Measuring Nonprofit Efficiency with DEA

A Performance Tool for Researchers and Managers

Jason Coupet, PhD

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School of Public and International Affairs
North Carolina State University
(Moving to Andrew Young School at Georgia State in January)

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NC STATE UNIVERSITY

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What is Efficiency?

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There is a debate in among nonprofit researchers and managers about how much efficiency matters, and how to measure it well.

Measuring efficiency well requires a useful definition, and there is sometimes confusion about where the terms comes from. Efficiency can be operationalized in different ways, but the binding principle involves maximizing what an organization does or produces, ***ceteris paribus***.

The concept is tied to Pareto Efficiency, a defining concept in economics where a person or community can be made better off in a dimension without being worse off an any other dimension.

What is Efficiency?

Sometimes, donors/foundations wanting to give ”efficiently” can look to financial ratios as a measure of financial performance, benchmarking nonprofit organizations by different measures of spending. Researchers looking to measure efficiency for the purpose of theory building can sometimes use these ratios as well. But this can be inconsistent with what efficiency is supposed to be.

Data Envelopment Analysis (DEA) is a mathematical linear program designed to construct a measurement of efficiency from a series of input and output ratios to better measure what nonprofits *do* with resources. It also is a useful benchmarking tool, since the linear program envelopes nonprofits along side similar peers for the purposes or organizational learning.

Data Envelopment Analysis

Data Envelopment Analysis

DEA uses a nonparametric, deterministic linear programming methodology that estimates a single, synthesized measure of an organization's performance. The singular performance measure is estimated by maximizing the sum of each organization's output to input ratio.

Some Terms:

1. **DMU**: Decision Making Unit
2. **Inputs**: Resources expended by the nonprofit
3. **Outputs**: public services produced/made
4. **Weights**: Quantitative score of how important an input/output is
5. **Production Function**: The (modelled) relationship between inputs and outputs

What is DEA?

Performance Score

Nonprofit Outputs

$$\max_{u,v} \quad \theta = \frac{\sum_{m=1}^{M} u_m y_{mk'}}{\sum_{n=1}^{N} v_n x_{nk'}} \qquad (1.1)$$

Nonprofit Inputs

subject to

$$1 \geq \frac{\sum_{m=1}^{M} u_m y_{mj}}{\sum_{n=1}^{N} v_n x_{nj}} \qquad (1.2)$$

