“ASSESSING UNIVERSITY RECTRUITMENT AND PROMOTION DECISIONS FROM THE COST PERSPECTIVE”

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THE RECRUITMENT PROCESS

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In universities recruitment panels make decisions on the candidate to fill each academic post advertised.

The decisions are typically based on qualifications with research profile playing a prominent role.

Academic promotion decisions, which also impact the career cost of an academic, also offer major scope for discretion.

This paper uses a recently developed method for disentangling ‘price’ and ‘technical efficiency’ to assess retrospectively recruitment and promotion decisions at a Greek University from the ‘cost’ perspective.

THE INPUT-OUTPUT SET

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INPUTS	OUTPUTS
Publications and citations up to joining Dept+2 years[1]	Publications from joining Dept+2 years (A+ plus A/1.2)
Number of years in post-2[2]	Publications from joining Dept+2 years (B+C/1.5)
	Citations on papers since joining +2 excluding self citations

1. Publications reduced into a single input using the equivalence A+=1.2A, A=1.5B, B=1.5C, A+=15 citations excluding self. (Australian ERA2010 ranks)

2. The first 2 years in post are treated as slack to set up research agenda in post - the publications in those 2 years are credited to career pre-joining.

RATIONALE

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In the Greek Higher Educational system the cost of an academic is determined by the duration at each level (Lecturer to full Professor) the academic spends. Salary within each level is quite uniform for academics at that level.

The duration at each level ‘should’ depend on the outputs (especially research) of the academic at that level. However, the initial level of recruitment plays a major role on TOTAL cost as promotions from that point on are a combination of time in post and research output by the academic.

In Greece academics have a law-mundated level of teaching hours which is uniform at all hierachical levels. So in theory the same proportion of salary cost of each academic goes to cover teaching costs.

Therefore career salary costs differences between academics should be primarily a function of duration in post and research output.

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THE CONCEPT OF 'PRICE' EFFICIENCY

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We argue that the salary and corresponding hierarchical level offered at recruitment to an academic and subsequent promotions are NOT 'uniquely' determined by the CV. The recruitment panels have flexibility to optimise them from the institution's perspective.

Our assessment aims to establish the extent to which this flexibility has been used effectively (or uniformly) across all academics.

Price efficiency measures the degree to which prices (in our case cost per unit of research output and per year in post) have been optimised.

COST EFFICIENCY IN THE CLASSICAL DEA MODEL

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$$Min\left\{C=\sum_{i=1}^{m}p_{io}x_i \mid \sum_{j=1}^{n}\lambda_j x_{ij}\le x_i, \sum_{j=1}^{n}\lambda_j y_{rj}\ge y_{ro},\ \lambda_j, x_i\ge 0\right\} \quad \textbf{(1)}$$

This model is valid for DMUs that face 'exogenously fixed' input prices p. The DMUs are '**price takers**' and the model determines optimal input mix x.

Model (1) is not valid in our case since the recruitment level of the academic and subsequent promotion decisions carry significant discretionary component on the part of those making the decisions.

EXISTING MODELS FOR ASSESSING 'PRICE EFFICIENCY'

Price efficiency is intended capture the extent to which a unit which is not a price taker has attained optimal input mix and prices to minimise the aggregate cost of its outputs.

Tone and Tsutsui (2007)

$$Min\left\{\rho \mid \sum_{j=1}^{n}\lambda_j C_{ij}^{T} \le \rho C_{io},\ \sum_{j=1}^{n}\lambda_j y_{rj} \ge y_{ro},\ \lambda_j \ge 0\right\} \quad Min\left\{\sum_i C_i \mid \sum_{j=1}^{n}\lambda_j C_{ij}^{T} \le C_i,\ \sum_{j=1}^{n}\lambda_j y_{rj} \ge y_{ro},\ \lambda_j \ge 0\right\}$$

ρ^* $\qquad$ C^{**}

$$\frac{C^{**}}{C_o} = \frac{C_o^T}{C_o} \times \frac{\rho^* C_o^T}{C_o^T} \times \frac{C^{**}}{\rho^* C_o^T}$$

Key to this model is that it works in 'cost component' C^T space where C^T is the product of the input x and its unit price p. Input is taken as optimal under observed prices, in the classical DEA cost model.

The T&T model yields the optimal sum of aggregate cost components C**.

