“Assessing University Research Output from Different Perspectives”

This research 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.

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Presented at the International Federation of Operational Research Societies Conference, Barcelona July 13-18, 2014

MOTIVATION-1

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

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

The pay of the academic staff member, however, is affected primarily by his/her performance on research (e.g. through internal promotion or recruitment at high salary due to research profile.)

MOTIVATION-2

In Greece, where this case study takes place, academics have a law-mandated 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.

Outreach activities are either paid for outside the university system (eg consultancy or government service) or they are research related and so impact salary via research output.

Thus it is generally accepted that research output is the primary determinant of the salary of an academic.

MOTIVATION-3

We therefore ask the question:

Given the research output of an academic could the University have saved on salary costs of that academic?

The findings can be useful at a number of ways:

- identifying appointments which in retrospect have been financially economical, which can affect recruitment policies;

- identifying how promotions have been matched by research output which can impact promotions policy.

APPROACH TO ESTIMATING POTENTIAL ON SAVINGS ON RESEARCH

Potential savings for given research outcomes can result from a combination of:

a) reducing the time taken to deliver the research;

b) paying less per unit time (salary) of the academic;

c) Paying less per unit of research outcome;

The approach can be formulated in the form of a DEA model as follows:

THE DEA INPUT-OUTPUT SET

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INPUTS	OUTPUTS
Publications up to joining Dept+2 years[1]	Publications from joining Dept+2 years (A+ plus A/1.2)
Number of years in post-2 years[2]	Publications from joining Dept+2 years (B+C/1.5)

1. Publications reduced into a single input using the equivalence A+=1.2A, A=1.5B, B=1.5C (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.

The input set depicts research profile at recruitment and time in post as the two 'resources' used by the academic to deliver their research in post, captured in the output set.

USING A 'PRICE EFFICIENCY' DEA MODEL TO ESTIMATE POTENTIAL SAVINGS

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We use the model developed in Portela and Thanassoulis (2014) Omega, The International Journal of Management Science Vol 47 pp 36–44 DOI http://authors.elsevier.com/sd/article/S0305048314000267

The model allows for determining minimum aggregate cost of securing a given output bundle (in-career research in our case) through the SIMULTANEOUS optimisation of inputs levels and input prices

INPUT	PRICE
Publications up to joining Dept+2 years	Starting salary/publications at recruitment (P1- euro'000)
Number of years in post-2	Mean annual salary (P2-euro'000)

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PORTELA AND THANASSOULIS PRICE EFFICIENCY MODEL

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$$\min_{\gamma_i,\theta_i,\lambda_j,z_{ij}} \{C = \sum_{i=1}^{m} \gamma_i p_{io}\ \theta_i x_{io} \mid \sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta_i x_{io},\ i = 1,...,m,\ \sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{ro}, r = 1,...,s,$$

$$\sum_{j=1}^{n} z_{ij}\ p_{ij} \leq \gamma_i p_{io}, i = 1,...,m\ \sum_{j=1}^{n} z_{ij} = 1,\ i = 1,...,m,\ \beta_i \leq \gamma_i \leq \alpha_i,\ z_{ij}, \lambda_j, \theta_i \geq 0\} \sum_{j}^{n} \lambda_j = 1$$

Model 1

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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ADAPTING THE PORTELA AND THANASSOULIS PRICE EFFICIENCY MODEL

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The optimal solution to model 1 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 $z_{ij}^* > 0$).

We used in model 1 the following bounds:

γ: upper bounds 1.2 and lower bounds 0.8, for both γ. This conveys the view that starting and mean annual salaries could not have been more than 20% away from what transpired in reality.

θ: upper bounds 1 for both inputs. This conveys the view that we wish to explore whether fewer publications on entry and/or duration of career could have delivered the research output of an individual and thereby deliver cost savings.

POTENTIAL SAVINGS AND THEIR DECOMPOSITION

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The cost efficiency yielded by model (1) is the ratio of the minimum estimated to the observed aggregate cost of inputs,

