

Christensen L R, Jorgenson D W & Lau L J. Transcendental logarithmic production frontiers. *Rev. Econ. Statist.* 55:28-45, 1973.

[University of Wisconsin, Madison, WI; Harvard University, Cambridge, MA; and Stanford University, CA]

This paper introduces transcendental logarithmic functional forms for econometric models of producer behavior. These forms provide flexibility in determining patterns of production empirically. The paper presents econometric models of production for the US economy, estimated by the method of nonlinear three-stage least squares. [The *Science Citation Index*® (SCI)® and the *Social Sciences Citation Index*® (SSCI)® indicate that this paper has been cited in over 225 publications since 1973.]

Dale W. Jorgenson
Harvard University
Department of Economics
Cambridge, MA 02138

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This paper was the first of a series of 27 papers I have published on the econometrics of producer and consumer behavior. The research was conceived when my coauthors were graduate students working under my supervision at the University of California, Berkeley. Our collaboration continued after I moved to Harvard University in 1969 and led to publication of this paper on producer behavior in 1973 and a companion piece on consumer behavior in 1975.¹

Our *Review of Economics and Statistics* paper has been widely cited because it contains three important ideas that have been further developed by me and my coauthors, by our students, and by others. The primary contribution of our article is the introduction of transcendental logarithmic, or translog, functional forms for econometric models of producer behavior. Relative to functional forms in use at the time our article was published, translog functional forms

provide much greater flexibility in the empirical determination of production patterns.

The second key idea contained in our paper is utilization of the dual formulation of production theory in parameterizing econometric models of production. The chief advantage of this formulation is in generating demands and supplies as explicit functions of relative prices. By using duality, these functions can be specified without imposing arbitrary restrictions on patterns of production. I developed the approach to duality presented in our article in greater detail in my article with Lau published in 1974.²

The third innovation included in our article is the introduction of the method of nonlinear three-stage least squares. This method is used for estimating unknown parameters in systems of nonlinear simultaneous equations. I have discussed the nonlinear three-stage least squares method in much greater detail in a paper with Jean-Jacques Laffont published in 1974.³ This technique has been incorporated into several econometric software packages and has been widely utilized in modeling both producer and consumer behavior.

Measures of returns to scale utilizing transcendental logarithmic functional forms were introduced by Christensen and William Greene in 1976.⁴ I developed transcendental logarithmic forms for modeling the rate of technical change with Barbara Fraumeni in 1981.⁵ These and other extensions of the translog form have led to a wide range of empirical applications. Results on producer behavior through 1984 have been summarized in my survey article, which will be published in the *Handbook of Econometrics* in 1985.⁶

1. Christensen L R, Jorgenson D W & Lau L J. Transcendental logarithmic utility functions. *Amer. Econ. Rev.* 65:367-83, 1975. (Cited 95 times.)
2. Jorgenson D W & Lau L J. The duality of technology and economic behaviour. *Rev. Econ. Stud.* 41:181-200, 1974. (Cited 10 times.)
3. Jorgenson D W & Laffont J J. Efficient estimation of nonlinear simultaneous equations with additive disturbances. *Ann. Econ. Soc. Meas.* 3:615-40, 1974. (Cited 15 times.)
4. Christensen L R & Greene W H. Economies of scale in U.S. electric power generation. *J. Polit. Econ.* 84:655-76, 1976. (Cited 75 times.)
5. Jorgenson D W & Fraumeni B M. Relative prices and technical change. (Berndt E R & Field B, eds.) *Modeling and measuring natural resource substitution*. Cambridge, MA: MIT Press, 1981. p. 17-47.
6. Jorgenson D W. Econometric methods for modeling producer behavior. (Griliches H Z & Intriligator M D, eds.) *Handbook of econometrics*. Amsterdam: North-Holland, Vol. 3. In press, 1985.