"An Assessment of Efficiency and Productivity Change of Central Administrative Services of UK Universities using Data Envelopment Analysis."

This presentation has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: THALES. Investing in knowledge society through the European Social Fund.

Prof. Emmanuel Thanassoulis*
Aston Business School
Aston University
Birmingham B4 7ET-
England

*The Assistance of Kostas Bakoulas in this research is acknowledged.

Presented at the Workshop on
ASSESSING EFFICIENCY IN HIGHER EDUCATION USING FRONTIER METHODS
June 24-25, 2013 Thessaloniki, GREECE

Motivation for the Study

According to the UK Higher Education Statistics Agency (HESA) in 2002-03:

Expenditure on Administration and Central Services was 19.4% of total HEI expenditure in the UK

Hence expenditure on administration is substantial and competing with direct expenditure on academic activities.

Motivation of the Study (ctd)

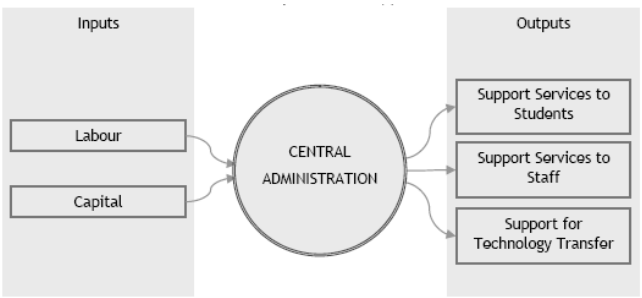
Given the competition between academic and administrative functions for resources it is important to assess the cost-efficiency of each one of these functions at an institution. In respect of administration the following questions need to be addressed:

- How much is spent on administration and what drives such expenditure?
- Is there a trade-off between cost efficiency and quality of service in administration ?
- Has there been any change over time in productivity of administrative services in UK HEIs?

This presentation reports some of the findings in respect of the foregoing questions.

The Unit of Assessment

Initial consultations with senior administrators and academics suggested the following conceptual framework for the unit of assessment:



The Assessment Method

We opted for Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) as the assessment methods.

These are boundary methods, suitable for assessments against ‘best practice’.

We report here only the findings based on DEA.

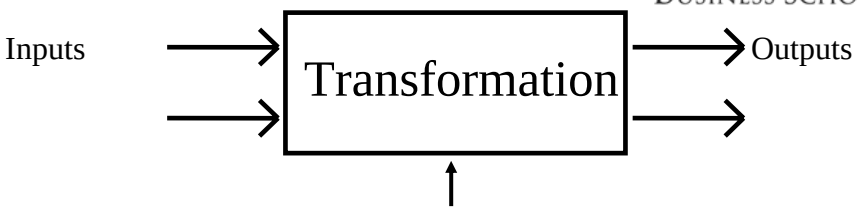
Brief Introduction to DEA

DEA makes it possible to assess the comparative efficiency of homogeneous operating units such as hospitals, schools, police forces, tax offices, groups of individuals etc.

The operating units typically produce outcomes (e.g. health outcomes in the case of health services, cleared crimes in the case of the police, academic attainments in the case of schools, etc) – These are referred to as - outputs

To secure their outputs operating units typically use resources referred to as - inputs

Brief Introduction to DEA (ctd)



The units to be compared transform *inputs* into *outputs*

DEA makes it possible to compare the operating units on the levels of outputs they secure relative to their input levels. The comparison is for the case where we have:

- Multiple inputs and
- Multiple outputs

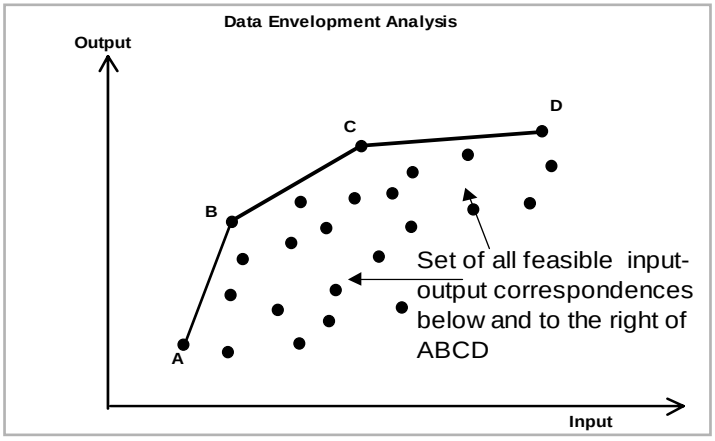
Measures of Comparative Efficiency

The measure of efficiency is normally one of:

