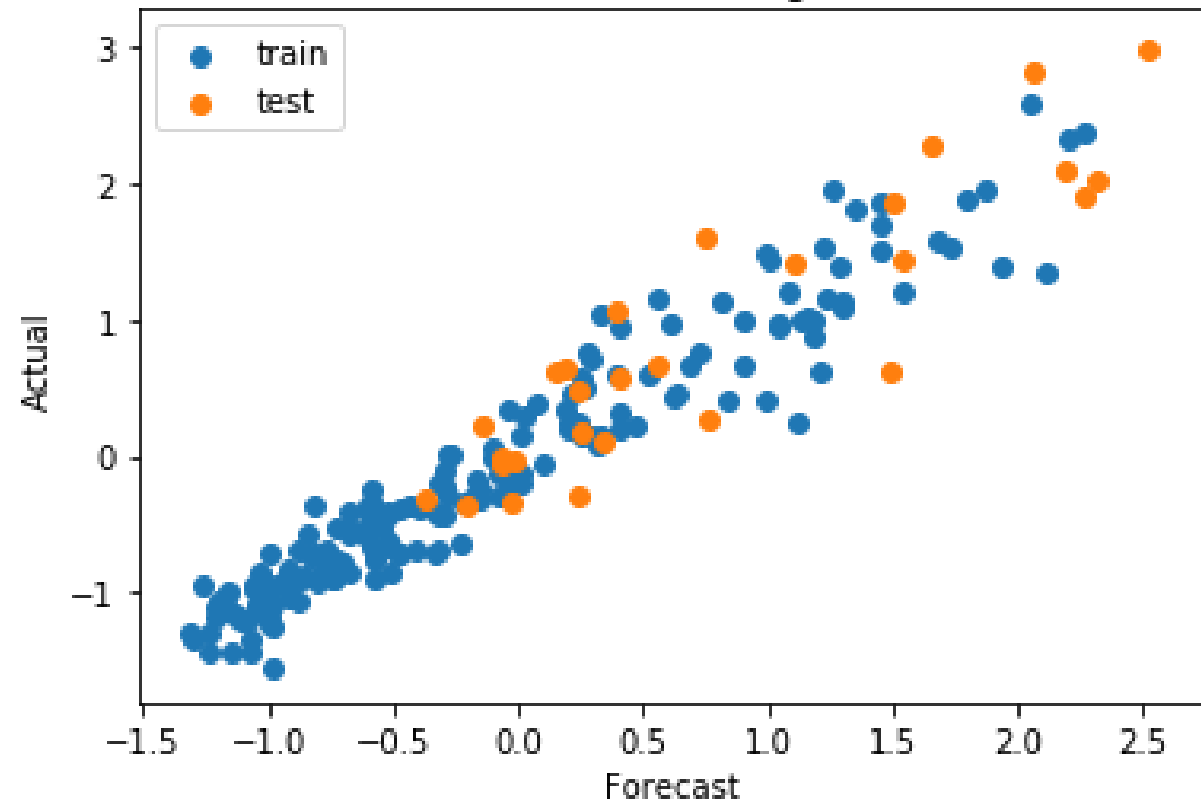


Machine Learning Model – Linear Regression

Train/Test split



Actual vs. Prediction Fit (Regression Model)



