Chapter VII

Forecasting the Term Structure of Interest Rates Using Neural Networks

Sumit Kumar Bose, Indian Institute of Management, India
Janardhanan Sethuraman, Indian Institute of Management, India
Sadhalaxmi Raipet, Indian Institute of Management, India

Abstract

The term structure of interest rates holds a place of prominence in the financial and economic world. Though there is a vast array of literature on the issue of modeling the yield curve, there is virtually no mention of the issue of forecasting the yield curve. In the current chapter, we apply neural networks for the purpose of forecasting the zero-coupon yield curve. First the yield curve is modeled from the past data using the famous Nelson-Siegel model. Then, forecasting of the various parameters of the Nelson-Siegel yield curve is done using two different techniques: the multilayer perceptron and the feed-forward network. The forecasted Nelson-Siegel parameters are then used to predict the yield and the price of the various bonds. Results show the superiority of the feed-forward network over the multilayer perceptron for the purposes of forecasting the term structure of interest rates.
Introduction

The term structure of interest rates is a relation of the yield and the maturity of default-free zero-coupon securities and provides a measure of the returns that an investor might expect for different investment periods in a fixed income market. The term structure of interest rates is a topic of central importance in economic and financial theory. As a result, the modeling and estimation of the term structure has received considerable attention of a number of researchers right from the early sixties. Broadly speaking, there are two popular approaches for modeling the term structure of interest rates: a) fitting curves to the data using standard statistical techniques and, b) dynamic asset-pricing method. The parsimonious representation dictated by an exponential decay term such as Nelson and Siegel (1987), Svensson (1994) and the spline representation categorized into parametric and nonparametric splines such as Adams and van Deventer (1994), Fama and Bliss (1987), Fisher, Nychka, and Zervos (1995), McCulloch (1971, 1975), McCulloch and Kwon (1993), Tanggaard (1997), Vasicek and Fong (1982), and Waggoner (1997) belong to the former approach of estimating the term structure. While Vasicek and Fong (1982) explore the possibility of using exponential splines, McCulloch (1975) explores the possibility of fitting parametric cubic splines. Dynamic asset pricing method of estimating the term structure includes no-arbitrage models of Heath, Jarrow, and Morton (1992), Ho and Lee (1986), Hull and White (1990) and the various equilibrium models such as the affine general equilibrium models, for example the model of Pearson and Sun (1994). Affine models hypothesize yield as affine function of the state variables and include the models of Cox, Ingersoll, and Ross (1985) and Duffie and Kan (1996) apart from others. In spite of a flurry of research activity on modeling the yield curve, there has been little research effort on forecasting the yield curve (Diebold & Li, 2002). Forecasting the term structure of interest rates is important from the viewpoint of investment decisions of firms, saving decisions of consumers, policy decisions of governments, pricing and hedging decisions of derivatives, valuation decisions of various financial products especially the debt instruments and managing the bond portfolio apart from a host of other decisions. No-arbitrage models are applicable only at a particular time slice as their focus is on fitting the cross section of interest rates at a particular time. The models therefore fail to capture the time-series dynamics. These models are hence not very useful for forecasting purposes. The equilibrium models, on the other hand, are able to capture the time-series dynamics, but fail to pay attention to fitting the cross section of interest rates at any given time. Though the equilibrium models are better candidates in contrast to the no-arbitrage models for forecasting purposes, the forecasts generated by the equilibrium models have been shown to be extremely poor. Most models so far in the literature — including the no-arbitrage models and the equilibrium models — fail to model the dynamic relationship between the parameters of a term-structure model. Models of McCulloch (1993), Nelson-Siegel, and others try to explain the movements of the term structure with the aid of various factors and consequently attach labels to these factors having important macroeconomic and monetary policy underpinnings. Others such as Pearson and Sun (1994) interpret the factors in their model as “short rate” and “inflation,” and Litterman and Scheinkman (1991) interpret the factors used in the model as “level,” “slope,” and “curvature.” The labels attached to the factors stand for the influence the factors have
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