Aalto University – School of Science and Technology

Mat-2.4177 Operaatiotutkimuksen projektityöseminaari L

Project Plan – Analyzing efficiency of Finnish health care units

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Table of Contents

Introduction

A growing literature studying data envelop analysis (DEA) has emerged since the seminal paper of Charnes et al. (1978) offering numerous methods for examining the efficiency of decision-making units (DMUs). More importantly, according to Hollingsworth et al. (1999), there has been increasing interest in measuring specifically the productive performance of health care services since the mid-1980s. Salo & Punkka (2011) describe that DEA models in health care give insights into which DMUs are more efficient than others when health indicators are viewed as outputs and when inputs consist of health-care investments and possibly contextual factors as well. For example, Garcia et al. (2002) analyze the efficiency of primary health units and explore how sensitive the DEA results are to the selection of output variables. In addition, Linna et al. (2010) have compared the performance of hospital care in four Nordic countries.

However, there are some problems related to DEA-approach. Non-parametric methods, such as DEA, give the highest available efficiency score 1 for many units already with relatively small amounts of output/input -variables leading to results with low value of information. In addition, in case of low number of observations, the efficiency frontier might be based on outliers causing results to be sensitive. This is the case specifically in small countries, such as Finland, where the number of comparable health care organizations is typically small. These impose significant challenges when comparing sufficient approaches and methods to study the efficiency of health care units, and imply that especially parametric statistical methods might be problematic.

There are some different methods that can be used to evade the problems described above. For example, one can use different weights for input- and output-variables, or estimate the efficiency frontier with Bootstrap method. Salo & Punkka (2011) develop comparative results for ratio-based efficiency analysis (REA) based on the decision-making units' relative efficiencies over sets of feasible weights that characterize preferences for input and output variables. On the other hand, Staat (2006) presents results of a research using a DEA-bootstrap approach to study the efficiency of hospitals in Germany. He states that efficiency estimates based on DEA-type methods are biased upwards, and the bias depends on sample size N as well as on the curvature of the frontier and the magnitude of the density at the frontier. Furthermore, he proposes that in order to obtain bias corrected estimates for the multiple-input-multiple-output case, the bootstrap method must be applied. Medin et al. (2010) estimate cost efficiency scores for the performance of university hospitals in the Nordic countries by using the Bootstrap bias-corrected procedure. Finally, Xue et al. (1999) use the Bootstrap method to obtain a theoretically appropriate solution to the problem posed in the regression analysis of the DEA efficiency scores due to the inherent dependency among the DMUs' efficiency scores.

Objectives & research questions

This study is conducted as a part of the course "*Operaatiotutkimuksen projektityöseminaari*" at Aalto University, School of Science and Technology, to address the needs of THL, Terveyden ja hyvinvoinninlaitos (*engl. National Institute for Health and Welfare*). THL is a research and development institute under the Finnish Ministry of Social Affairs and Health, and it works to promote the well-being and health of the population, prevent diseases and social problems. Furthermore, THL is the statutory statistical authority in health and welfare, and maintains a strong knowledge base within its own field of operations. THL is

especially interested in efficiency and costs analyses regarding health care services. The purpose of this study is to help THL to identify appropriate approaches to analyze efficiency of Finnish health care units.

It is important to recognize that theoretically only one, the most appropriate method, should be used for examination of efficiency of DMUs in order to enable clear cross-country comparisons and communication. However, at the moment no universally accepted dominant method exists. Therefore, the aim of this study is to develop, test and analyze methods for comparing efficiency of different health care units in Finland. Considering the problems discussed earlier, following four issues need to be taken into account in the study when choosing the appropriate method. First, since Finland is a relatively small country, only a small number of observations is available (N<30-40). Second, the number of efficient DMUs should be reduced. Third, the effect of outliers on the efficiency scores should be reduced. Finally, uncertainty related to efficiency scores should be reported by using confidence intervals or other methods of probability-theory. Finally to summarize, the main research question of this study followed by three sub-questions can be stated as follows:

- *What is the most appropriated method for comparing the efficiency of health care units in Finland?*
    o *How a small sample size leading to biased efficiency estimates can be taken into account?*
    o *How the efficient frontier can be controlled in order to reduce the number of efficient DMUs and their effect on efficiency scores?*
    o *When output variables are taken as given, how the model should be constructed and specified?*

In order to address these questions, this study aims to achieve following objectives:

