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ASSESSING CHARITIES USING DATA ENVELOPMENT ANALYSIS

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Abstract

Data envelopment analysis (DEA) is a technique that takes account of multiple inputs and outputs to assess the relative efficiency of organisational units. Unlike regression its assessments are not based on any average but on best observed practice (and weighted combinations thereof). Whilst DEA has seen an explosive growth in its application to various fields, it has rarely been applied to the voluntary sector. This paper gives an elementary non-mathematical introduction to the technique and demonstrates one way in which it can be applied to assessing charities. In particular we assess the efficiency with which fundraising expenditure and administrative expenses are used to generate voluntary income.

Background

The number of nonprofit organisations has grown enormously over the past 20 years. Not only have their numbers increased but also the scope of their work has widened to the point where they are involved with almost every aspect of human endeavour. In Britain, for example, there are currently estimated to be over 500,000 Not for Gain Organisations (NGOs) in existence (NCVO, 1998). The turnover of the 209,000 of these that are registered charities was estimated at £17 billion in 1997 (Pharoah, 1998).

The recent growth in the size of the sector has, however, not been without its problems. Individual giving to charity has been relatively static over the past five years and there is evidence that the proportion of UK households electing to give to charity is contracting (Pharaoh and Tanner 1998). Competition for funds is thus becoming increasingly intense and charities are ever more compelled to address the issues of concern to donors to make the strongest case possible for support (Sargeant 1999).

Fundraising and administrative efficiency have generated the most interest of late, certainly in the popular press (Pybus 1998). Donors are reported as increasingly demanding that ever-larger percentages of their gift are applied directly to the charity cause and not, as they see it, 'squandered' on fundraising and administration. Whilst this is clearly unrealistic, since the funding of a charity's management activity is essential to its future survival, it is important to note that such concerns exist and to take account of them in the subsequent design of strategy. Increased press attention and bad publicity for a small number of charities have focused the minds of potential supporters on suitable bases for comparison between organisations.

Considering first fundraising costs, focus group work by Doble (1990) suggests that donors believe that the target of 75% of voluntary income applied directly to the cause should be the goal for most organisations. Interestingly, the author found that whilst donors perceive this to be the ideal, the majority suspect that the actual amount applied directly to the cause is rather less than 50%. Harvey and McCrohan (1988) suggest that the figure of 60% may represent a threshold. In their study donors who believed that 60% or more of their donation would be applied directly to the cause gave significantly higher sums than those who did not. More recent work by seems to confirm these findings: Glaser (1994 p.178) reports that the variable "adequate amount spent per program" was the second most important factor cited in a decision to donate.

The perceived fundraising efficiency of an organisation can therefore have a considerable impact on its ability to raise funds. Despite the intense donor interest in efficiency, little research has been conducted to determine what might be considered a satisfactory level of performance. Instead the fund-raising profession has historically been subject to what might be regarded as an arbitrary set of benchmarks (Lindahl, 1992). In the U.S., watchdog groups such as the Philanthropic Advisory Service (PAS) and the Council of the Better Business Bureau specify a 40% and 35% limit on fund-raising cost respectively. In the U.K, Hind (1995) recommends that such ratios should lie in the range 10-30%. No direct justification for the numerical value of these limits has been offered. Within the Top 500 fund-raising charities in the U.K, Pharoah (1997) reports that this ratio varies from 1-51% with a mean figure of 8%.

A number of studies have examined the issue of administrative efficiency. Authors such as Tuckman and Chang (1991) and Sargeant and Kaehler (1998), have examined an organisation's administration costs as a proportion of its total expenses. Both studies have attempted to explain variation in this ratio through the use of regression analyses. As Sargeant and Kaehler (1998, p33) note, "there are important variations between sub-sectors, but the most important general factor seems to be the size of the charity. Larger charities are able to reap the benefits of economies of scale… Small is beautiful but also expensive". The authors also identify significant sub-sector effects, related to the category of cause, which can impact on reported levels of administration cost. These should clearly be taken account of in any assessment of relative performance.

The issue of efficiency in the nonprofit sector has therefore been previously addressed, either by the development of an arbitrary series of benchmarks, or by regression based analyses designed to model 'average' performance. In this paper the technique of DEA will be employed to compliment these earlier analyses by attempting to identify 'best practice' in the voluntary sector. By so doing it is hoped that the practices of better performing organisations can be highlighted and disseminated to others.