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

The total potential savings can be decomposed

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

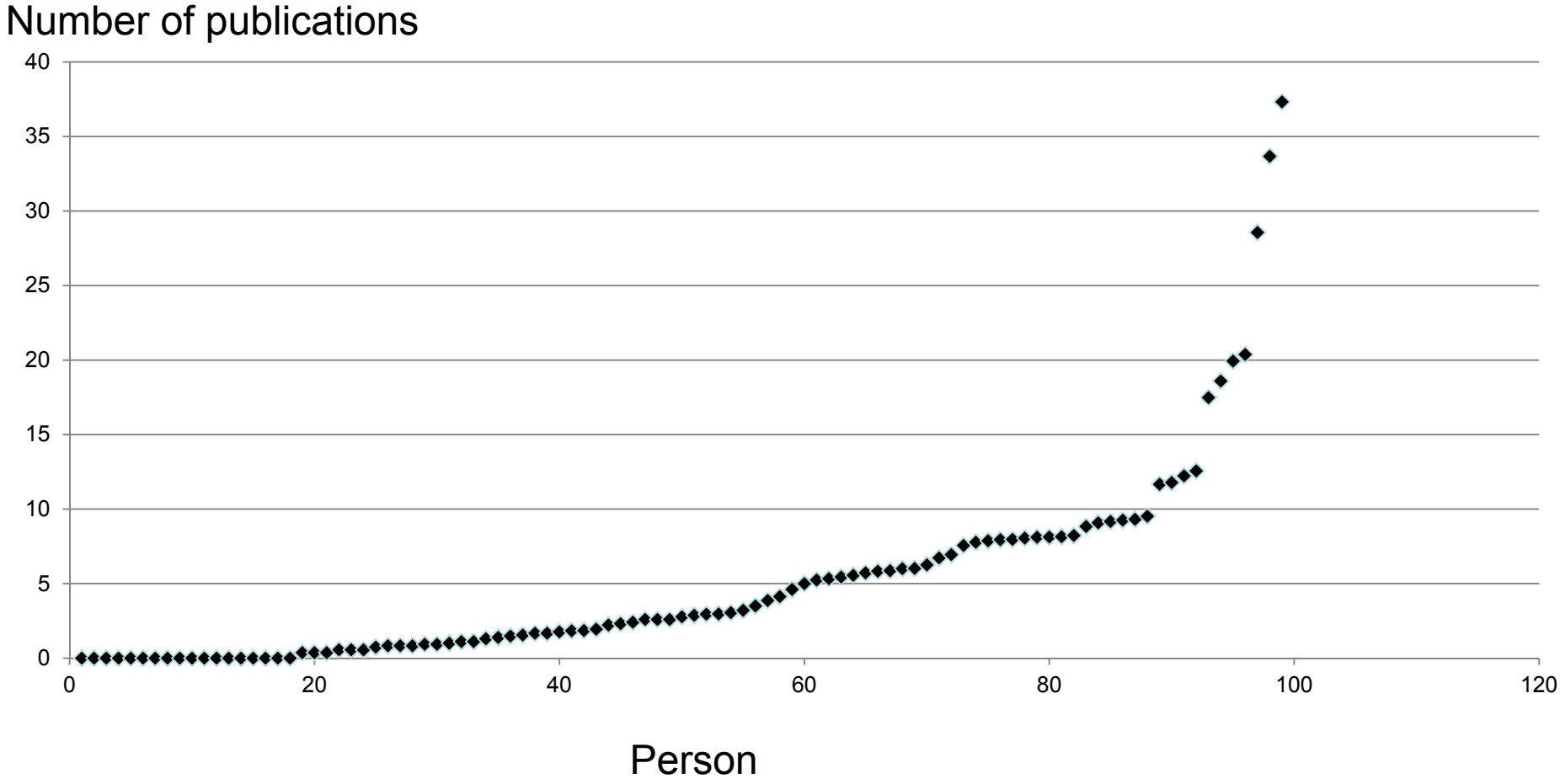
The proportion of actual expenditure which can be saved through changes in volumes of inputs is:

