MONTHLY INFLATION FORECASTING USING PYTHON FOR STRATEGIC FINANCIAL PLANNING IN THE U.S.

1. Background

In the wake of pandemic-related economic volatility and supply chain disruptions, a mid-sized financial advisory firm in the U.S. needed a tool to predict future inflation. Their goal was to support internal financial modeling and provide clients with regular inflation updates to guide decisions on pricing, contracts, investments, and supplier negotiations.

We were commissioned to build a time series forecasting system using Python, combining macroeconomic indicators such as CPI, unemployment rates, and crude oil prices. The deliverable included both the forecast model and an automated reporting pipeline.

2. Objective

- To forecast monthly U.S. inflation (CPI) over a 12-month horizon using multivariate time series models in Python
- To quantify the influence of economic drivers like commodity prices and labor market indicators on inflation
- To provide an automated, Jupyter-based reporting solution with graphs, metrics, and executive summaries
- To support business units with inflation outlooks for budget planning and hedging strategies

3. Data Used

Sources:

- U.S. Bureau of Labor Statistics (CPI)
- Federal Reserve Economic Data (FRED): Unemployment Rate, Fed Funds Rate
- EIA (U.S. Energy Information Administration): Crude Oil Prices (WTI)
- Time Period: Jan 2015 – Mar 2023 (monthly data)

Key Variables:

- Headline_CPI_YoY

- Unemployment_Rate
- Fed_Funds_Rate
- WTI_Oil_Price
- Core_CPI_YoY (for validation only)

4. Methodology

4.1 Data Preparation

- Cleaned and resampled all datasets to monthly frequency
- Filled missing values (e.g., oil price interruptions) using forward fill
- Differenced CPI series to stabilize variance
- Created lag features (1, 3, 6 months) for unemployment and oil prices
- Stationarity checked via ADF test and visual inspection

4.2 Models Applied

- **ARIMAX** (ARIMA with exogenous regressors):
  - Target: Headline_CPI_YoY
  - Exogenous: Unemployment_Rate, Fed_Funds_Rate, WTI_Oil_Price
- **Prophet with Regressors**:
  - Added holidays (e.g., Thanksgiving, year-end spikes)
  - Included monthly dummy variables for seasonality control
- Forecast horizon: 12 months forward (Apr 2023 – Mar 2024)
- Evaluation (backtesting on 2022 data):
  - MAE, RMSE, Directional Accuracy

5. Forecasting Results

Model	MAE (2022)	RMSE	Direction Accuracy
ARIMAX	0.41%	0.54%	91.6%
Prophet	0.47%	0.62%	89.3%

- ARIMAX had tighter confidence intervals and better performance in volatile periods
- Forecast for Q2 2023–Q1 2024 projected **inflation easing from 4.6% to ~2.9%**, assuming stable oil prices and modest Fed hikes

6. Insights and Applications

- **Oil price lags (3 months)** showed a consistent leading signal for headline CPI spikes
- Fed Funds Rate increases had visible dampening effects on inflation 4–6 months out
- Suggested **supply contract adjustments** for Q4 2023 based on predicted inflation dip
- Supported CFO teams in **scenario planning** with high/low inflation bands from model output

7. Reporting Output

- **Python Script (Jupyter Notebook)**:
    - Modular: data import, preprocessing, forecasting, validation
    - Parameter tuning support and model export (.pkl)
    - Plot generator with rolling forecasts and confidence bands
- **PDF Report (17 pages)**:
    - Executive Summary with forecast highlights
    - CPI historical trend and projection chart
    - Forecast driver impact dashboard
    - High-sensitivity scenario table: CPI under 3 oil price paths and 2 Fed scenarios
- **Excel Output**:
    - Monthly inflation forecasts (point, upper/lower bounds)
    - Forecast comparison with BLS-released actuals
    - Editable planning sheet for internal budget forecasting

8. Strategic Impact

- The client incorporated forecasts into **monthly budget refresh cycles**
- Purchasing teams used projected inflation to **renegotiate Q3 vendor pricing**

- The model was extended to include food and housing CPI subsets for further granularity
- The system is now used internally to **brief clients quarterly on macroeconomic outlook**