Applied Economic Forecasting using Time Series Methods

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Preface

Economic forecasting is a key ingredient of decision making both in the public and in the private sector. Governments and central banks, consumers and firms, banks and financial institutions base many of their decisions on future expected economic conditions or on the predictions of specific indicators of interest such as income growth, inflation, unemployment, interest rates, exchange rates, earnings, wages, oil prices, and so on. Unfortunately, economic outcomes are the realization of a vast, complex, dynamic and stochastic system, which makes forecasting very difficult and forecast errors unavoidable. However, forecast precision and reliability can be enhanced by the use of proper econometric models and methods, like those we present in this book.

We wish to satisfy an audience including both undergraduate and graduate students willing to learn basic and advanced forecasting techniques, and researchers in public and private institutions interested in applied economic forecasting. For this reason, the book is divided into four parts. In Part I, the first chapter provides a brief review of basic regression analysis, followed by two chapters dealing with specific regression topics relevant for forecasting, such as model mis-specification, including structural breaks, and dynamic models and their predictive properties. The fourth chapter, on the topic of forecast evaluation and combination, is the first exclusively dedicated to forecasting. The material in Part I could be used in the senior year of an undergraduate program for students who have a strong interest in applied econometrics, or as an introduction to economic forecasting for graduate students and researchers from other disciplines.

Part II of the book is devoted to time series models, in particular univariate autoregressive integrated moving average (ARIMA) models and vector autoregressive (VAR) models. Specifically, Chapter 5 deals with ARIMA models, Chapter 6 with VAR models, Chapter 7 with cointegration and er-

ror correction (ECM) models, and Chapter 8 with Bayesian methods for VAR analysis. The material progressively becomes better suited for master level and/or PhD level classes, in particular the chapters on cointegration and Bayesian VARs. Models considered in Part II are also common tools for practical forecasting in public and private institutions.

Parts III and IV of the book contain a collection of special topics chapters. Each chapter is self-contained, and therefore an instructor or researcher can pick and choose the topics she or he wants to cover. Part III deals mainly with modeling parameter time-variation. Specifically, Chapter 9 presents Threshold and Smooth Transition Autoregressive (TAR and STAR) models, Chapter 10 Markov switching regime models, and Chapter 11 state space models and the Kalman filter, introducing, for example, models with random coefficients and dynamic factor models.

Part IV deals with mixed frequency data models and their use for now-casting in Chapter 12, forecasting using large datasets in Chapter 13 and, finally, volatility models in Chapter 14.

Each chapter starts with a review of the main theoretical results to prepare the reader for the various applications. Examples involving simulated data follow, to make the reader familiar with application using at first stylized settings where one knows the true data generating process and one learns how to apply the techniques introduced in each chapter. From our own teaching experience we find this to be extremely useful as it creates familiarity with each of the topics in a controlled environment. The simulated examples are followed by real data applications - focusing on macroeconomic and financial topics. Some of the examples run across different chapters, particularly in the early part of the book. All data are public domain and cover Euro area, UK, and US examples, including forecasting US GDP growth, default risk, inventories, effective federal funds rates, composite index of leading indicators, industrial production, Euro area GDP growth, UK term structure of interest rates, to mention the most prominent examples.

The book is mostly software neutral. However, for almost all the simulated and empirical examples we provide companion *EViews*® and *R* code. The former is mostly - but not exclusively - a menu driven licensed software package whereas the latter is an open source programming language and software environment for statistical computing and graphics supported by the

R Foundation for Statistical Computing.[1]. We provide code and data for all the simulated and empirical examples in the book on the web.[2] Moreover, all the tables and figures appearing in the book were produced using *EViews*®.

As the title suggests, this book is an *applied* time series forecasting book. Hence, we do not have the pretense to provide the full theoretical foundations for the forecasting methods we present. Indeed, there are already a number of books with thorough coverage of theory. The most recent example is the excellent book by Elliott and Timmermann (2016) which provides an in-depth analysis of the statistical theory underlying predictive models, covering a variety of alternative forecasting methods in both classical and Bayesian contexts, as well as techniques for forecast evaluation, comparison, and combination. Equally useful and complimentary are the many standard econometrics textbooks such as Hendry (1995), Judge, Hill, Griffiths, Lütkepohl, and Lee (1988), Stock and Watson (2009), Wooldridge (2012), and the many graduate time series textbooks such as Box and Jenkins (1976), Clements and Hendry (1998), Diebold (2008), Hamilton (1994), or Lütkepohl (2007), among others.

We should also highlight that this book is an applied *time series* forecasting book. As such, we will not discuss forecasting using economic theory-based structural models, such as Dynamic Stochastic General Equilibrium (DSGE) models, see, e.g., Del Negro and Schorfheide (2013) for an exhaustive overview and references. Typically, these structural models are better suited for medium- and long-horizon forecasting, and for policy simulations, while time series methods work better for nowcasting and short-term forecasting (say, up to one-year ahead).

This book would not have been completed without the invaluable and skillful help of a number of our current and former TAs and RAs. Special thanks go to Cristina Angelico, Francesco Corsello, Francesco Giovanardi, Novella Maugeri, and Nazire Özkan who helped with all the simulation and empirical examples throughout the entire book, as well as Hanwei Liu who wrote the *R* codes. Their contributions to the book were invaluable. We would also like to thank many cohorts of undergraduate, master, and PhD

[1]Please visit the web page http://www.eviews.com for further information on *EViews*® and *R* programming language Wikipedia web page https://en.wikipedia.org/wiki/R_(programming_language).

[2]Please visit our respective webpages www.unc.edu/~eghysels or www.igier.unibocconi.it/marcellino to download the code and data.

students who took courses based on the materials covered in the book at Bocconi University and at the University of North Carolina, Chapel Hill and the Kenan-Flagler Business School.

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