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

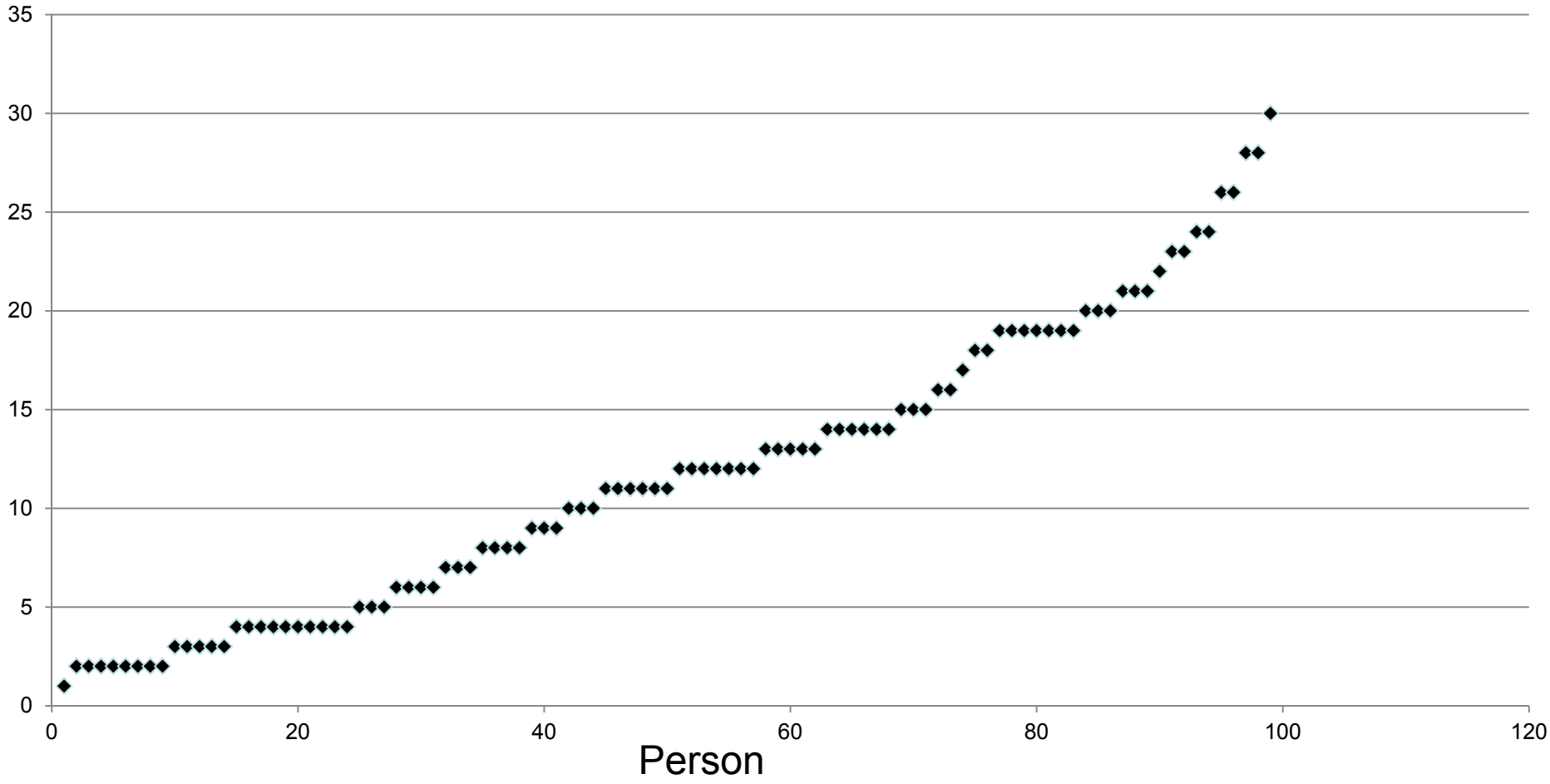
The proportion of actual expenditure which can be saved through changes in input prices is:

