Assessing the cost-effectiveness of University academic recruitment and promotion policies

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MOTIVATION-1

A university academic typically is paid to deliver in three areas:

- Teaching
- Research
- Other services (administration, outreach to the community etc).

While the pay of the academic for teaching and ‘other services’ is relatively synchronous with the services delivered, it is NOT so in general for Research.

There can be considerable lead time between the conduct of research and measurable outcome being observed, on which payment can be based.

Institutions essentially make payments to an academic in advance on the prospect of research output based on observed research to date.
The question then arises as to whether an institution has been cost-efficient in making ‘advance payments’ on research in the form of salary on appointment and promotions.

The findings can be useful in a number of ways:

- They can influence policy on criteria for recruitment salaries;

- They can influence criteria and policies on academic promotions.
We wish to set the salary cost of an academic over the period the academic has been in post against the research outcomes attributable to that academic.

For salary profile we need variables to capture salary at appointment and the promotion profile of the academic.

For research outcomes we need variables to capture publications by number and quality and ‘impact’.

Impact can be academic and non academic.

However, at this stage data exist only on academic impact through citations.
Our data is drawn from a University in Greece, involving 45 ft faculty of an academic Department.

Our model uses the career compensation of each academic.

So far as the research profile of an academic is concerned we have used peer-reviewed journal papers and citations only.

We have used the Australian ERA2010 ranking of journals in order to reflect the quality of each publication.

Citations data are based on Scopus.
DEA INPUT-OUTPUT SET

RESOURCES (DEA INPUTS)
X1: a dummy input set at the level of 1 for all units.
X2: the time in post (years)

ANNUAL SALARIES (UNIT PRICES)
P1: the initial salary on recruitment (euros)
P2: the mean annual salary (euros)

RESEARCH OUTPUTS (DEA OUTPUTS)
Y1: Publications before recruitment in A+ journals
(Add to Y1 A journals, A=0.5A+)
Y2: Publications before recruitment in B journals
(Add to Y2 C= 0.5B and D=B/6)
Y3: As Y1 but for publications after recruitment
Y4: As Y2 but for publications after recruitment
Y5: Citations from articles in journals included in the analysis (before and after recruitment)
TWO DEA MODELS

Model 1

Minimise aggregate cost $C$ by reducing by $\gamma$ the input price $p$ and by $\theta$ the time $x$ taken to deliver the research.

s.t.

Salary PPS constructed identically with the input-output set.

Mean salary cannot be below appointment salary.

Appointment salary cannot be below some legal minimum.

Model 2

\[
\begin{align*}
\min \ C &= \sum_{j=1}^{n} \lambda_j x_{ij} + \sum_{i=1}^{m} \theta_i x_{io}, \quad i=1, \ldots, m \\
\text{s.t.} \quad \sum_{j=1}^{n} \lambda_j y_{rj} &\geq y_{ro}, \quad r=1, \ldots, s \\
\sum_{0=1}^{1} z_{ij} p_{ij} &\leq \gamma_i p_{i0}, \quad i=1,2 \\
\sum_{j=1}^{n} \lambda_j &= \theta_1 = 1, \theta_2 \leq 1 \\
\gamma_1 p_{1o} &\geq \gamma_2 p_{2o} \\
\lambda_j, \theta_i &\geq 0, \quad i=1, \ldots, m
\end{align*}
\]

Minimise aggregate cost \( C \) by reducing by \( \gamma \) the input price \( p \) and by \( \theta \) the time \( x \) taken to deliver the research.

Salary efficient peers LOOSELY linked to input and output efficient peers. Mean \( z_j \) value to at least match \( \lambda_j \) value.

Mean salary cannot be below appointment salary; Appointment salary cannot be below some legal minimum.
VALUE JUDGMENTS INCORPORATED IN BOTH MODELS

\[ u_{A_{before}}^+ \geq 2u_{B_{before}} \]
\[ u_{A_{after}}^+ \geq 2u_{B_{after}} \]
\[ u_{citations} \geq u_{B_{before}} \]
\[ u_{A_{after}}^+ \geq 1.2u_{A_{before}}^+ \]
\[ u_{B_{after}} \geq 1.2u_{B_{before}} \]
\[ u_{citations} \leq u_{B_{after}} \]

Citations are in units of 10 while publications are in units of 1.
POTENTIAL SALARY SAVINGS—when duration in post and initial salary kept as observed.

Series 1 is when salary peers are loosely connected with research output peers (Model 2) – Potential savings 14% of actual.

