General principles of assessment (Sensorveiledning)

HECON4250 – Term paper assignment spring 2019

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All questions should be answered!

A good submission (Grade C) should cover all the main points listed below.

An excellent submission (Grade A) should in addition cover at least most of the optional points below.

1) Concepts (40%)

a) Define the concepts a) technical efficiency, b) technical productivity and c) scale efficiency. Illustrate the concepts in a figure.

Main points:

- An output/input diagram with a VRS frontier and a line representing maximal feasible productivity (CRS frontier)
- A definition of production possibility set (PPS), technology, feasible set or equivalent and a frontier/boundry of this set.
- Technical efficiency (TE) defined as a constrained output/input ratio relative to the PPS
- Productivity as an output/input ratio and Technical productivity (TP) as a technology-based useful concept when the lack of prices preclude a price-weighted index.
- Scale efficiency (SE) as the productivity of a technical efficient point relative to the productivity at optimal size.

Optional points:

- Diagrams in other subspaces (i.e. cost/allocative efficiency, revenue efficiency)
- Qualitative (being efficient or not) and quantitative (efficiency measures <= 100%) concepts.
- Formulas (or equivalent text) on how to calculate the Farrell measures of TE, TP and SE.

b) What does the Malmquist index measure, and how can it be decomposed? Illustrate your discussion in a figure.

Main points:

- An output/input diagram with an observed unit, VRS and CRS frontiers for two different time periods.
- The Malmquist index (MI) as a technology-based useful concept when the lack of prices preclude a price-weighted TFP-index.
- The interpretation of MI smaller or larger than 1.0 (100%)
- The need for a common reference base for comparison.

- The main decomposition into Frontier/Technology change (T) and Catching-up/Efficiency (E) components.
- The subsequent decomposition of E into Pure efficiency change (P) and Scale efficiency change (S).

Optional points:

- Diagrams in other subspaces (i.e. cost/allocative efficiency, revenue efficiency)
- The possibility of basing the MI on Distance functions.
- The importance of using a constant productivity (CRS) frontier as the reference
- Formulas (or equivalent text) on how to calculate the MI and its decomposition.
- Variations on first-year, last-year, pooled or geometric average based MIs.

c) What are the roles for input prices and output prices in efficiency and productivity analysis?

Main points:

- The possibility of using input and output prices as weights to construct a TFP-index of productivity
- The lack of explicit output prices in many public sector and health services
- The use of technology-based measures when prices are missing.
- Cost efficiency, allocative efficiency and optimal input mix

Optional points:

- Revenue efficiency, output allocative efficiency and optimal output mix.
- Profit efficiency
- Diagrams in relevant subspaces (i.e. cost/allocative efficiency, revenue efficiency)
- The welfare basis of market prices as carriers of information on willingness to pay and marginal costs.

d) Discuss briefly reasons why policy makers would be interested in efficiency and productivity analysis.

Main points:

- Cost control in the light of alternative uses of resources (opportunity costs) within the health sector, in other public sectors, and in private use
- Information to stakeholders in a market with information asymmetries
- Operating decisions in purchasing, organisation, quality control, cost control
- Policy advise for incentives, reimbursement schemes, restructuring (merging, specialisation, size)

Optional points:

- The welfare basis for allocating resources to health care in the light of treatment costs and benefits
- The need to complement with other performance measures related to quality, process, structure, access, equity etc.

2) Empirical analysis (60%)

Using a data set for 149 Nordic hospitals in 2008 (uploaded as Nordic_hospitals_2008.xls):

a) Suggest variables in the data set to enter a *one* input, *two* output model of cost efficiency. Justify your choices.

Main points:

- The need for completeness (as far as possible) in covering all inputs and all outputs.
- The use of Costs as the only input in the data set, which incidentally also is a summary measure of the real inputs.
- The need to deflate costs due to differences in currency and input price levels.
- All treatments/discharges/patients should be covered in the two outputs
- DRG-points as a case-mix adjusted measure of patient treatments
- A reason for the specific aggregation of the 6 DRG-variables into 2 outputs. Several different specifications are allowable.