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

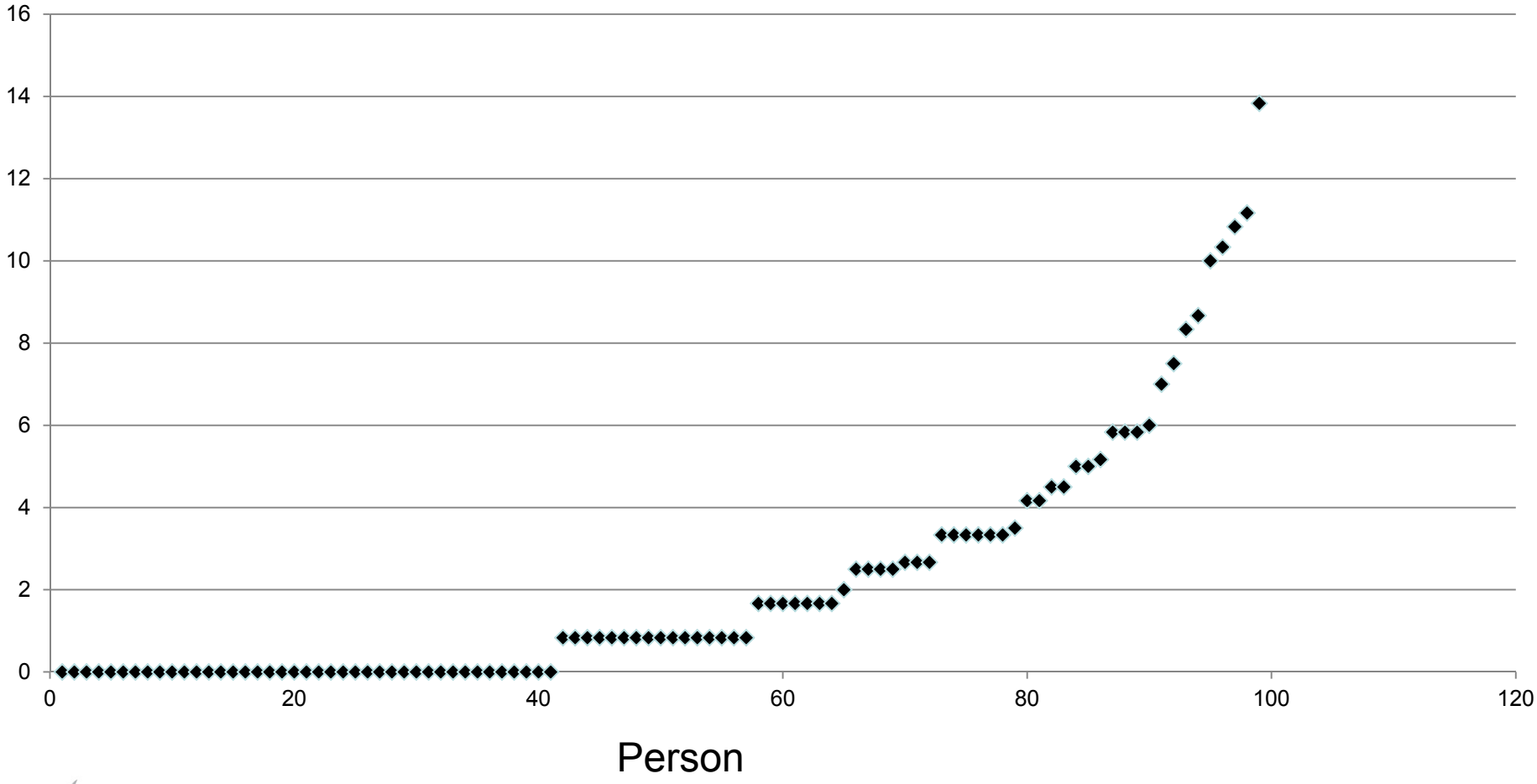
INPUT 1: PUBLICATIONS A+ EQUIV AT RECRUITMENT



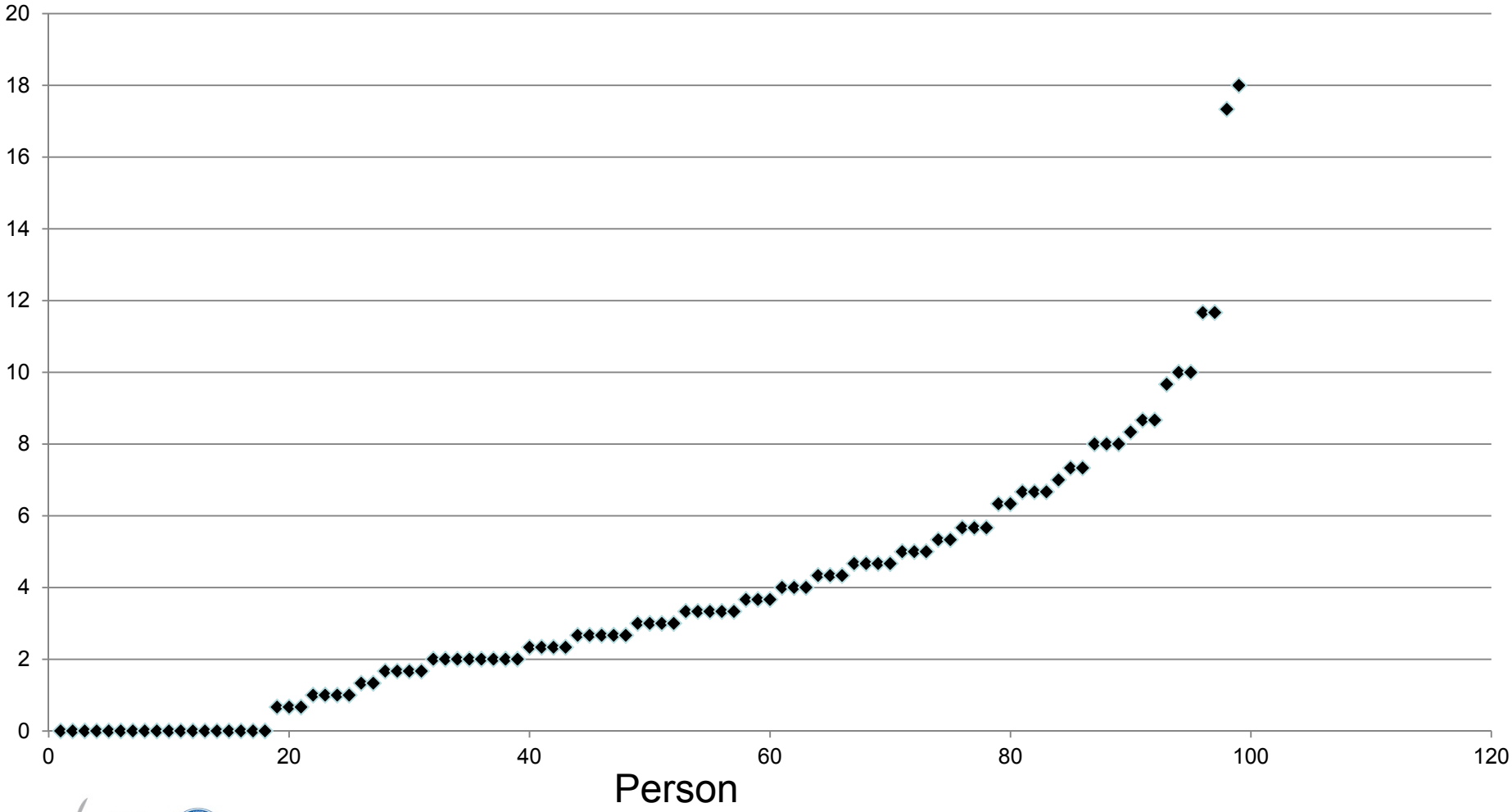
INPUT 2: YEARS IN POST (-2)