Train RMSE: 0.25

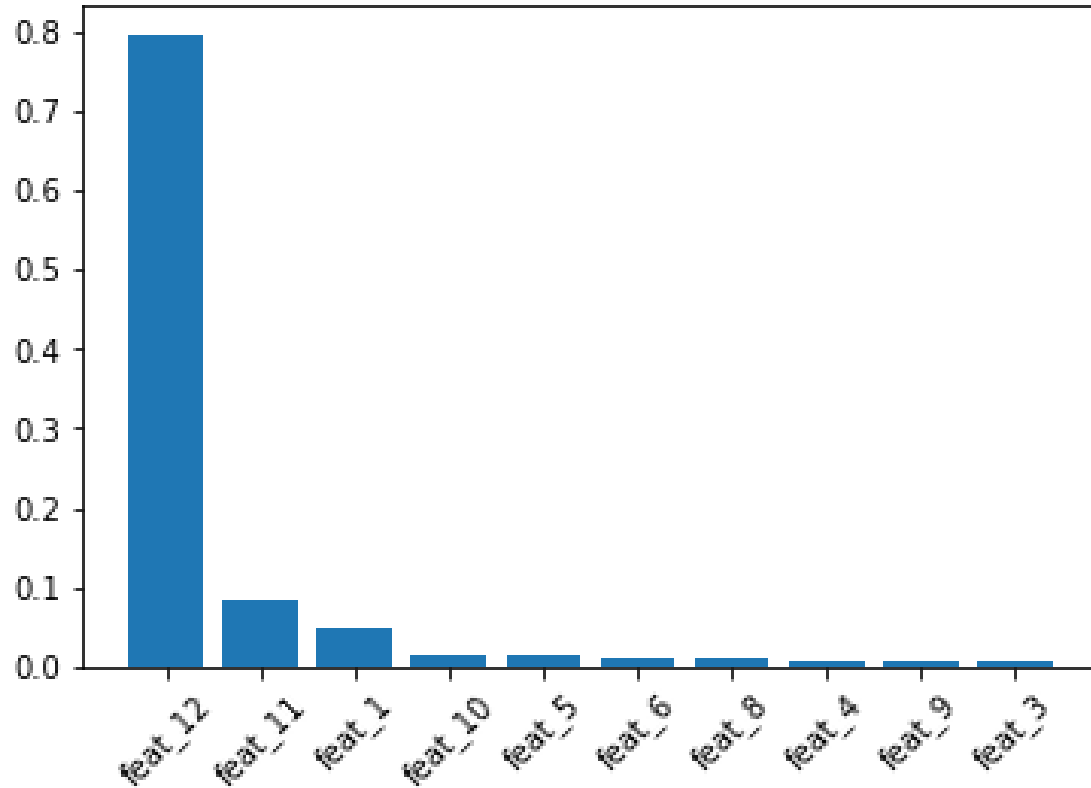
Test RMSE: 0.42

Train R2: 0.93

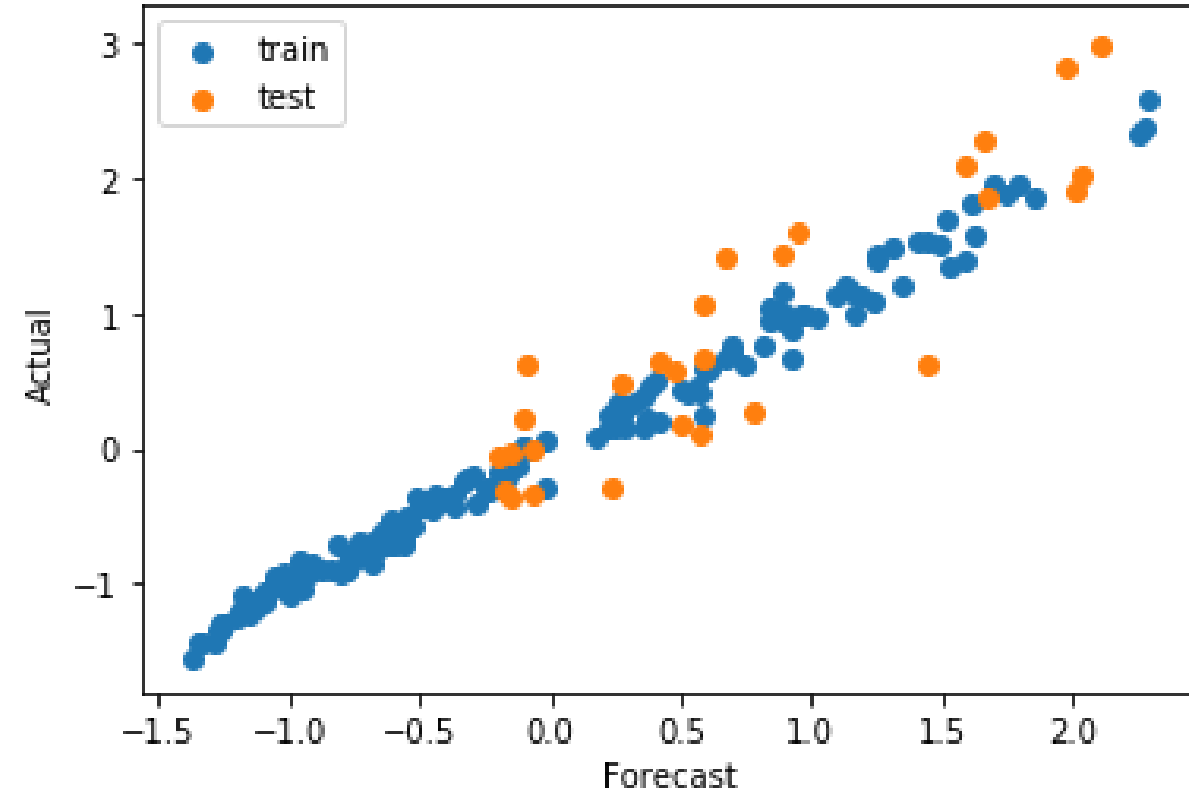
Test R2: 0.81

Machine Learning Model – Random Forest

Feature importance analysis



Actual vs. Prediction Fit (Random Forest Model)



Train RMSE: 0.10

Test RMSE: 0.47

Train R2: 0.99

Test R2: 0.77