Performance scores cannot exceed 100%

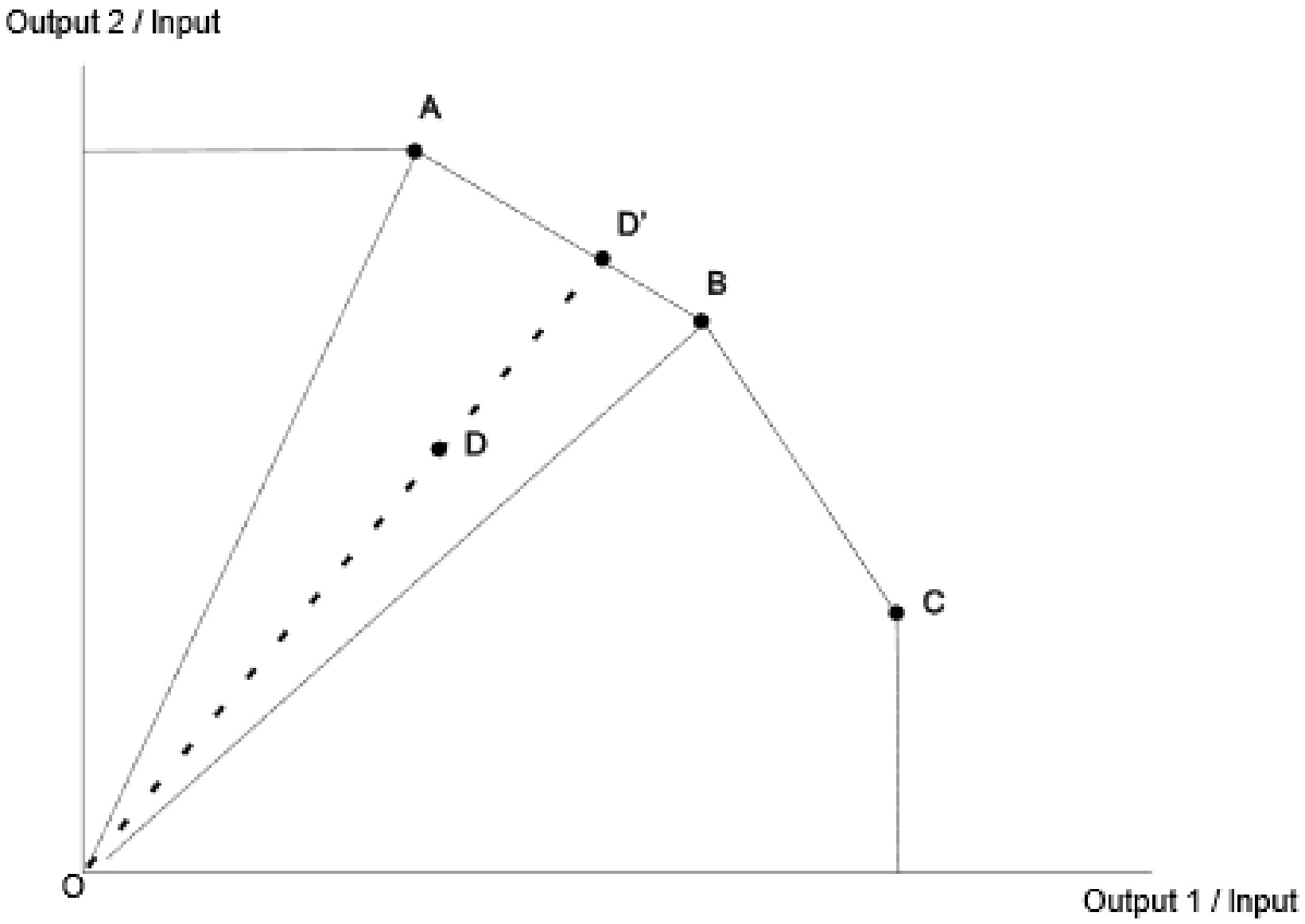
$$\sum_{n=1}^{N} v_n x_{nk'} = 1 \qquad (1.3)$$

The sum of all weiights is one

$$u_m, v_n, y_{mj}, x_{nj} > 0 \qquad \forall m, n, j \qquad (1.4)$$

All inputs and outputs must be positive numbers

What is DEA?



DEA Steps

DEA Steps:

1. Carefully select a sample of nonprofits.
2. Carefully select inputs and outputs
3. Adjust for missing data/ measurement error
4. Assess returns to scale
5. Consider weight restrictions
6. Consider weight restrictions
7. Execute the DEA linear program

WalkThrough

Walkthrough

DEA can be done in Stata, R, Python, and even Excel, but we will use a canned simpler package called Efficiency Measurement System (EMS). It can be downloaded for free.

EMS is essentially a compiled VBA in a standalone program. I uses Excel files (.xls not .xlsx), uploaded and formatted, and results can be exported back into .xls or .CSV files.

Some Basic Files for this Walkthrough can be found in my GitHub.

Walkthrough

Resources:

- Brief Walkthrough in R
- Walkthrough in Python
- Walkthrough in Stata Journal
- PIM-DEA
- Our Paper in NVSQ

Benefits

1. It typically works well to benchmark nonprofits that use many kinds of resources to achieve many different goals.
2. DEA uses variable weights not only to compose performance scores but to also assign peers.
3. Researchers do not need to identify any particular functional form for measuring efficiency.

Drawbacks

1. Be careful selecting inputs and outputs, and in sampling.
2. DEA is *not* statistical, so doesn't model error terms.
3. Scores are enveloped, so the scores can be quite sensitive to outliers
4. Doesn't provide qualitative information about efficiency/performance

Contact

E: jacoupet@ncsu.edu
E: publicperformancelab@gmail.com
: ProfessaJay