OUTPUT 1: PUBLICATIONS A+ EQUIV IN POST



OUTPUT 2: PUBLICATIONS B EQUIV IN POST



INPUT PRICE P1: MEAN STARTING SALARY PER A+ PUBLICATION (euro'000)

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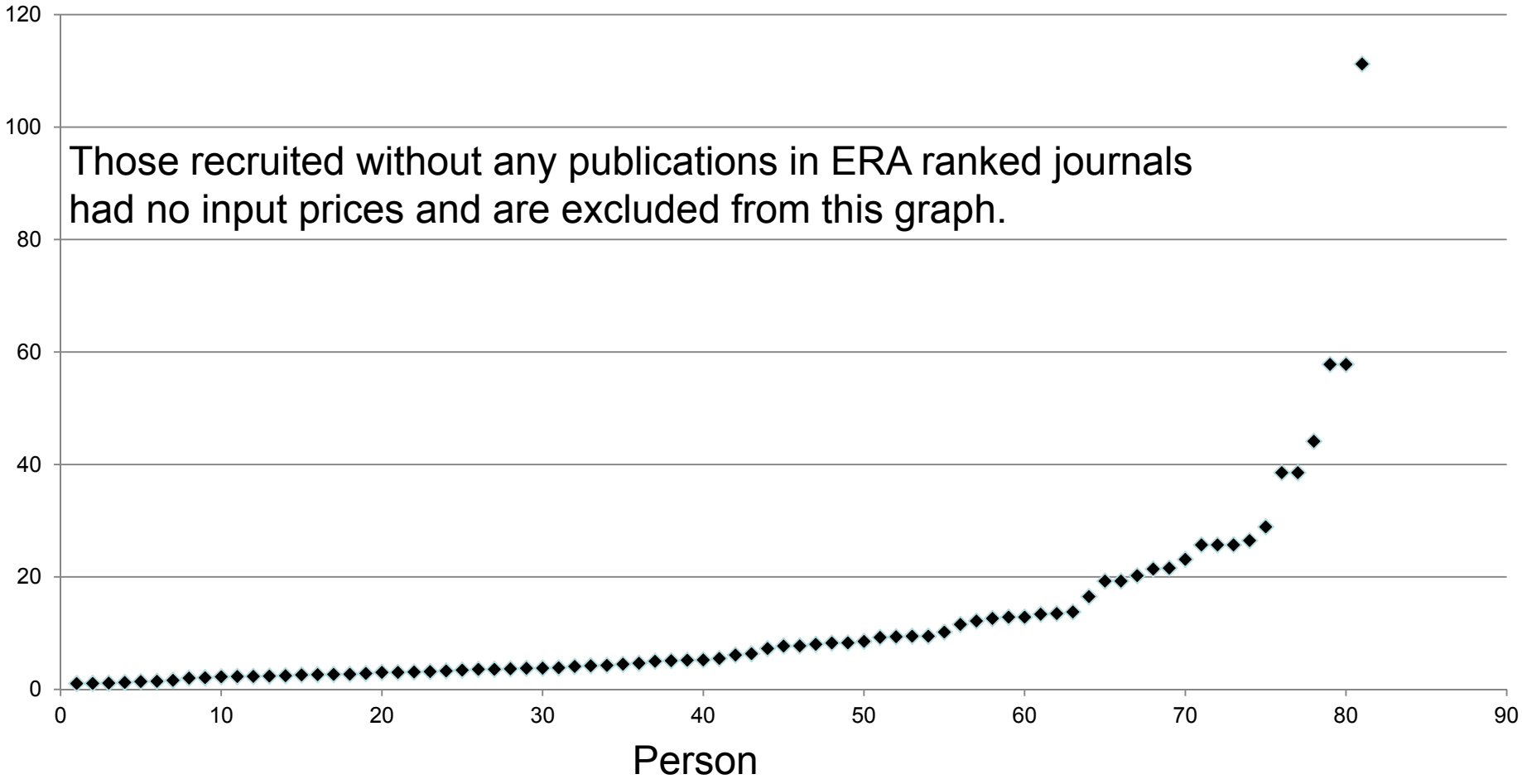

