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Book Review: A Practitioner's Guide to Stochastic Frontier Analysis Using STATA

Kumbhakar, S. C., Wang, H.-J. & Horncastle, A. P. A Practitioner Guide to Stochastic Frontier Analysis Using STATA. Cambridge University Press, USA: 359 pages. ISBN: 978-1-107-02951-4

This book is excellent in explanation of technical efficiency measurement by stochastic frontier analysis. This book enables readers to understand how technical efficiency is computed and interpreted. Each chapter starts with a theoretical of stochastic frontier model followed by examples of applying the theory to real data. Data and STATA syntax of all examples are downloadable from website. This ensures that practitioners can apply these tools to their research.

Chapter 1 starts with introduction of the structure of this book. Chapter 2 discusses fundamental background to measure technical efficiency. It begins with relationship between production function and technical efficiency. Then the meaning of output-oriented and input-oriented are introduced. Other theories such as returns to scale, elasticity of substitution, separability, transformation of production functions, and functional forms of production function are discussed. This chapter also provides ideas to measure technical efficiency when there are multiple outputs using distance function.

After fundamental background of technical efficiency is explored, Chapter 3 starts to adopt production frontier model to measure the technical efficiency using cross-sectional data. Most of the contents are about output-oriented technical efficiency. Several approaches are discussed when technical efficiencies are estimated using the stochastic production frontier. They are distribution free, maximum likelihood under assumption of half-normal, truncated normal, exponential. This chapter also presents heteroscedasticity test and how to correct the problem. The adoption of scaling function to technical inefficiency from Wang and Schmidt (2002) is discussed.

Chapter 4 focuses on input-oriented technical efficiency estimation from the cost frontier model with cross-section data. The basic concept of input-oriented technical efficiency is explained in connection to cost function. It also reviews the properties of cost minimization function. Similar to the previous chapter, approaches which are distribution free, maximum likelihood under assumption of half-normal, truncated normal and exponential are applied to cost frontier model to estimate input-oriented technical efficiency.

In chapter 3, technical efficiency is estimated from production frontier model where inputs are exogenously given and the scalar output is a response to the inputs. In chapter 4, technical efficiency is estimated from cost frontier model where output is given and inputs are choice variables. Chapter 5 discusses the technical efficiency estimation when the objective of producers is to maximize profit, where both inputs and outputs are choice variables. This chapter starts by deriving the relationship between profit function to output-oriented technical efficiency. Then the distribution free and maximum likelihood approaches are introduced to estimate the technical efficiency.

The first five chapters are in “Single Equation Approach with Cross-Sectional Data” section. Chapters 6 and 7 are in “System Models with Cross-Sectional Data” section. Chapter 6 mostly focuses on how to estimate input-oriented technical efficiency from the cost system model that consists of cost functions and cost share equations, derived from the first-order conditions (FOCs) of the cost minimization problem. The use of these share equations along with the cost function does not require any additional assumption. The share equations do not contain any new parameter that is not already in the cost function. This additional information provided by these share equations helps estimating the parameters more precisely. The inclusion of the share equations in the estimation allows us to estimate the allocative inefficiency. This chapter also shows how different covariance restriction of the error terms in the system can be adopted in estimating the model under the assumption of distribution free and maximum likelihood. Further, it introduces how to estimate technical efficiency when there are multiple outputs and inputs using cost function.

Chapter 7 provides the estimation of technical efficiency using a profit model that consists of profit function and the profit share equations. As in chapter 6, the share equations add information in estimating parameters and yield more efficient parameter estimates. This chapter starts by deriving a profit system and then discusses the estimation methods. The profit system model consists of the FOCs of profit maximization. This is an advantage of estimating a profit function using only the FOCs, allowing profit to be negative while the logarithm form cannot be used.

Chapters 8 and 9 are in “The Primal System Approach” section, which refers to a system approach where the production function is used along with the FOCs from either cost minimization or profit maximization. Chapter 8 discusses the estimation of technical and allocative inefficiency and how it may be incorporated in a cost frontier model, theoretically. In the cost minimization problem, the input prices and outputs are assumed to be exogenous and the levels of inputs are the choice variables. Chapter 9 provides the estimation of technical and allocative efficiency when output is endogenous; hence the cost frontier cannot be adopted. This chapter assumes that firms maximize profit by making their decision on inputs used and the output production. It can identify how much of profit increase can be achieved through improvement in technical efficiency and how much can be achieved through an optimal mix of inputs.

Chapters 10 and 11 are in "Single Equation Approach with Panel Data" section. The previous chapters present technical efficiency estimation using cross section data which observed once for every firm unit. When cross section data is used, we need to be aware that the estimation results depend on the assumptions for the noise and the inefficiency component. The technical inefficiency component must be independent of the regressors. When the panel data is used, as discussed in chapter 10, some of these limitations are removed. One of the advantages of panel data is that it allows for heterogeneity by introducing an "individual unobserved effect" which is time invariant and individual specific, and not interact with other variables. Furthermore, using panel data enable us to be able to examine whether inefficiency has been persistent over time or time-varying. This chapter also discusses if, regarding the time-invariant individual effects, the individual effects represent (persistent) inefficiency, or if the individual effects are independent of the inefficiency and capture (persistent) unobserved heterogeneity. Another question that panel data can help answer is whether the individual effect are fixed parameters or random variables. Chapter 11 explains the changes in productivity and profitability overtime and decomposing them into their constituent parts. This analysis can examine the impact of policy or management decision on efficiency and if certain approaches are better than others to improve efficiency. The results can be applied to banking sector, for example, whether the change in productivity for a bank has been driven by the bank improving its relative efficiency, by scale improvement, or by general technological improvement.

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