EC4333 Project: Adapting Yield Curves for Negative Interest Rate Regimes

Agrawal Naman, Daniel Tan Wei Hao, Divina Justine Widjaya, Eric Wen, Teo Yi Xuan

1 Introduction

The persistence of negative interest rates in several economies, particularly in Europe and Japan, has raised significant challenges for financial modeling. Traditional interest rate models often assume positive rates, rendering them less effective in negative rate environments. This project seeks to explore the Nelson-Siegel-Svensson (NSS) model and other term structure models to assess their effectiveness in fitting yield curves with negative interest rates. We aim to replicate key findings from recent papers on the topic and apply these models to real-world data from the Eurozone.

2 Motivation and Objectives

Negative interest rates have disrupted financial markets, creating a need for more robust models to understand their effects. The Nelson-Siegel-Svensson model has shown promise due to its flexibility in fitting yield curves under various market conditions, including negative rates. However, many alternative models—such as the Cox-Ingersoll-Ross (CIR) model, Ho and Lee model, and Black-Derman-Toy (BDT) model—struggle with negative rates. This project aims to:

- Review the literature on yield curve modeling with negative interest rates.
- Replicate results from key papers (e.g., [1]) using the NSS model.
- Extend the analysis by testing alternative models and comparing their effectiveness in negative rate environments.
- Propose improvements to overcome the limitations of traditional models.

3 Methodology

1. **Data Collection and Anlalysis:** We will use real-world bond yield data from European countries that have experienced negative interest rates, particularly focusing on the Eurozone. The data could be sourced from databases such as Bloomberg and the European Central Bank.
2. **Replication and NSS Model Estimation:** We will estimate the parameters of the Nelson-Siegel-Svensson model and other relevant models. The goal is to fit the yield curves and assess the models' performance in the presence of negative yields. We will use the sum of squared residuals (SSR) method for parameter calibration, following the approach outlined in [1].
3. **Comparison and Improvement of Models:** To provide a comprehensive assessment, we could compare the fit of the NSS model to other models, such as Gaussian Affline model Black model, extensions of NSS such as Arbitrage Free NS (AFNS), shadow rate term structure model, and possibly others. Our objective is to first modify some of these models to make them suitable for negative interest rates (if required) and then analyze the fit of these models during different time periods and across various countries to determine which performs best in negative rate environments. Based on our literature review and model application, we could propose ways to improve upon the limitations identified in existing models. This may include modifying distributional assumptions or combining elements from different models to create a hybrid approach.

Essentially, this project will provide a thorough review of existing yield curve models and their applicability to negative interest rates. By replicating key studies and testing new approaches, we aim to contribute to the ongoing discussion on how to best model yield curves in negative rate environments.

References

[1] Maria Teresa Medeiros Garcia and Vítor Hugo Ferreira Carvalho. A cross-sectional application of the nelson-siegel-svensson model to several negative yield cases. *Cogent Economics & Finance*, 7(1):1582319, 2019.