Abstract

This course will present the methodology of econometric estimation of economic efficiency. We will examine the stochastic frontier model as an econometric extension of the classical microeconomic theory of production and cost at the individual producer level. Basic models for production, cost and ‘distance’ will be examined. We will examine major extensions of the models to provide scope for cross firm heterogeneity (such as heteroscedasticity) as well as unobserved heterogeneity captured by the stochastic specification of the model. The second day of the course will turn to more advanced applications, such as Bayesian and classical methods of estimation and, especially, panel data models. In addition to the examination of theoretical and econometric methods, we will study several applications from the recent literature.

The course will include lectures that develop the relevant theory and extensive practical, laboratory applications. Emphasis in the laboratory sessions will be on estimation of stochastic frontier models and using them to compute measures of economic efficiency. Course participants will apply the techniques on their own computers using the LIMDEP computer program and several ‘real’ data sets that have been used in applications already in the literature.

Prior knowledge is assumed to include a course in microeconomics, calculus at the level assumed in the first year of a Ph.D. program in economics and a course in econometrics at the beginning Ph.D. level out of a textbook such as Greene, W., *Econometric Analysis*, 7th edition. Familiarity with LIMDEP will be helpful, but is not necessary.

Students in this course will obtain background in both the theory and methods of estimation for stochastic frontier modeling. This course will provide a gateway to the professional literature as well as practical application of the methods at the level of the contemporary research in the field. LIMDEP is the leading computer program for this type of estimation, so students will have also studied the application of the techniques using the modeling tools familiar to researchers in the area.

The home page for the course is

http://people.stern.nyu.edu/wgreene/FrontierModels2013.htm
Course Outline

This is a course in econometric analysis of technical and economic efficiency. The theoretical foundation is an extension of basic microeconomics of the firm and production/cost functions. The empirical centerpiece is the stochastic frontier model pioneered by Aigner et al. (1977). The course will consist of two days of discussions and laboratory sessions which will apply the techniques to ‘live’ data sets. Discussions will cover the topics listed below. Lab sessions will apply the techniques discussed in the preceding sessions. Practicals will consist of directed exercises and student assignments to be completed singly or in groups.

http://people.stern.nyu.edu/wgreene/FrontierModels2013.htm

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<td>2</td>
<td>Frontier Modeling: Programming estimators, the gamma frontier, modifying least squares, DEA</td>
<td>Greene, 1980, Greene, 1990</td>
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<td></td>
<td><strong>Lab 1: Software, LIMDEP, Regression Computation, COLS, DEA, TFP</strong></td>
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<td>4</td>
<td>Production, Cost and Other Models: Cost frontiers, Allocative inefficiency, The Green Problem, Multiple outputs, Distance functions, Profit and revenue functions</td>
<td>Christensen, 1976, Kumbhakar, 2004, Atkinson, 2005</td>
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<td><strong>Lab 2: Estimating Stochastic Frontier Models and Technical Inefficiency, DEA, Model building, production and cost models, estimating inefficiency</strong></td>
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<tr>
<td>Session Day 2</td>
<td>Topics</td>
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| 5            | Review of Stochastic Frontier Modeling  
Estimating inefficiency, functional form | Greene survey |
| 6            | Heterogeneity in the Stochastic Frontier Model:  
Model extensions, Heteroscedasticity, One and two  
step estimation, A latent class model, random parameters | Greene, 2004b  
Hadri, 1999  
Wang, 2002  
Orea, 2004  
Greene, 2005  
Greene, 1990  
Greene, 2003b,c  
Kim, 2000  
Kleit, 2001  
Huang, 2004  
Koop, 1997  
Greene 2010  
Barrios/Lavado 2010 |
|              | Bayesian and Maximum Simulated Likelihood  
Estimation: Bayesian approaches, The normal-gamma model,  
Sample selection, spatial modeling | |
|              | **Lab 3: Estimating stochastic frontier models with heterogeneity and heteroscedasticity** |
| 7            | Panel Data: Fixed and Random Effects, FE and RE in  
the stochastic frontier model, Extensions of the panel model, True random and fixed effects | Greene, 2003a  
Pitt, 1981  
Schmidt, 1984  
Horrace, 2000  
Koop, 1997,  
Greene, 2005,  
Battese, 1988, 1992, 2005  
Greene, 2004b, 2005  
Farsi, 2003 |
| 8            | Applications from the Literature | Alvarez, 2005  
Farsi, 2003  
Holloway, 2005  
Kleit, 2001  
Kumbhakar, 2005 |
|              | **Lab 4: Estimating stochastic frontier models with panel data**  
**Model building. Studying production, cost, and economic inefficiency** |
|              | Summary and Closing Observations | Fried survey |