Optional points:

- The importance of a variable in terms of explanatory power
- The problems of multi-collinearity and heteroscedasticity
- The lack of information on quality, severity and research output
- The challenges of including quality and other aspects in a simple production model

b) Calculate cost efficiency using ***both*** Stochastic Frontier Analysis (SFA) ***and*** Data Envelopment Analysis (DEA). Justify the assumptions you need to make.

Main points:

- Assumptions for SFA, a) Functional form of the cost function, i.e. Logarithmic, Cobb-Douglas or Translog, and b) Functional form of inefficiency distribution, i.e. Half-Normal, Truncated Normal or Exponential
- For DEA, the scale properties (VRS or CRS)
- Justification for main SFA and main DEA model
- Main results: mean cost efficiency, significance of efficiency (i.e. lambda) in SFA.

Optional points:

- Basic assumptions of cross-section SFA, i.e. normally distributed stochastic error and identification of inefficiency through skewed error term.

- Basic assumptions of DEA, i.e. feasibility, free disposal, convexity and minimum extrapolation
- Estimation procedures for the models, Maximum likelihood, Linear programming
- Alternative models and comparison of results, i.e. VRS vs CRS DEA and different distributions for SFA
- Challenges of testing the assumptions, Likelihood ratio tests, Bootstrapping

c) Compare the distributions and the average levels of cost efficiency in the SFA analysis and the DEA analysis. Why do the results differ?

Main points:

- Mean and variation (range/min/max or standard deviation) of cost efficiency estimates.
- The tendency for SFA estimates of CE to be higher than DEA because part of the variation is attributed to stochastic noise
- The countertendency for higher DEA estimates because the non-parametric frontier fits closer to the data
- A scattergram showing the association of the DEA and SFA CE estimates.
- Comments on the min/max and dispersion.

Optional points:

- Histograms or Kernel diagrams of CE density
- Outliers

d) Based on your results, what can be said about the optimal size of Nordic hospitals?

Main points:

- The Elasticity of scale (ES) estimate from the SFA model and the presence of increasing or decreasing returns to scale, the optimal size being large or small (or non-existing)
- The Scale efficiency (SE) estimates from DEA where SE=1 signifies optimal scale
- A scattergram showing the association of the DEA SE and costs (or ln(Cost) for closer view of smaller units), with comments on units that are too small or too large

Optional points:

- The problem of constant ES estimate in a Cobb-Douglas SFA model
- The dependence in DEA SE estimates and thereby optimal scale of input or output mix
- The difficulty of estimating SE in SFA or ES in DEA

e) What can be said about the efficiency loss due to the fact that Nordic hospitals are not all of optimal size?

Main points:

- The use of (1-SE) from DEA to measure the extent of scale inefficiency
- Calculation of % loss, and the quantification of loss in monetary terms
- Comments on the extent of the scale inefficiency loss compared to technical efficiency loss (or total loss due to less than maximal productivity)

Optional points:

- The problem of resizing a hospital due to political, geographical or organisational restrictions

f) What are the limitations of your analysis?

Main points:

- The limitations inherent in the assumptions of each method (SFA or DEA), especially the challenges of separating inefficiency from stochastic noise
- The lack of good data on quality of care and severity of illness
- The challenges of including external/environmental variables in the analysis
- The difficulty of modelling behaviour and cost functions simultaneously
- The sample size
- The lack of panel data that could have opened possibilities for better identification of inefficiency
- The lack of sensitivity analysis
- The need to complement these analysis with other methods and performance measures

Optional points:

- Bootstrapping as a means to test the properties of the DEA estimates
- The comparability of health services production technologies in different Nordic countries
- The endogeneity of variables and the simultaneous determination of inputs, outputs and quality
- The use of a hospital as a single agent (decision making unit) with coherent behaviour and consistent decisions