- The ratio of observed to maximum possible output levels for <u>given input</u> levels (output efficiency);
- The ratio of minimum possible to observed input levels for <u>given output</u> levels (input efficiency);

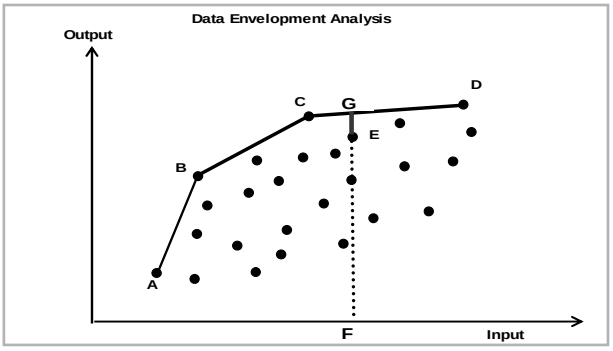
DEA makes it possible to estimate the maxima output or minima input levels needed in the above definitions.

Constructing the Efficient Boundary



Using interpolations between observed units the set of all feasible input -output correspondences is constructed and its boundary identified

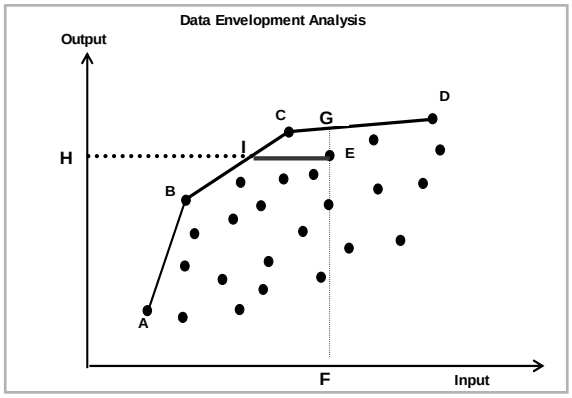
A Closer Look at DEA



- Output Efficiency of E: **FE/FG**
- Output benchmarks for E: **Units C and D**
- Scope for output augmentation at E: **EG**

Returns to scale (increasing, decreasing, constant):
Revealed by the intercepts of the segments of the efficient boundary.

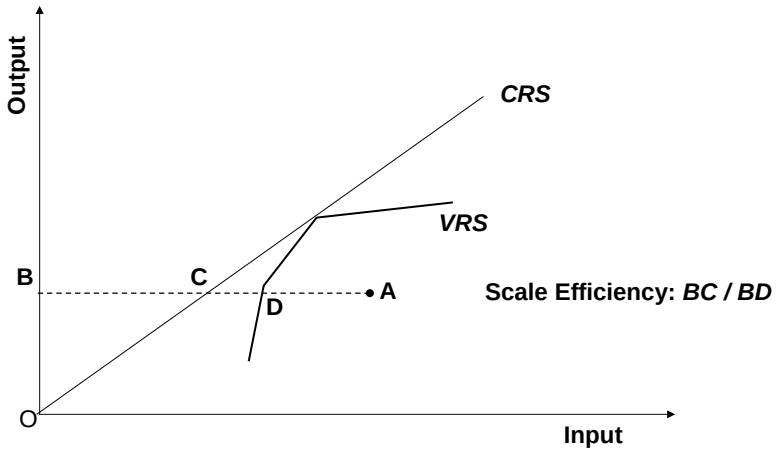
A Closer Look at DEA



- Input Efficiency of E:
  HI/HE
- Scope for resource conservation at E:
  IE
- Input conservation benchmarks for E:
  Units B and C.