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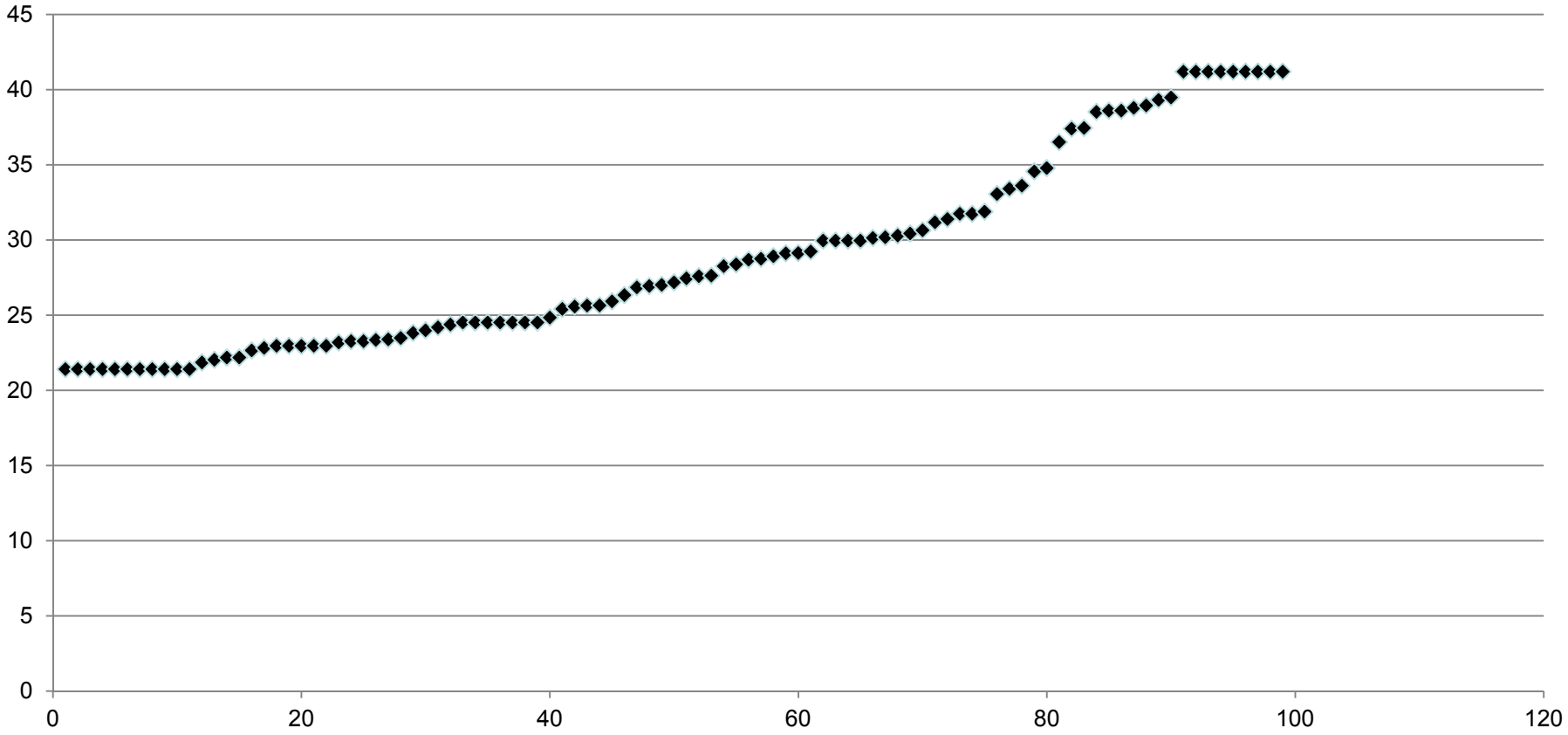
INPUT PRICE P2: MEAN ANNUAL SALARY (euro'000)