Introduction to DEA

We begin with a quick summary of what DEA involves before looking at it in more detail. Given a set of input and output data for a set of organisational units to be compared, data envelopment analysis seeks to objectively identify the best practice units and then constructs an 'efficient frontier' based on these units. Using this frontier one can then measure the relative efficiency of all the remaining units, this is effectively achieved by reference to the proximity of a unit to the efficient frontier. Thus, unlike regression-based approaches, DEA is based on measuring performance relative to this best practice frontier rather than on average practice.

Suppose we have a single input or resource which is employed to produce a single output, the obvious measure of efficiency would be the ratio of output to input, i.e. the productivity. Now suppose there are two outputs (y_1 and y_2) and one input (x), we can then calculate a separate productivity ratio for each output and plot the resulting ratios as the co-ordinates of a point on a scatter-plot, together with the associated points for every other unit being assessed.

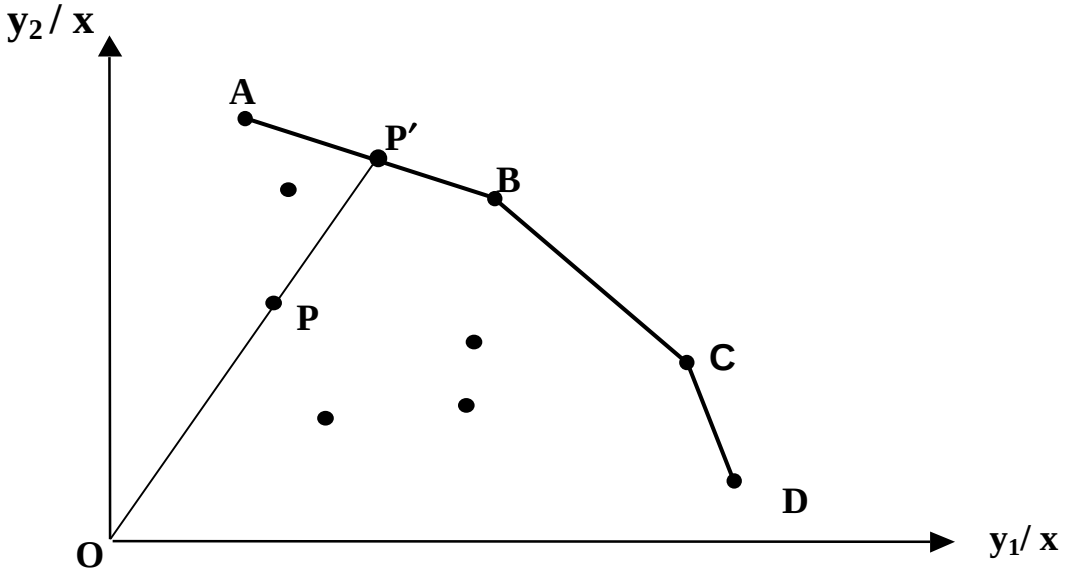

Figure 1. Plot of ratios for individual units.

The above diagram illustrates four units (A to D) which are efficient and so define the efficient frontier ABCD. All points on the frontier are deemed to have a relative efficiency of 100% in DEA. Points which are behind the frontier are less efficient and are said to be 'enveloped' by the frontier – hence providing the name for this method. A unit located at the origin would have zero efficiency since it is producing zero output. As we move from the origin toward the frontier the efficiency increases. The actual score depends on how close you are to the efficient frontier. If say, a unit is three quarters of the way to the frontier, as measured from the origin, then its efficiency is ¾ or 75%. This means thatto reach the frontier and be rated efficient it would have to reduce its input level to 75% of its current value whilst maintaining current output, alternatively it could maintain the current input level and aim to expand output by a factor of 4/3 i.e. a 33% increase.

More generally, for a unit located at point P on such a plot, the efficiency is given by the ratio of distances OP/OP′ where P′ is the point on the frontier found by extending the line from the origin through P. Such a line as OP′ is referred to as a 'ray' and hence our measure is called a 'radial' measure of efficiency. The point P′ is called the 'projection' of P onto the frontier, it provides a target for P and corresponds to a weighted combination of the units at either end of the facet upon which P′ lies (A and B in the above diagram). A and B are called the 'reference units' for unit P and may be viewed as providing cases of good practice to emulate. Notice that A and B are actual organisational units whereas the weighted combination P′ is an imaginary composite unit; there may be context-dependent reasons why such a unit may not be feasible. Whilst the values of the ratios at this point may be used as target values for unit P, there is no reason why P may not set itself any other point on the frontier as an efficient target. What is special about P′ is that it corresponds to producing the two outputs in the proportions currently being used.