Scale Efficiency:

A measure of the impact of scale size on productivity



Scale Efficiency: *BC / BD*

Issues which can be Addressed

ASTON BUSINESS SCHOOL

In respect of each unit assessed we can:

- Obtain a measure of its relative efficiency;
- Its efficient peers (Benchmarks) (role model efficient units best comparable with it);
- Its targets (the input - output levels which would render it efficient);
- The inputs and outputs underpinning its efficiency rating;
- Whether it operates under increasing or decreasing returns to scale;
- Whether its productivity has changed over time in absolute terms and relative to the rest of the units.

Set of Inputs-Outputs for University Administration

ASTON BUSINESS SCHOOL

Following extensive consultations and statistical analyses the set of inputs and outputs used was:

INPUTS	OUTPUTS
Administrative Staff Costs	Total Income from Students
Other Admin Operating Expenses	Non Administrative Staff Costs
	Technology Transfer
	Quality-Related Research Income

Definition of Inputs-Outputs

ASTON BUSINESS SCHOOL

INPUTS

- *Administrative staff costs* include identifiable staff costs of academics engaged in administration.
- *Other Operating Expenses* includes, among other things, equipment that has not been capitalised, expenditure on maintenance contracts, telephone costs, and payments to non-contracted staff or individuals.

Definition of Inputs-Outputs

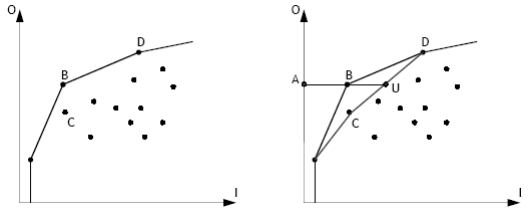
ASTON BUSINESS SCHOOL

OUTPUTS

- *Total Income from Students* is the sum of the total block grant for teaching received by each institution from HEFCE and income from other, non-HEFCE funded students.
- *Non Administrative Staff Costs*, with reference to the HESA Finance Manual, is defined as Total Staff Costs minus Total Administrative Staff Costs, which is used as an input.
- *Technology Transfer* can be proxied by Total Research Grants, and Total Other Services Rendered.
- *Quality Related Research Income* is the RSE-based component of research income.

Dealing with Outliers

We used the concept of “super-efficiency” to identify outliers and then NOT permit them to locate the efficient boundary.



We adopted subjectively a threshold of super-efficiency of 1.3 or 130% to deem a unit ‘outlier’.

We treated no more than 5% of units as outliers.

Dealing with Outliers

- Our sample comprises data for 100 universities during the period 1999/00-2004/05.
- Following the outlier identification procedure we identified the units shown below as outliers (5% of the sample):

  – **1999-00:** I-0017, I-0047, I-0034, I-0020, I-0078*
  – **2000-01:** I-0017, I-0034, I-0051, I-0020, I-0078
  – **2001-02:** I-0017, I-0056, I-0051, I-0020, I-0078
  – **2002-03:** I-0017, I-0034, I-0056, I-0051, I-0020
  – **2003-04:** I-0017, I-0034, I-0051, I-0020, I-0078
  – **2004-05:** I-0017, I-0034, I-0056, I-0051, I-0020

**New Coding for anonymity*

Model Specification

- VRS model – Input oriented
- Outliers have been re-scaled to be on the boundary formed by the non-outlier units;
- A balanced panel between the first (1999/00) and the last (2004/5) year is reported upon here.
- 100 universities are therefore included in the assessment reported here.

Data Analysis

The DEA assessment returned the following results for VRS efficiencies for each year:

	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05
Mean:	85.23	84.33	82.24	80.64	84.11	82.70
Median:	86.57	88.25	82.79	79.26	84.89	82.83
Stdev:	13.42	14.86	14.79	14.66	13.24	13.92
Min:	37.32	31.79	27.12	40.76	42.17	42.20
Q1:	76.57	71.25	71.23	70.14	73.88	71.87
Q3:	98.70	100	98.85	94.65	97.76	95.94

