Bayesian Time Series Analysis of US Unemployment Rates

STAT 447C Final Project - Project Report

Rohan Joseph (67089839)

Due Date: April 19th 2024

Abstract

- Brief summary of objectives, methods, key results, focus on uncertainty quantification and calibration.

[To be added]

Introduction

- *Introduce the problem:* Forecasting US unemployment rates using Bayesian time series analysis.
- Provide context and the importance of understanding and predicting unemployment rates.
- The importance of forecasting and uncertainty quantification.
- Introduction to Bayesian forecasting and Hidden Markov Models (HMM).

[To be added]

Problem Formulation

- *Real-world inference task/problem:* Forecasting future US unemployment rates based on historical data (1948-2024) using HMM.
- *Context:* Briefly explain the significance of unemployment rates in economic planning and policy-making.
- *Key modeling/methodological challenge:* Applying Bayesian time series analysis to reveal seasonal patterns, understand historical trends, and provide probabilistic forecasts of future unemployment rates. Also have a focus on calibration
- Note the importance of accurate uncertainty measures in forecasting.

[To be added]

Literature Review

- Summarize key findings from existing literature on Bayesian forecasting and unemployment rate analysis.
- Highlight gaps your project aims to fill or how it builds upon previous work.
- Discussion of uncertainty quantification in economic forecasting.
- Calibration of probabilistic forecasts in existing literature.

[To be added]

Data Analysis

- *Model:* A Bayesian model is precisely described (e.g., using the ... ~ ... notation).
  - Description of Bayesian HMM for modeling unemployment rates.
- Implementation code in the appendix (e.g., using Stan)
  - R code for implementing the HMM using Bayesian methods.
- *Motivation of prior choice:* If appropriate, several choices are compared or sensitivity analysis is performed.
- *Critical evaluation of the posterior approximation:* An appropriate combination of diagnostics, synthetic datasets and other validation strategies.
  - Techniques used for uncertainty quantification and calibration of forecasts.
  - Model diagnostics and validation strategies.
- *Methodological/Theoretical aspect:*
  - Assessment of the approach's robustness and creativity.
  - Discussion on the choice of HMM and Bayesian calibration methods.
- *Calibration of uncertainty:*
  - Explanation of calibration tests for predictive intervals.
  - Presentation of calibration test results.
  - Analysis of how well the model's uncertainty measures align with observed data.

[To be added]

Discussion

- *Project Theme:* Assess the soundness and creativity of the approach within the context of Bayesian forecasting and time series analysis. Discuss the model's ability to handle the intricacies of unemployment data and its forecasting accuracy.
- *Summarizing results:* Summarize key findings and their implications for understanding and forecasting US unemployment rates.
  - Interpretation of the forecasting results.
- Implications of calibrated uncertainty for economic decision-making.
- Discuss the limitations of your study, such as data constraints, model assumptions, or potential biases.
- Suggest areas for future research or methodological improvements.

[To be added]

Conclusion

- Recap of the project's contributions to Bayesian forecasting and calibration.
- Reflect on the value of Bayesian methods in economic time series forecasting.
- Final thoughts on policy implications and the value of calibrated forecasting.

[To be added]

References

[To be added]

Appendix

[To be added]