Forecasting App for the FRED Q2 2025 Challenge

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April 4, 2025

Overview

This document provides technical documentation for a **Streamlit application** developed to generate **probabilistic forecasts** for selected questions in the **Federal Reserve Economic Data (FRED) Q2 2025 Challenge**. The app employs a hybrid of **Monte Carlo Simulations** and **Bootstrapping** to model possible futures based on historical data.

Functionality Summary

- Uses a **weighted combination** of Monte Carlo Simulations (MCS) and bootstrapping.
- Provides an **interactive interface** for uploading FRED data, configuring simulations, and visualizing forecast distributions.
- Allows users to **select forecast horizons** and customize the number of simulations.

Workflow

1. **Data Upload:** Users download relevant economic time series from FRED and upload them into the app.
2. **Forecast Horizon:** The user selects a future date to forecast, which defines the simulation horizon.
3. **Simulation Parameters:** The number of Monte Carlo simulation paths is configurable. A higher number improves distribution stability.
4. **Run and Visualize:** The app simulates future values using both MCS and bootstrapping, then presents the resulting distributions visually.

Methodology

Monte Carlo Simulation (MCS)

Assumes that log returns follow a normal distribution:

$$r_t = \ln\left(\frac{P_t}{P_{t-1}}\right) \sim \mathcal{N}(\mu, \sigma^2)$$

Thousands of future paths are generated based on historical mean (μ) and standard deviation (σ).

Bootstrapping

Empirical returns are sampled **with replacement** to capture historical features.

Hybrid Approach

Forecasts are created by blending the two distributions:

$$F_{\text{hybrid}} = w \cdot F_{\text{MCS}} + (1 - w) \cdot F_{\text{Bootstrap}}$$

Where w is a tunable weight parameter.

Why This Approach?

- **Analytical tractability** from MCS and **empirical realism** from bootstrapping.
- Better modeling of **extreme events** compared to Gaussian only models.
- **User customizability** enables exploration across different parameter regimes.

Limitations

- The assumption of normally distributed log returns may not hold in financial data. But is a good starting point.
- Bootstrapping is inherently historical and assumes past patterns will continue.

Future Directions

- Empirically test the distributional assumptions of log returns.
- Explore alternative distributions such as:
  - Student's t-distribution
  - Skew-normal distribution
  - Generalized error distributions

Conclusion

This project provides a flexible and intuitive forecasting tool tailored to the FRED Q2 2025 Challenge. By combining statistical simulation and empirical sampling, it balances mathematical rigor with realistic market behavior.