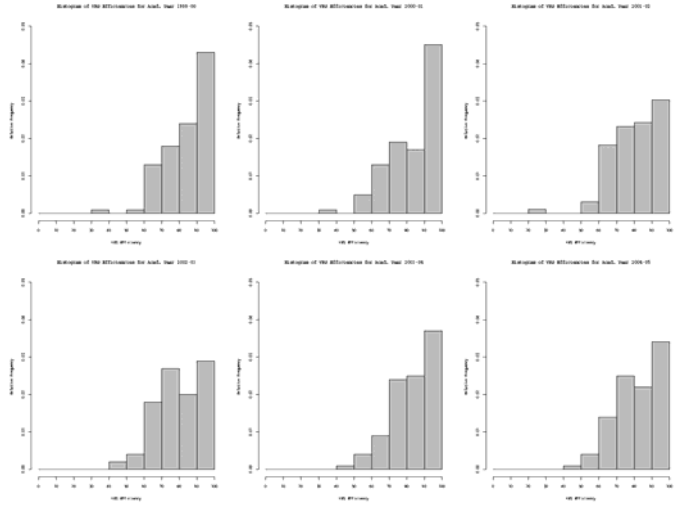
-Efficiencies not comparable across years;

- Wide range in efficiencies in each year;

-Stable median and standard deviation suggests stable spread of performance over time

Data Analysis

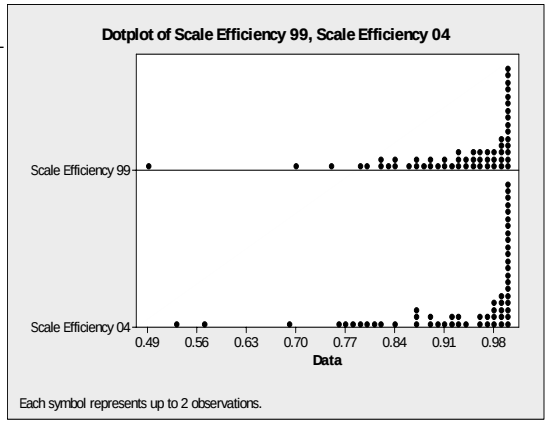
Histograms of Efficiencies for each Academic Year



Data Analysis

The DEA assessment returned the following results for Scale efficiencies for first and last year:

	1999-00	2004-05
Mean:	0.9387	0.9368
Median:	0.9667	0.9842
Stdev:	0.0808	0.9547
Min:	0.4850	0.5314
Q1:	0.9074	0.9033
Q3:	0.9999	1.0000



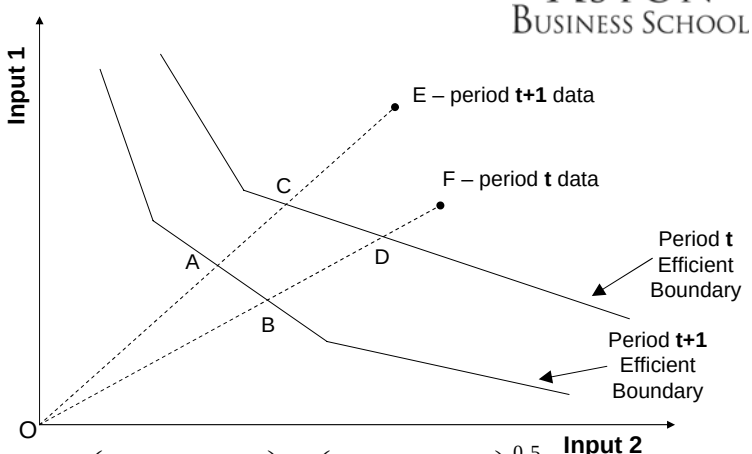
Generally scale size is productive but 25% of HEIs can save up to 10% of expenditure by improving scale size.

In both years, the least scale efficient HEIs can save costs by increasing scale size. (They operate under IRS.)

Efficiency vs. Productivity

- Efficiency measures the distance of an observation from the efficient boundary.
- Productivity measures average product in the form of output per unit input.
- The two measures do not necessarily tell the same story about the performance of the observation, especially over time.

Malmquist Indices Decomposition



$$MI = \left(\underbrace{\frac{OA}{OE} \div \frac{OD}{OF}}_{\text{Efficiency 'Catch-up'}} \right) \times \left(\underbrace{\frac{OC}{OA} \times \frac{OD}{OB}}_{\text{Boundary Shift}} \right)^{0.5}$$

MI and component values over 1 mean productivity gains.

