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THE ECONOMIC COST OF SUBSIDY-INDUCED TECHNICAL INEFFICIENCY: A METHODOLOGICAL POSTSCRIPT

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In this journal Obeng (1994) concluded from a Data Envelopment Analysis (DEA) study of US urban transit companies that subsidies enhance technical efficiency. The purpose of this note is to point out that this result is largely artificial. We first summarise the methodological assumptions underlying the Obeng study. Then we outline the basic difficulties in his approach and the ways to remedy them.

Obeng measures technical efficiency for 73 U.S. urban transit companies operating in 1988 using 3 inputs and 1 output. The definition of the inputs and the outputs is quite standard in the urban transit literature. Inputs are labour, fuel and fleet size. Output is vehicle miles. In a first phase the author specifies a non-parametric DEA production technology and measures technical efficiency in the inputs relative to this frontier (1). In a second phase the analysis is repeated, but the author adds two explanatory or environmental variables, namely operating and capital subsidies. Comparing the efficiency scores from both phases, the author concludes that subsidies enhance technical efficiency.

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(1) Actually, the article gives contradictory information as to the returns to scale assumptions. Equation 5 imposes variable returns to scale, while equation 4 postulates constant returns to scale. See Lovell (1993) for a discussion of various DEA models.

Apart from the Obeng (1994) contribution, there is – to the best of our knowledge – only one frontier study on urban transit performance which explicitly deals with the effect of subsidies. Filippini, Maggi and Prioni (1992) estimate a parametric cost frontier for Swiss bus companies and report, among others, on the influence of subsidies. In their view subsidies have positive or negative impacts on urban transit performance, depending on the political proximity of the regulator and on whether the regulator can or cannot control the information from the companies. More specifically, it turns out that decentralized government bodies, in the Swiss case the Cantons, are better able to monitor the performance of urban transit operators than the central, i.e., the confederal, government. Since there is little evidence on the impact of subsidies on frontier-based technical efficiency measurement in urban transit, it is worthwhile to reconsider the Obeng (1994) study in a methodologically correct way.

The main point of our criticism is that Obeng (1994) cannot conclude from a comparison of the efficiency scores in both phases that subsidies promote technical efficiency. The basic reason is that radial efficiency scores cannot decrease when dimensions are added to a non-parametric production technology (as indicated in Nunumaker (1985) and Thrall (1989)) (2). Therefore, it is simply impossible to distinguish between the effect of the methodology and the impact of the variables on the efficiency scores. The claim of the author that his result contrasts with the traditional wisdom in the urban transit literature is preliminary, to say the least.

In the current state of the literature on technical efficiency measurement there are in general two alternative approaches to consider the effect to environmental variables (see Lovell (1993, 1994)). First, there is a one stage approach which incorporates environmental variables into the definition of the production technology itself. Its basic underlying assumption is that the included variables determine the shape of the production frontier along with inputs and outputs. Second, in a two stage procedure the technical efficiency scores are computed relative to a certain frontier technology in a first step and explained by a series of explanatory variables

(2) There is a contradiction between this theoretical result and the comments on page 16 mentioning that for some observations efficiency scores worsened. This is probably an artefact of inaccurate computation.

in a second step. This approach essentially assumes that the second stage explanatory variables do not affect the shape of the frontier, but only the extent of technical efficiency, i.e., the distance to the frontier.

Technical efficiency measurement using either approach can serve a variety of purposes. These two alternative methodologies are, however, not equivalent for explanatory purposes. This is shortly indicated in the following sections.

ONE STEP APPROACH

First, one may consider that efficiency measurement is not accurate if one ignores subsidies. When opting for a non-parametric frontier, and apart from the basic difficulty mentioned above, one must make assumptions on the impact of subsidies in advance. This impact is represented by the choice of the orientation. On the one hand, if an input orientation is chosen, then a unit is compared with a «composite» unit that receives less subsidies (less is better). On the other hand, if an output orientation is preferred, the unit is evaluated relative to a «composite» unit receiving more or equal amounts of subsidies (more is better). Obeng does not specify the way the subsidy variables were introduced in the DEA model and gives no legitimation fot the classification selected.

Griffell-Tatjé et al. (1992) have proposed a solution to this problem by including the environmental variables, i.e., the subsidies, into the multiplier problem. They do not impose a sign on the associated multipliers. Accordingly, the multipliers are positive or negative depending on which solution improves the objective. If the associated multiplier is positive (negative), then the orientation of the environmental variable is input (output). It must be added, however, that this method may lead to confusing results if no clear patterns emerge among the multipliers. As a matter of fact, this problem even becomes more difficult when multiple environment variables are to be considered for inclusion in a model.

TWO STEPS APPROACH

The alternative method attempts to solve the problem under a slightly different perspective. Indeed, after computing the efficiency score relative to a non-parametric production model, it tries to explain these radial efficiency results with a series of explanatory variables. For the latter purpose, an obvious choice in the case of multiple explanatory variables is the classical regression approach. A special method of estimation is required to take account of the censoring of the efficiency score at unity. Very often the Tobit estimator is used. Another possibility is to estimate a logit model explaining the dichotomous efficiency status. The sign of the coefficient for each variable indicates its influence on technical efficiency. Note that an alternative in the second step is to explain the total slacks for each dimension – instead of the radial efficiency measure – using a SUR model (see, e.g., Fried et al. (1993)).

Given the problems associated with using a one step approach for non-parametric reference technologies, the analysis proceeding in two steps is a more valid explanatory methodology. For the particular case of the Obeng article, it is a natural way to go if one wants to determine the effect of subsidies on US urban transit performance.

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