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Subal C. Kumbhakar, Hung-Jen Wang and Alan P. Horncastle
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A PRACTITIONER'S GUIDE TO STOCHASTIC FRONTIER ANALYSIS USING STATA

A Practitioner's Guide to Stochastic Frontier Analysis Using Stata provides practitioners in academia and industry with a step-by-step guide on how to conduct efficiency analysis using the stochastic frontier approach. The authors explain in detail how to estimate production, cost, and profit efficiency and introduce the basic theory of each model in an accessible way, using empirical examples that demonstrate the interpretation and application of models. This book also provides computer code, allowing users to apply the models in their own work, and incorporates the most recent stochastic frontier models developed in academic literature. Such recent developments include models of heteroscedasticity and exogenous determinants of inefficiency, scaling models, panel models with time-varying inefficiency, growth models, and panel models that separate firm effects and persistent and transient inefficiency. Immensely helpful to applied researchers, this book bridges the chasm between theory and practice, expanding the range of applications in which production frontier analysis may be implemented.

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To Damayanti Ghosh

SUBAL C. KUMBHAKAR

To Yi-Yi Chen

HUNG-JEN WANG

To Maria, Joan, and Victor

ALAN P. HORNCASTLE

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Preface

This book deals with the estimation of productive efficiency using an econometric approach, which is popularly known as *stochastic frontier analysis*. The terminology relates to the fact that we are interested in the estimation of frontiers that envelop the data while maintaining the traditional econometric assumption of the presence of a random statistical noise. The frontiers we estimate are consistent with neoclassical microeconomic theory. Because, in reality, producers are not always efficient, the efficiency analysis can be viewed as an extension of the neoclassical theory. In this sense, the approach we consider in this book is based on sound neoclassical production theory and not purely an *ad hoc* empirical exercise.

Our primary goal in writing this book was to extend the everyday application of these tools beyond the expert practitioner or academic by making it relatively easy for the reader to carry out the complex computations necessary to both estimate and interpret these models. Our secondary goal was to ensure that the latest theoretical models can be implemented by practitioners, as many applications are limited by the software currently available.

As such, we aim at providing the reader with sufficient tools to apply many of the developed models to real data. In order to do this we have created a series of programs written for use in Stata, and they can be downloaded from the following website: https://sites.google.com/site/sfbook2014/. These commands are not part of the official Stata package, but instead are commands that we wrote ourselves in the form of Stata ado-files.

Thus, this book does not represent a comprehensive research monograph covering all areas of stochastic frontier models. Our focus is mostly on those models for which we have provided Stata codes and, as such, our list of references is limited to this purpose.

For a purely theoretical underpinning of stochastic frontier analysis the reader should consider first reading the book by Kumbhakar and Lovell (2000), *Stochastic Frontier Analysis* (Cambridge University Press). However, this is not essential as this book is intended to provide stand-alone reference materials for the reader to gain *both* a basic understanding of the theoretical underpinnings *and* a practical understanding of estimating production, profit, and cost efficiency.

As such, each chapter includes a theoretical introduction of the stochastic frontier model followed by worked examples of applying the theory to real data (examples include dairy farming, electricity generation, and airlines). These empirical examples are interwoven with the theory such that the reader can immediately apply the theory covered in the text. In order to follow these empirical examples, and thus to get the most benefit from this book, the

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reader must have Stata installed along with the programs provided with this book. Instructions on installation of the programs and explanations on the command syntax are provided in Appendix E, along with information on how to download the datasets and the empirical examples.

This book incorporates some of the most recent stochastic frontier models developed in the academic literature. Such recent developments include models of heteroscedasticity and exogenous determinants of inefficiency (Wang [2002]); scaling models (Wang and Schmidt [2002]); panel models with time-varying inefficiency (Kumbhakar [1990]); growth models (Kumbhakar and Wang [2005]); and the panel models of Greene (2005a), Wang and Ho (2010), Kumbhakar et al. (2014), and Chen et al. (2014). Other developments using semi- and nonparametric approaches are not included in this book.

We wish to express our gratitude to Knox Lovell, Peter Schmidt, Robin Sickles, Bill Greene, Leopold Simar, Mike Tsionas, Subhash Ray, and many others whose work and ideas have influenced our thinking in a major way. David Drukker of StataCorp was kind enough to provide comments on some chapters. We are thankful to him for this. We also thank Scott Parris, our ex-editor, and Karen Maloney, the current Senior Editor at Cambridge University Press, for their constant support. The excellent research assistance provided by Chun-Yen Wu is also gratefully acknowledged. We would also like to thank Oxera for its support to Alan. Last, but not least, we thank our family members, especially our wives (Damayanti Ghosh, Yi-Yi Chen, and Maria Horncastle), for their constant support and encouragement in finishing this project, which took several years.

Subal C. Kumbhakar, Hung-Jen Wang, and Alan P. Horncastle

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