Productivity Change - Process

- We calculated the Productivity Change between 1999-00 and 2004-05.
- Data has been deflated using The Higher Education Pay and Prices index with basis year on 1999-00.

Bottom two HEIs on productivity

Data for 2004/5 – constant prices, Normalised so that 1999/00 = 1

Prod Index	Admin staff cost	OPEX	Student income	Non Admin staff	Res'arch grants	QR
0.7	1.93	0.98	1.23	0.9	1.23	0.81
0.74	1.41	1.42	1.04	0.98	1.05	10.8

In both universities the normalised data show substantial rise in admin staff costs against modest rise or even drop in activities.

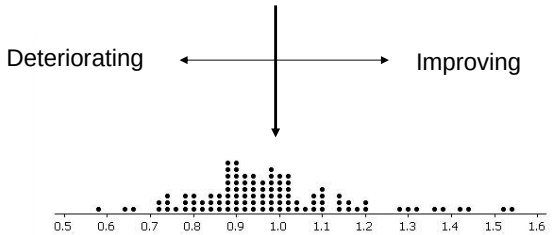
Top three HEIs on productivity

Data for 2004/5 – constant prices, Normalised so that 1999/00 = 1

Prod Index	Admin staff cost	OPEX	Student income	Non Admin staff	Res'arch grants	QR
1.59	0.82	0.62	1.07	1.30	1.59	1.14
1.35	0.89	0.92	1.26	1.28	0.9	0.41
1.34	0.98	0.94	1.23	1.30	1.96	1.12

In these three universities that gain the most in admin productivity, admin costs fall over time while outputs rise, with only two exceptions on research income.

Productivity Change 1999/00 to 2004/5 – Staff Costs Model

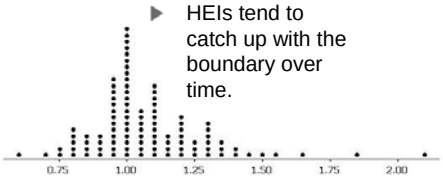


NB: An index of 1 means stable productivity between 1999/0 and 2004/5.

An index below 1 means productivity drop. Eg. a value of 0.9 means the same work load is costing in 2004/5 11% more than it did in 1999/0. An index above 1 means productivity improvement.

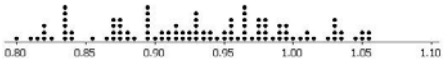
Productivity Change Decomposition – Staff Model

- HEIs tend to catch up with the boundary over time.



Efficiency Catch-up

- Benchmark performance tends to deteriorate over time.

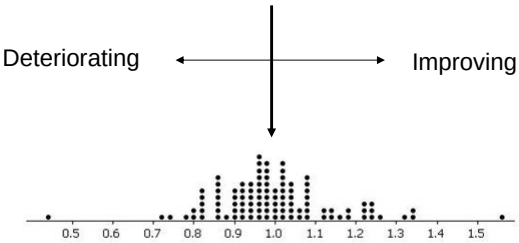


Boundary Shift

Scale Efficiency Catch-up

- HEIs with negative effects due to scale exceed those with positive effects

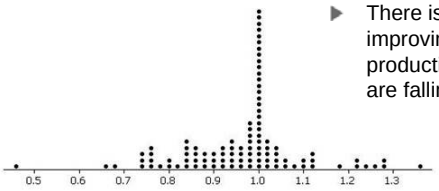
Productivity Change 1999/00 to 2004/5 – Staff and OPEX Combined



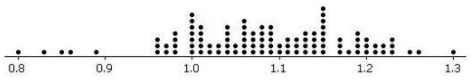
- We have a virtually symmetrical distribution with half the units improving and the rest deteriorating in productivity.

Productivity Change Decomposition – Joint Model

- There is clear evidence that the boundary is improving in that best performance is more productive in 2004/5 than in 1999/0. Most units are falling behind the boundary.

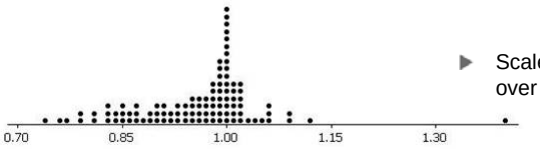


Efficiency Catch-up



Boundary Shift

- The catch-up and boundary shift results are the reverse from when staff costs were the sole input. This suggests perhaps that non staff expenses were managed better than staff costs, over time.