For the case of two inputs and a single output it is once again possible to plot two ratios on a scatter-plot and construct a frontier from which the efficiencies of units can be calculated.

Returns to scale considerations

Under constant returns to scale an efficient unit which increases all its input levels by a certain percentage should achieve an increase in outputs of the same percentage to remain efficient. The DEA model which makes this assumption is known as the CCR model after the initials of its originators (Charnes, Cooper, Rhodes 1978). In Figure 2 we plot the case of a single output versus a single input for the units being assessed.

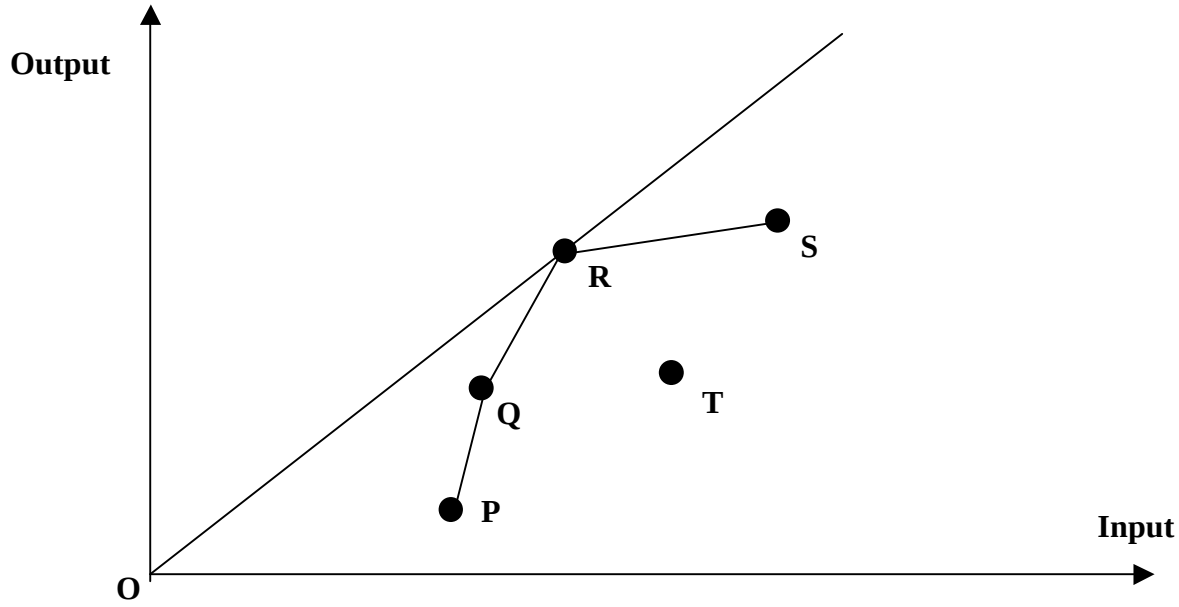

Figure 2. Plot of units in input-output space.

In Figure 2 the most productive unit is R because it has the highest ratio of output to input. On a diagram such as this one can compare the productivity of units by imagining a line from the origin to each point, the slope of such a line tells us the productivity of the unit. Under constant returns to scale the efficient frontier in input-output space consists of the line OR and its extension. Points below this line produce less output per unit input. For such units to reach the frontier and become efficient they can reduce input consumption whilst maintaining their output level. In Figure 2 this corresponds to a horizontal movement to the left until the frontier line is reached - at the 'target' point; the efficiency score is then the ratio of the input value of this target point to the current input value. Alternatively, input can be left unchanged and output increased. In Figure 2 this corresponds to a vertical upward movement until the frontier is reached at another target point; the efficiency score is provided by the ratio of the current output to the output at the target point. These two approaches to efficiency are known as 'input orientation' and 'output orientation', respectively. Under constant returns to scale these two ways of measuring efficiency provide the same score. There is of course the possibility of simultaneously reducing input and increasing output and hence approaching the frontier by moving in a 'north-westerly' direction.

