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Accounting for externalities in the measurement of productivity growth: the Malmquist cost productivity measure

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Abstract

This paper starts with the basic premise: that conventional measures of productivity growth—often used as a measure of corporate performance—which ignore external or social output, are biased. We then construct an alternative productivity growth measure using activity analysis which integrates the externality/social output into a generalized productivity measure reflecting social responsibility. This method is very general and could be applied to gauge corporate social responsibility. We provide an application to US agriculture to demonstrate the approach: we show that conventional measures of productivity are biased upward when production of negative externalities (or bad) outputs is increasing. Conversely, this same measure of productivity is biased downward when externalities in production are decreasing.

JEL classification: D62; Q52

Keywords: Malmquist; Productivity; Externalities; Activity analysis; US agriculture

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1. Introduction

The purpose of this paper is to demonstrate how one of our most fundamental measures of performance—namely productivity growth—can be amended to account for nontraditional outputs, such as negative and positive externalities or other social outputs. The measure we propose, the Malmquist cost productivity measure (MCP) is a measure of total factor productivity that can readily integrate multiple outputs and is easily estimated. In order to make our proposed measure concrete, we illustrate its use with an application to the issue of performance in the agricultural sector when accounting for environmental degradation. Given the trend toward 'corporate' farming in the US, this provides a somewhat unusual, but we think relevant, example of measuring 'corporate' social performance, where our focus is on environmental responsibility.

More generally concerns about environmental degradation have prompted the adoption of measures that would internalize externalities in production. The measures taken, ranging from command and control policies such as regulation to more market oriented policies such as issuing tradable pollution permits, were aimed at preventing the use of the environment as a medium whereby undesirable (or bad) outputs could be freely disposed. This has required that models of production be extended to accommodate joint production of "goods" and "bads". Early contributors included Shephard (1970) and Shephard and Färe (1974).

Initial studies were more geared towards a comparative evaluation of environmental performance of decision making units (DMUs) within a static framework. Literature on production frontier construction is extended and modified to measure environmental performance in addition to capturing efficiency at the decision making unit (DMU) level. The two competing approaches, stochastic frontier estimation and data envelopment models, while determining the technology to be used as a basis for constructing different measures of DMU performance, they shared equal responsibility in providing means of measuring environmental performance. As a result, empirical applications on the measurement of environmental performance have flourished from both strands. For example while Reinhard et al. (1996) used a stochastic production frontier approach to construct environmental efficiency indexes at the farm level, Ball et al. (1994) and Tyteca (1997) adopted the data envelopment analysis to measure the environmental performance. Yet Reinhard et al. (1997) used both approaches on the same data set to "analyze the strengths and weaknesses of the two methods in computing the comprehensive environmental efficiency scores". Comparative studies such as Reinhard et al. (1997)'s confirmed the theoretically expected results. Since stochastic production frontiers contain a random error, which attribute some of the deviations from the frontier to uncontrollable chance events (and/or measurement errors), they have generated higher environmental efficiency scores than those measured by DEA, which is a deterministic technique that attributes all the deviations from the best practice to inefficiency. Nevertheless, these studies also showed that although the magnitude of environmental efficiency scores are different, both approaches generate very similar results in ranking DMU's with respect to environmental performance and that the difference in efficiency scores obtained from alternative approaches is a matter of scaling.

Stochastic production frontier models and DEA models also differed in their construction of the best practice technology. While DEA models satisfy monotonicity and curvature restrictions by construction without imposing a parametric structure on the technology, these