

# Preface

Stochastic filtering has been in use in engineering and in particular in the area of signal processing for a long time. Its usefulness in financial economics has been recognized for some time. The objective of a filtering application is to determine the best (in some sense) estimate for the states that drive a stochastic dynamical system. The measurable observations that the researchers have are not these states but some linear functions of these states. As an example, we can think of observations on futures prices on some asset, but we do not know anything about the stochastic convenience yield that may be contributing to the futures price formation. Filtering is an iterative process that enables us to estimate the states of the system as well as any hyper-parameters of the models. In the simplest case when there are no gaps in the measurable observations and all observations are made on equal time step, the solution to the problem is the well-known Kalman-Bucy filter. This basic structure, also referred to as state space model, has been found to be a valuable tool within Central Banks as well as financial institutions to deal with difficult inference problems as well for forecasting.

Complications arise when the functions relating to the unobservable states and the measurable observations are not linear. There may be missing observations or the conditional distributions are not necessarily Gaussian or even the time steps between the observations are not equal. To cater to such variations many improvements have been proposed in the literature.

The purpose of this book is to provide a comprehensive account of this very important tool with a view to making it more popular among researchers in finance and economics. It is not intended to give complete

mathematical treatment of different stochastic filtering approaches, but describe them in simple terms and illustrate their application with real historical data for problems normally encountered in these disciplines. Although no prior knowledge in this area is assumed, the readers are expected to have knowledge of probability theory as well as general mathematical aptitude. The book is intended as a reference for graduate students and researchers interested in the field. It is also suitable for use as a text for a graduate level course on stochastic filtering.

The idea of such a book was growing since I started my own PhD research. I came to quantitative finance research after working in the information technology area for several years in technical software development and maintenance in commercial organizations. Besides, my early graduate level education in physics encourages a scientific frame of mind to deal with problems in financial economics. I attempted to synthesize the contents based on my life experiences in a diverse range of activities. I sincerely believe that this book will offer fresh perspectives to the readers in dealing with problems encountered in financial economics. The book is less demanding on mathematical aptitude and at the same time conveys the underlying complexities with the help of examples familiar to the readers in the finance and economics disciplines.

The book aims to be an example-driven elucidation of a complex technical area so that it appeals to a wide variety of readers in the discipline of finance and economics. The algorithmic presentation of the models for the applications will help readers to take up new challenges in their own field of study/research. This will also help them to get a clear understanding of the filtering issues quickly and enhance the models that suit their own perceptions.

The first chapter deciphers the notion of filtering and various ways of estimating models under different assumptions. Once this is understood, the succeeding chapters take up relevant applications in finance and economics and show how filtering framework applies in those situations. The second chapter focuses on the foreign exchange market and extracts embedded risk premium in the forward exchange rates. The third chapter explores the notion of risk premium in the equity market with a difference. It analyzes the price of risk and not just the total quantity of risk.