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<thead>
<tr>
<th>Time</th>
<th>Class</th>
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<tr>
<td>09:30 – 10:00</td>
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<td>Registration and Setup</td>
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<tr>
<td>10:00 – 11:00</td>
<td>(1.1)</td>
<td>Microeconomic Essentials, Regression Models, Frontier Functions</td>
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<tr>
<td>11:00 – 11:15</td>
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<td>[Coffee Break]</td>
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<tr>
<td>11:15 – 12:15</td>
<td>(1.2)</td>
<td>Frontier Models, Data Envelopment Analysis, Total Factor Productivity</td>
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<tr>
<td>12:15 – 12:30</td>
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<td>Break, set up lab, initial tutorial</td>
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<tr>
<td>12:30 – 13:15</td>
<td>LAB 1</td>
<td>Software, Regression Modeling, Modifications of OLS, COLS, DEA</td>
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<tr>
<td>13:15 – 14:15</td>
<td></td>
<td>[Lunch]</td>
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<tr>
<td>14:15 – 15:15</td>
<td>(1.3)</td>
<td>Stochastic Frontier Model, Frontier Model Extensions, Gamma Frontier, Sample Selection, Spatial Model</td>
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<td>15:15 – 15:30</td>
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<td>[Coffee Break]</td>
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<tr>
<td>15:30 – 16:30</td>
<td>(1.4)</td>
<td>Frontier Functions and Distance Functions, The Greene Problem Allocative Inefficiency, Multiple Outputs</td>
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<tr>
<td>09:00 – 09:15</td>
<td>(2.5)</td>
<td>Set up and review</td>
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<tr>
<td>09:15 – 10:15</td>
<td>(2.6)</td>
<td>Heteroscedasticity  Heterogeneity, Simulation and Latent Class Models</td>
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<td>10:15 – 10:30</td>
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<td>[Coffee Break]</td>
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<tr>
<td>10:30 – 11:30</td>
<td>(2.7)</td>
<td>Simulation Based Estimation; Bayesian Models</td>
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<tr>
<td>11:30 – 11:45</td>
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<td>Break, set up lab, get started</td>
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<tr>
<td>11:45 – 12:30</td>
<td>LAB 3</td>
<td>Heterogeneity, Heteroscedasticity, Alternative Models</td>
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<td>12:30 – 13:30</td>
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<td>[Lunch]</td>
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<tr>
<td>13:30 – 14:30</td>
<td>(2.8)</td>
<td>Models for Panel Data, Random and Fixed Effects, True RE and FE</td>
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<td>14:30 – 14:45</td>
<td></td>
<td>[Coffee Break]</td>
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<tr>
<td>14:45 – 15:45</td>
<td>(2.8)</td>
<td>Battese/Coelli, Latent Class, Random Parameters, Distance Functions</td>
</tr>
<tr>
<td>15:45 – 16:00</td>
<td></td>
<td>Applications from the Literature, Summary and Conclusions</td>
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<tr>
<td>16:00 – 16:45</td>
<td>LAB 4</td>
<td>Stochastic Frontier Models for Panel Data</td>
</tr>
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Timetable

