

ERRATA

Productivity Analysis in the Service Sector with Data Envelopment Analysis

Third Edition

Necmi K Avkiran

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Please see attached pages with corrections.

The above findings point to a weak consistency between ranks suggested by DEA and the two financial ratios. This observation can be partly explained by the noise that would be present in data collected across five years particularly in an aggregate figure such as total assets. Nevertheless, the positive and significant Spearman rank correlations point in the right direction, thus providing some confidence in decisions based on DEA when compared to common financial ratios. Finally, at the risk of stating the obvious, let us say that the degree of consistency between DEA based ranks and ranks derived from non-frontier measures will also depend on the correspondence of variables that comprise such performance models. Furthermore, DEA works on the principle of capturing the interaction amongst multiple inputs and outputs and it is this advantage of DEA over financial ratios that we need to recall. That is, there is no compelling reason here to expect a strong positive rank correlation although it is always comforting when different approaches yield similar results.

13.4. Conclusions

We choose the slacks-based measure of efficiency rather than relying solely on the traditional models of data envelopment analysis because it is a fully units-invariant model. That is, we are able to capture the non-radial components of inefficiency in a scalar without being concerned about the different dimensions of variables. Furthermore, we successfully test for stability of the efficient frontier, a step that is often omitted or not reported. As a result, we are more confident of the appropriateness of our productivity model and methodology to the task on hand.

Efficient frontier techniques such as DEA rely on relative evaluation by comparing the position of the inefficient unit to the frontier. As such, a stable frontier we have confidence in becomes critical to any benchmarking decisions that may emanate from DEA. That is, in determining potential improvements for inefficient units, management needs to be careful in selecting units to be emulated. The stability and integrity tests illustrated in this study provide a sound group of approaches that can be employed toward building confidence in managerial decision making.

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Thus, the DEA analysis to emerge from stage 3 represents performance due to managerial efficiency only.

18.4 Proposed Research Design

This section continues to detail the research design put forward by Fried et al. (2002) and the improvements suggested in this chapter.

18.4.1 Stage 1 - Initial Data Envelopment Analysis to measure input and output slacks

As mentioned before, Fried et al.'s (2002) analysis begins with traditional DEA using the BCC model (refer back to equation 1). However, the BCC model (or, the CCR model i.e. Charnes, Cooper and Rhodes 1978), while producing units-invariant (i.e. dimension free) radial inefficiency estimates, does not generate units-invariant estimates of non-radial inefficiency⁶⁸ (1995). For consistent interpretation of DEA and SFA estimates, we need to choose a fully units-invariant DEA model. Such a solution exists within the slacks-based measure (SBM) of efficiency (see Cooper, Seiford and Tone, p.97, and Tone 2001).⁶⁹ Here it is possible to argue for either output maximisation or input minimisation; Fried et al. (2002) arbitrarily select input minimisation and thus in stage 2 they focus only on input slacks. We propose a more comprehensive analysis where total input and output slacks are measured simultaneously against the same reference set, facilitated by a non-oriented SBM model that is fully units-invariant. The fractional program for the non-oriented constant returns to scale SBM is shown below (Tone 2001) where ρ is the scalar that captures non-radial slacks.

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⁶⁸ Non-radial inefficiency is traditionally known as 'slacks'. For brevity, the term 'slacks' covers radial and non-radial inefficiency in the rest of our chapter.

⁶⁹ While the additive DEA model can also capture slacks, it is neither units-invariant nor able to generate a scalar measure of efficiency.

inefficiency for the same input and unit. We extend Fried et al.'s (2002) method by estimating statistical noise in output generation as well (see Equation 7).

$$\hat{E}[v_{r,j}|v_{r,j} + u_{r,j}] = s_{r,j}^+ - z_j \hat{\beta}^r - \hat{E}[u_{r,j}|v_{r,j} + u_{r,j}], \quad r = 1, \dots, M, \quad j = 1, \dots, I \quad (7)$$

18.4.3 Stage 3 - Final Data Envelopment Analysis with adjusted inputs and outputs

Stage 3 is a repeat of stage 1 analysis using input and output data adjusted in stage 2. The results of stage 3 analysis represent SBM DEA analysis of managerial efficiency purged of the influence of operating environment and statistical noise. That is, in this final stage of the three-stage efficiency analysis, all units are re-evaluated after inputs and outputs have been adjusted for influences of operating environment and statistical noise. Our proposed methodology is an improvement over Fried et al. (2002) who base their analysis on comparing DMUs after adjusting inputs for radial slacks only and do not work with a fully units-invariant DEA model.

18.5 Summary

We detail a potential improvement on the performance evaluation method by Fried et al. (2002) that can be used to measure an organisational unit's performance purged of the impact of environment and statistical noise, thus helping identify the true managerial performance. Key contributions of this chapter to the organisational performance measurement and efficiency literature include, (i) a comprehensive approach where total input and output slacks are identified simultaneously against the same reference set before levelling the playing field, (ii) identifying percent adjustments attributable to the operating environment and measurement errors, and (iii) using a fully units-invariant DEA model i.e. SBM.

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The proposed improvements specifically designed to address the key limitation of DEA, namely the assumption of no measurement error, and the more general problem of how to account for environmental effects, create new opportunities for researchers to revisit their existing studies or design new studies from ground up. Researchers who have access to environmental data are encouraged to apply the three-stage method.