Available online at www.sciencedirect.com
ScienceDirect
Omega 37 (2009) 204–214
omega
The International Journal of Management Science
www.elsevier.com/locate/omega

Applications

A multicriteria blockmodel for performance assessment☆

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Received 29 July 2005; accepted 30 August 2006
Available online 18 October 2006

Abstract

This paper considers a network-based view of performance differences between organisations. Each organisation is considered in terms both of its size—the level of performance—and its shape—the means whereby the performance is achieved. Since many organisations prefer to monitor their performance via a number of performance measures rather than a single efficiency this is the approach adopted. A weighted additive multicriteria model is used to give an overall measure. The weights, inevitably imprecise, are modelled probabilistically resulting in correspondingly probabilistic estimates of the difference between pairs of organisations. Significant differences are identified and a binary network of relations built showing pairs for which performances are not significantly different from each other. Similarly, correlations between sets of measures leads to a second network showing pairs with similar shape. Blockmodels are built to show the extent to which differentiation between organisations can be found. This structural description is used to examine the changes in performance differences over time. The data used for illustration describe the performance of some airports over a nine year period.

Keywords: Air transport; LP; Multicriteria; Performance measurement

1. Introduction

Organisations continually try to improve their performance. This may often be helped by emulation: by finding similar but better performing organisations and learning from them. This process was given considerable methodological impetus by the introduction of data envelopment analysis (DEA), not least in the field of air transport (e.g. [1]). It is a characteristic of this method that performance is defined by a single efficiency measure which is the ratio between the weighted sum of outputs and the weighted sum of inputs. In the original formulation weights are unrestricted and found as the result of an optimisation. In this it differs from ratio analysis in which performance is described by a set of ratios which may be aggregated by forming a weighted sum in which case the weights must be supplied by the user. This is the general approach of multicriteria decision analysis (MCDA). In practical implementations of DEA some restrictions are frequently placed on weights thereby reducing the difference between the two methods [2]. As well as differing in the attribution of values to weights MCDA is typically concerned with the aggregation of a number of measures rather than with a single overall efficiency.

Many organisations choose to describe their performance not by a single efficiency measure but as a set of performance ratios. There are two obvious motivations for this: first, a desire to have a variety of measures to reflect the interests of a number of stakeholders and, second, that communicating to managers within the

☆ This manuscript is processed by Area Editor Prof. B. Lev.

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doi:10.1016/j.omega.2006.08.004

organisation the specification of subsidiary objectives is more easily facilitated. Additionally, third parties usually prefer to describe performance against a number of criteria be it the *Financial Time*s in its annual survey of MBA programmes [3] or the UK government in setting performance targets for public services [4]. Against this, regulators of what have been public sector bodies make use of the efficiency analyses provided by frontier models such as DEA [5].

It is to the first group, those choosing to use a number of performance measures, that this paper is addressed, for whatever one may think of the possible theoretical superiority of other approaches [6] there are many organisations which prefer to use these various performance indicators. The purpose of this paper is to propose some simple methods to assist in the search for organisations to emulate and also to assist in understanding how a market might be altering in terms of performance differentiation. The arguments are illustrated by reference to a sample of international airports.

The rest of this paper is organised as follows: Section 2 describes the data used; Section 3 introduces the idea that performance may be disaggregated into two components which measure the overall level of achievement and a proxy for the policy pursued; Section 4 shows the effect of imprecision in the specification of weights; Section 5 introduces a network-based measure to describe the performance of an ensemble of organisations; Section 6 discusses the results.

2. The data

It is common for the performance of airports to be compared [7]. The transport consultants TRL have published since 1999 an annual assessment of the performance of a number of international airports and airport groups [8]. Previously, but by the same author, the reports were published by Symonds Travers Morgan [9]. These reports have looked at different airports and airport groups, the number increasing over time. For the analyses in this paper airport groups were disregarded leaving 14 airports which have appeared in all nine reports between 1997 and 2005:

BNE Brisbane
CPH Copenhagen
FRA Frankfurt
LGW London-Gatwick
LHR London-Heathrow
MEL Melbourne
MUN Munich
PER Perth
SFO San Francisco
SIN Singapore
STO Stockholm
SYD Sydney
VAN Vancouver
VIE Vienna

In the reports a number of variables are discussed and for each the relative performance of the airports is given. To permit comparison all financial data are converted to Special Drawing Rights (SDR) as used by the World Bank. An overall evaluation of airport performance is made using six performance ratios chosen to reflect the interests of various stakeholders. The six ratios are:

operating profit/assets;
commercial revenue per passenger;
aeronautical revenue per ATM;
WLU/assets;
WLU per employee;
operating cost per passenger;

where ATM means air traffic movement (a takeoff or landing) and WLU means work load unit, a measure combining the number of passengers and the amount of freight using the airport (WLU = passengers + (freight + cargo)/100, freight and cargo in kilogrammes). Further discussion concerning the choice of measures is given in the reports.

3. Analysis useful for an airport

Process improvement by emulation (benchmarking) requires that organisations are found which, first, exhibit superior performance and, second, have objectives which are compatible with those of the organisation seeking improvement (the target organisation). Overall performance for an airport is found as the weighted sum of the six variables above, each suitably transformed to a common metric. The scores on which the published ranking is based are formed as the weighted sum of scaled variables so that the score for airport i is

$$\left.\begin{aligned} y_i &= \sum_j w_j q_{ij}, \\ q_{ij} &= \pm(v_{ij} - \bar{v}_j)/s_j, \\ \text{and} \quad & \sum_j w_j = 1, \end{aligned}\right\} \tag{1}$$