Series 2 is when salary and research output peers are identical (Model 1) - Potential savings 13% of actual.
Salary peers loosely connected with research output peers. Median potential savings are 56% of actual.
Potential reduction in recruitment salary ($\gamma_1$ – median 1), mean annual salary ($\gamma_2$- median 0.96) and time duration for research ($\theta_2$ - median 0.43).

The lion’s share of overall cost reduction is through estimated shorter time duration for the production of the research output. Salary peers loosely connected with research output peers.
Performance by research profile offered on recruitment.

<table>
<thead>
<tr>
<th>Quartile on B equiv papers at recruitment</th>
<th>Mean B Papers at recruitment</th>
<th>Mean (X2)</th>
<th>Mean (γ1)</th>
<th>Mean (γ2)</th>
<th>Mean (θ2)</th>
<th>Mean cost efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>0.532</td>
<td>16.273</td>
<td>1.022</td>
<td>0.855</td>
<td>0.497</td>
<td>48.678</td>
</tr>
<tr>
<td>Q2</td>
<td>1.609</td>
<td>7.909</td>
<td>0.981</td>
<td>0.912</td>
<td>0.385</td>
<td>42.862</td>
</tr>
<tr>
<td>Q3</td>
<td>2.973</td>
<td>8.955</td>
<td>1.018</td>
<td>0.956</td>
<td>0.559</td>
<td>61.798</td>
</tr>
<tr>
<td>Q4</td>
<td>10.166</td>
<td>9.045</td>
<td>0.870</td>
<td>0.830</td>
<td>0.639</td>
<td>59.809</td>
</tr>
</tbody>
</table>

Those with longest duration have the fewest papers! Most economical to recruit with 3 or so B-equivalent papers Are 10 B papers at recruitment too many? Were Q4 persons overpaid?
## Promotions v performance

<table>
<thead>
<tr>
<th>Q1</th>
<th>Ratio Mean annual to recruitment salary</th>
<th>B Papers Mean</th>
<th>Mean (X2)</th>
<th>Mean (γ1)</th>
<th>Mean (γ2)</th>
<th>Mean (θ2)</th>
<th>Mean cost efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>1.000</td>
<td>6.446</td>
<td>4.045</td>
<td>0.894</td>
<td>0.680</td>
<td>0.891</td>
<td>67.749</td>
</tr>
<tr>
<td>Q2</td>
<td>1.056</td>
<td>3.418</td>
<td>6.455</td>
<td>0.960</td>
<td>0.416</td>
<td>1.002</td>
<td>49.862</td>
</tr>
<tr>
<td>Q3</td>
<td>1.160</td>
<td>2.921</td>
<td>10.818</td>
<td>0.921</td>
<td>0.484</td>
<td>1.005</td>
<td>50.445</td>
</tr>
<tr>
<td>Q4</td>
<td>1.435</td>
<td>2.521</td>
<td>20.727</td>
<td>0.778</td>
<td>0.431</td>
<td>1.002</td>
<td>38.994</td>
</tr>
</tbody>
</table>

Mean cost efficiency is highest for those who have not had any promotion yet (i.e. Q1)

Promotion is linked to duration in post (Q4, \( X_2 = 21 \) years) but lowest cost efficiency (39%) means post appointment research not enough.

Recent recruits offer better qualifications on entry – not yet promoted (Q1 and Q2)
Conclusion

We have looked at the potential for savings in the salary component of an academic devoted to research.

The model implicitly assumes the same proportion of the salary of each academic is devoted to research.

Salary on recruitment and mean salary in post are treated as not exogenously fixed, but rather the institution through its policies (especially on promotions) can influence the salary at which staff of a given calibre can be employed and retained.
We find that there is much scope for savings on the component of salary dedicated to research – over 50% of the component on average if we allow the salary at appointment, the mean in post salary and the duration in post to be optimal.

Clearly other scenarios can be explored such as:

- Varying the subjective weight relations between pre and post appointment publications and citations;
- Varying the subjective weights for different journal ranks;
- Keeping salaries as given and maximising research output;
- Any combination of the above.

The Analysis can aid policy formation at Institution level for academic recruitment and promotion decisions.
Notes of Caution

This work is to be seen as ‘work in progress’

There are a number of assumptions which would need to be debated and modified as need be.

They include:
- The use of research output only when it appears in journals;
- The use of a subjective trade off between papers published in journals of different ranks;
- The assumption that the same proportion of an academic’s salary is dedicated to research across all staff;
- The potential trade off between research and other outputs (eg teaching) whereby teaching and other outputs paid for by salary should enter the model.
Thank you!

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POTENTIAL SAVINGS V DURATION IN POST

Potential Savings when only salary can change

Potential savings when salary and duration in post are optimised.