Camanho and Dyson (2008) Model

$$Min\left\{C=\sum_{i=1}^{m}p_{io}x_i \mid \sum_{j=1}^{n}\lambda_j x_{ij}\le x_i, \sum_{j=1}^{n}\lambda_j y_{rj}\ge y_{ro},\ \lambda_j, x_i\ge 0\right\}$$

- Solve the traditional cost model (1) assuming that:
  - All units can be assessed with the minimum prices for each input ;
  - OR alternatively
  - All units can be assessed in relation to all observed combinations of prices.

The ratio of overall minimum aggregate cost and minimum cost from model 1 above under the unit's own observed prices is labelled 'market efficiency'.

In these and one or two other related approaches (eg Ray et al. (2008), and Fare and Grosskopf (2006)) we have no SIMULTANEOUS optimisation of input quantities and prices.

THE PORTELA AND THANASSOULIS PRICE EFFICIENCY MODEL

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"*Economic efficiency when prices are not fixed: Disentangling quantity and price efficiency*" (forthcoming in Omega)

The approach assumes units are not price takers and identifies a component of 'price efficiency' reflecting the extent to which the DMU could have made savings by securing better input prices than those it actually paid.

The model optimises input mix and input prices **simultaneously** using a non-linear model.

PORTELA AND THANASSOULIS (forthcoming) PRICE EFFICIENCY MODEL

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Omega, DOI http://authors.elsevier.com/sd/article/S0305048314000267

$$\min_{\gamma_i,\theta_i,\lambda_j,z_{ij}} \left\{ C = \sum_{i=1}^{m} \gamma_i p_{io}\, \theta_i x_{io} \;\middle|\; \sum_{j=1}^{n} \lambda_j x_{ij} \le \theta_i x_{io},\ i = 1,\ldots,m,\ \sum_{j=1}^{n} \lambda_j y_{rj} \ge y_{ro}, r = 1,\ldots,s, \right.$$

$$\left. \sum_{j=1}^{n} z_{ij}\, p_{ij} \le \gamma_i p_{io}, i = 1,\ldots,m \ \sum_{j=1}^{n} z_{ij} = 1,\ i = 1,\ldots,m,\ \beta_i \le \gamma_i \le \alpha_i,\ z_{ij}, \lambda_j, \theta_i \ge 0 \right\} \sum_{j}^{n} \lambda_j = 1$$

Model 2

The θ_i reflect potential proportional changes in observed levels of inputs;

The γ_i reflect potential proportional changes in observed input prices between user-specified upper bounds α_i and lower bounds β_i.

$\sum_{j}^{n} \lambda_j = 1$ defines the traditional VRS PPS using observed input-output levels;

$\sum_{j}^{n} z_{ij} = 1$ i=1...m defines a convex Price Possibility Set using observed input prices.

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The optimal solution to model 2 yields input quantity targets ($x_i^* = \theta_i^* x_{io}$), price targets ($p_i^* = \gamma_i^* p_{io}$), benchmarks for input-output quantities (all units j whose $\lambda_j^* > 0$), and benchmarks for each price i, (i.e. all units j whose $z_{ij}^* > 0$).

The Camanho and Dyson (2008) 'price efficiency models are special cases of model (2) in which no lower bound is placed on input prices attainable (case 1) or where only combinations rather than individual observed input prices are deemed feasible.

The traditional Farrell cost efficiency is a special case of model (2) where $\gamma_i = 1$ for all i.

The cost efficiency yielded by model (2) is the ratio of the minimum estimated to the observed aggregate cost of inputs,

$$CE = \frac{C^*}{C_o} = \frac{\sum_{i=1}^{m} \theta_i^* \gamma_i^* x_{io} p_{io}}{\sum_{i=1}^{m} x_{io} p_{io}}$$

DECOMPOSING THE POTENTIAL SAVINGS IN COSTS.

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The total potential savings estimated are:

$$\frac{\sum_{i=1}^{m} x_{io}p_{io} - \sum_{i=1}^{m} x_{io}^{*}p_{io}^{*}}{\sum_{i=1}^{m} x_{io}p_{io}} = 1 - \frac{\sum_{i=1}^{m} x_{io}^{*}p_{io}^{*}}{\sum_{i=1}^{m} x_{io}p_{io}} = 1 - CE$$

This can be written as

$$\frac{\sum_{i=1}^{m} x_{io}p_{io} - \sum_{i=1}^{m} x_{i}^{*}p_{io}^{*}}{\sum_{i=1}^{m} x_{io}p_{io}} = \frac{\sum_{i=1}^{m} (x_{io} - x_{io}^{*})(\frac{p_{io}+p_{io}^{*}}{2})}{\sum_{i=1}^{m} x_{io}p_{io}} + \frac{\sum_{i=1}^{m} (p_{io} - p_{io}^{*})(\frac{x_{io}+x_{i}^{*}}{2})}{\sum_{i=1}^{m} x_{io}p_{io}}$$