- *To produce suggestions for the most appropriate DEA-method for studying Finnish health care units supported by justified arguments.*
    o *To compare, how different DEA-methods can be applied in studying the efficiency of Finnish health care units.*
    o *To understand the characteristics of different DEA-methods, and what kind of challenges or biases they may impose.*
    o *To examine, how the comparison of heterogeneous units can be taken into account in the model.*
    o *To examine, how the choosing of variables affects the results.*
    o *To study the applicability of Bootstrap-method for sensitivity analysis.*
    o *To study the applicability of REA-method for producing more robust results.*
    o *To examine the applicability of quality indicators for efficiency analysis.*

Research approach & scope

Data is already available from the behalf of THL for oral health care and special health care units in Finland, and will be received by authors within one or two weeks. Data consists of samples for two consecutive years for both types of units, from which the second sample will be used to validate results. Initial idea is to focus primarily on one type of unit by examining it throughout. If the team has enough time, also the second unit will be covered in the study. Input-variables in the data are already weighted, and internal weights of output-categories are taken as given. We will analyze the data by using REA-method instead of basic DEA-approach due to the problems related to DEA. However, the basic DEA results will be created as a by-product. Furthermore, different programs available will be used to analyze the data. To summarize,

the emphasis will be on studying the applicability of different DEA-methods and the REA-method in order to find a method that would best reflect the reality.

However, it is very important to understand what efficiency really is. Therefore, lots of effort will be made in order to identify different factors and forces in the background. Only by understanding the whole situation and the factors affecting the processes of different units, can realistic arguments be made to support one method over another.

Resources

The group consists of five members: Yrjänä Hynninen, Joona Putkonen, Jussi Vähä-Vahe, Petri Ollikainen and Antti Tenhola. All members have extensive background in the field of systems science and applied mathematics. Yrjänä Hynninen acts as a project manager and takes the major responsibility of communication with the client and course personal as well as coordinating the project.

Since the data is not yet available for the research team, the focus for the next two weeks will be on studying literature regarding quality indicators, DEA- and Bootstrap-methods, and familiarizing ourselves with programs that will be used to analyze the data. Data analysis will start right away when the data is available. Project schedule is presented in detail in Table 1.
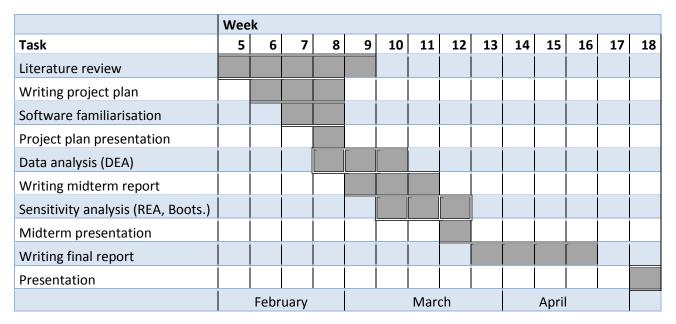
Table 1 Project schedule

Task	Week													
	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Literature review	■	■	■	■	■									
Writing project plan		■	■	■										
Software familiarisation			■	■										
Project plan presentation				■										
Data analysis (DEA)				■	■	■								
Writing midterm report					■	■								
Sensitivity analysis (REA, Boots.)						■	■	■						
Midterm presentation								■						
Writing final report									■	■	■	■		
Presentation														■
		February				March				April				

Intermediate milestones are project plan presentation on February 25th and midterm presentation on March 25th. The final project presentation will be held on May 6th. Personal work contribution and tasks' total work allocation is presented in Table 2. As a project manager, Yrjänä Hynninen will be rewarded with 7 credits (á 27h), others with 5.

Contribution						
Task	Yrjänä	Joona	Jussi	Petri	Antti	Total
Literature review	30	10	19	10	10	79
Project plan writing	2	1	1	10	10	24
Midterm report writing	20	15	15	15	15	80
Software familiarisation	2	10	1	1	1	15
DEA	15	15	15	15	15	75
REA & bootstrapping	20	20	20	20	20	100
Final report writing	45	30	30	30	30	165
Meetings	20	15	15	15	15	80
Coordination	20	4	4	4	4	36
Seminars and excursions	15	15	15	15	15	75
Total	189	135	135	135	135	729

Risks

In Table 3 we have listed the most significant risks of the project and given a description how we plan to face and prevent them.

Table 3 Risks and their prevention

Risk	Prevention
Results will be reported without analyzing if they make sense	Extensive attention throughout the process will be put on understanding the whole picture and implications of the results.
Final report will not be useful for THL	Project manager will stay closely in touch with the client in order to understand their needs. Project plan, midterm report and final report will be sent to the client before submitting to ensure client satisfaction.
Received data do not provide basis for justified recommendations	In this case we have to settle only for recommending future research.
Project is delayed	Project schedule is planned in detail with intermediate milestones. Project manager will do frequent checks to make sure everyone follows the schedule.

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