COST EFFICIENCIES – SIX DEPARTMENTS (100 STAFF)

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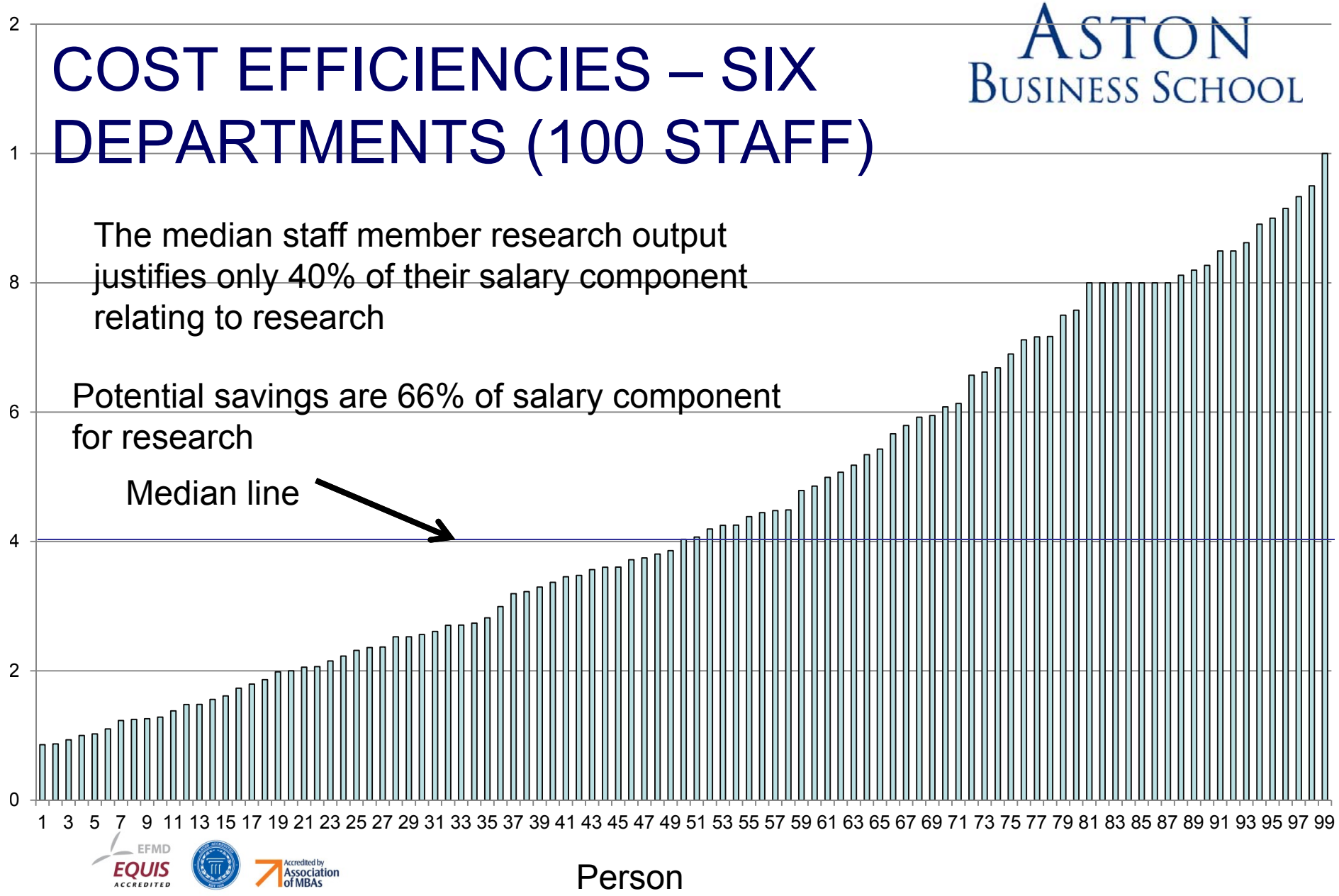