Scale Efficiency Catch-up

- Scale efficiency deteriorates over time.

Old vs. New Universities

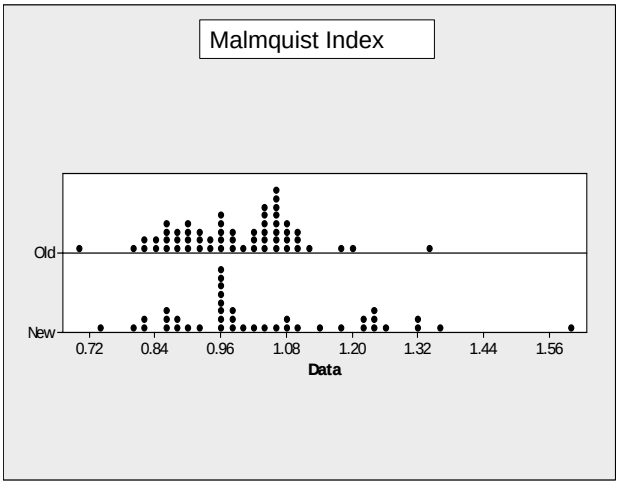
	VRS catch up	Scale Eff. Catch up	Boundary Shift	Malmquist Index
Old	1.0118	1.0034	0.9711	0.9610
New	0.9295	0.9913	1.1258	1.0354

- The picture of New is the reverse of Old HEIs. Where Old HEIs gain New HEIs regress and vice versa
- The difference is greatest on boundary shift where New HEIs clearly reflect on an improving boundary (but that boundary is not necessarily defined by New HEIs)

Old vs. New Universities

Comments:

- There is a clear difference in productivity change of Old vs. New HEIs.
- Productivity change of New HEIs exhibits larger variance, than Old HEIs.



Summary of Findings

- Generally, efficiency scores are quite high for all years but there is scope for savings in the expenditure at the level of 15%-20%.
- In 1999-00 there could be a saving in expenditure of £630m, while in 2004-05 this saving could be £700m. In both cases this is a 17% reduction in expenditure.
- At the sector level, the cost of administration (staff and other expenditure) in 2004-05 based on productivity of 1999-00 would have been £4,125,287,000. The actual cost was £4,157,371,000. This represents a virtually static productivity when we weight Malmquist indices by size of HEI.
- The next step in our analysis is to explore factors contributing to variation in productivity change and its components.

ASTON BUSINESS SCHOOL

- Between 1999/00 and 2004/5 we find a divergent picture between administrative staff cost on the one hand and OPEX or the two inputs taken jointly on the other. In the case of administrative staff taken as the sole input we find that there is on average a drop in productivity so that for given levels of the proxy output variables staff cost is about 95% in 1999/00 compared to what it is in 2004/5, at constant prices.
- Looking deeper it is found that generally units do keep up with the benchmark units but it is the benchmark units that are performing less productively by almost 7% in 2004/5 compared to 1999/00. The situation is not helped by a slight loss of productivity through scale sizes becoming less productive, by about 1.5% in 2004/5 compared to 1999/00.
  - In contrast when we look at OPEX as a sole input or indeed at administrative staff and OPEX as joint resources we find that productivity is more or less stable between 1999/00 and 2004/5. There is a slight loss of about 2% but given the noise in the data this is not significant.

ASTON BUSINESS SCHOOL

- What is significantly different between administrative staff on the one hand and OPEX or the two joint inputs on the other is that benchmark performance improves on average by about 8% between 1999/00 and 2004/5.
- Unfortunately non benchmark units cannot quite keep up with this higher productivity. Also there is a slight deterioration again in scale size efficiency and the net effect is that despite the improved benchmark productivity, productivity on average is stable to slightly down between 1999/00 and 2004/5.
  - As with cost efficient practices here too our analysis has identified a small set of units which register significant productivity gains and others which register significant productivity losses between 1999/00 and 2004/5. An investigation of the causes in each case would be instrumental for offering advice to other units on how to gain in productivity over time and avoid losses.