If we assume variable returns to scale then the efficient frontier according to DEA appears as PQRS in Figure 2. Points P and Q are in a region of increasing returns to scale (because the line from the origin to these points gets steeper as we expand). Point S is in a region of

decreasing returns to scale. Point R represents the most productive scale size. Notice that the frontier envelops the units more closely under variable returns to scale and so as the units are closer to it they will tend to have higher efficiency scores – hence this is a more generous method of assessment. Indeed units P, Q and S are now 100% whereas under constant returns to scale they were classed as inefficient. Only unit T is inefficient under both constant and variable returns models. The DEA model used for variable returns to scale is known as the BCC model (after Banker, Charnes and Cooper, 1981). For an input orientation this finds a weighted combination of other units which produces at least as much output as the assessed unit but whose input levels are all scaled down by a factor which is maximised. An interesting fact regarding this model is that the efficiency scores can be different depending on whether an input or output orientation is used. Under constant returns both orientations provide the same score because in each case the target point lies on a single line that passes through the origin (line OR and its extension in Figure 2) and using trigonometry one can use this fact to prove that the scores will be equal. However under variable returns this is no longer the case. In practical terms one chooses the orientation based on which variables can be controlled by the managers of the organisational units; thus if they can control input levels then an input orientation is appropriate.

Application of DEA to charity assessment

Different aspects of performance can be measured using DEA according to which variables are selected for inclusion in the analysis. The present work looks at how much charities spend on administration and fundraising in relation to the amount of voluntary income they generate. Thus in a DEA context we are using two inputs (administration expenses and fundraising expenses) to generate a single output (voluntary income). The dataset for this analysis comprised the financial accounts of the CAF (Charities Aid Foundation) Top 500 U.K. Fundraising Charities. The dataset is compiled annually by the CAF from public sources with copies of the resulting data being returned to each of the charities concerned for correction, should any amendments prove necessary. The data may therefore be considered a reliable reflection of the performance of these 500 organisations. Of these charities we restrict attention to organisations where each of these two inputs is at least £10,000 (using data for 1997), this left us with a data set consisting of 327 charities. These had averages as follows: fundraising expenditure £943,000, administration £392,000, and voluntary income £5.57million. The correlation between fundraising expenditure and voluntary income was 0.9, but that between administration expenditure and voluntary income was only 0.53.

We shall apply the more generous assessment provided by the variable returns to scale model. Since the output is voluntary income it is not under the direct control of charities and so an output orientation is not appropriate. Instead we use an input orientation because each charity is able to control its expenditure. Initially the analysis was carried out for all charities where each expenditure figure exceeded £1000; this resulted in a set of 339 units (charities) to be assessed. The analysis was repeated but with a revised lower bound of £2000 leading to a slightly reduced set of 336 units and finally with a lower bound of £10,000 for each of the two inputs (327 units). These changes affected the scores of the smallest charities because removal of a unit from the frontier causes that segment of the frontier to shift to a new position and so any assessments which use that segment as a benchmark will be altered upwards. With DEA as the number of units being assessed is reduced - the scores rise, other things being equal. This is to be expected since we are dealing with *relative* performance. The published data which we used rounds all figures to the nearest thousand pounds and so those charities with very low expenditures will have a higher percentage error and thus greater uncertainty in their scores as a result of this rounding error. Clearly this is a problem that can be overcome by using data that

has not been rounded. In what follows the results are based on the data set where each input was at least £10,000.

There were 13 charities with a relative efficiency score of 100%. These are listed in Table 1 with their relevant data. We see that there are charities of all sizes included. This is to be expected with the more accommodating frontier based on variable returns to scale. There was little evidence that charity size tended to be associated with higher efficiency: for the 327 units assessed the correlation between efficiency score and the three variables was 0.34 for voluntary income, 0.18 for fundraising spend, and –0.14 for administration expenditure. The last two columns of Table 1 show how much voluntary income is raised per pound of fundraising spent, and how much is raised per pound of administration expenditure. At first sight it might seem odd that a charity such as Oxfam is considered by DEA as efficient as the Prince's Trust given that the latter dominates on both of these ratios. The explanation lies in the fact that Oxfam is nearly ten times larger (based on voluntary income) and so appears on a different facet of the frontier e.g. it might be located at point S in Figure 2 whereas the Prince's Trust might be closer to R. Note that since we are here dealing with three variables the appropriate form for Figure 2 would show a frontier that was a many-faceted surface in three dimensions rather than a series of linear segments.

Charity	***Fundex***	***Volinc***	***Admin***	***Volinc/ Fundex***	***Volinc/ Admin***
British Heart Foundation	8068	65205	406	8.1	160.6
Cancer Research Campaign	7894	69152	681	8.8	101.5
Children's Hospice for the Eastern Region	64	596	18	9.3	33.1
Gardener's Royal Benevolent Fund	56	2763	29	49.3	95.3
Grand Charity of Freemasons	103	10214	83	99.2	123.1
Institute of Cancer Research	360	18585	1369	51.6	13.6
National Trust	16517	84758	1549	5.1	54.7
N.S.P.C.C.	7278	36249	170	5.0	213.2
North West Cancer Research	13	784	55	60.3	14.3
Oxfam	9046	89188	2144	9.9	41.6
Prince's Trust	722	9635	66	13.3	146.0
Salvation Army	2978	61028	1664	20.5	36.7
Springhill Hospice	24	762	37	31.8	20.6

Table 1 List of efficient charities with data in £000's. Key: fundex = fundraising expenditure, volinc = voluntary income.