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Summary results – Institution level

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Mean drop in A+ publications at appointment[1]: Down to:	**0.85 (median 1)**
Mean potential reduction in years taken to deliver the in post research: Down to:	**0.51 (median 1)**
Mean potential reduction in cost per initial A+[1] publication down to:	**0.81 (median 0.8)**
Mean potential reduction in annual salary down to:	**0.86 (median 0.8)**
Proportion of total salary costs savable by accepting lower publications on appointment and/or delivering research in fewer years	**53.53%**
Proportion of total salary costs savable through lower mean annual salaries	**12.47%**
Grand total proportion of salary costs that can be saved	**66%**
Proportion of salary costs that can be saved ignoring the first 2 years in post	**68%**

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1: Excludes those offering no A+ equivalent publications

Example 1- Academic with scope to achieve savings through input level reductions

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Person 1 Potential Savings mainly via input levels 66%-time and initial A+ 2% -Salary	Inputs		Outputs		Input prices	
	A+ at Appnt	Years in Post	A+ in post	B in post	Euro'000 per publication at recruitment	Mean annual salary
Actual	20.37	4	0	1.67	1.05	22.185
Target	7.10	1.29			1.05	21.408

Efficient peer to person 1 on years in post and publications at recruitment	A+ at Appnt	Years in Post	A+ in post	B in post	Euro'000 per publication at recruitment	Mean annual salary
Peer 1 (λ=0.3)	6.02	2	0	5.667	3.557022	22.962
Peer 2 (λ=0.7)	7.55	1	0	0	2.833412	21.408

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Example 2- Academic with scope to achieve savings through input price reductions

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Person 2 Potential Savings only via input prices 0%-time and initial A+ 18% -Salary	Inputs		Outputs		Input prices	
	A+ at Appnt	Years in Post	A+ in post	B in post	Euro'000 per publication at recruitment	Mean annual salary
Actual	33.67	2	2.67	3	1.22	41.19
Target	33.67	2			1.05	32.95

Efficient peers to person 2 on input prices	A+ at Appnt	Years in Post	A+ in post	B in post	Euro'000 per publication at recruitment	Mean annual salary
Actual - Peer price A+ on recruitment	20.37	4	0	1.67	1.05	22.185
Actual - Peer 1 Mean salary (z=0.34)	1.67	4	0	2	12.85	21.408
Actual - Peer 2 Mean salary (z=0.66)	11.67	14	0	0.67	2.57	38.89

Contrasting Senior with Junior Academics

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	Professors and Associate Professors	Assistant Professors and Lecturers
Staff Numbers (Normalised Junior=100)	186	100
Expenditure on salaries (Normalised Junior=100)	621	100
Mean drop in A+ publications at appointment (excluding those with 0 A+ at appoint) (θ1)	0.86 (st dev 0.2)	0.835 (st dev 0.2)
Mean potential reduction in years taken to deliver the in post research: (θ2)	0.44 (st dev 0.3)	0.62 (St Dev 0.26)
Proportion of salary costs that can be saved: (Ignoring the first 2 years in post)	69.5%	57%

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.

The Portela and Thanassoulis (Omega 2014) approach to determining and decomposing potential cost savings was used, allowing for the simultaneous optimisation of input levels and input prices when the latter are not fully exogenously fixed.

We find that there is much scope in savings on the component of salary dedicated to research – over 60% of the component on average.

In the case of senior staff about 68% of salary costs can be saved compared to 54% in the case of non senior staff.

The approach identifies for each individual how much could have been saved for the research output they have delivered by way of:

- Recruiting one with lower compatible qualifications; and/or
- Paying them a lower starting salary; and/or
- Delivering the research in fewer years; and/or
- Being paid a lower annual salary.

The foregoing have implications for those making 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 if need be.

They include:

- The use of research output only when it appears in ranked 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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