The proportion of savings accounted for by potential changes in mix and volumes of inputs is:

$$\frac{\sum_{i=1}^{m}\left(x_{io}-x_{io}^{*}\right)\left(\frac{p_{io}+p_{io}^{*}}{2}\right)}{\sum_{i=1}^{m}x_{io}p_{io}}$$

The proportion of savings accounted for by potential changes in mix and levels of input prices is:

$$\frac{\sum_{i=1}^{m}\left(p_{io}-p_{io}^{*}\right)\left(\frac{x_{io}+x_{i}^{*}}{2}\right)}{\sum_{i=1}^{m}x_{io}p_{io}}$$

This component reflects the price efficiency of a unit.

Summary statistics-inputs and outputs

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– INPUTS

	Inputs		Outputs			Input prices	
	A+ Equiv At Start	Years in post	A+ in post	B in post	Cit'ons in post (10's)	Start salary per start A+	Mean annual salary in post
Min	0	1	0	0	0	21.408	21408
Max	147.581	30	16.66	40	97	111229.	41196
Med	4.27474	11	0.83333	3	0.8	2393.44	27177.23
mean	10.2073	11.7128	2.33993	4.19802	4.23663	8228.88	28845.12
st dev	18.3757	7.29018	3.34787	5.08815	11.7896	15243	6455.511

Summary results

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Mean potential rise in initial A+ publications up by -θ1	**1.303783**
Mean potential reduction in years in post down to - θ2	0.422161
Mean potential reduction in cost per initial A+ publication down to - γ1	0.826461
Mean potential reduction in annual salary offered at recruitment, down to - γ2	0.847353
Proportion of total salary costs savable by rise of initial publications and drop in years in post-	0.472455
Proportion of total salary costs savable through lower mean annual salaries	0.118572
Grand total proportion of salary costs that can be saved	0.591027

A closer look at the Profs of a Department

		A+ In	yrs	E/A+	E/yr	A+ pst	B pst	Cit p
Prof 1								
	Act	0.689	28	35.58	37.40	1.66767	7	1.5
	Targ	0.527	7.500	28.470	29.923	0	2	0
Prof 2								
	Act	0	24	0.021	30.43	0	0	0.000001
	Targ	19.135	1.353	0.021	24.350	5.833	4	2.6
Prof 3								
	Act	1.615	10	18.55	38.94			
	Targ	2.078	2.000	14.845	31.160			
Prof 4								
	Act	0	26	0.021	29.131			
	Targ	36.938	3.960	0.021	23.305			

Prof 2's research output is worth only 24.3k euro pa and only over 1.3 years. He should have offered more publications on recruitment.

All except Prof 1 should have had more publications on recruitment and all should have achieved in post publications in less time and at lower mean annual salary.

A closer look at the Associate Profs of a Department

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		A+ In	yrs	E/A+	E/yr
Associate 1					
	Act	7.933	14	2.698	27.018
	Targ	7.025	8.947	2.159	21.614
Associate 2					
	Act	0.9	21	23.787	27.593
	Targ	1.697	8.067	19.029	22.074
Associate 3					
	Act	1.3889	15	21.574	29.964
	Targ	1.017	5.000	17.259	23.971
Associate 4					
	Act	7.044	8	4.254	29.964
	Targ	5.529	4.410	3.403	23.971

A+ pst	B pst	Cit p
5.833	11.667	8.7
4.5	8.667	0.1
0.833	5.667	0.8
5	4	2.3

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Conclusion

Academic recruitment and promotion are some of the most important decisions a university makes

While they are largely judgmental decisions at the academic level there is scope for assessing their efficacy from the financial perspective

A formulation in which recruitment salary and salary in post are treated as not exogenously fixed was used.

The Portela and Thanassoulis approach to determining and decomposing price efficiency was used, allowing for the simultaneous optimisation of input levels and input prices when the latter are not fully exogenously fixed.

There is substantial variation in **price efficiency** between the academics assessed which suggests judgement beyond the strict research output reflected in the assessment has played a role in recruitment and promotions

The results are an initial illustration of an approach. E.g:
- the input-output set used has substantial subjective judgment
- the global optimality of the non linear solutions cannot be verified.