The distribution of efficiency scores appears in Table 2 and is rather disturbing. The distribution is strongly skewed to the right and there are only 49 charities (15% of the total) with efficiencies exceeding 50%. There are 141 charities (43% of the total) scoring 20% or less. It would appear from this that best practice as indicated by the small proportion who are doing well remains to be disseminated to the vast majority of organisations we have assessed. However, in the next section we shall see that there are various qualifications that need to be attached to such a conclusion.

Efficiency range (%)	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-99	Efficient
Percentage of charities	17%	25%	19%	15%	8%	4%	2%	2%	1%	3%	4%

Table 2 Distribution of efficiency scores.

Further work

There are some caveats associated with our results. We have only dealt with three variables in this paper; this has been to aid understanding of the technique since it has permitted our presentation to be based on graphical displays rather than a mathematical exposition. A different analysis might take account of further variables such as income from grants, which our analysis has ignored. The choice of inputs and outputs will of course affect the resulting scores. The inclusion of further variables implies that we can no longer picture the situation graphically and one then relies on mathematical procedures to mirror in higher dimensions what we have presented here. Having more variables will lead to a higher proportion of units appearing relatively efficient, this is because increasing the number of dimensions will in general increase the number of facets which compose the frontier and so raise the number of units classed as relatively efficient. One way of dealing with this loss of discrimination is to group together related variables and generate separate scores for each aspect of performance (Tofallis 1996).

A second caveat relates to the selection of units to be compared. There is always a strong argument to compare like with like. Hence there is something to be said for carrying out separate analyses for different charity sectors e.g. charities for the blind, or those geared toward animal protection. By reducing the number of units being compared we shall also be removing some of the best performers (those that define the efficient frontier) and so the frontier will shift (towards the origin in Figure 1) making the scores of the remaining units higher.

A paper devoted to the selection of units and variables to be included in a DEA investigation is Golany and Roll, 1989. An introductory monograph on DEA is Norman and Stoker, 1991, whilst a more technical treatment is provided by the collection of papers in Charnes et al 1994. Applications of DEA to the non-profit sector are few in number, they include Luksetich and Hughes (1997) on US symphony orchestras and Callen (1994) on Canadian health-specific (e.g. cancer, heart disease etc.) organisations, the latter uses the DEA score as an explanatory variable in a regression model for money donations.

Conclusion

These caveats aside, the results of the analysis suggest that there may indeed be some justification for donor concerns over fundraising and administrative expenditures. The performance of many charities would appear to fall well short of the efficient frontier with no immediately obvious explanation forthcoming for why this might be so. Indeed an examination of those organisations comprising the efficient frontier suggests no particular pattern in respect of either categories of cause, or the nature of the contact that these organisations might have with the beneficiary group. In short, the efficient charities would appear to be an eclectic group with little in common with each other, bar their efficiency.
In comparing between nonprofit organisations, authors such as Hind (1995) suggest that:

a) Charities funded predominantly by endowments will attract little fundraising costs at all and therefore appear efficient.
b) Organisations reliant on grant income will be likely to employ far fewer staff than those forced to seek funding from the general public and therefore appear efficient.
c) Charitable service providers will likely attract higher levels of administrative overhead than organisations that simply issue grants to others within the sector. The Imperial Cancer Research Fund, for example employs its own researchers, whilst the Cancer Research Campaign in ostensibly a grant making body.

It is interesting to note, however, that those charities comprising the frontier include only one charity funded primarily by endowments (the Grand Charity of Freemasons) and no charities at all that rely solely on grant income. There are also many service providers included in the efficient frontier generated by the analysis. Thus whilst a more detailed analysis taking account of a wider number of factors might therefore be instructive one must still question why such a large proportion of these organisations performed so poorly on the measures we looked at.

Further work will of course be necessary to compare the manner in which efficient charities operate with those highlighted as comparatively inefficient in the preceding results. Such an analysis would be helpful not only in improving the operational stewardship of the voluntary sector, but also in providing guidance to donors in respect of those organisations likely to have the greatest impact on their chosen category of cause.

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