Day 1 Class Essentials of Frontier Modeling

Day 2 Class Frontier Model Extensions
Software

I. Stochastic Frontier Estimation

Only two of the large integrated econometrics programs currently in general use provide programs and routines for frontier and efficiency analysis, LIMDEP/NLOGIT and Stata. The freeware program, FRONTIER 4.1 by Tim Coelli (find it on the web) can also be used for a small range of stochastic frontier models. FRONTIER is now rather old (mid 1990s), however, and is not being updated or maintained. A version of FRONTIER 4.1 in R has been developed by Arne Henningsen (January, 2009). Belotti et al. (see www.econometrics.it) have written some new routines for Stata. Chris Parmeter has written some additional code in R. LIMDEP has included an extensive package for frontier modeling since the mid 1980s. New features and models are added to LIMDEP on an ongoing basis. To my knowledge, LIMDEP’s range of capabilities for frontier and efficiency estimation remains the most extensive available. Each of the others listed provide a subset of LIMDEP’s features. Both SAS and TSP (Eviews) contain a command that will estimate the parameters of a basic stochastic frontier model, however neither of these packages provides the extensions of the estimator used to estimate and analyze efficiency.

II. Data Envelopment Analysis

There are several packages that specialize in Data Envelopment Analysis (DEA) – a search of the web for this topic will amply demonstrate the variety of tools available for this mini-industry. Some of them are quite extensive. Tim Coelli has also developed another, separate program, DEAP for data envelopment analysis. Like FRONTIER, however, DEAP is rather old – 1996, and is not current with methodological developments of the last decade. However, it is freeware, and it does provide the basic capabilities needed by the entry level analyst. LIMDEP also contains a limited capability for data envelopment analysis. To my knowledge, LIMDEP is the only program (small or large) that provides both stochastic frontier and DEA capabilities sufficient to model in both frameworks and extensively compare the results.
Stochastic Frontier Models and Economic Efficiency Estimation
William Greene
Stern School of Business, New York University

References

A major comprehensive reference work is

Surveys that describe the content of the course are

An appropriate econometrics text for this course is
Greene, W., Econometric Analysis 7th Ed., Prentice Hall, 2012. (Selected chapters are posted on the course home page.)

Additional articles that constitute the platform for the methodology include:
Stochastic Frontier Models and Economic Efficiency Estimation
William Greene
Stern School of Business, New York University


Greene, W., 2003a, “Panel Data,” Chapter 11 in Greene, W., Econometric Analysis.


Stochastic Frontier Models and Economic Efficiency Estimation
William Greene
Stern School of Business, New York University


Course Materials

The following materials are provided for use and reference during the course: Those marked with * may be downloaded from the course home page.

I. Introductory Information and Course Summary
II. Class Presentation Slides: Session1.ppt – Session8.ppt
III. * Empirical Studies: Airlines, Electricity, Banks, World Health Organization
IV. Laboratory Sessions
   Lab1.lim ... Lab4.lim: Command files for computations
   Assignment1.pdf ... Assignment4.pdf: Assignments
   * Lab1.ppt ... Lab4.ppt: Class discussion materials
V. Data Sets
   .lpj file: Limdep project files for six applications: Banks, Dairy Farms, Electricity, Airlines, WHO, Swiss Railways
VI. Reading Materials
   * A. Survey Papers
      Greene on stochastic frontier modeling
      Fried, Lovell and Schmidt on efficiency estimation
      Sena on frontier and efficiency estimation
      LIMDEP manual chapter 33 on stochastic frontiers and DEA
   * B. Textbook materials: Chapters 12, 14, 15, 19 of Greene, Econometric Analysis, 7th edition
   * C. Articles from the literature. See Reference List for details.
VII. * NLOGIT Software: The software is mounted on all lab machines. A manual is placed on your computer. A temporary version that you can install on your laptops is also provided. Go to http://people.stern.nyu.edu/wgreene/FrontierModels2013.htm and scroll down to the bottom of the page for the links to the files.