SPECIFICATION AND ESTIMATION OF STOCHASTIC FRONTIER PRODUCTION FUNCTIONS

by

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ABSTRACT

This thesis is concerned with the specification, estimation, application and testing of stochastic frontier production functions. The majority of the material in this document is derived from seven research papers written over the past four years. The thesis begins with a review of frontier estimation methods, with an emphasis on information relevant to agricultural applications. The two primary methods of frontier estimation, stochastic frontiers and data envelopment analysis (DEA), are described and compared. The influence of data noise is observed to be crucial in the selection of appropriate methods.

A stochastic frontier production function for panel data in which the technical inefficiency effects are specified to be the product of a deterministic exponential function of time and time-invariant inefficiency effects is specified. This model specification is introduced to address criticisms of earlier stochastic frontier specifications for panel data which assume time-invariant technical inefficiency effects. An application involving Indian paddy farmers illustrates the use of the model.

A stochastic frontier production model for panel data in which the technical inefficiency effects are permitted to be a function of firm-specific variables and time is also specified. This model is an improvement over the two-stage approach to the modelling of technical inefficiency effects, which is inconsistent in its statistical assumptions. An empirical application using the above mentioned data, along with information on the age and formal schooling of the farmers, indicates that age and education do have a significant influence upon the levels of the technical inefficiency effects of these Indian paddy farmers. Two additional applications of this model specification are also conducted. The first of these involves a larger panel data set on farmers from three Indian villages. In this application, farmer age and years of formal schooling, along with farm size, are found to influence the technical inefficiency effects of the farmers in two of the three villages considered. The second application involves panel data on electricity generation in Australian coal-fired power plants. In this application, capacity factor, unit size, plant vintage and coal quality are shown to have a significant influence upon plant inefficiency.

Following this, the computer program, FRONTIER Version 4.1, which has been written to estimate the above-mentioned frontier models, is described in detail. This program can also be used to estimate a number of other model specifications, including cross-sectional models and cost frontiers. The program calculates maximum-likelihood estimates, their estimated standard errors, and technical efficiency predictions.

Finally, Monte Carlo methods are used to investigate the finite-sample properties of estimators for parameters of a stochastic frontier production function in which the technical inefficiency effects have half-normal distribution. The relative performance of the maximum-likelihood (ML) and corrected ordinary least-squares (COLS) estimators are investigated, together with five alternative test statistics for testing for the absence of technical inefficiency effects. The results indicate that there is substantial bias in both ML and COLS estimators when the percentage contribution of inefficiency in the composed error term is small. It is also concluded that ML estimators should be used in preference to COLS estimators because of large mean squared error advantages when the relative contribution of the variance of the technical inefficiency effects is greater than 0.5. The results also show that Wald and likelihood-ratio tests of the null hypothesis of no technical inefficiency effects have incorrect size, and that a one-sided likelihood-ratio test and a test of the third-moment of the OLS residuals have correct size, with the one-sided likelihood-ratio test having the better power of the two.

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